

# 62. Emergency water supply in cold regions

During the 1990s events in the Balkans, the ex-Soviet republics, Afghanistan and Northern Iraq have demonstrated that human disasters are not limited to tropical regions of the world. In cold or mountainous regions, relief workers are faced with particular technical challenges, such as the prevention of damage to pipes and equipment caused by freezing temperatures. Following on from Technical Brief No. 44 (Emergency water supply) this Brief provides additional material for emergency and post-emergency water and sanitation staff working in regions with cool or cold climates, where freezing temperatures are likely.

## General considerations for cold regions

- Initial assessment procedures should take into account climatic factors, including the possibility of seasonal freeze-ups, to determine whether cold region technology may be necessary.
- In some countries, a high level of infrastructure may have existed before the disaster. The repair of complex urban systems requires experienced engineers.
- In cold regions 'winterization studies', should be carried out in the summer, where possible. These should be designed to predict the possible effects a harsh winter may have on the provision of aid (see page 120).

- Winter conditions (snow and ice) can make access routes impassable. Importing water into the disaster area may not be a feasible option. Local water sources may have to be used — even if it is poor quality.

## Water sources and water quality

### Groundwater

In winter, groundwater is usually warmer than surface water. Using groundwater, therefore, will help to prevent water freezing in treatment systems, storage tanks and pipework. In all situations, however, levels of salinity or dissolved metals will determine whether groundwater is a suitable source or not.

### Rivers and streams

Winter freezing of surface water run-off greatly reduces flow volumes and increases the concentration of ions, as more of the flow originates from groundwater sources (springs) during winter. Spring thaws lead to temporary deterioration in water quality as run-off washes impurities into the system.

### Lakes

Ice is relatively pure. As surface water freezes, it rejects most salts and dissolved organic matter. These impurities, however, are concentrated in the water beneath the ice.



# Emergency water supply in cold regions

## Locally made water storage tanks

- Tank designs should take into account
  - the likelihood of water freezing over; and
  - the amount of damage that this causes.
- Heat lost to the air increases the likelihood of stored water freezing over. The surface area to volume ratio of the tank will affect the rate of heat loss. So:
  - a large tank will take longer to freeze over than a small one;
  - a round tank will lose heat more slowly than a rectangular one of the same volume; and
  - straight sides are better than corrugated sides as they have a smaller surface area.
- If possible, some form of insulation should be used, e.g. spray-on polyurethane foam.
- Valves can be protected by being covered and insulated where possible.
- Heat loss to the ground can cause structural instability if the frozen ground starts to thaw. Mounting the tank on an insulating concrete, or gravel, base will reduce heat transfer.
- Tank roofs should be designed to cope with extra loads arising from snow falls. Steep-angle roofs, for example, allow the snow to slide off.
- Designs should take account of rising and falling surface ice within a tank, which can cause damage to internal fittings (e.g. ladders). Internal fittings should be avoided if at all possible.

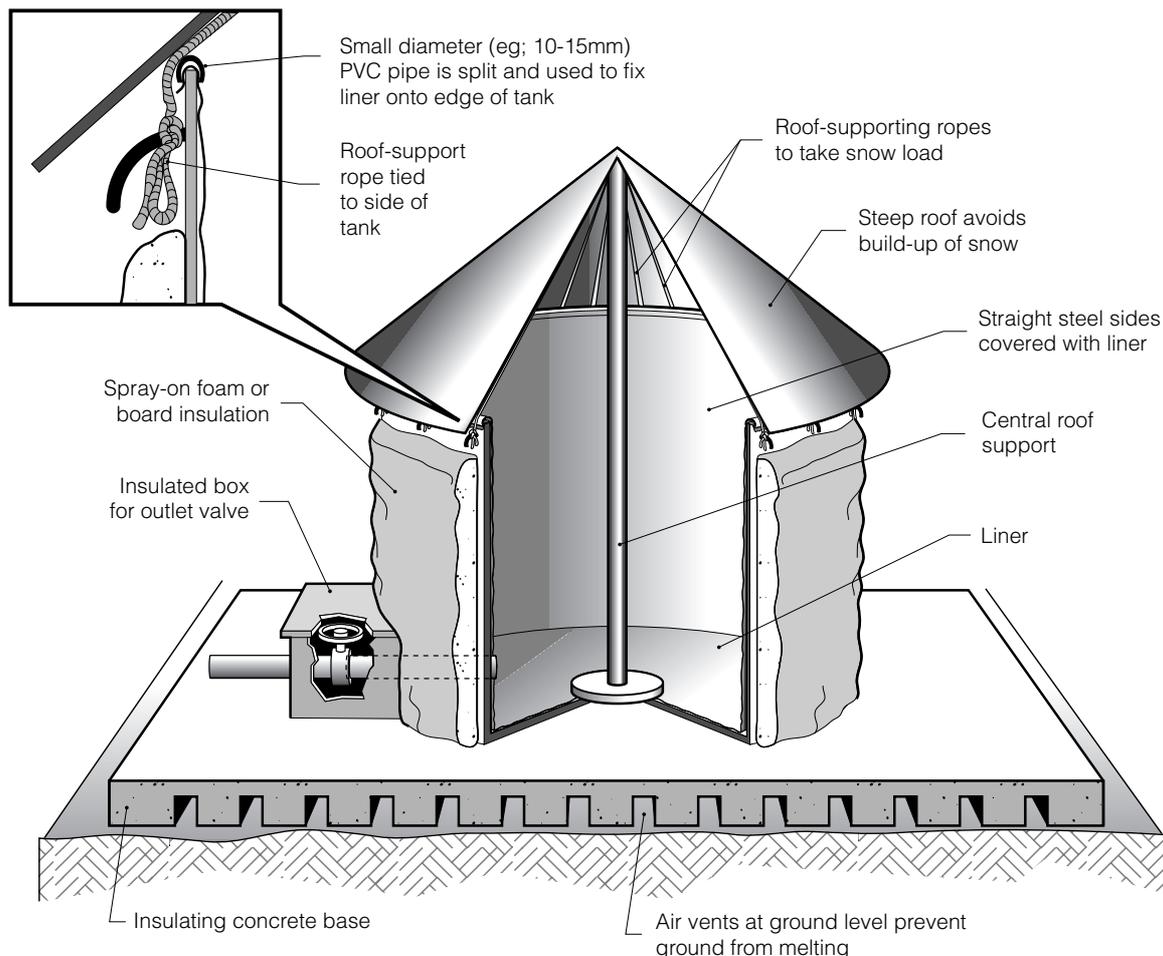


Figure 1. Temporary water storage tank, showing useful features for cold regions

# Emergency water supply in cold regions

## Water treatment

Low temperatures affect the rates of chemical reactions and biological processes.

### Sedimentation

When treating water to remove sediments by settlement, the size of the settlement tank required can be calculated as a surface area.

$$\text{Area (m}^2\text{)} = \frac{\text{Design Flow Rate (m}^3\text{/s)}}{\text{Settlement Velocity (m/s)}}$$

- Jar tests are used to determine the Settlement Velocity;
- The Design Flow Rate is calculated from the size of the population.

Since settlement velocity depends on the viscosity (thickness) of the water, it is important to use water at the correct temperature. (Increased water viscosity implies a slowing of the process by a factor of 1.75 for water at 1°C compared to water at 20°C.)

Tests should be undertaken using the outside temperature to avoid underestimating the size of settlement tank required.

### Slow sand filtration

The rate of flow will be slower in a cold climate both because the biological action of the 'schmutzdecke' layer is reduced and because of increased water viscosity.

### Chlorination

This reaction rate is seriously affected by temperature (for every 6°C drop in temperature, the necessary contact time increases by a factor of between 1.5 and 3.5). Operators can use jar tests (for example using the Horrocks' method as described in Technical Brief No.46) to determine a suitable contact time and amount of chlorine to be added *provided that the tests are done using water samples at outside temperatures.*

## Water distribution systems

The forces exerted by water expanding as it freezes and becomes ice, are the equivalent of a static head of water about 25km high! Protection of pipes and valves against frost is essential.

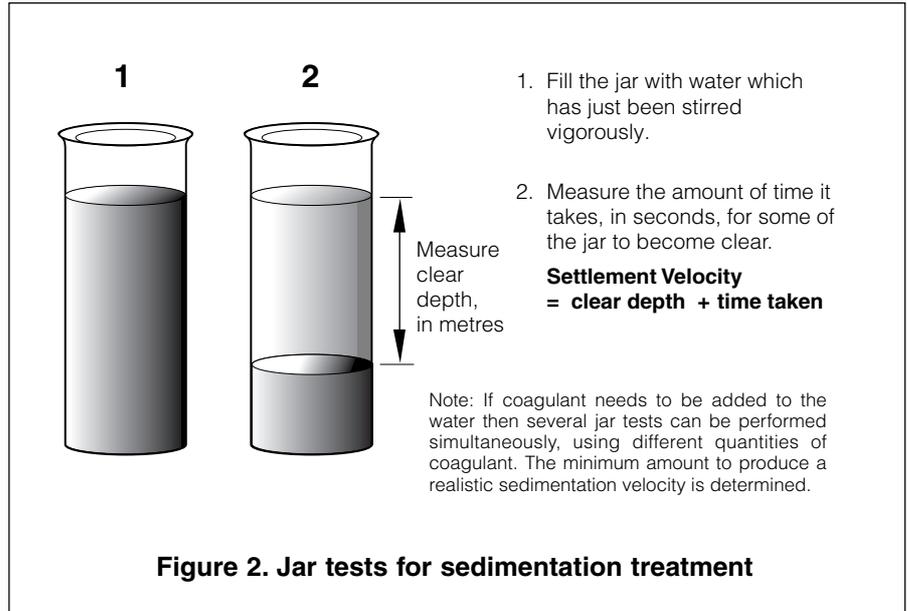


Figure 2. Jar tests for sedimentation treatment

### Immediate measures

Water is more likely to freeze if it is not moving, so:

- for a temporary supply, pipes should be *drained* when water is not flowing. For a gravity flow system, *continuous flow* can be maintained by leaving some distribution taps permanently open.
- In a pumped system, the water can be *recirculated* along dual pipe arrangements that allow water to continue flowing.

### Longer-term measures

- If possible, pipes should be buried deeper than the depth of maximum frost penetration and lagged with insulation.
- Care should be taken to locate distribution points as close as possible to where people live, and preferably indoors. As well as preventing problems of taps freezing, exposure is a serious health risk, especially for the elderly, and shelter will avoid the need for people to queue in the open.

### Pipe materials

Using suitable materials will reduce the probability of pipes splitting if the water freezes inside.

- Medium Density Polyethylene (MDPE) remains ductile even at very low temperatures (to -60°C).

- PVC is more brittle at low temperatures and is therefore more easily damaged than MDPE.

### Pumps

Handpumps and mechanical pumps can be protected by a pump-house, which will reduce the likelihood of water freezing inside the pumps and causing damage.

### Mechanical pumps

To avoid running and maintenance problems:

- Make sure that the correct grade of engine oil is used. (Oil more suitable to warmer climates may be so thick at low temperatures that it can prevent the engine from starting.)
- Use diesel suitable for cold regions. 'Gelling' can be prevented by keeping pumps indoors. (Diesel is likely to gel if transported from a warm region to a mountainous area where it is cold.)

### Handpumps

- A lift pump is less likely to suffer from frost damage because the cylinder is underground.
- A small hole (approximately 3mm in diameter) cut in the riser pipe near the base will let the pump drain at night. (Note, however, that this will reduce the efficiency of the pump and limit the maximum depth from which water can be extracted).

# Emergency water supply in cold regions

## Winterization studies

If an emergency occurs during the summer months, in regions where winters are cold, it will be essential to carry out a winterization study. Such studies are designed to improve the efficiency of winter aid provision. They identify inadequate technology, possible logistical difficulties, and health issues that will be caused by the forthcoming winter. Measures can then be introduced to overcome potential problems before they arise.

### Consider the following:

How will a harsh winter affect:

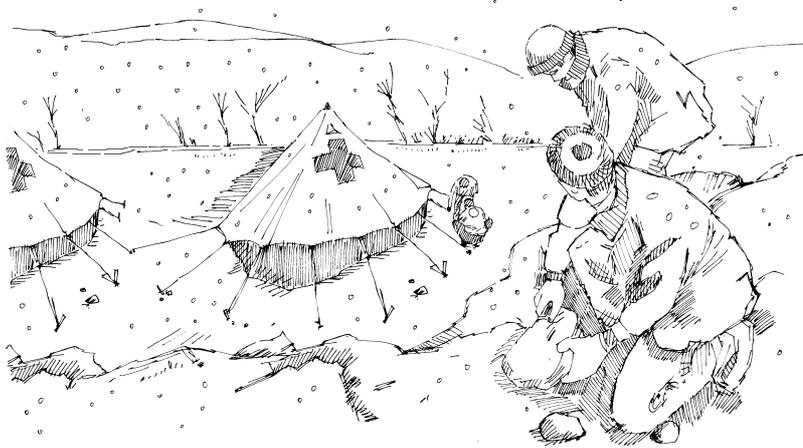
- water supply systems;
- sanitation systems;
- logistics; and
- health and motivation?

Is it worth stockpiling:

- fuel;
- food;
- materials, tools and equipment;
- suitable bags for containing wastes
- heaters, tents and blankets?

## Working in cold climates

- People work more effectively in cold climates when they are warm. The value of dressing sensibly, eating enough and having regular hot drinks should not be underestimated.
- Personal kit should include warm, waterproof clothes, hat and gloves and sturdy boots. Note that the 'windchill factor' can make the climate seem much colder than the thermometer reading.
- Personal medical kits should contain adequate medication for respiratory tract infections (coughs and colds).
- Vehicles should carry shovels, snow chains and tools as well as spare tyres. Carrying food, water and four-season sleeping bags is also advisable.
- Health risks include hypothermia, snow-blindness and carbon monoxide poisoning (which can occur when small stoves are used in confined areas, with inadequate ventilation).



## Further reading

Buttle, M. and Smith, M.D., *Out in the Cold: Emergency water supply and sanitation for cold regions*, WEDC, Loughborough University, Loughborough, 1999.

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WATER AND ENVIRONMENTAL HEALTH AT LONDON AND LOUGHBOROUGH (WELL) is a resource centre funded by the United Kingdom's Department for International Development (DFID) to promote environmental health and well-being in developing and transitional countries. It is managed by the London School of Hygiene & Tropical Medicine (LSHTM) and the Water, Engineering and Development Centre (WEDC), Loughborough University.

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