

Managing Fuel

Fuel management can be a complicated task, and anyone approaching the problem maintaining a fuel supply needs to understand the benefits and limitations. Wherever possible, humanitarian organizations should seek to outsource fueling services, using direct delivery or refueling stations where possible. Unfortunately the humanitarian landscape requires direct active management of fuel supplies in many instances.

As a general rule, fuel should be treated as a specialized sub-category of storage and transportation, and requires special attention. Humanitarian agencies working in disaster settings should consider making special precautions and procedures for fuel management, especially if fuel management becomes a large part of the portfolio of activities.

Common Terms in Fuel Management

| | |
|-------------------------|---|
| Dispenser | A nozzle, hose or other device that is used to deposit or deliver fuel from a storage container to a vehicle or another storage container. |
| Flowmeter | A meter that is used to record the flow of fuel, usually liquids measured in litres. Flowmeters are usually used for recording usage over time. |
| Drum | A common unit for transporting liquid fuel. The most common unit of drum is a 200 litre drum. |
| Discharge | The act of draining or removing liquid or gas from a tank/drum/canister or other form of container. |
| Hot Work | Any activity or process that generates a source of ignition, this could be through a flame, heat or a spark. Activities such as welding are considered "hot work." |
| Flashpoint | The temperature at which flammable fuels become combustible when exposed to an external ignition source. Different substances have different flashpoints. |
| Fuel Reservoirs | Any container of any kind that used to hold fuel. This may include canisters, drums, tanks, bladders and other form factors. |
| Phase Separation | The gradual separation of a mixture of compounds into two distinct compounds. In the case of liquid fuel, phase separation entails fuel separating into different layers, including impurities and water. |
| Stale Fuel | Fuel that is old and has become impacted by chemical changes. Stale fuel is inefficient and can impact the performance or even damage engines. |

Terminology

It is common to use the term “fuel” to refer to different products. Furthermore, equal terms in different languages refer to different product types. The following translation sheet, illustrates the basics on fuel terminology:

| French | English (US) | English (UK) | Spanish | Use | Handling Specifics |
|---|--|--|--|--|--|
| COMBUSTIBLE (Carburant) | FUEL (Motor fuel) | FUEL (Motor fuel) | COMBUSTIBLE (Carburante) | | |
| METHANE | METHANE | METHANE | METANO | Town gas | Gas |
| ETHANE | ETHANE | ETHANE | ETANO | | Gas |
| PROPANE | PROPANE | PROPANE | PROPANO | Bottled gas for fridge, heating, etc. | Gas |
| BUTANE | BUTANE | BUTANE | BUTANO | Bottled gas for fridge, heating, etc. | Gas |
| G.P.L. | L.P.G. | L.P.G. | G.P.L. | Liquefied Petroleum Gas | Gas used for car fuel, (adapted engine) |
| AVGAS, LL100 Essence Avion | AVGAS, LL100 | AVGAS, LL100 | AVGAS, LL100 | Aviation Gasoline: for piston engines | Very volatile, fluid, blue colour, same smell as petrol. Very flammable, explosive. Can be used in a petrol engine with 3% oil added |
| ESSENCE - super - normale - sans plomb | GASOLINE - premium - regular - unleaded | PETROL - super - regular - unleaded | GASOLINA - super - normal - sin plomo | | Volatile, fluid, colourless (or almost). Very flammable, explosive. Cannot be replaced by diesel, but can replace Avgas in some aircraft. Various octane indices between regular and super |
| KEROSENE, JETA1 | KEROSENE, JETA1 | KEROSENE, JETA1 | KEROSENO, JETA1 | Turbine engine aircraft | Same as for Paraffin but with aeronautical specifications: Filtering, packing and storing. |
| PETROLE (Lampant), PARAFFINE (Canada) | KEROSENE (Lamp oil) | KEROSENE (Lamp oil), PARAFFIN (Oil) | KEROSENO, PETROLEO | Lamps, fridges, burner, etc. | Colourless, specific smell. Fuel for so-called “lamp oil” equipment |
| GASOIL, GAZOLE | GASOIL, DIESEL | GASOIL, DIESEL | GASOLEO, DIESEL | Cars | Greasy, yellowish, frequently coloured, heavy smell. When pure, solidifies at -5°C and requires an additive (or 20% lamp oil). This also acts as the injection pump lubricant. |
| FUEL, FIOUL, MAZOUT | FUEL OIL | FUEL OIL, PARAFFIN | FUEL | Heating | Same as diesel without additives for low temperatures and lubrication |
| HUILE | OIL | OIL | ACEITE | Lubrication | Greasy, different viscosities for different uses |

| French | English (US) | English (UK) | Spanish | Use | Handling Specifics |
|------------------|---------------------------------|-----------------------|----------|---------------|---|
| PARAFFINE | PARAFFIN, WAX | PARAFFIN, WAX | PARAFINA | Candles | |
| PETROLE LOURD | HEAVY FUEL | HEAVY FUEL | | Slow engines | Heavy combustible for marine engines and power plants |
| ASPHALTE, BITUME | ASPHALT | ASPHALT | ASFALTO | Road surfaces | |
| PETROLE (BRUT) | CRUDE PETROLEUM, KEROSENE | ROCK OIL, PARAFFIN | CRUDO | Natural state | |

Adapted from MSF

Fuel Storage

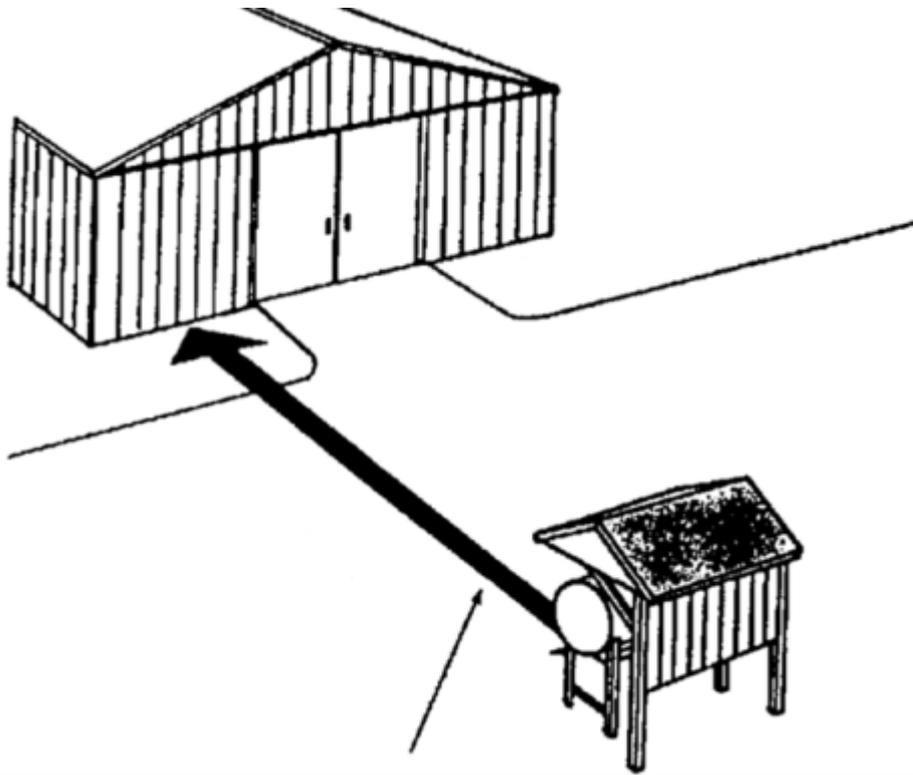
Storage of fuel can be extremely hazardous. Liquid or compressed gas fuels by their nature are highly combustible and should be treated separately than other storage items.

Choice of Storage Location

Any location used to store fuel should follow a few basic rules.

Fuel storage should always be separate from other stored items! Fuel should have its own storage location, outside of a main facility. A fuel storage location should be:

- At least 10 meters from the nearest warehouse or storage location (ideally more).
- As far away from offices and residences as possible. If possible, store fuel in a different location than where people live and work entirely.



Minimum 10 metres

Access to the fuel storage locations should be controlled, and only authorized persons should have the ability to enter. All staff working around fuel storage should be informed of risks and safety procedures.

Fuel storage areas should be well ventilated to avoid the build-up of fumes, and should ideally be shaded to avoid excessive temperatures. Never store fuel in fully enclosed spaces such as shipping containers with the doors closed. Pressure, heat and increase in fumes can lead to combustion.

NEVER store fuel next to any form of chemicals that may cause a violent energetic reaction.

General Storage Considerations

The overall size and consumption needs will determine the configuration of fuel storage arrangement. A few general rules to consider:

- Avoid storing fuel in drums as much as possible, and as much as the operation permits. Emphasize storage in tanks or bladders.
- Gasoline/Petrol should only be stored in small quantities, and in above ground, well ventilated places. Petrol is volatile and degrades quickly in ambient temperatures, and should be ordered in low volume, frequent quantities.
- Diesel fuel can generally last for up to six months before it shows signs of deterioration. Planners should aim to only store fuel for up to six months' worth of

anticipated demand.

- Diesel can be stored above and below ground, but storage areas should always still be well ventilated.

Irrespective of the storage modality, planners should also consider key elements when developing fuel storage:

- Fuel storage should be on solid, firm ground, ideally purpose built for storage. Fuel in large quantities can be extremely heavy.
- Consider environmental impact. Depending on the arrangement, sawdust or sand may be scattered on the ground to absorb any spills.
- All storage locations should be well ventilated, and have adequate drainage.
- All fuels are corrosive and should not be used with plastic accessories, such as plastic buckets or plastic pipes. Also avoid contact with Teflon and tire inner-tubes.
- Managers should develop a spill response plan, and fire response plan. Plans should be continually communicated to employees or persons handling fuel.

Some general guidelines for site Identification include:

- Sites should be situated away from other potential hazards that might increase the likelihood of accidental fire.
- Fuel storage areas should have easy access for tanker trucks, if required. If vehicle refuelling is happening on site, pumps with counters should be readily available.
- There should be proper structures to accommodate shade and ventilation requirements of fuel.
- Site should have emergency exits in warehouses and perimeter walls.
- Area should not be prone to lightning strikes or seasonal fires.

Example Storage Structures:

Built-up Fuel Storage Room

- Next to generator storage area.
- Enclosed, but well ventilated.
- Separated from other storage locations.
- Fire extinguisher on site.
- Lockable door/access controlled.
- Mostly used for storage of drums/other moveable containers.



Covered Fuel Dispensing Shed

- Easy access for vehicles.
- Covered to prevent direct sunlight.
- Fire extinguisher on hand.



Recessed / Below Ground Tank Storage

- Large volume tanks, interconnected.
- Requires powered pumping system.
- Segregated sections for different types of fuel.
- Professional installation.
- Remote monitoring equipment in place.



Some organizations may wish to make one large central fuel repository to serve as a distribution center for other bases or other agencies operating in the area. Fuel depots or "fuel farms" can be a good idea if operations are running at sufficient scale, and managers understand the demand over the coming months, however they require specialized planning and management.

If agencies are planning specific fuel depots, things to consider:

- The fuel depot should be strategically located near consumption, but still in a safe location.
- Depots may require their own stand-alone locations, and require their own management and security on site.
- Depots should be in safe locations, free from flooding or persistent violent crime, and not near potential targets.
- Depots should have sufficient and easy access for vehicles and refueling tanker trucks.
- Fuel storage sites should have specialized access control for visitors.
- Some countries may have heightened regulations for fuel storage locations over a certain size, including safety and security.

- Fuel depots should have an advanced fire prevention and fire suppression system in place, installed by a professional company.

Monitoring Systems

There are a variety of monitoring systems available, including visual and remote monitoring systems.

Remote/Electronic Monitoring – Electronic monitors can be used to monitor both temperature and volumes of fuel storage tanks. Electronic monitors require specialized sensors to be manually inserted into fuel tanks that continually monitor the condition of the fuel. Electronic sensors are useful in that:

- They can be used to generate reports, such as stock outs.
- They can be set to trigger alarms in case of high heat or low volumes.
- The readout device does not need to be next to the fuel itself, and can be in an office or even communicate to mobile phones/computers.

Electronic monitors must be correctly installed and calibrated. When obtaining an electronic monitor, please follow manufacturer guidelines and consult with the seller.

Example remote fuel monitoring devices:



Visual Monitoring – Many tank or storage containers come with gauges or “sight tubes” that allow managers to quickly look at fuel levels without having to open the containers. Visual sight tubes are by far the easiest and safest way to visually inspect fuel levels; other monitoring devices such as sensors or gauges can degrade over time or simply be calibrated wrong, but visually seeing fuel levels is significantly harder to misinterpret.

Example Sight Tube:



In case site tubes and regular gauges are not available, managers can use what is called a “no-spark” dipstick - any clean wooden stick or ruler can be used to identify height within drums or tanks. Dip sticks work by inserting the stick into the fuel container at a 90 degree angle, and visually inspecting where the stick makes contact with the fuel.

Due to the nature of storage solutions, irregular shaped containers may make getting accurate readings difficult. It is advisable to make visual markings next to sight tubes or physically on dip sticks when adding fuel for the first time. As an example - place 20 litres (or whichever unit of measure makes sense) in the container, and then mark the relative height. Repeat with the same pre-defined interval until the container is full. This will enable faster and more accurate tracking of fuel levels.

Temperature Changes and Fuel

Ambient and outside air temperatures can greatly impact fuel stored over any period of time.

Flashpoints - A flashpoint is the temperature at which fuel is combustible. Different types of fuel are only flammable at different ambient temperatures, meaning each one of them has an independent minimum flash point. It should be noted that even though external temperatures may not reach flashpoints for certain fuels, enclosed containers, enclosed storage spaces, or containers in direct sunlight can still reach unsafe limits.

Fuel Type Minimum Flash Point

Ethanol (70%) 16.6°C (61.9°F)

Gasoline (Petrol) -43°C (-45°F)

Diesel 52°C (126°F)

Jet Fuel (A/A-1) 38°C (100°F)

Kerosene* 38-72°C (100-162°F)

*Mixture dependent

Liquid fuel also expands and contracts in changing temperatures at a higher rate than water. For example, diesel fuel stored at 25 degrees centigrade is approximately 2.5% more voluminous than diesel fuel stored at 0 degrees centigrade. Though that may seem like a small overall percent, it can certainly impact physical structures and can impact storage and consumption planning. Fuel delivered on a cold day but stored in an underground temperature regulated environment will expand, meaning users will have slightly more fuel than anticipated. The inverse is also true, however, and fuel stored in warm conditions may functionally be less than planned at the point of consumption. It should be noted that engines that consume liquid fuel still generally consume the same volume of fuel for the same activities, meaning more fuel will generally be consumed in colder climates.

When planning large reservoirs of liquid fuel to be used over a long period of time, planners should anticipate changes to volumes based on the location of storage and seasonal temperature changes.

Change in density in diesel fuel per temperature:

| Temp C | -10 | -5 | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Litre per KG | 1.175 | 1.180 | 1.185 | 1.189 | 1.194 | 1.199 | 1.204 | 1.209 | 1.213 | 1.218 | 1.223 | 1.228 | 1.234 | 1.239 | 1.244 |
| KG per Litre | 0.851 | 0.848 | 0.844 | 0.841 | 0.837 | 0.834 | 0.831 | 0.827 | 0.824 | 0.821 | 0.817 | 0.814 | 0.811 | 0.807 | 0.804 |

Fuel Storage Containers

Drums

The global standard for storing and transporting fuel in drums is the 200 litre metal drum. There are however multiple variations, including metal drums and containers of various sizes, and drums made from plastic. Drums are useful because they are mobile, and can be moved and stored as single units, however basic caution must be taken.



Drums should be stored on pallets, separated from the ground. Though ground storage is possible, pooling water from rain/flooding, or other spilled chemicals can impact containers and contents. Pallets used for drum storage should be sturdy and not structurally compromised. Drums stored on pallets should be centred on pallets and not hanging off edges.

Drums used for storage should be in safe, usable condition. A drum in good condition:

- Should not leak.
- Should not display excessive signs of rust.
- Should be able to be safely and tightly sealed/resealed.
- Should not be so bent/damaged that it cannot be safely moved or stored.
- Should not have debris or dirt inside.

Fuel contained in a leaking drum should be transferred without delay to a drum in good condition. Be aware that there is no effective way to seal a leaking drum that is full. Drums can be sealed by welding, which should never occur around any amount of fuel. Leaks are often caused by improper handling of drums.

Full/partially full drums should not be double stacked unless there is a proper and safe racking system in place. Avoid placing full drums on top of other full drums. NEVER stack above two drums high. Full/partially full drums should be stored sitting upright. Drums should only be stored on their sides if:

- There is a safe and purpose built structure that can support the weight of the drum and contents.
- The drums are completely resealable and will not leak.
- The drums are empty.

Storing fuel in drums can be considered “modular” because the numbers and types of drums can change based on need while a fuel tank is static. There are however challenges when managing fuel in drums.

Drums containing different types of fuel should be completely segregated, ideally with a physical structure or sign differentiating the different types. Drums should be clearly marked as containing fuel, or not mislabelled as mislabelled as containing something else. Labels should clearly indicate the type of fuel contained inside, and the date of purchase. Intermixing of fuel types can cause problems – the wrong fuel placed in the wrong engine can permanently disable vehicles and generators.

The general rule is that fuel should be dispensed under the First In/First Out (FIFO) rule – the oldest fuel should be consumed first, and stock cards and warehouse ledgers should clearly reflect purchase dates. Long term storage of fuel should be in metal drums or containers.

For handling and moving drums comes with its own safety needs. Wherever possible persons moving drums should wear gloves.

Ideally, drums should be moved using safely operated handling equipment:

- Right sized hand truck or dolly to move individual drums.
- Drums can be moved on a pallet using a forklift, however drums must be braced and secured on the pallet.

Drums can be rolled to vehicles/storage locations, however:

- The ground must be smooth, and free from hazards that can puncture a drum or generate sparks.

- Drums must be tightly sealed.
- Ramps or planks can be used to move up and down between two heights, but inclines should not be more than 30 degrees.

Care must be taken when opening and working around open drums. Fuel drums that are hot to the touch should be opened very slowly to avoid rapid release of pressurized content. When opening drums, the tops of drums should be cleaned off to avoid debris falling into the fuel. When checking fuel levels, use a “no-spark” dipstick – any clean wooden stick or ruler can be used to identify height within drums.

Tanks/Reservoirs

Fuel tanks are widely considered the best practice for large scale or long term (up to six months) storage of fuel.



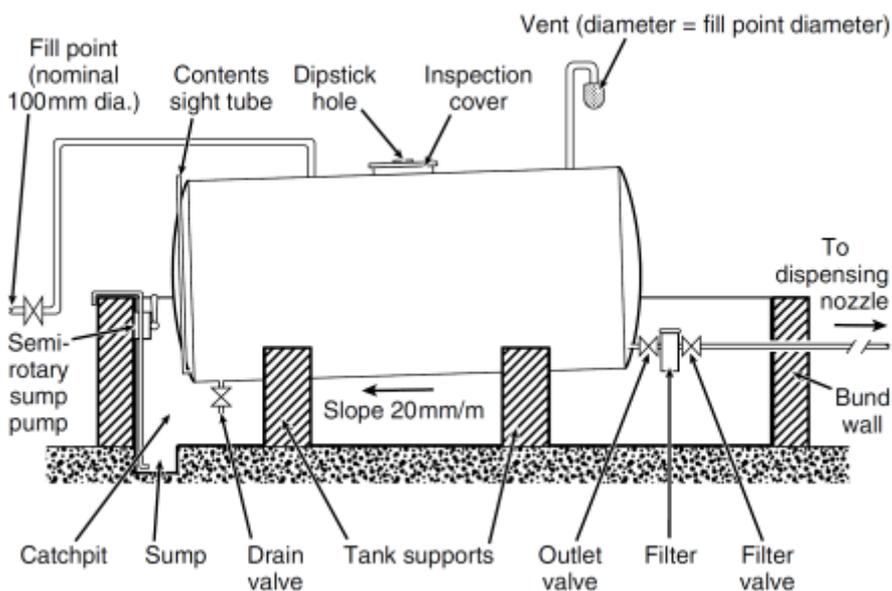
Tank/reservoir storage has many advantages:

- Capable of storing and moving high volumes of fuel relatively efficiently.
- Allows for adequate and necessary electronic and remote monitoring equipment.
- Minimizes accidental spills.

There are multiple configurations for tank storage, the advantage of which is scale ability. General rules for managing fuel tanks:

- The total volume stored in tanks should not exceed anticipated six months' worth of consumption.
- Tanks should be in well ventilated, and well shaded.
- Tanks should ideally have built up walled structures around them. Walled structures will need to have the appropriate holes to run fuel lines in and out of the secured space.

- If tanks are stored in the open, there should be a protective crash barrier surrounding them.
- If tanks are stored in recessed or below ground, dug-out spaces, the site should not be prone to flooding, and there should be adequate drainage.
- Tanks should be in good condition, without leaks or signs of distress.
- If different types of fuel are stored in different tanks, they should be clearly marked and clearly separated, possibly by a physical barrier.
- Tanks generally require cleaning every six months, both inside and out. When tanks are cleaned, all loose debris, build up and any other substance should be cleaned as much as possible.
- Inspections around a fuel tank should be conducted several times a year to look for signs of degradation, warping or leaking.
- Some tanks are installed with a slight incline to enable evacuation from a dedicated drain.
- In some contexts, permanent fuel storage will require special signage under local regulations. Consult with local authorities on regulations regarding marking fuel tanks.
- Using multiple tanks can function like a FIFO system - with fuel only being refilled one tank at a time, enabling distributors to “cycle” through oldest fuel first.



Source: Red R, *Engineering in Emergencies*

In general, tanks will come with a variety of openings, perforations.

Fill/Discharge – Tanks should have at least one valve dedicated to refilling and/or discharging fuel for regular consumption. Sometimes tanks will have multiple lines, one for refilling and one for discharge. Discharge lines should never be at the very bottom of the tank, and should be at least 1/10 of the height from the bottom.

Drainage – Used for draining tanks completely so cleaning/debris removal can be undertaken.

Air Intake – A small inlet to equalize pressure when discharging fuel, or to release pressure build-up when temperature differences between the outside and inside of the tank.

Inspection Cover – Depending on the tank, there may be one or more larger openings that allow for dipsticks, visual inspection, cleaning, or other activities. Sometimes inspection covers are used for refilling as well.

Connected Fuel Tank Systems

Tanks can be networked or linked where required.



Linked tanks enable storage planners to “right size” their storage needs, using as much or as little storage as required. Linked tanks can even be used to push fuel between reserves with specialized equipment and pumps.

Installation and use of networked fuel tanks generally requires fairly advanced knowledge. Agencies thinking of installing and managing larger fuel reserves should first solicit outside companies that have experience with these types of projects.

Fuel Bladders

In some contexts, agencies may employ flexible fuel bladders to store fuel. Fuel bladders have the advantage of being collapsible, meaning they are easier to transport and warehouse. This makes them extremely useful for prepositioning and rapid deployment.



Before using bladders for fuel storage there are some points humanitarian agencies should consider.

Though fuel bladders can be used for long term storage, agencies should always consider permanent hard-sided structures where available. In the event a bladder is deployed in an emergency, agencies should consider replacing them after a few months.

Fuel bladders should be made from PVC, or other chemical resistant material, and must be specifically made for the storage of fuel. Bladders should be UV resistant.

Bladders should be inspected for damage or tears along the seams before deployment/set up. Always follow manufacture recommendations for storage, handling, and overall life span. Bladder stored in excessive heat may experience degradation faster than normal.

Fuel bladders should follow the same precautions as other forms of storage. Bladders should:

- Be properly shaded.
- Clearly marked as containing fuel.
- Segregated by fuel types.
- Kept in a secured location with controlled access.
- Be kept away from open flames and sparks, and have adequate fire safety precautions taken at all times.



Fuel Dispensing

The type of fuel dispenser required depends on the location, functionality and overall needs of the operation. Ideally, any fuel dispenser in use will have access control and a calibrated counter that records fuel dispensed over time.

Additionally, the quality of the fuel will also guide how fuel will be dispensed to users. Fuel from unknown or low quality sources will often come with debris or sediment, or the mixture itself may be impure. If pumping low quality fuel, then users may require a filter (screen or cloth) as fuel comes out of the pump. Other general rules:

- Avoid pumping from the bottom of the container as sediment or debris may build up.
- Avoid also pumping from above the first 10 cm on the top of the tank.
- Avoid dispensing fuel until more than 24 hours after it is delivered - fuel in transit can become well mixed, and the fuel needs time for the debris to settle to the bottom.
- Pumps or dispenser systems must NEVER draw directly from the bottom of a tank. Outflows from tanks should be at least 1/10 from the bottom of the total height to avoid sediment from clogging the pipes/tubes/pumps.

Hand Pumps

There are multiple types of handpumps, however they all follow the same logic; the pump is manually inserted into the fuel container, and fuel is drawn by mechanical hand motion. Hand pumps are useful when:

- Operating in emergency contexts with no other form of power.
- When dispensing fuel from a mobile platform (drums of fuel on the back of a truck).
- Dispensing fuel from small containers or when used relatively infrequently.



Hand pumps don't always have the ability to give a readout of flow, meaning persons using the hand pumps must find alternate ways of tracking and recoding the volume of fuel dispensed. One method is to pump fuel into standardized containers of known size (example: 20 Litre jerrycan). As quantities are dispensed, dispensers should also record outflow in a log book or stock card.

Powered Pumps

Powered fuel pumping options are far more optimal for large scale fuelling operations. Powered pumps can be broken down into two general categories:

- Fuel dispensed directly into vehicles/small containers.
- Fuel pumped between two large storage containers.

Fuel Transfer Pump



Vehicle Fuel Dispensers



The process of dispensing fuel directly to vehicles, or dispensed into smaller hand carried containers will benefit greatly from stationary pumping stations. Stationary pumping stations can either be permanently fixed to the ground, or be permanently fixed to the side of a permanent structure. Pumping stations have a few considerations:

- Pumping stations require electricity to work, meaning a break in the availability of electricity will halt distribution.
- Pumping stations have nozzles that are right sized for vehicle tanks.
- Some pumping stations have “flowmeters” built into them, that continually record volumes dispensed.

Pumping stations ideally should not be attached to or right next to fuel tanks – vehicles moving around and electrical equipment are additional hazards to fuel management. Additionally, a separating wall between tanks and pumps might mitigate risks associated with spills of fuel or fire related incidents. Even with safety precautions, pumping stations will still always be relatively close to fuel tanks, and personnel conduct around a pump station should be the same as any commercial refuelling station – no smoking, no open flames and always pay attention to safety!

Pumps used to convey fuel from one tank to another tank usually high volume, purpose built pumping mechanisms. Delivery trucks meant to fill up revisors or tanks should have their own sub pumps that are either diesel powered, or draw electricity directly from the truck engines.

Gravity Fed Distribution

A gravity fed distribution system works by using gravity to carry fuel relatively short distances. The system works by placing the tank on a platform or elevated position, and feeding fuel from the side of the tank to a lower position using a hose.

The advantages of a gravity fed system include:

- No need for external power to move fuel.
- A flowmeter can easily be installed.

However, the disadvantages of a gravity fed system are:

- Not useful in all locations/space configurations.
- Require specialized setup, and a large tank.
- Not mobile.

Fuel tanks/reservoirs are ideal for gravity fed fuel distribution systems, however proper plans must be made when developing a gravity fed solution.

Tanks used for gravity fed distribution must be at sufficient height. The discharge point of the tank must be at least 50 cm above the highest point of distribution nozzle, however drops of 2-3 meters are recommended to adequately move fuel.

Platforms for elevated tank storage should be adequate for the anticipated weight of the planned storage container (estimate at least 0.85 kg per litre of storage + weight of the tank itself).

Ideally, gravity fed lines will be made of rigid pipes that run directly to the distribution points. Pipes should be clearly marked, and not exposed to hazards. Wherever possible, gravity fed pipes should be run overhead to final destination.

Fuel Storage Safety

Fire Safety

The use of proper fire suppression tools are essential around fuel storage.

Any location used to store fuel should have proper fire extinguishers on hand and readily accessible. There are different classes of fire extinguishers used for different purposes.

Fire Extinguisher Classes Per Region:

| American | European | UK | Australian/Asian | Fuel/Heat Source |
|----------|--------------|--------------|------------------|------------------------------------|
| Class A | Class A | Class A | Class A | Ordinary combustibles |
| | Class B | Class B | Class B | Flammable liquids |
| Class B | Class C | Class C | Class C | Flammable gases |
| Class C | Unclassified | Unclassified | Class E | Electrical equipment |
| Class D | Class D | Class D | Class D | Combustible metals |
| Class K | Class F | Class F | Class F | Kitchen Grade (Cooking oil or fat) |

The only extinguisher type that should be used on fires caused by liquid and gaseous fuel are Class B fire extinguishers. Class B extinguishers work by emitting CO₂, which “suffocates” the flames. Class B extinguishers technically emit a toxic compound, so persons using the extinguishers should know how to do so safely, and only operate them in the proper manner.



Large foam based extinguishers can be used for large quantities of fuel storage, but they must be rated for liquid fires.

NEVER attempt to put out a liquid or gas fire using water:

- Water may evaporate almost instantly in a fuel fire and give the flame more oxygen to expand.
- Flammable liquids tend to be lighter than water, so running water may actually spread flaming liquid around.

Fire extinguishers must be routinely checked and refilled/repressurized. Extinguishers should be checked once a month, recharged once every 6 months, or according to the manufacturer recommendations.

Class B Fire Extinguishers



Fuel storage areas will also benefit from the use of “sand buckets” or other form of fire suppression system using sand or dirt. Buckets full of sand should be placed on the ground near storage, and can be tossed onto flames to prevent spread. Sand buckets should be brightly coloured and clearly labelled so they are not accidentally removed or mistaken for trash.

Example Fire Bucket:



Depending on the size and complexity of the operation, fire or smoke detectors and alarms may be required. Local regulations may also require alarm systems around storage. Consult local authorities to understand the prevailing laws surrounding fire

prevention and suppression.

Other general fire safety rules:

- NEVER conduct welding or other “hot work” near fuel storage facilities.
- Make sure all fire exits are not locked from the inside, and that all emergency evacuation areas are free from debris.
- Avoid at all costs storing reactive chemicals, medical items, food or anything else near fuel for whatever reason.

Marking

Fuel storage areas should be well marked

Hazard signs should be written in plain the local language, but also display locally recognizable symbols. Signage should clearly indicate that smoking and other activities that might start a fire are prohibited.



Many countries and municipalities have special requirements for labeling and marking stationary fuel storage locations. Where required, signage and placards must follow local regulations. Consult with local authorities about what signage or placarding might be required in the country of operation.

Example Regulation Signs:



Spill Response

In the event of a spill or leaking container, the supervisor of the facility should be notified. The person discovering the spill and the site supervisor should record information on the spill (when it occurred, why it occurred, what was spilled, volume spilled, personnel involved, etc.), and keep on file at the storage location.

In the event of spills of flammable or combustible fuel, the following steps are strongly suggested:

- Inform all persons in the immediate area to evacuate, except those involved in the clean-up process.
- Notify the safety and security focal point.
- Eliminate all ignition sources, including static electricity, electrical switches, running motors, and exposed wiring.
- Increase ventilation and exhaust fumes to the outdoors.
- Put on the appropriate protective equipment.
- Confine the spill by blocking it. This is done by using the absorbent material in the spill kit. Prevent the spill from entering drains or sewer system.
- Cover the spill with absorbent materials and safely and properly dispose of used absorbents.
- Safely dispose of contaminated equipment including personal protective equipment.
- Seal and label all containers of disposed items as hazardous waste.

- Store waste in a safe spot in or near the storage facility, ideally outside, until pickup by a licensed hazardous waste disposal company can be arranged.
- For a major spill, or one that cannot be contained, the area should be fully evacuated.

Spill Clean-up

Materials used to support the clean-up spills should be readily available in all storage locations where fuel might be stored. These clean-up materials might include items such as the following:

- Oil absorbent pads.
- Brooms and squeegees.
- Large plastic covered trash bins.
- Nitrile gloves and latex gloves.
- Leather gloves.
- Boots.
- Respiratory masks.
- Salvage drums and containment pallets.
- Sandbags or bags of other absorbent materials.
- Danger tape.
- Safety cones.
- Helmet/ "hard hat".
- Face shield.
- Chemical resistant aprons.
- Emergency response guidelines.

Transporting Fuel

Wherever fuel is transported even relatively short distances, humanitarian organizations should endeavor to transport fuel as safely as possible.

Road Transport of Fuel

Road transport is by far the most common method of fuel transport that humanitarian agencies will directly manage, and all precautions should be taken to ensure safe management. As a general rule, wherever possible transport and delivery of fuel should be outsourced to a qualified outside company. Self-managed transportation of

fuel should ideally only be used when no other option is available, or when only limited quantities of fuel need to be transported.

Liquid fuels can easily move around inside their containers and dangerously shift weight while in transit. In all scenarios, fuel items transported by vehicle should be adequately braced and secured.

Drums

Transportation of fuel in drums is ideal for transporting relatively small quantities of fuel, or when specialized storage equipment isn't available.

Drums containing fuel should always be properly braced and tied down. Review the [road transportation section](#) of this guide for more information on proper use of tie downs and working load limits.



Full drums should ideally be transported upright, along their flat edge to avoid rolling around while in transit. Avoid double stacking full drums unless there is specialized railing or securing mechanisms in place.

Both the loading and offloading points should be prepared to receive the drums. This includes handling equipment and ramps. If the delivery location does not have any capacity to offload, the vehicle may have to travel with portable materials suitable for making a ramp. Portable materials may include wooden planks, however whatever is used should be capable of supporting the weight of a full drum rolling on/off the bed of a vehicle.

Bladders

In some circumstances, fuel can be transported using full bladders. Bladders can come in many sizes, and can easily take up the entire bed of a truck.

Any vehicle transporting fuel using a bladder should be capable of carrying the full weight of the load. Large bladders can easily become very heavy, and transporters may not fully anticipate weight requirements.



Fuel bladders on a vehicle should be properly braced and secured, just like any other load. Tie downs need to accommodate the full weight of the fuel, and the bladder itself should be properly rated for use as mobile transport. Consult with the manufacturer before using a bladder for transport purposes.

Tanker Trucks

Tanker trucks are purpose-built vehicles designed to transport liquids, including fuel. Tanker trucks for fuel are usually only owned and operated by private companies. If a humanitarian agency plans on owning and operating its own fuel tanker vehicle, it will need to ensure that the vehicle meets standards for containing/transporting fuel, is registered and legally able to operate in the local context, and that the drivers are fully certified and trained to operate a specialized vehicle. Prior to buying a fuel tanker truck, agencies should consult with a professional vendor, and with local authorities that manage road safety.



Road Transport Safety

Humanitarian agencies may own or operate their own vehicles, or may take a full responsibility in loading, securing and even driving vehicles transporting fuel. Even if regulations don't specifically stipulate them, there are several steps agencies should follow:

- Never ship fuel with any chemicals, combustible items, or other dangerous or reactive substances. If possible, avoid intermixing fuel with anything else in transport.
- Understand the local context - move the vehicle when is safest time of day and along the safest route.
- Avoid moving vehicles containing fuel through cities and inhabited settlements wherever possible.
- Instruct staff and drivers on proper transport and handling methods.
- Place signs in local languages indicating:
 - Warnings that the vehicle has combustible fuel.
 - Signs should prohibit smoking around the vehicle.

Please consult the [dangerous goods section](#) of this guide for more information transportation of hazardous materials.

Regulations

National and local regulations regarding the transport of fuel vary from context to context. These regulations might include:

- Specialized licenses or certifications for drivers.

- Limits on the overall volume of fuel that can be transported in different types of vehicles.
- Limitations on roads, routes, and hours of operation.
- The requirement to notify authorities in advance of vehicle movement.
- The need for specialized signage and placarding to mark vehicles.

Humanitarian agencies will need to speak with local police and local authorities to fully understand requirements.

Example markings on the back for a tanker truck:



Air Transport of Fuel

The transport of fuel using aircraft is highly regulated. International aviation safety standards strictly limit types, quantities, packaging and marking of fuel for different types of aircraft. Some aircraft – such as passenger aircraft – may specifically completely prohibit the transport of fuel as cargo.

Prior to sending any fuel – liquid or compressed gas – by air cargo, humanitarian agencies should consult with the airline and/or the forwarder organizing the shipment.

- All fuel items should be clearly marked, indicating the [UN ID number and having the appropriate label marking](#).
- Packages containing fuel should have the appropriate package size/overpacking requirements.
- Fuel items for shipment should be segregated from the rest of the cargo, or on the outside/top of a pallet for easy identification by loaders.

- Proper [shippers' declaration of dangerous goods and material safety data sheets](#) should be supplied.

Under no circumstances should humanitarian agencies attempt to ship fuel without notifying the airline/forwarder in advance. Serious injury or death may occur from unmarked or unidentified fuels in air cargo, and individuals and agencies can be subject to fines or jail time for failing to disclose fuel.

Other Modes of Transport

The requirements around transporting fuel through other means varies from context to context.

- Sea transport of fuel is feasible, however unlikely that fuel would be transported in small quantities. For organizing fuel using commercial transport, agencies should consult forwarders and follow all [documentation guidelines](#).
- Transporting fuel using river barge is common and largely considered safe. Agencies should consult with the transport provider for proper procedures for packaging and loading.
- Use of smaller boats or pack animals to transport fuel is also acceptable, however all precautions for securing, weight and overall handling should be followed at all times.

Quality Assurance of Fuel

Purchasing Fuel

Fuel impurities often start at the level of the supplier. After an emergency, or in less developed markets, pure quality fuel may be difficult to come by, and agencies must take active steps to ensure that they monitor and prevent fuel purity problems from impacting their operations. Inappropriate or impure fuel in particular can damage vehicles and generators, costing significantly more money in the long run.

Some fuel impurities might include:

- Mixing of liquid fuel and water – this may be accidental or intentional on behalf of sellers to increase profits.
- Dirt and organic matter.
- Intermixing of different fuel types (example: petrol and diesel).

Agencies should monitor fuel as it's delivered and conduct their own purity checks. Ongoing issues with purity may indicate fraud, or at least will point out unreliable or poor quality suppliers. Any problems identified with purchased fuel must be recorded and actions should be taken against suppliers that provide poor quality fuel.

When purchasing fuel in drums, each container should be opened and checked with a no-spark measuring stick. If available and required, inspectors should also use "water detecting paste" - when applied to a measuring stick, water detecting paste changes color when it comes into contact with water, and is a useful way to identify impure mixtures early on.

Filtration/Settling

Impurities in liquid fuel and intermixtures of different types of fuel can be addressed through the process of letting the fuel settle.

- **Debris** - Organic debris, rust, fuel byproducts and other solid contaminants are usually heavier than liquid fuel, and will eventually sink to the bottom.
- **Phase separation** - Liquid impurities, such as water and other fuel components are different densities, and will eventually separate themselves into distinct layers through a process called phase separation.

Once liquid fuel has been delivered to a storage location, it is advisable to let the fuel settle for a minimum of 3 days before using it. This will allow sediment to fall to the bottom, while also allowing for different compounds to separate. If fueling from a drum, never move the drum just before withdrawing fuel.

A quick method for identifying impurities on the spot is to fill a glass jar or transparent jerry can with samples from the liquid fuel. After drawing sample fuel from the bottom of the container, place the clear full container in a shaded location and let it sit for 30 minutes, making sure to not disturb or move the container in any way. A full separation of different impurities including water will take several hours, but observers will still be able to identify problems early on.

If there is an ongoing issue with the quality of fuel as it arrives, then agencies may wish to invest in a separate settling tank system. This includes placing fuel in a dedicated settling tank that is only used to monitor and remove impurities before being pumped into other longer term storage tanks.

When pumping liquid fuel, never pump the last 10 % of fuel in a tank. As water is heavier than diesel fuel, and water and most of the impurities will also go to the bottom of the tank. The remaining fuel in the tank must be filtered with care or used in

the workshop for cleaning or other purpose.

When pumping fuel between two containers, it's advisable to use a mesh filter of some kind. Drums secured and delivered in remote locations can still accumulate debris inside, even after settling. It's also advisable to use a water retention funnel when pumping directly into a vehicle. Even fuel has been properly stored and settled, water can still build up inside containers from condensation, and excess water in fuel can damage engines of vehicles.

Ongoing Quality Assurance

It is strongly advisable to use only dedicated pieces of equipment to each type of fuel. Never use the same pumping tools (pump, filter, funnels, etc...) for different fuels as this may lead to intermixing and impurities. These dedicated items must also always be kept clean and dust free.

Tanks will also need to be periodically emptied and cleaned. The frequency of needing to clean tanks depends on the purity quality of the fuel itself. A general rule is tanks should be cleaned every 2-5 years, or more frequently if required. Cleaning of tanks can be facilitated by having two tanks of identical capacity - simply emptying one tank into the other for the duration of the cleaning.

When cleaning a fuel tank, persons should use proper protective gear:

- Gloves
- Respirator mask
- Protective goggles
- Adequate and safe clothing

The cleaning process includes:

- Allowing all fumes to escape after all fuel has been removed - open the lid to the tank and leave open for at least 24 hours.
- Removing excess debris or grime using a shovel.
- Scrubbing the interior of the tank with steel brush or steel wool.
- Ideally cleaning can occur using only hot water, but cleaning solvents can be used as long as they are completely washed from the tank at the end.
- Once debris has been removed, the tank must be let to thoroughly dry.
- All debris from the tank must be disposed of in a safe and ecologically friendly manner.

Shelf Life

Liquid fuels degrade and go “stale”. There is no predetermined rate for fuel expiration because there are multiple factors that lead to the degradation of fuel:

- **Hydrolysis** – Fuels exposed to water over a long period of time began to chemically break down.
- **Microbes** – Microorganisms can live in liquid fuels in certain conditions, and will reproduce rapidly, eventually breaking down the fuel.
- **Oxidation** – Excessive exposure to oxygen produces acids as a biproduct.

In all forms of degradation, the result is liquid fuel turning into sludge or a gummy compound that can no longer be used and can damage engines. Excessive exposure to temperatures above 30 degrees centigrade will make the degradation process even faster.

Though there is no specific shelf life, the general rule to follow is:

| Fuel Type | Shelf Life Duration |
|------------------|---|
| Petrol | 6 Months |
| Diesel | 6-12 Months |
| Jet Fuel | 6-12 Months |
| Kerosene | 12 Months (if delivered by pumping) - 5 years (if in original unsealed container) |
| Propane | 5 Years+ (also depends on how long the sealed container can last) |

In reality, agencies should only purchase and store as much fuel as they plan on using in the next 3-6 months wherever possible. Excessive fuel stored on site can be dangerous and attract thieves.

Accounting

Fuel should be accounted for just like any stored item. There should be logbooks or stock cards that capture the inflow-outflow of fuel, including quantities, dates, intended use and persons involved in the transaction.

Because most fuel is delivered in liquid form, it can be challenging to properly measure consumption. There are a few strategies for proper accounting for liquid fuels:

Strategy

Example

Only dispense into containers of known sizes

Pump fuel into a completely empty 20 litre jerrycan, and record the deduction from stock as 20 litres.

Use equipment with flowmeters where possible.

Some hand cranks and powered pumps come with flowmeters - instruments that measure flow through a hose over the duration of the pumping. Use the reading as the number of litres deducted from stock.

Measure empty space in before pumping

If delivering fuel from a tanker truck or other delivery mechanism, and fuel is being delivered to a tank that is not empty, use a measuring stick to determine the volume first, then fill the tank to 100% full. Record the difference between the two numbers as deducted from stock.

Only dispense full containers

When handing out fuel, only dispense full 200 litre drums or full canisters of compressed gas, and record the deduction from stock. This method only works for some operations at scale however.

It is very important to remember that fuel contracts noticeably with temperature decreases, and that fuel itself can evaporate. There may be variations in the long run that make perfect accounting impossible. Best practice tips for tracking fuel include:

- Keep lids to fuel containers tightly sealed when not in use.
- Record the outside temperature on the stock card when fuel is first delivered and try to measure levels at or around the same temperature.
- With seasonal changes, expect a 2.5% +/- in overall volume as an acceptable variance. Fuel delivered in cold weather may appear as gaining volume while fuel delivered in hot weather may lose volume.