

Appendix 1

Deicer Storage Tank Manual

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1. Overview

The two most common causes of polyethylene tank failures are

1. Improper installation (including unsupported fittings pulling away from tanks).
2. Stress cracks.

Stress cracks may be caused by improper installation of the tank or tank anchors, exposure to environmental elements (e.g. sun uv rays), an uneven foundation, and/or impact (e.g. during tank delivery or vehicle collision).

Over time the tanks may degrade. Tank degradation typically results in a thinning of the tank walls. Degradation may also cause the tank walls to become either brittle or soft.

The plumbing and valves usually fail at joint connections or fittings. Pipe failures are typically caused by excessive vibration, vehicle impact, or degradation due to sun exposure.

This document provides guidance on purchasing the polyethylene tanks for deicer products, siting and installing tanks, determining when secondary containment is required, providing secondary containment, and inspecting tanks for signs of failure.

2. Purchasing Deicer Tanks

Tanks should have uniform thickness from top to bottom. ‘Tapered’ tanks are not recommended because the upper sidewalls, domes, and bottoms are thinner than the bottom sidewall. The domes of tapered tanks are more likely to be weakened by sun exposure (i.e. experience UV deterioration) and may collapse under a snow load.

Tanks must be manufactured to hold liquid products that are denser than water. Calcium, Magnesium and Sodium Chloride solutions typically have a specific gravity between range of 1.2 and 1.3. Tanks that are manufactured with lower specific gravity ratings (e.g. close to 1) are more likely to fail. Tanks with a higher specific gravity rating (e.g. a heavy duty tank) will last longer, especially if the tank will be exposed to extreme sun and/or consistent temperatures over 100° F. Contact tank manufacturers or vendors for tank specifications and recommendations.

Tanks should be manufactured with UV resistant or UV stabilized plastics. Table 1 compares the two primary types of polyethylene used to make plastic tanks. Most manufacturers construct tanks from both kinds of plastic.

Table 1- Comparison of Linear Polyethylene Tanks and Cross linked Polyethylene Tanks

Linear (LPE or HDPE)	Cross linked (XLPE)
Good environmental stress crack resistance	Excellent environmental stress crack resistance
Stress fractures have a tendency to ‘unzip’ or grow quickly	Stress fractures crack and leak, rather than release the entire contents of the tank.
Good cold impact resistance	Excellent cold impact resistance
Can be used for potable water	Cannot be used for potable water
Can develop high tensile strength ¹	Can develop high tensile strength if processed correctly
Can be recycled when the tank is replaced.	Cannot be recycled when the tank is replaced.

¹ Tensile strength determines how much force can be applied before the tank permanently deforms.

Linear (LPE or HDPE)	Cross linked (XLPE)
Can be welded (can be repaired)	Cannot be welded (can't be repaired)

Used tanks should be inspected for physical damage and stress cracks before purchasing.

See the Section 5.2.3 of this document for inspection methods.

The history of the used tanks (e.g. age, type of product previously stored, exposure to elements, and prior damage) should be obtained before purchasing, if possible. Polyethylene tanks have a typical useful life of 10 to 15 years.

Tanks should be thoroughly cleaned and rinsed before changing from one product to another. Avoid combining liquids in the same tank. The materials are very often not compatible.

Tank farms should be sized for the normal winter average amount of product used.

Frequent loading and unloading puts more stress on storage tanks. Larger tanks may not have to go through the loading/unloading cycle as often as a smaller tank.

3. Siting and Installing Deicer Tanks

3.1. Siting and Installation BMPs

Prior to the installation of new tanks, the location must be assessed to determine if secondary containment is required. Perform risk assessment using Table 2 of this guidance document.

- If deicer tanks are sited in a high risk location, secondary containment **must** be installed.
- If deicer tanks are sited in a moderate risk location, secondary containment may need to be installed.
- If deicer tanks are sited in a low risk location, secondary containment still may be required.

Regardless of risks, consider ways to keep deicer onsite in the event of a total tank failure. Spills should be contained within the confines of the yard, kept out of storm drains, and away from water sources.

Secondary containment must be able to hold at least 110% of the capacity of the tanks or 110% of the capacity of the largest tank in multi-tank systems.

If multiple tanks are located onsite, the tanks must be plumbed to insure that complete failure of one tank will not drain all the tanks in the system (tank operations must be isolated). Tank isolation may be achieved by placing valves between the tanks, installing separate pumping systems, or any other method that insures the contents of one tank will not unintentionally flow into another tank. Valves between tanks must be kept closed unless transferring product from one tank to another.

Efforts should be made to minimize seeping and leaking at fittings. Examples include:

- Support hose brackets and flanges (and anything else that hangs on the tank) so the weight of the attachments don't pull against the tank.
- Consider using bolted fittings (bolts on both the inside and outside of tank) rather than threaded fittings (flange on inside with bolt on outside).

- Install fittings above the knuckle of the tank (at least 1 foot from the bottom of the tank) where the wall thickness is most even.
- Use a flexible connector or expansion joint to allow the tank to move naturally.
- Use corrosion resistant fittings (e.g. poly, reinforced nylon, or stainless steel).
- Install valves close to the tank wall.
- Use flexible hoses to help absorb impacts from vehicles and/or handling.
- Use lightweight hoses and valves to minimize stress at the hose/tank connection. Large, heavy fittings, valves, connections, and hoses add stress to the tank walls
- Use separate port valves to fill and to empty the tank. This will reduce stress at the valves.

The circumference of the tank must be measured and recorded the first time the tank is filled. See Section 5.2.4 Circumference Measurements.

Tanks should be protected against wind and seismic activities. Wind and seismic activities may move tanks. Movement may be an issue with fixed piping. Tie downs may also assist with empty tanks floating inside containment structures. Empty tanks may float in a little as 5 inches of water.

New tank installations should be tested to insure the tank and piping hold water before filling with product. Tanks should be filled with water prior to use. Check for unsecured fittings, shipping damage, or manufacturing defects. Tanks should be tested for a minimum 5 of hours.

Tanks, valves, and piping should be protected from vehicle impact. Vehicle impact protection may be provided by either physical barrier (e.g. GM barrier or guardrail) or by siting the tank away from vehicle movement areas (e.g. inside a shed or storage bay), as appropriate.

Tank should be protected from UV and temperature deterioration. Unprotected tanks exposed to sunlight for an extended period of time, absorb ultraviolet light (UV) which can cause discolorations, make the tank brittle, and eventually crack. Most tanks have an optimal operation temperature range between 0°F and 100°F. However, most tanks are rated for minimum and maximum temperatures lower or higher than this range. Tank locations should minimize exposure to the sun, especially during the summer months, when temperatures are the highest (e.g. locate tanks on the north or east side of buildings). Shaded areas and covered storage (e.g. roof or building) will lessen the damaging effects from UV rays.

Tanks must be vented to avoid pressurization while loading or unloading product. Venting is built into most tanks (e.g. an opening built into the top lid). Tanks can also be vented by installing a pipe opening near the upper part of the tank. Typically the pipe has an elbow fitting facing down to prevent rain from entering the tank.

3.2. Determine if Secondary Containment is Required at the Site

Before installing new tanks determine if secondary containment is required for the site location. Every effort should be made to keep deicer spills onsite, even when containment is not required.

Table 2- Risk Matrix for Deicer Tank Locations

Box 1- Drainage Around Tank		Points for Box 1
Direct discharge A large spill would flow into a piped system or a ditch that discharges to surface water or a flood plain	7 points	
Indirect discharge A large spill would flow across the ground toward surface water	3 points	
Infiltration A large spill would flow across or sink into the ground	1 point	
Box 2- Presence of Surface Water (<i>within 1/4 mile downslope</i>)		Points for Box 2
Small freshwater stream, wetland, closed basin, flood plain, or lake	7 points	
Large freshwater stream or river	3 points	
No fresh surface water	1 point	
Box 3- Bonus Points (total the points for all statements that apply to the site)		Points for Box 3
A spill would flow across the ground and the adjoining downslope property is agricultural or residential (non-WSDOT)	3 points	
A spill would flow toward a protected waterbody (e.g. scenic waterway, reservoir, or significant community involvement)	3 points	
Property is not owned by WSDOT	3 points	
Property is located in a wellhead protection zone or groundwater restriction area or the water well is located onsite within 250' of tank.	3 points	
Risk Level for the Site 14-26 points = High Risk (Secondary containment must be provided) 9-13 points = Medium Risk (Secondary containment should be provided) 2-8 points = Low Risk (Secondary containment is not required)		Total Points

Instructions Table 2.

1. Before tank is installed look at the area where the tank or tanks will be sited.

2. Pick the answer in each Box 1 and 2 that best describes the site and surrounding area. Write the number of points that corresponds to the description in the blank column.
3. Add the points from any statement in Box 3 that describes the site. 12 possible points.
4. Add the points for Boxes 1, 2, and 3. Compare total points to the risk level for the site.

4. Secondary Containment of Deicer Tanks

4.1. Secondary Containment BMPs

Secondary containment **must** be able to hold at least 110% of the capacity of the tank or 110% of the capacity of the largest tank in multi-tank systems. Secondary containment should prevent a spill from leaving an area by physically confining the product. Preferably, spills should be controlled immediately adjacent to the tank.

If multiple tanks are located on-site, the tanks must be plumbed to insure that the complete failure of one tank will not drain all the tanks in the storage system (tank operations **must** be isolated). Tank isolation may be achieved by placing valves between the tanks, installing separate pumping systems, or any other method that insures the contents of one tank will not unintentionally flow into another tank. Already included.

Valves that connect multiple deicer tanks must be kept closed unless transferring product from one tank to another.

Drips from hoses should be minimized. Consider placing hoses in trenches or using drip-less nozzles to reduce repeated small spills.

Pooled water inside containment areas must be inspected for the presence of deicers before opening any drain valves or pumping water out of containment systems. Deicer is typically darker than water (brown or yellow brown). Deicer appears thicker than water. Deicer may foam when agitated. The release of clean water should be either noted on the EMS Corrective Action sheet or kept on a separate log.

Structural modifications to piped drainage systems must be coordinated with WSDOT Facilities.

Drain valves on secondary containment systems must be kept closed whenever there is product in the tank (unless draining rainwater or snowmelt). **Containment is not provided when valves are open.**





Drain valves on secondary containment systems must be manually operated (not automatic). Manual valves should be used on all drains.

If spilled products flow into a municipal sanitary system, the municipality must be notified of the potential for deicer products entering the system. The documentation records should be kept onsite, at the Maintenance yard responsible, or at the District office.

The integrity of secondary containment systems should be checked annually, preferably before the first delivery of the season. Integrity tests typically consist of allowing the containment system to fill with water and checking that the water level doesn't drop over a period of time.

4.2. Methods for Providing Secondary Containment

Four options are provided. Regardless of option, the containment system must hold at least 110% of the capacity of the largest tank.

Considerations	Concrete Structure	Berm	Building	Drainage Control
<p>Description</p>	 <p>Four-sided concrete box with a concrete bottom.</p> <p>Structure may have a drain valve that releases water from the bottom of structure or a drain pump.</p>	 <p>Barrier that stops or slows the movement of deicer out of a defined area.</p> <p>Area may have a drain that releases water held inside the berms.</p>	 <p>Covered structure that does not allow deicer to flow outside.</p> <p>Buildings that do not physically confine spilled product do not provide secondary containment.</p>	 <p>Area surrounding deicer tank flows to a drain that is sealed or closed while there is product inside the tank.</p> <p>Or, area surrounding tank flows to sanitary sewer.</p> <p>Or, area surrounding tank flows to a surface impoundment or retention pond.</p>

Considerations	Concrete Structure	Berm	Building	Drainage Control
Materials	Concrete and rebar	Compacted soil, grindings, or sealed concrete barrier	Typically concrete or sealed barrier	Drain plug, valve, or cover
Size	<p>Moderate</p> <p>May increase capacity by adding height to the structure.</p> <p><i>Example for two 10,500-g tanks</i></p> <ul style="list-style-type: none"> - 15' x 30' x 5' or - 14' x 36' x 4' or - 18' x 32' x 3½' 	<p>Large</p> <p>Berms usually 2-3' high. Size depends on slope of containment area.</p> <p>Typically increase capacity by making wider or longer.</p> <p><i>Example for two 10,500-g tanks</i></p> <ul style="list-style-type: none"> - 50' x 25' x 2½' or - 85' x 25' x 1½' 	<p>Moderate</p> <p>The size is similar to a concrete structure.</p> <p>Typically the containment will be a portion of an existing building (e.g. a bay in a pole building).</p>	<p>Small</p> <p>Little or no aboveground impact.</p>

Considerations	Concrete Structure	Berm	Building	Drainage Control
Cost	<p>High</p> <p>\$15,000 to \$30,000 (typical WSDOT costs)</p> <p>Cost depends on size, site conditions, site location, and who does the work.</p> <p>Colorado DOT costs for similar structures run \$25,000 to \$40,000. Cost includes site prep, materials (e.g. concrete, pumps, and plumbing), and construction.</p>	<p>Low</p> <p>< \$2000</p> <p>Berms can be made with material on hand (grinding, soil, or GM barrier).</p> <p>Berms may need drain pipes, valves, or sealants.</p>	<p>Low (modification)</p> <p>< \$2000</p> <p>If existing building can be modified without changing structure (e.g. use existing sumps or install curbs).</p> <p>High (new construction)</p> <p>> \$60,000-\$100,000</p> <p>New construction is a capitol improvement.</p>	<p>Low – Moderate</p> <p>< \$5000</p> <p>No cost or low cost if yards has existing drain valves that can be kept closed without creating operational issues.</p> <p>Low cost if existing drainage can be modified by installing valves or drain plugs.</p> <p>Some drainage modifications may require engineer and/or Facilities oversight.</p>
Operational issues	<ul style="list-style-type: none"> - Frequent release of water at some sites 	<ul style="list-style-type: none"> - May provide containment for other products - Frequent release of water at some sites 	<ul style="list-style-type: none"> - Limited traffic movement - Shelters employees from weather - May provide containment for other products 	<ul style="list-style-type: none"> - Ponded water may be safety issue (e.g. Ice) - Frequent release of water at some sites - May provide containment for other products
Additional benefits (besides containment)	<ul style="list-style-type: none"> - Vehicle impact - Wind and seismic (if use tie downs) 	<ul style="list-style-type: none"> - Depends on design 	<ul style="list-style-type: none"> - Deterioration from sun - Vehicle impact (e.g. barrier or support) - Limits vandalism 	<ul style="list-style-type: none"> - None

Considerations	Concrete Structure	Berm	Building	Drainage Control
Potential problems with containment	<ul style="list-style-type: none"> - No containment or limited containment if drain left open - May develop cracks - Ponded water reduces containment capacity 	<ul style="list-style-type: none"> - Walls may fail or erode under pressure - May develop cracks - Inadequate seals may allow spill to seep through joints - No containment or limited containment if drain left open - Ponded water reduces containment capacity 	<ul style="list-style-type: none"> - Inadequate seals may allow spill to seep through joints. - Spills may be released when enter building if using door as part of containment 	<ul style="list-style-type: none"> - No containment or limited containment if drain valve left open or cover left off - Ponded water reduces containment capacity
Groundwater and soil protection	Yes	No	Yes	When area is paved
Design Assistance	Typical drawings are available.	Guidance Section 4.3	Guidance Section 4.4	Capacity <u>must</u> be verified by engineer.
Permits	<p>Possible if structure holds more than 5,000 gallons.</p> <p>Not specifically allowed under building codes.</p> <p>Depends on local enforcement.</p>	Not likely	<p>New construction will require permits.</p> <p>Minor modification won't usually require a permit.</p> <p>Coordinate with Facilities where appropriate.</p>	<p>Depends</p> <p>Installing drain plug or stop valve at the outlet does not require a permit.</p> <p>Modification of an existing piped systems may require a permit.</p>

4.3. Guidance for Constructing Containment Berms

- Berms should be constructed of material that stops the movement of deicer (e.g. asphalt grindings, concrete barrier, or compacted soil).
- Berms constructed of concrete barrier must be sealed at the joins to prevent the movement of product.
- Berms should be well compacted so if a tank failure occurs the berm material will stay in place.
- The base of the berm should be wider than the top. Berms should not be steeper than 1 foot vertical to 1-1/2 feet horizontal. Slope of 1:2 or 1:3 are recommended.
- Berms should be less than three (3) feet tall. Berms that are two (2) feet tall or less are recommended.
- If the site is located in an area where precipitation ponds inside the berm, the berm should have a manually operated drain at the low point to release rain water and snow melt.
- Drain valves that release water from the bermed area must be closed when there is product in the tank.
- An anti-seep or poured concrete collar should be installed around drain pipes that run through compacted soil. The collars reduce erosion around the pipe.

4.4. Guidance for Buildings Used to Provide Secondary Containment

- Existing structures may be modified to provide secondary containment.
- New construction must be authorized by WSDOT Facilities and may require capital funds.
- Building floor drains must be dead end sump or go to sanitary sewer.
- If building drains go to sanitary system, notify the municipality that deicer has the potential to enter the municipal system.

Buildings may be used provide other benefits besides secondary containment.

- Reduce sun exposure
- Protect from vandalism
- Keep snow and rain out of containment structures
- Shelter employees from weather

5. Maintenance and Replacement of Deicer Tanks

5.1. Deicer Tank Maintenance BMPS

Tanks must be monitored for stress cracks. Stress fractures typically develop near the bottom of the tank. Visually inspect the exterior of the tank for obvious defects each time the tank is filled. If the age of the tank is not known, the tank should be assumed to be over five years old and the tests listed in Section 5.2.3 should be conducted. Elevated temperatures can accelerate deterioration and weaknesses. Stress cracks should not be ignored. Details on routine inspections are listed in Section 5.2. Replacement guidelines are listed in Section 5.3.

Sight tubes, if used, should be protected from impact and frequently inspected for deterioration.

Fittings and pipes must be checked at least annually. Check fittings for tightness (don't over tighten). Replace gaskets when brittle or when tightening the fitting does not fix seepage. Replace fittings as needed. A detailed description of annual inspections for pipes and fittings is in Section 5.2.2.

5.2. Routine Inspections of Deicer Tanks

Stress cracking, brittle, spongy, or discoloration of tank wall material, and excessive swelling or deflection of a tank wall all are indicators of tank deterioration. Similar indicators of deterioration may occur at fittings, gaskets and connectors.

5.2.1. Monthly Visual Inspection

Visually inspect tanks, piping, and secondary containment monthly. During the visual inspection of tanks and piping look for:

- cracks of any kind
- separation of components
- breaks in piping
- evidence of leaks
- discoloration (deicer soaking into the tank)
- physical damage (e.g. impact, gouges, bulges, or dents)
- vibrating or flexing portions
- foundation and supports

Repair or replace damaged components where appropriate. Tank replacement guidelines are listed in Section 5.3.

5.2.2. Annual Inspection of Piping and Equipment

Exposed piping, joints, welds, and connections must be examined at least annually for degradation, misalignment, and tightness.

Annual inspections are intended to be more comprehensive and detailed than monthly visual inspections. Typically annual inspections will occur while preparing for the winter maintenance season.

1. Examine pipe runs for leaks, drips, or unusual moisture.
2. Examine pipe joints and connections (e.g. flanges and flange gaskets) for misalignment, tightness, and deterioration.
3. Check pipe systems for deficiencies resulting from vibration, expansion, contraction, settlement, or impact.
4. Insure pumps and all other equipment function properly.
5. Inspect pumps and other equipment for leakage, fouling, corrosion, and wear.

Replace or repair pipes and equipment as appropriate.

5.2.3. Annual Physical and Stress Crack Inspections for Tanks Over 5 Years Old

Physical Inspection

Inspect the tank for any cuts, permeation, bulging, softening, or becoming brittle. Other things to look for:

- webs of cracks (excessive brittleness)
- deformation that is different than normal expansion (swelling)
- spongy tank walls (softening)
- discoloration of the tank wall (permeation)
- deep crack or gouges

Some cracks and gouges can be repaired. Adding a tank “girdle” or metal banding at the bottom of the tank will not help control deterioration.

Stress Crack Inspection

1. Choose an area of the tank where cracking is likely to occur (e.g. near the top of the tank, on the lower sidewall, or near fittings and connections). Cracking is more likely to be found where the tank has the most exposure to the sun.
2. Use a black, water-soluble marker to fill in an approximately 3 inch square area.
3. Before the marked area dries, quickly rub off the excess ink with a soft cloth.
4. Stress cracking will show up as a web of fine lines. Small UV cracks may appear near the surface, but are usually not very deep. Impact cracking and damage may also show up using the marker ink test

Repair or replace damaged tanks where appropriate. Tank replacement guidelines are listed in Section 5.3.

5.2.4. Circumference Measurements

1. Measure the circumference of the tank (distance around) at a fixed height (e.g. 2' from bottom of tank) the first time the tank is filled to capacity after installation.

This is the baseline measurement. Future measurements should be taken at the same height.

2. Measure the tank at the same fixed height every five years. The tank should be full when the measurement is taken. Ambient air Temperature may affect the measurement.
3. If the circumference measurement is more than 1% but less than 2% of the baseline measurement, take circumference measurements every two years.

Replace damaged tanks where appropriate. Tank replacement guidelines are listed in Section 5.3.

5.3. Deicer Tank Replacement

If any of the following conditions are observed during any of the tank inspections, the tank must be taken out of service.

1. If there is a crack at least 2" long with a depth of more than 1/3 of the thickness of the tank shell in the area of the bottom 25% of the tank.
2. If there is crack at least 4" long with a depth of more than 1/3 the thickness of the tank shell in the area of the top 75% of the tank.
3. If any significant brittleness or softness is noticed in the area of the bottom 25% of the tank.
4. If the circumferential measurement is greater than the baseline measurement by more than 2%.

The absence of any of the above criteria does not guarantee the tank is structurally sound.

Where appropriate, use best professional judgment, consult the tank vendor, or have the tank tested by a third party to determine if a tank is fit for use. Bulges or localized discoloration, though not noted above, can indicate a problem. Additional inspections (e.g. acoustic emission testing or ultrasonic testing) can be performed by professional testing companies.