CHAPTER 5
WATER STORAGE

5-1. General.

Basic criteria for determination of capacity requirements and for design and construction of water storage facilities can be found in TM 5-813-4/AFM 88-10, Vol. 4. This section discusses only those aspects unique to the Arctic and Subarctic. Water storage is provided for domestic and fire protection services. The requirements for water will typically be lower at remote facilities in the Arctic and Subarctic than at similar operations in the temperate zone due to conservation and lower external water needs. The water needs will vary with the type of facility, so general criteria are not possible. A special design study to determine specific water needs will be undertaken for each new facility so that cost-effective designs for water supply, water storage and wastewater systems can be ensured.

5-2. Tank materials.

Common construction materials for water tanks include wood, steel, and concrete. Wood stave tanks are constructed with prefabricated pieces that can be shipped relatively easily to any remote site. Leakage is a problem with intermittent or fill-and-draw operations since the joints can open slightly if the wood is allowed to dry. Figure 5-1 illustrates the cross-sectional details of a wooden tank with an internal liner and insulation constructed in the Canadian Arctic on a pile foundation. In Alaska welded steel tanks are most commonly used. Tanks have been insulated with polystyrene or polyurethane boards or with sprayed-on polyurethane. Figure 5-2 shows a welded steel tank with board insulation and metal cladding resting on an insulated gravel pad. Concrete tanks have been used

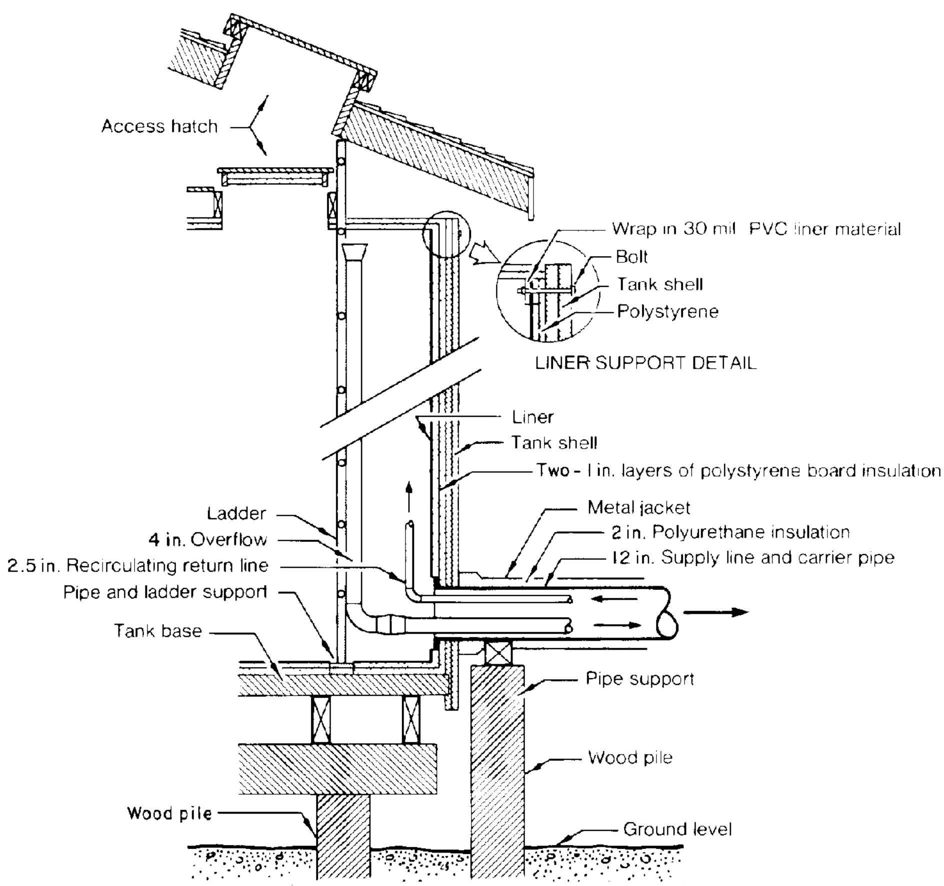

Figure 5-1. Wood tank with insulation and liner on inside.

where aggregate is available and the foundation conditions permit slab construction. Concrete tanks will be covered with earth and insulated if necessary to reduce heat losses as shown in figure 5-3.

replacement is very high in remote locations so that the type of coating initially selected should be of high quality and properly applied. Cathodic protection is also required.

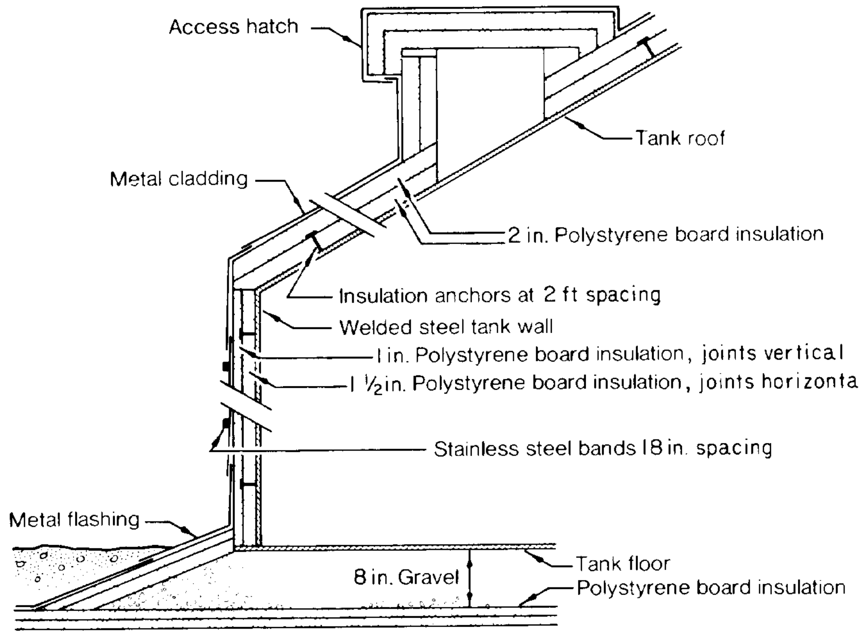

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Figure 5-2. Steel tank with board insulation and metal cladding.

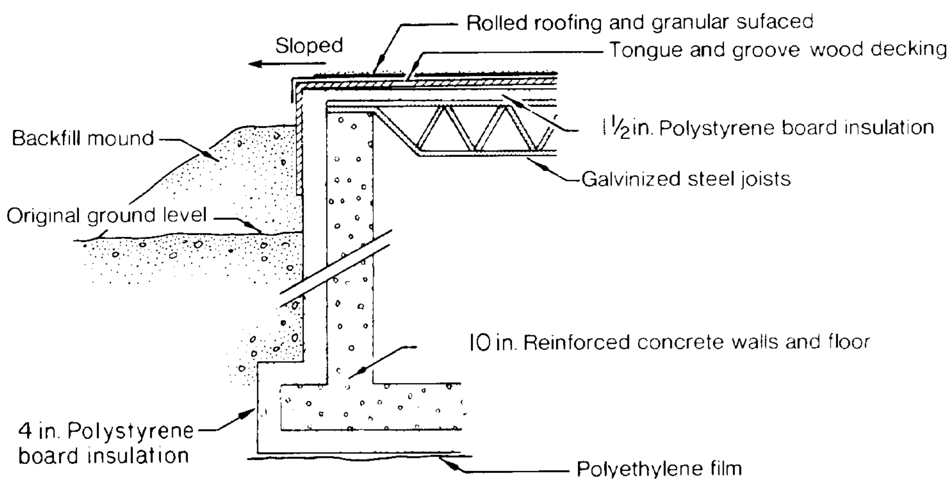

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Figure 5-3. Insulated buried concrete tank.

Seismic conditions must be evaluated prior to selection of a rigid concrete tank. Welded steel tanks are more cost effective for high-risk seismic areas.

a. Corrosion protection. Steel water tanks must be painted in accordance with applicable standards. Manufacturers' recommendations regarding acceptable temperature limits for the application of these paints must be strictly followed to avoid premature failure. The cost of sandblasting and liner

b. Insulation. Successful tank insulation has been provided by earth cover, wood, glass fiber, cellular glass, polyurethane and polystyrene block materials. Tanks can also be enclosed with a protective shell. Such an exterior shell is either constructed against the tank or a walkway provided between the tank and the exterior wall as shown in figure 5-4. The air gap and the wind protection will reduce heat losses,

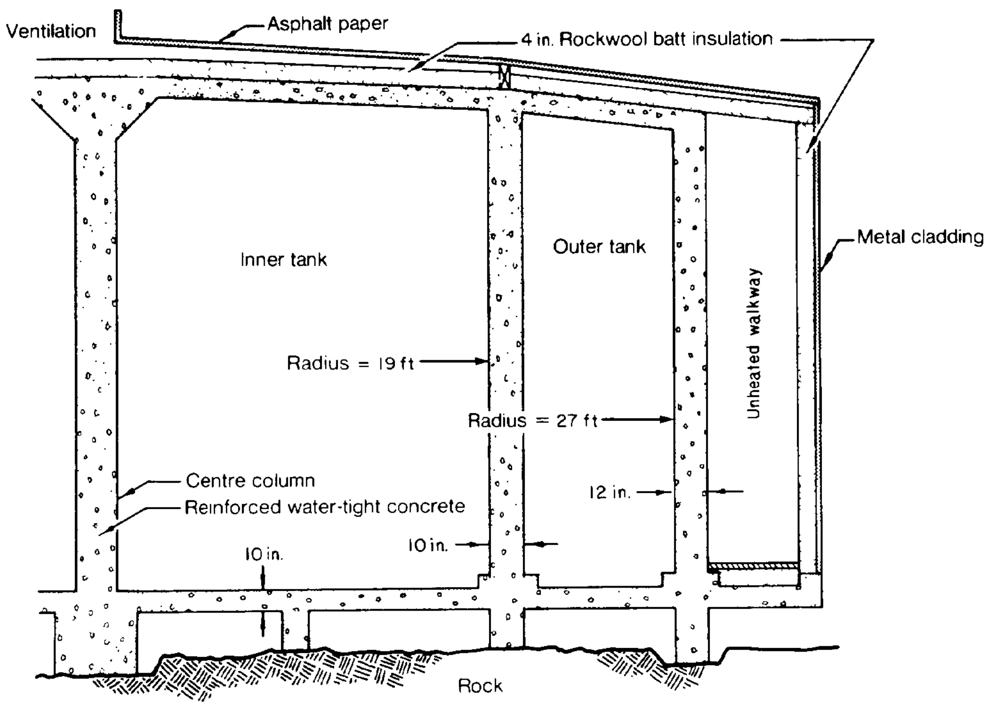

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Figure 5-4. Above-ground concrete tank, Greenland.

and this heat loss reduction can be further enhanced by installing insulation. Moisture-resistant insulation materials must be installed in contact with the tank at inaccessible locations since moisture from leaks, condensation, rain or ground water can drastically reduce the insulating effect.

c. Foam insulations. Near-hydrophobic plastic foam insulations are readily available and commonly used. Polyurethane can be obtained as either prefabricated boards or foamed in place by spraying directly onto the tank. The latter has been the more common approach in Alaska. To ensure a good bond all loose scale or paint flakes are removed, the surface solvent-cleaned if it is oily, and a compatible primer applied. Foaming-in-place requires a dry surface, winds less than 3 miles per hour, air temperatures above 36 degrees F and tank surface temperatures above 50 degrees F. The hardened foam must then be protected from vandalism, weather and ultraviolet light. This is commonly done with low temperature elastomers or similar coatings compatible with polyurethane that are sprayed onto the insulation. Two or three coats are recommended with the first application within one day of foam application. Polystyrene or polyurethane boards can be glued and strapped (with 1-1/2 inch wide stainless steel banding, 18 inches on center) to the exterior of the tank. Large tanks will require clips. The insulation boards will be less than 3 inches thick to allow installation on a curved tank surface. Two layers of insulation are preferred so that the joints between boards can be staggered (see figure 5-2). Sheet metal cladding is then applied for weather and vandal protection. Insulation boards composed of high density foams (compressive strength about 1500 psi) are sometimes placed under a tank (figure 5-3) for protection of the frozen subgrade.

5-3. Tank design.

Water storage tanks must be designed to prevent the formation of ice in the tank under all foreseeable circumstances and tanks must be completely drainable. Floating ice in the tank can destroy interior appurtenances, and ice formed on the walls can collapse and cause structural failure or punctures in the tank bottom. Surface icing can be avoided by maintaining the water temperature above 39 degrees F and there will be a continuous circulation. In some cases the return line of a circulating water distribution system is discharged to the storage tank to promote circulation and maintain temperatures. In other cases a small amount of water is withdrawn, heated with a boiler or heat exchanger and pumped back into the tank.

a. Appurtenances. Breather vents will be located on the inside of the tank and vented into an attached pumphouse or building rather than directly to the outside. Ice will form in an exposed vent due to condensation and a vent blocked with ice will result in an vacuum in the tank as water is withdrawn and possibly cause the tank to collapse. Overflow piping will either be inside the tank or protected with insulation and heat tracing if placed on the exterior. Since ice can damage float type water level indicators, the pressure transducer type is recommended. Temperature monitoring at various levels for control and for alarms will be included in the design.

b. Thermal considerations. Whenever practical, tanks must be buried or covered with soil to reduce the effect of low air temperature. Elevated tanks must be avoided unless they are absolutely necessary for the water distribution system since they expose the greatest surface area to the worst climatic conditions. All exposed tank surfaces and risers for elevated tanks must be insulated. The economical thickness of insulation can be determined by the calculation procedures in chapter 12, paragraph 12-9*i*. Thermal calculations are also necessary to size the heating systems used to replace heat losses or to heat the water for distribution. The unit capacity of a heat exchanger or boiler must be equal to the maximum rate of heat loss.

5-4. Tank foundations.

Foundation considerations are similar to those for other arctic and subarctic structures and are covered in TM 5-852-4/AFM 88-19, Chap. 4. Foundation design for tanks is complicated by the very high loads imposed by the stored water and the need to keep the water in the unfrozen state. The unfrozen water is a heat source that can have an adverse effect on the underlying permafrost and must be considered during design for a tank on grade.

5-5. Earth reservoirs.

Water impoundments for domestic and industrial water supply and for hydropower have been successfully constructed in the Arctic and Subarctic. The most likely configuration for military facilities is an earthen embankment to either increase the storage capacity of an existing lake or stream or to impound water in a natural drainage swale. Construction of these embankments must be in accordance with TM 5-852-4/AFM 88-19, Chap. 4. A liner is necessary within the embankment or to seal the entire reservoir, when permeable soils are present or used for construction. Successfully used liner materials include Hypalon synthetic rubber, chlorinated polyethylene (CPE) and elasticized polyolefin. (See EPA 600/8-79-027 for further detail on linings.)