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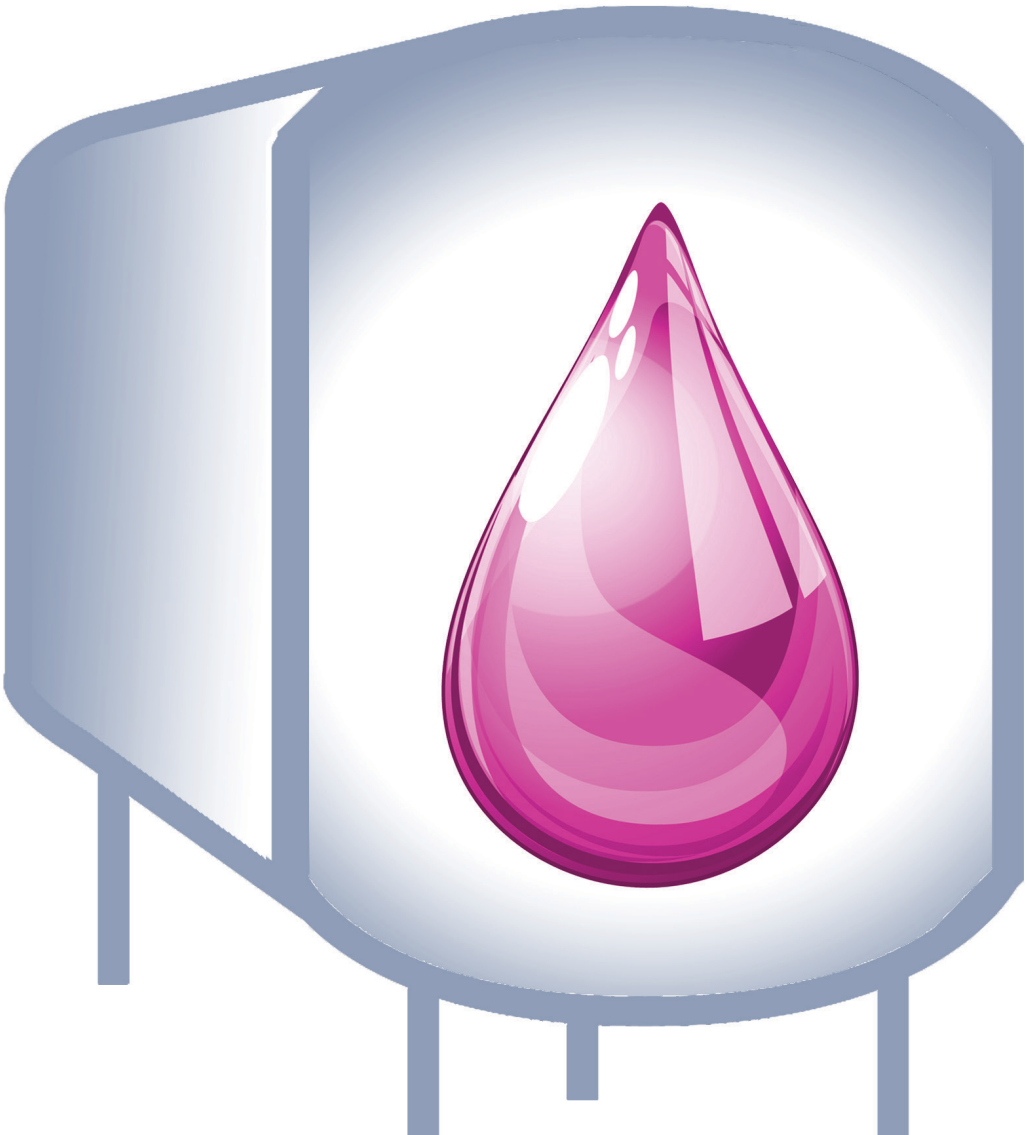
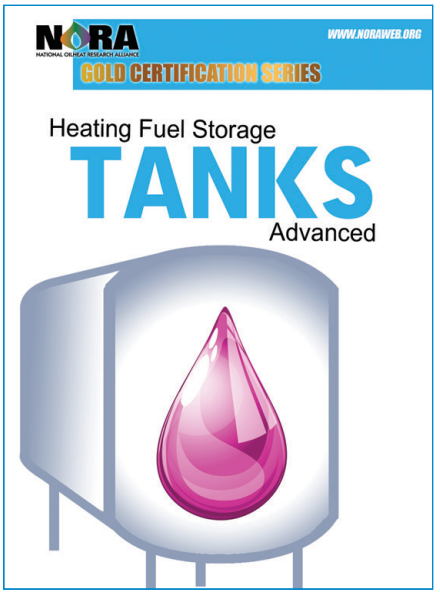
GOLD CERTIFICATION SERIES

Heating Fuel Storage TANKS Advanced





This publication is designed to serve as a training guide and to be used in conjunction with a course taught by a qualified instructor.

The reader should use local codes and manufacturer's specifications and instructions in setting up and maintaining storage tanks and systems.

The authors and NORA have attempted to present accurate information. However, NORA does not make any representations or guarantees and does not assume or accept any responsibility or liability with respect thereto.

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Introduction

In this manual we will be addressing both underground storage tanks **(UST)** and above ground storage tanks **(AST**). ASTs can be found in basements, garages, crawl spaces, sheds and outdoors.

A properly installed and maintained storage tank is an extremely safe and efficient way to store power. A full 275-gallon tank holds over 34 million BTUs of potential heat in the fuel itself. This is equivalent to more than 11,000 kilowatts of electricity. All this energy is at the customer's ready disposal day and night.

This on-hand power contributes to Oilheat's deserved reputation for comfort, cleanliness, safety and efficiency.

However, it is critical the storage tank be properly selected, installed and maintained. Also, homeowners must be aware that the tank is their property and their responsibility. Working with their fuel provider, they can be confident of many years of worry-free service.

This manual, the companion to the *NORA Gold Series Advanced Tank* course & certification provides recommended practices for tank choice, installation, maintenance, inspection and more. It also functions as a self study guide. It is designed to assist the industry to embrace implementation of good tank management programs.

Chapter 1

Why Tanks Fail

Why is it some storage tanks have lasted for over fifty years while others fail in less than one year? Are some individual tanks that much better or that much worse than similar tanks made by the same manufacturer, in the same plant, at the same time?

Research indicates that most tank failures can be attributed to one of four reasons. In order from the most likely to the least likely:

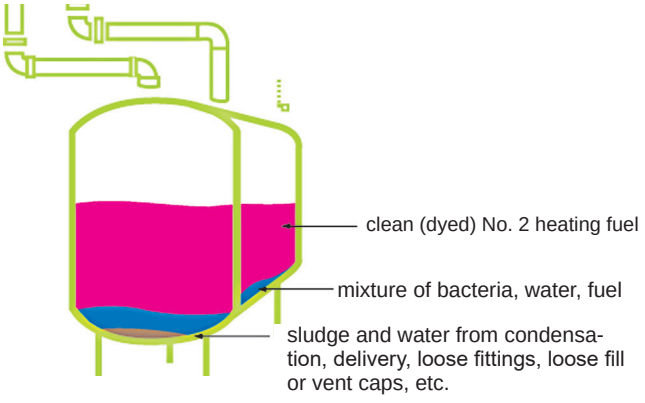
1. Corrosion
2. On-site damage
3. Transportation damage
4. Manufacturing defects

1. Corrosion

Internal corrosion is the main cause of AST tank failure. Regular tank maintenance, including checking the tank for the presence of water, should be recommended to all customers. The presence of water in the tank can contribute to corrosion in several ways. Fuel storage experts report that bacteria can live in the water and feed on the fuel. The bacterial by-products can be a catalyst for the creation of a biologically active sludge that can accelerate the rate of corrosion of the tank and other components of the system. This is known as microbial induced corrosion.

The liquid in the tank will typically separate into three layers:

- The top layer is the clean fuel
- The second layer is a mixture containing bacteria, water and fuel
- The third is sludge and water from condensation, delivery, loose fittings, loose fill or vent caps, etc.



Results of recent studies suggest the bacteria in the second level often excrete substances that are acidic. These substances can combine with moisture and form compounds that negatively affect fuel quality, the steel tank bottom and system components.

Keeping water out of above ground heating oil storage tanks will help maintain fuel quality, reduce the frequency of service issues and help prevent corrosion related component failures.

While this isn't always as easy as it sounds, there are several simple things that can be done to reduce the accumulation of water in tanks and help minimize risk of corrosion:

- **Make sure all tanks are fully drained before being installed.** Tanks can accumulate significant amounts of water during storage and shipment even when plugs are placed in the tank tappings. Any time a tank is installed with accumulated water it invites trouble that can affect the tank's longevity.

- **Keep tanks full during the summer months.** NORA's research has shown that when ASTs are left less full over the off season, condensation is increased. Condensation can generate about 1 quart of water in tanks that are left ¼ full during the off season. Topping off tanks in late spring can help reduce the amount of water generated by condensation.

- **Install tanks inside whenever possible.** Outside ASTs accumulate significantly more water than inside tanks because they are subject to wider range of temperature. As outside tanks are warmed during the day and then cooled at night, they accumulate more water from condensation than similar tanks that are installed inside where temperature changes are minimal.

In instances where an inside tank cannot be accommodated, encourage the customer to consider protecting the outside tank with an enclosure. Some manufacturers make integrated tank units designed for outside installations. In addition to the aesthetic benefit, the enclosure shades the tank and helps reduce the impact of wide temperature swings.

- **Do not pump the fuel from a tank being replaced into a new tank.** Transferring fuel from the tank being replaced into the new tank also transfers existing contaminants from the old tank into the new tank. This can lead to premature tank failure, regardless of whether the tank being replaced is located underground or above ground. USTs seem to generate less condensation and have less internal corrosion. Bacteria usually thrive in warm environments, such as within an inside tank or an AST exposed to the summer heat.

Customers often object to disposing of the fuel in their tank. Try to schedule non-emergency tank replacements at a time when the tank being replaced will have less fuel in it, generally less than ¼ of a tank. This remaining volume of fuel should be disposed of properly. When larger volumes of fuel are present, or the replacement is being performed on an emergency basis, the use of a temporary tank on-site is a viable alternative. While a temporary tank seems expensive in the short-term, the longer-term benefit of extending the life of the new tank will prove worthwhile.

- **Be vigilant for signs of water in tanks during service calls and tune-ups.** Inspect the condition of filters, filter canisters, pump strainers and pump components for the presence of water and for evidence of water, such as rust. Evidence of water in the fuel system can indicate there is an accumulation of water in the tank. In addition to causing 'no-heat' conditions, accumulated water can affect fuel quality and can cause service issues.

Tanks installed with direct fill pipes, such as USTs or ASTs installed outdoors, can usually be checked for water using a tank gauge stick and water indicator paste. Water is heavier than the fuel and generally settles at the lowest part of the tank. In assessing an AST, try to gauge it where the bottom of the tank is at its lowest point. As stated, condensation is a water generator for ASTs.

With USTs, water accumulates due to mechanical failure of components such as fill caps, fill cap gaskets and vent caps. Less seldom, a broken or corroded fill or vent pipe may provide a means of surface water to enter.

Checking basement tanks for the presence of water presents a unique set of challenges. In some cases the tank is not pitched towards the bottom fitting and in other cases this fitting was plugged at the time of installation.

Tank top component removal to facilitate tank gauging should only be undertaken when evidence exists that water may be present (excess water in the filter, rust in pump cover

Fills that are flush to the ground, fills with missing caps, broken tank gauges and vials are among the common causes of water entry. These situations should be corrected to ensure a watertight seal.

or filter canister, etc.). Removal of tank top fittings requires those fittings be properly sealed after the gauging is completed to assure tank integrity is maintained.

When checking any tank for water, the burner should be off. Water finding paste should be applied to the bottom several inches of the side of a tank gauge stick adjacent to the side with the measurement increments embossed. Whenever possible, a non-folding gauge stick should be used. Fully insert the gauge stick into the tank until it touches the bottom. Leave the stick at the bottom for about 30 seconds. If water is present, the paste changes color to the height of the accumulated water.

When trace amounts of water are detected, complete removal may be impossible, but every effort should be made to reduce the level.

All the paste has changed color indicating that the water level may be higher than indicated. Paste should be cleaned off and reapplied to a higher level to determine the actual level of water in the tank.

Much of the focus with water in the tank has been on condensation. However, anytime water is identified in a tank it is important to inspect the tank system, identify any means of water entry and advise the customer of recommended repairs.

Pumping out the water doesn't correct the situation, it merely treats the symptom. Sometimes, accumulated water is the result of other problems with the tank or its components.

When a measurable amount of water is identified, it should be removed, the source determined, and the problem corrected so that a reoccurrence is prevented.

External Corrosion is the main cause of failure of unprotected USTs. It occurs when the moisture and oxygen in the soil around the tank, along with other elements in the soil, lead to corrosion of the tank.

ASTs are also subject to external corrosion due to contact with walls, structures, soil, organic matter, etc. Manufacturers' instructions provide valuable information regarding tank placement and recommended maintenance.

2. On-site Damage

On-site damage is easily prevented when proper handling, installation and maintenance procedures are followed.

Some manufacturers suggest that damage inflicted during installation and damage from delivery practices may be a greater cause of tank failure than corrosion.

To prevent the occurrence of on-site damage tanks should be:

- installed in full compliance with manufacturer instructions and NFPA recommended practices
- properly secured and supported
- protected from weather
- regularly inspected

Observed defects should be corrected as soon as possible.

3. Transportation Damage

This occurs when tanks are mishandled during transportation from the factory, warehouse and/or from the supply house to the job site.

To prevent transportation damage, tanks should always be secured during shipping and handled with care when being loaded and unloaded. When tanks are pushed along the truck bed or dropped from the truck, the tank's structure can be weakened and the tank often suffers visible damage.

4. Manufacturing Defects

This accounts for the lowest percentage of oil tank failures. UL listed tanks are tested to ASME standards and most must pass a series of tests before being shipped. Thus, the majority of defects are discovered before a tank leaves the factory. The defective tanks identified through testing are not shipped to a distributor.

Preventing Premature Tank Failure

The best way to ensure tanks perform reliably is to make sure that everything is done correctly:

- **Secure tanks during transport** to the job site and use the proper equipment to load the tank on the truck and place the tank in position at the job site to eliminate most transportation damage

- **Properly install tanks**: follow manufacturers' installation instructions and NFPA recommended practices. Install above ground tanks inside or protect them in an enclosure to eliminate much on-site damage

- **Eliminate accumulated water** to greatly reduce internal corrosion

An outdoor tank enclosure can help avoid problems.

Chapter 2

Codes and Regulations

When installing a new or replacing a fuel storage tank, keep in mind that applicable OSHA guidelines, environmental regulations, fire codes and the rules and regulations of the local authority having jurisdiction must be followed. The installer must adhere to the authority's regulations regarding the size, type, location and construction of the tank, the piping and the accessories.

Installations are subject to the requirements of two national codes, one published by The National Fire Protection Association (NFPA) and the other published by the International Code Council (ICC).

Copies of current NFPA regulations can be obtained by calling 1-800-344-3555 or found on their website, *nfpa.org*

Generally, NFPA 31 *Standard for the Installation of Oil Burning Equipment* covers the installation of above ground tanks under 660 gallons and NFPA 30, *Flammable and Combustible Liquids Code* covers the requirements for the installation of ASTs larger than 660 gallons and all USTs.

Copies of current ICC regulations can be obtained by calling 800-786-4452 or found on their website, *iccsafe.org*

Once it is determined which particular national code is used by the local jurisdiction, verify the revision date of the code currently adopted by the jurisdiction. The national model codes are revised every few years and unfortunately do not identify what revisions were made to the previous code. Following the revision currently being enforced by the local authority helps avoid issues with approval of the completed installation.

Also keep in mind local authorities may adopt a national code and then adjust it for various reasons. For example, areas subject to seismic issues, windstorms, heavy snowfalls or flooding often have additional requirements. In addition, commercial sites with a total tank capacity of more than 1,320 gallons are subject to Federal EPA Spill Prevention, Control and Countermeasure (SPCC) regulations.

Remember, it is the correct edition of the required code; along with any state and/or local amendments, ordinances and requirements that must be followed.

Chapter 3

Storage Tank Selection Criteria

Before installing a new or replacement tank consider the factors that will affect the tanks performance over its service life. These may include:

1. What size should the tank be?
2. What regulations govern the installation?
3. Where will the tank be installed?
4. What factors will affect tank corrosion?
5. What type of tank is best suited for the site?

After investigating each of these factors, discuss your recommendations with the customer.

NORA suggests the best way to properly size a fuel storage tank is to estimate **annual fuel consumption** then **divide by 3.**	
Customer is expected to use 1,800 gallons	*Formula:1,800 ÷ 3 = 600* A 500 gallon tank or two 275 gallon tanks will suffice.
Customer is expected to use 1,000 gallons	*Formula: 1000 ÷ 3 =333* A 275 or 330-gallon tank will suffice.
Customer is expected to use 750 gallons or less	*Formula: 750 ÷ 3 = 250* A tank no larger than 275 gallons is recommended.

1. Tank Size

Tanks for permanent installation are available in many shapes and sizes, from slightly over 100 gallons to well over 1,000 gallons. The 275-gallon AST is the most common tank in residential use.

Historically, there have been no widely accepted guidelines regarding selecting the tank size for a particular building. The consensus is the tank should be large enough to minimize delivery frequency and small enough to ensure the fuel doesn't sit dormant for long periods.

The home heating industry is now frequently relying on the use of above ground tanks as the preferred method of storage. Underground tanks are commonly being replaced with smaller capacity above ground tanks. When a larger tank storage system is needed, configurations of multiple ASTs are used.

While smaller tanks do require more frequent deliveries, their use is helpful in reducing the time fuel resides in storage. Heating fuel is susceptible to a natural aging process influenced by heat, oxygen, microorganisms, metals and oxides. When these influences combine with moisture, either from condensation or from water suspended in the fuel, an environment for incubating tank sludge can be created. This sludge can get in the piping, the filters, the pumps, and the nozzle causing operational problems. This is the primary reason regular removal of accumulated water is recommended throughout this guide.

Using the formula in the table above helps assure the fuel in the tank is reasonably fresh and resources are not challenged by excess deliveries. Of course, there are unique situations that may warrant changes, including location of the tank and the customer's preference or concerns.

The key is to balance delivery frequency with reasonable product turnover so aging of fuel is minimized.

Keep in mind that even with this method of sizing, at any given time some of the fuel in the tank will be over a year old. In the case of a UST or an AST with the fuel supply line piped through the top, a portion of the tank contents, including fuel residues and oxidized fuel, may be much older.

In areas close to salt water, such as beach communities, it may be prudent to install even smaller tanks and monitor for water accumulations more frequently. This aides in minimizing increased corrosive effects from the tank "breathing" salt air.

2. Regulations

Always follow the regulations from the local authority having jurisdiction, including those for setbacks and clearances.

There are requirements for distances from:

- ☑ Fuel fired equipment
- ☑ Property lines
- ☑ Buildings, doors and windows
- ☑ Air intakes
- ☑ Gas and electric service ports
- ☑ Combustion exhausts

3. Location

Tanks can be installed indoors or outdoors. Outdoor tanks can be installed either above the ground or underground.

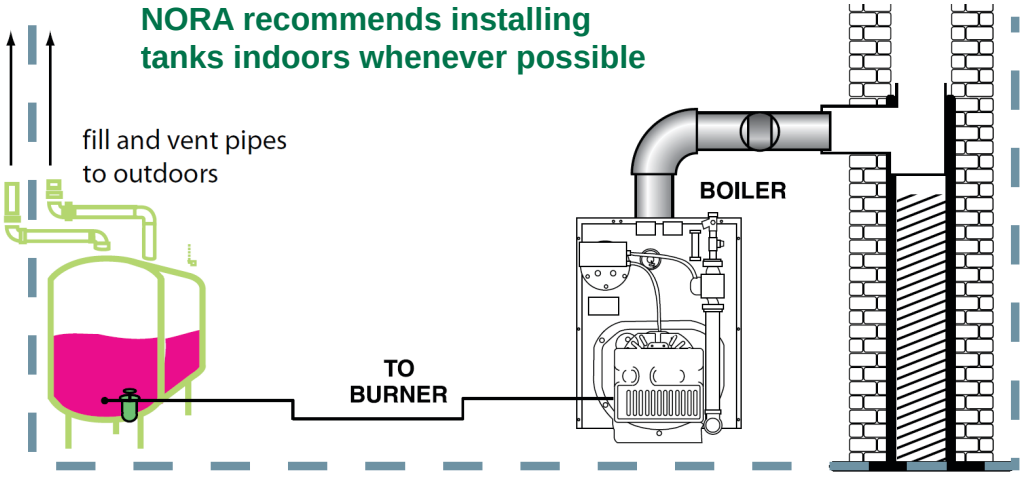
Where space and applicable regulations allow, NORA believes the benefits associated with indoor installation support the policy of installing tanks indoors whenever possible.

Take the following into consideration when selecting a tank location:

Proximity to drains, wells and or water courses: The tank and/or the associated piping should be located so that, should an accidental release occur, fuel will not have a pathway to a surface water body, an onsite potable well, a storm drain system or a septic system.

Installers should ask the homeowner to identify any yard drains, sump pits, foundation drains, wells or septic systems on the property. Basement sump pump pits and foundation drains can provide a pathway for the fuel to travel when a release occurs from an indoor tank.

The tank location, piping configuration, siphon potential and containment alternatives



are just a few of the items that may need to be considered. If the sump is the type that relieves water pressure from beneath the floor, creating a lip around the sump above the floor surface may be all that is needed to prevent the fuel from entering.

Adding a lip around the sump can prevent fuel from entering.

The distance from the closest safe place for the delivery vehicle to park. Remember to consider the length of the delivery hose and that the hose must be able to reach the fill in all weather conditions.

Protect tanks and piping from weather and physical damage.

The accessibility of the tank for inspection and servicing the tank and its components needs to be considered. In general, it's best to discourage the installation of tanks in locations that impede ease of inspection. Areas that may present the risk of accelerating corrosion should also be avoided.

Accessible above-ground tank installations have an advantage over in-ground installations in that:

- when properly installed and prudently located, it's relatively easy to conduct a tank inspection
- areas of concern can be quickly noticed and corrected
- above ground-tank installations are less costly than in-ground tank installations

4. Corrosion

Factors that cause corrosion should always be taken into consideration when selecting the best type of tank for a particular location.

For USTs, NFPA requires the tanks be protected from exterior corrosion by a properly designed, installed and maintained cathodic protection system, special coating, or fabricated from an approved or listed corrosion resistant material or system. Fiberglass tanks can be used and steel tanks manufactured to the Steel Tank Institute sti-P3 standard or ACT 100 and ACT 100U standards meet the requirement.

If an indoor installation is not viable or the customer prefers having the tank installed outside and above ground, the location should be based on regional weather patterns or conditions and the elements that most affect external corrosion.

It is best to situate the tank where the effects of radical temperature change can be avoided. A shady spot that has some protection from weather is ideal. Long exposure to direct sunlight contributes to temperature swings that

Do NOT install an AST underground
and
Do NOT install a UST aboveground.

accelerate the creation of condensation. Additionally, long exposure to direct sunlight subjects the tank coating to damaging UV rays.

The selected location should provide sufficient room to inspect all the sides of the tank, sufficient room to avoid debris or snow and ice from collecting on the tank and sufficient access to facilitate keeping the area beneath the tank free of debris.

In some instances, suggesting the customer consider having the tank installed within an enclosure or recommending the customer consider a non-metallic tank system can help minimize the risk of premature tank obsolescence.

5. Tank Type - Above Ground

Standard Steel Tanks

Above ground steel tanks are generally available in sizes from 120 gallons to 330 gallons. Current manufacturing technology includes an updated head design that improves both tank performance and resistance to accidental over pressurization.

Many above ground steel tanks are now manufactured with an electrostatic powder coated finish. Tanks that are manufactured with only a coat of primer paint should be painted with an industrial quality coating before or during installation.

Standard steel tank

The 275 gallon or the 330 gallon tanks manufactured to the UL 80 standard are the most common in use for homes. The UL 80 tank is designed for the storage of fuel both inside basements and outside above ground. They are typically 'ob-round' to facilitate fitting through doorways and stairways to basements.

A "standard" UL 80 275 gallon tank is approximately 27" x 44" x 60" and stands either horizontally or vertically.

Manufacturers also make tanks in slightly different dimensions to accommodate installations challenged by limited basement accesses or narrow doorways.

Cylindrical tanks and tanks manufactured to the UL 142 standard are also available, but these are not as common as the 275 ob-round.

It is important the UL label on the tank be read and followed. Tank manufacturers specify that tanks should be inspected and drained of water annually. It is important to make the tank owner aware of this.

UL-80 label affixed to storage tank.

Tanks were manufactured of various gauge steel over the years. The current UL 80 standard requires a minimum of 12 gauge steel thickness (0.1046 inches). Older tanks may have been fabricated of 14 gauge steel. These tanks are almost 25% thinner than what is mandated today.

A UL 80 tank must have a ½" (minimum) outlet underneath the tank to facilitate water draw off. When this tapping is used for the fuel supply connection, it also serves as a bottom draw off for any water in the tank—provided the tank is properly pitched.

If the tapping is not used for the fuel supply to the burner, it should be piped to facilitate removal of water. Merely making the fitting liquid tight by the insertion of a plug defeats the purpose of the design. Typically the tank top is fabricated with either three or four 2" fittings to accommodate the fill piping, the vent alarm and vent piping, the level gauge and the fuel line(s) when a single pipe configuration from the bottom draw off is not used.

The typical UL 80 ob-round tank is supported by 1¼" pipe nipples threaded into the leg brackets integral to the tank.

UL 80 tanks designed for the mobile home market and other specialized situations are available. Some designs presume the tank may be installed beneath the mobile home. While this provides the benefit of protecting the tank from weather conditions, installations of this nature can impede future inspection and removal of any accumulated water.

Externally coated steel tank

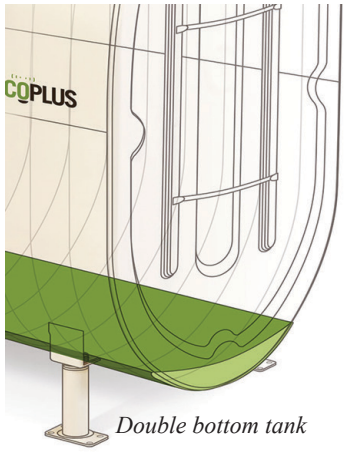
Always check with the tank manufacturer for a copy of their current tank installation instructions.

For example, Granby UL-80 Tank Installation Instructions can be found at *granbyindustries.com/wp-content/uploads/2017/11/SI0015_Ea-UL-80-installations-and-maintenance-guidelines.pdf*

Externally Coated Steel Tanks

The majority of UL 80 tanks available today are fabricated with an exterior finish coating applied to the steel. Manufacturers also offer tanks with external polyurethane coatings that better protect the outside of the tank from rusting and corroding.

Double bottom tanks



Double bottom tank

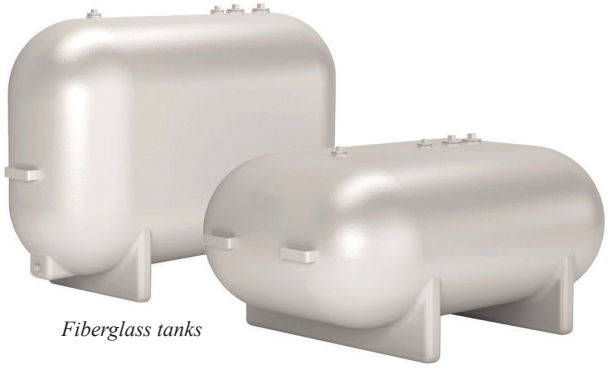
Another improvement to UL 80 tanks is the "double bottom" tank with interstial space leak detection monitoring. These tanks have a second bottom to contain a leak should internal corrosion create a breach of the primary tank steel. A sensor installed in the interstitial space triggers an alarm and notifies that the inner tank has been compromised.

"Polyethylene within steel" tanks

Above Ground "Polyethylene Within Steel" Tanks

These systems are comprised of two separate but integral units. The primary interior storage tank is constructed of seamless polyethylene which is both compatible with heating fuel and is not electrically conductive, thus it is not susceptible to the electrochemical mechanics of corrosion.

This tank is within a secondary galvanized steel enclosure which provides structural support for and protection of the polyethylene tank while providing secondary containment should the polyethylene tank leak.



Fiberglass tanks

Roth Tank Installation Instructions can be found at: *roth-usa.com/PDF_Download_Files/DWT%20Installation%20Manual%202017.pdf*

Granby 2 in 1 installation instructions can be found at: *granbyindustries.com/wp-content/uploads/2017/04/si0018-fa-granby-2-in-1-in-stall-instructions.pdf*

Above Ground Fiberglass Tanks

Above ground fiberglass tanks are available for both indoor and outdoor installations. These UV and fire resistant tanks do not corrode.

They are available in 240 and 300 gallon sizes as well as both single wall and double wall construction. The double wall model has a visual sight glass to facilitate inspection.

The dimensions of these tanks are slightly different from those of the standard 275 gallon ob-round tanks.

Capacity	Length	Width	Height
240 US Gallons	65"	24"	53"
300 US Gallons	80"	24"	53"

Granby above ground fiberglass tank installation instructions can be found at: *granbyindustries.com/wp-content/uploads/2017/04/SI-0152-rev-1a.pdf*

Tank Type - In Ground

NFPA 30 stipulates that underground storage tanks and their piping be protected from corrosion. Unprotected steel tanks are not compliant with the requirements of the major code bodies.

While these tanks provided many years of secure storage age, combined with the inability to visually inspect them, resulted in tank failures along with other issues this guide seeks to address.

Tanks manufactured of 10 gauge steel meet UL 58 criteria for underground installations, however, NORA recommends 7-gauge sti-P3, ACT-100® or fiberglass tanks.

sti-P3

sti-P3 tanks are steel tanks protected with a factory installed corrosion protection system designed by the Steel Tank Institute. They carry a standard 10 year warranty (an optional 30 year warranty is available) against failure due to corrosion.

These tanks feature a three part protection system:

- an exterior polyurethane, fiberglass reinforced plastic (FRP) or coal tar dielectric coating
- factory installed electrical isolation bushings in the tank fittings
- sacrificial anodes designed to provide protection of exposed steel in the event of an isolated coating failure

sti-P3 tanks are available in single and double wall configuration. Double wall models allow for leak monitoring by means as simple as manual gauging of the interstice through the access tube when it is extended to grade.

The sacrificial anode protection needs to be tested at installation and periodically thereafter. Owners of sti-P3 tanks should contact a tank inspection service provider or certified cathodic protection tester for the testing.

sti-P3 tank

ACT-100 tank

ACT-100

The ACT-100 uses an advanced multi-component fiberglass reinforced plastic (FRP) coating applied directly to the exterior of the steel tank shell to provide corrosion protection. Since the 100 mil, high impact, abrasion resistant coating is significantly thicker than the coating of a sti-P3, the tanks are not equipped with sacrificial anodes.

ACT-100 tanks are also available in single or double wall configuration.

ACT-100-U

The ACT-100-U is another version of a coated steel tank. In this case, a 70 mil coating of urethane is used to isolate the steel from the electro chemical mechanisms of corrosion. Like the ACT-100, the tank is not equipped with sacrificial anodes and is reliant on the superior coating for corrosion protection. The urethane is thinner and softer than the FRP coating of the ACT-100, a protective material is installed beneath the tank to cushion it on the backfill. The ACT-100-U is also available in both single wall and double wall configurations.

In Ground Fiberglass Tanks

Fiberglass reinforced plastic (FRP) tanks are available in the U.S. for underground installation. FRP tanks do not rust because they are made of corrosion-resistant materials eliminating the possibility of leakage due to either internal or external rusting.

Chapter 4

Installation Procedures

All heating equipment must always be installed in accordance with manufacturers' instructions and the regulations of the local authority having jurisdiction. As with all mechanical trades, installation of the equipment requires that personnel maintain a safe workplace, follow industry safety practices and utilize personal protective equipment as appropriate.

The following pages highlight and emphasize some key requirements for a well-installed tank. The recommendations are intended to supplement the instructions published by the manufacturers. The principal focus of these recommendations is to promote practices that help prevent premature failure of newly installed tanks and to promote practices that aid preservation of fuel quality.

When performing tank installation and maintenance always check and comply with the current applicable codes and current manufacturers' instructions.

General Instructions

Transportation and handling

- Never attempt to move a tank with fuel in it
- Tanks should be properly secured and supported during transport to the job site to minimize the possibility of damage. Tanks should be gently handled, never pushed or dropped off a truck. Once at the job site, tanks should be strapped to a hand truck or other suitable device and carefully moved to the installation location

WARNING

Warranty is valid provided manufacturer's instructions are respected.
Warranty certificate and installation and maintenance guide are available at www.granbyindustries.com/UL80

1) ***DO NOT TRANSFER OIL FROM THE OLD TANK TO THIS NEW TANK.***
2) This tank has been pressure tested at factory. Unless local codes dictate otherwise, do not pressure test.
3) Before installation, remove all water and / or ice that may have accumulated during storage of the tank.
4) Install in accordance with the authorities having jurisdiction, local building codes and NFPA 31.
5) This tank is intended for STATIONARY use ONLY.
6) Tilt tank 1/4" per foot TOWARD the bottom opening EVEN IF A TOP DRAW fuel supply system is used.
7) Inspect tank at *least annually* per instructions and regulations from the authorities having jurisdiction.
8) Use water paste dip test to check for accumulated water at least once per year - REMOVE ANY ACCUMULATED WATER
9) Vent pipe diameter must be in accordance with the latest version of NFPA 31.

***** Always consult installation manual for a complete guide to best installation practices *****

Tank manufacturers provide important guidelines for installation. Failure to follow these may void the warranty and lead to unnecessary and preventable problems.

Even with plugs in place, tanks can accumulate water while in storage.

Storage

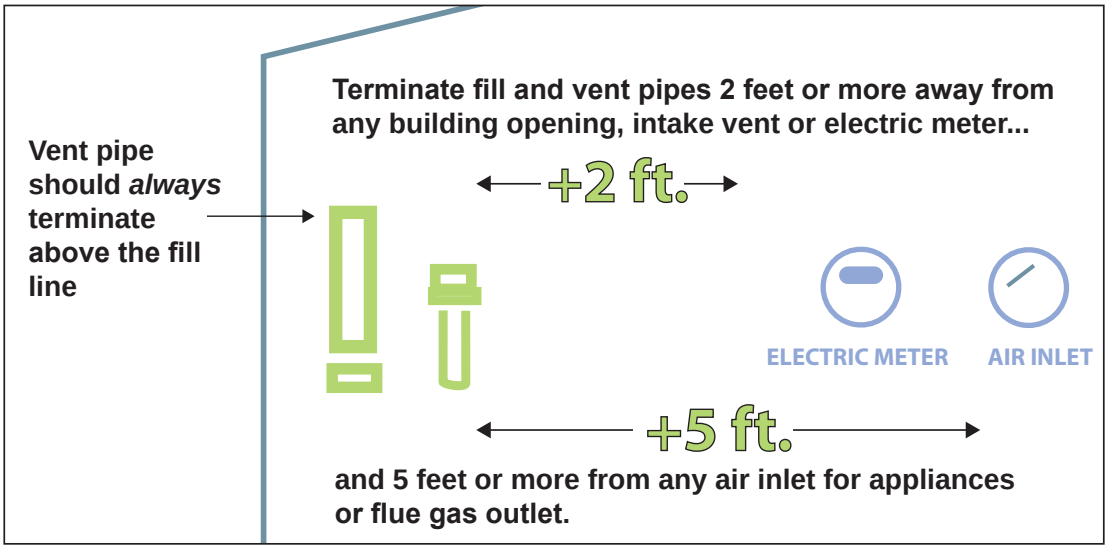
- When storing tanks prior to installation, remove the thread protector inserts and install threaded plugs to keep water out
- It's best to store tanks indoors or in a weatherproof enclosure

Receiving

- Before beginning an installation, always check at the job site to be sure that the tank has not been damaged during manufacturing or shipping. If minor repairable damage such as a small scratch is found, it should be repaired according to the manufacturer's instructions before installing the tank. If the damage affects the integrity of the tank, the tank should not be installed
- Be aware water can be present in a new tank. Even with protective shipping plugs in the threaded tappings, temperature changes can create openings large enough for air and water to enter the tank. Be sure to remove water and/or any other contaminants in the tank before installation

Fill and Vent Piping

- Fill pipes and vent pipes must be minimum schedule 40 wrought iron, steel or brass. Galvanized pipe can be used for above ground tank installations but is not approved for use underground. NFPA 31 also allows "other piping that is part of an engineered fuel storage system that is listed to UL 180"
- Pipe fittings must be schedule 40 and be either malleable iron, steel, stainless steel or brass. The 2020 version of NFPA 31 also lists "press connect type



During the sales process a company representative should explain to the customer why they should purchase fresh fuel to fill the new tanks.

fittings listed to UL 180" as acceptable. The selected fittings material should be compatible with the material selected for the piping. Use of dissimilar metals must be avoided. Cast iron fittings must NOT be used

- All threaded joints and connections must be made liquid tight using a suitable pipe joint compound. **Not** all Teflon tape is approved. if using Teflon, verify that it is approved for use with the fuel
- Fill pipes and vent pipes must maintain pitch downward towards the tank to prevent traps where fuel can collect. Swing joints should be directionally installed and not incorporate the use of "street elbows'"
- Fill pipes must be at least 1¼" nominal pipe size
- Whenever possible, fill pipes for tanks buried in non-traffic areas should terminate no less than 1' above ground and high enough to avoid being obstructed by ice or snow
- When tanks are under driveways, walkways or lawns, maintenance of fill caps and gaskets is very important
- Fill pipes must be equipped with a metal cap indicating that the tank contains fuel oil
- Fill pipes should be easily accessible and equipped with a water tight fill cap assembly

- Vent pipes require a weatherproof cap with a screen no finer than #4 mesh
- Vent pipes must be at least 1¼" nominal pipe size
- Vent pipes must terminate not more than 12' from the fill pipe and at a point visible from the fill location
- All above ground tanks must be equipped with a vent alarm (whistle)
- Fill pipes and vent pipes must terminate outside the building and be located no less than 2' from any building opening, intake vent or electrical meter and at least 5' from any appliance air inlet or flue gas outlet

Filling

- **Do not transfer** any fuel from an old tank to a new tank. Fuel filtering systems do not remove all the microbes that may be present. Contaminants in aged fuel can accelerate fuel degradation and in some cases, accelerate creation of a corrosive condition inside the tank
- The initial delivery to a newly installed tank should be made while the installer or a qualified service technician is on site and available to inspect the tank and lines and verify the system is leak free. The installer should start the oil burner, test its operation and adjust as needed

Above Ground Tank Installations

NORA recommends indoor installations whenever possible.

Indoor tank installations offer many advantages including:

- Fuel doesn't degrade as quickly when stored at a constant temperature
- Fuel in indoor tanks typically has lower viscosity due to being warmer. This can help maximize combustion efficiency
- The incidence of "frozen" tanks and fuel lines is virtually eliminated
- Indoor tanks generate less condensation

- The potential for damage from vandalism, vehicles or weather is greatly reduced
- Indoor tanks are usually accessible for inspection. Often, when an indoor tank is in the infancy stages of failure, fuel odors can be noticed as the tank becomes slightly porous.

Did you know?

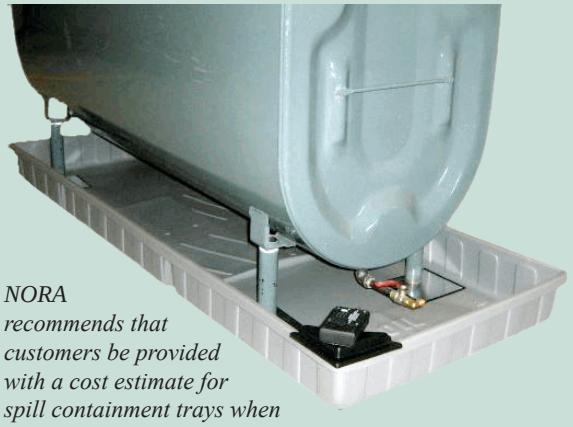
➢ Indoor tanks should be installed on the lowest floor of the building.

➢ Tanks should be installed in areas where they will not be affected by household activities

➢ A full 275 gallon tanks weighs over 2,000 pounds

➢ NFPA requires tanks in flood prone areas be anchored. See NORA's *Recommended Practice for Home Heating Oil Tank Flood Resistance* at the end of this book in Appendix II.

➢ Drip pans are available for installation beneath indoor tanks to contain small drips from valves or fittings, filter replacement, etc.



NORA recommends that customers be provided with a cost estimate for spill containment trays when new AST's are being installed indoors.

Indoor Installation Considerations Standard Steel Tank

Tank site — Indoor tanks should be installed on a poured concrete floor. If a poured concrete floor is not present, a 6" reinforced concrete slab is recommended.

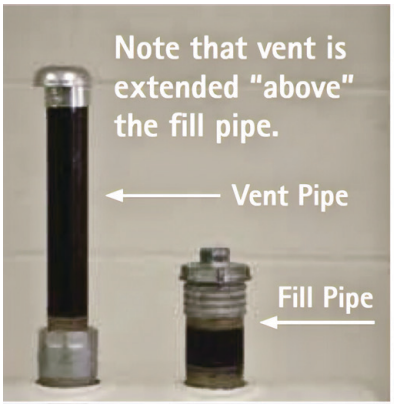
Clearances — The tank must be at least 5' from any open flame or fuel burning appliance. There should be no storage either above or below the tank and it should be placed at least 2" from walls to allow visual inspection from all sides.

Tank legs — 1¼" black iron pipes threaded on both ends to accommodate flanges, should be fully inserted in the leg support brackets. To provide proper pitch and adequate room for the shutoff valve and filter, the pipes should be approximately 10.5" long at the bottom draw-off end of the tank and 12" long at the opposite end. Check all tanks with a level to ensure the tank is tilted to the draw end and adjust for a minimum of ¼" per foot pitch towards the bottom outlet (high end 1.5 inches higher than low end).

Gauge — All tanks should have an approved tank gauge in one of the tappings on the tank.

Fill Pipe — The fill must be piped to the outside of the building and positioned to permit the spill-free delivery of fuel. Install swing joints, configured with nipples and elbows, to maintain the proper pitch on the pipe. Install a 45 or 90 degree elbow on the pipe outside the building and connect the fill box into the elbow or into a nipple extending upward from it. Terminate the fill pipe at least 2' from any building openings and 5' from any appliance air inlets or flue gas outlets. Position the fill pipe so that it's close to the building and high enough to clear any accumulated snowfall.

Vent alarm — Every tank must have a vent alarm installed in one of the tank tappings.



Vent pipe — The vent pipe must be piped from the vent alarm to the outside of the building. Install swing joints to maintain the proper pitch. Install a 90-degree elbow on the pipe outside the building and connect a nipple into the elbow to extend the vent pipe at least 6" above the level of the fill pipe cap. Position the vent pipe so that it's close to the building and close enough to the fill pipe for the vent alarm to be clearly heard during delivery. Terminate the vent pipe in an approved cap at least 2' from any building openings and 5' from any appliance air inlets or flue gas outlets.

Tappings — Install plugs in any unused top tappings. If the tank has a NPT opening on the bottom and the fuel lines are installed through the top of the tank, it's best to install a valve so that any accumulated water can be easily removed. The valve should be left closed with the handle removed AND plugged to reduce the possibility of fuel draining from the tank inadvertently.

Burner supply — Install a fusible link safety shutoff valve into the ½" threaded bung on the bottom of the tank. Install the filter after the shutoff and connect to the burner with a new coated copper tubing or a steel pipe supply line.

Outdoor Above Ground Tank Installation Considerations

- Outside ASTs must be installed on a rigid, non-combustible base. Generally, 6" of reinforced concrete is acceptable. In some areas prefabricated concrete slabs are also permissible. The tank should be attached to the base
- Outside above ground tanks require a vent alarm
- Tanks should not be located in places where they may be subject to damage

Any valve installed in the bottom of an outdoor tank should be of a type that will not crack or break if it has filled with water and then freezes.

from ice, snow or dripping water. Check for eaves, gutters and downspouts when locating a tank

- Tanks must be secured and supported to prevent settling, tipping, sliding, floating, or lifting. Special precautions must be

taken in flood prone areas and ballasting requirements may necessitate a larger slab to ensure that the tank is protected against flotation. NORA and NFPA have developed *Recommended Practices for Home Heating Oil Tank Flood Resistance*. These practices, found Appendix II are also included in the annex of the 2016 and later editions of NFPA 31

- Outdoor 275-gallon above ground tanks must be at least 5' from adjoining property lines
- Tanks must be positioned at least 2" away from any wall or structure. Advise the customer to keep this space and the space beneath the tank clear of any debris
- Horizontal tanks are less likely to tip over than are vertical tanks
- If tanks are installed in an area where vehicles are parked or where traffic flow is possible, protection from vehicular impact is a necessity
- Tanks must not block access to doors, windows, utility boxes or meters
- It is wise to locate tanks away from drains or drywells so as not to provide the stored product a path should a leak occur

Spill Protection for Above Ground Tank Installations

Indoor Installations

When tanks are installed above ground indoors, the use of tank trays beneath the tank can help mitigate housekeeping and nuisance calls. Particularly when the fuel filter and/or other components are located at the tank. The tank tray catches spillage which occurs during routine servicing and is easily cleaned, reducing complaints of odors. Also, AST failure is often preceded by tiny tank leaks, commonly referred to as "weeping." Any drips from the initial stage of tank failure are easily contained in the tank trays, minimizing unsightly staining beneath the tank and residual odors.

A tank tray fitted for an existing tank

It is a good practice to let customers know these units are available and installation of a tank tray is recommended when replacing an indoor tank. Alarms are also available. The alarm is tripped when fuel collects in the tray alerting the homeowner that a problem exists before serious damage has occurred.

Outdoor Installations

Outdoor above ground tanks are subject to additional conditions which can shorten tank life and compromise fuel quality, including:

- Severe temperature swings
- Potential coating damage from adverse weather and UV
- Being struck by falling objects
- Acts of vandalism

Installing tanks in enclosures can reduce these risks and help extend tank longevity.

In addition, protecting a tank in an enclosure provides some of the benefits provided by indoor installations including:

- Reduced frequency of "frozen" tanks and fuel lines
- Reduced rate of condensation

When installing a tank in an enclosure remember:

- Fuel lines from the enclosure to the burner should be insulated and installed in a manner that minimizes the potential of damage
- Drill penetrations for fill pipes, vent pipes and fuel lines before the tank is placed in the enclosure. If you must drill a penetration with the tank in the enclosure, try to drill from the inside out. If you must drill from the outside towards the tank, measure and adjust the drill bit to ensure that it cannot touch the tank or install a plate between the enclosure wall and the tank to "backstop" the drill bit
- Any penetrations made, whether for the piping or to use for inspection, must be located where they do not compromise the integrity or the containment capacity of the enclosure

NORA recommends when an outdoor AST is being considered, the customer be provided with an option for installing the tank in an acceptable enclosure. In addition to aesthetics, the enclosure helps minimize the impact of adverse conditions.

For more information about fuel spill protection for above ground tanks visit:
oilstoragesolutions.com
oilyeller.com
or check with the tank manufacturer.

In-Ground Tank Installations

Installing tanks underground requires a specialized understanding of the principles of corrosion, an understanding of soil properties and ground water conditions and a knowledge of safe work practices required for working around and in excavations.

The majority of jurisdictions no longer permit bare steel tanks to be installed in the ground. NFPA directs that tanks used for underground storage of fuel be protected by a cathodic protection system or be constructed of corrosion resistant materials. The use of the sti-P3, ACT-100 or fiberglass tanks should be encouraged for underground installation.

In some jurisdictions, underground tank installers are required to be certified and/or registered. The installation of underground oil tanks should not be undertaken casually. It is a highly specialized service. Performing underground storage tank installations can also increase insurable risk.

NORA suggests only those companies that routinely provide underground tank services as part of their product offerings install USTs.

NORA suggests fuel dealers consider using licensed and certified contractors to install USTs.

Chapter 5

Fuel Lines

NFPA requires that a readily accessible fusible link safety shutoff valve shall be installed:

1. **At the outlet of an above ground tank**
2. **Within 6"of the filter inlet and inside the building if the piping passes through a foundation**
3. **Within 12" of the inlet connection to the burner**

Fuel lines bring fuel from the tank, through a filter, to the fuel unit. All fuel line connections must be tight and leak-proof and all threaded connections should be joined with non-hardening, fuel resistant pipe joint compound. NORA recommends the use of pipe joint compound that is rated for both fuel oil and biodiesel, such as *Loctite® 565* or equivalent.

General Recommendations

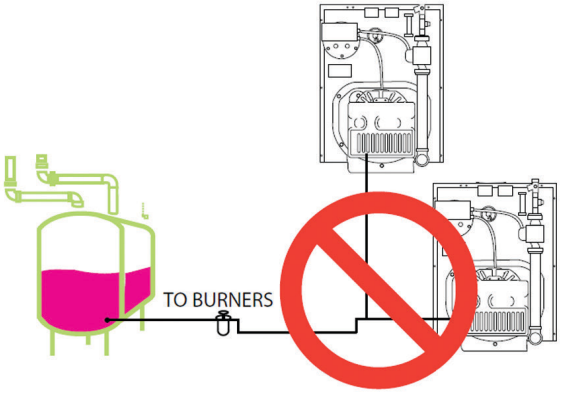
- Copper fuel supply (and return) lines should be connected with flare fittings and run from the tank to the burner with as few splices and fittings as possible
- Fuel lines should be protected from damage and properly secured
- Fuel lines that run outside of buildings should be insulated to protect against freezing
- All fuel line connections should be installed where they will be visible and accessible
- Whenever possible, each burner should have its own fuel line
- All fuel lines that contact concrete or soil should be protected in a continuous run of corrosion resistant tubing. Prior to 1990, many unprotected copper fuel lines were installed under concrete. NORA recommends customers upgrade these lines

Materials

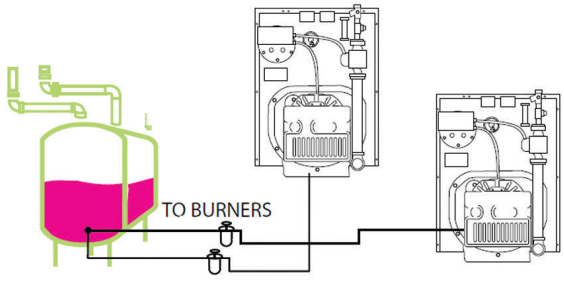
Fuel supply lines are typically made of steel pipe or copper tubing.

Copper tubing has become the choice for most applications because it's easy to work with, doesn't require as many fittings and in many instances, a continuous line can be run from the burner to the tank. Each of these factors reduces the amount of time necessary to install a line and reduces the expense of the installation. When copper tubing is used, the line should be polyethylene-coated and/or sleeved in protective tubing to substantially reduce the risk of corrosion.

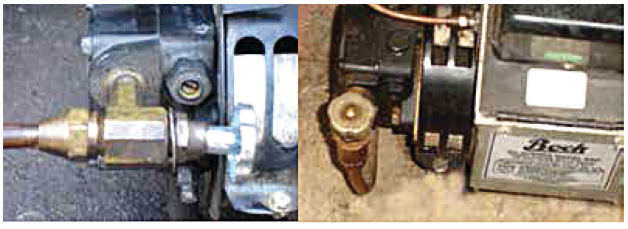
While studies have shown that fuel can degrade when exposed to copper, NORA recognizes the many advantages copper tubing provides and this is the material of choice in



Whenever possible, each oil burner should have its own oil line



The fuel line to the house is insulated, but the piping could benefit from some rustproofing paint.



Two views of suction lines with shutoff valve at the burner.

As shown here, fuel lines should be reasonably protected from damage and secured.

All fuel lines that contact concrete or soil should be protected in a continuous run of corrosion resistant tubing.

typical residential applications. The impact of the copper on fuel quality can be tremendously reduced when a one-pipe fuel line configuration is used.

Steel pipe can offer advantages particularly when an overhead installation is necessary or there is potential for damage copper piping. However, if steel pipe is in contact with concrete or soil, protection from corrosion is needed. When steel pipe is used, connections should be made with malleable iron fittings. Cast iron fittings can easily be broken and therefore should NOT be used on fuel lines.

Flexible fuel lines are available and are sometimes used to connect the fuel lines to the burner on appliances that have "swing-out" combustion chamber access doors. These lines allow for maintenance to be performed without disconnecting the fuel lines from the burner.

Sizing

Fuel lines should be sized and installed in accordance with the manufacturers' instructions for the fuel unit being used.

Lines should be large enough so that excess vacuum is not created and small enough that all air can be completely bled from the system.

For normal residential use, a minimum of 1/4" iron pipe or 3/8" OD copper line is recommended. However, ½" OD copper significantly lessens vacuum and is not overly large as to impede evacuating the air. In areas that experience frigid temperatures, ½" OD tubing should be considered with outside tanks.

Specific information regarding fuel units and recommended fuel line sizing is available on these manufacturers' websites:

Danfoss: *heating.danfoss.com*

Suntec: *suntecpumps.com*

Webster: *websterfuelpumps.com*

This chart is representative of a manufacturer recommended line sizes.

MODEL A SINGLE-STAGE TWO-STEP ● *TWO-PIPE MAXIMUM LINE LENGTH (H + R)*

Lift "H" Figure 4	3450 RPM					
	3/8" OD Tubing		1/2" OD Tubing			5/8" OD Tubing
	10 GPH	16 GPH	10 GPH	16 GPH	23 GPH	23 GPH
0'	33'	29'	100'	100'	72'	100'
1'	31'	27'	100'	100'	66'	100'
2'	28'	25'	100'	98'	59'	100'
3'	25'	23'	100'	89'	53'	100'
4'	23'	20'	92'	80'	46'	100'
5'	21'	18'	82'	72'	40'	100'
6'	18'	16'	72'	63'	34'	100'
7'	16'	14'	62'	55'	27'	88'
8'	13'	12'	52'	46'	20'	72'
9'	11'	9'	43'	37'	14'	56'
10'	-	-	33'	29'	8'	39'

MODEL B TWO-STAGE TWO-STEP AND TWO-STAGE HIGH-PRESSURE ● *TWO-PIPE MAXIMUM LINE LENGTH (H + R)*

Lift "H" Figure 4	3450 RPM					
	3/8" OD Tubing		1/2" OD Tubing			5/8" OD Tubing
	10 GPH	16 GPH	10 GPH	16 GPH	23 GPH	23 GPH
0'	70'	60'	100'	100'	100'	100'
2'	64'	55'	100'	100'	100'	100'
4'	58'	50'	100'	100'	100'	100'
6'	52'	44'	100'	100'	100'	100'
8'	45'	39'	100'	100'	100'	100'
10'	39'	34'	100'	100'	100'	100'
12'	33'	28'	100'	100'	94'	100'
14'	27'	23'	100'	91'	76'	100'
16'	21'	18'	81'	70'	59'	100'
18'	-	-	57'	49'	41'	100'

* Maximum firing rate not to exceed maximum nozzle capacity or strainer rating, whichever is less. A greater firing rate requires a suitable external strainer.

One Pipe vs. Two Pipe

With a one-pipe system the fuel pump only brings as much fuel from the tank as it pumps through the nozzle. If there's a one-gallon (1.00 GPH) nozzle installed, and the pump pressure is 100 PSI, then fuel will flow through the line at a rate of one gallon per hour. With a one-pipe system, if a customer burns 1,000 gallons of fuel per year, then 1,000 gallons pass through the filter and strainer.

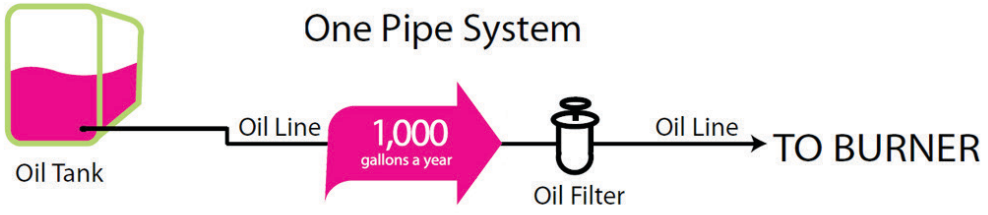
With a two-pipe system the fuel pump brings as much fuel from the tank as its gear set is designed for. The fuel unit pumps some of that fuel through the nozzle and sends the rest back to the tank through the return line. Since a typical pump can move about 17 gallons per hour, this means that for that same customer who burns 1,000 gallons a year, 17,000 gallons pass through the fuel filter and strainer!

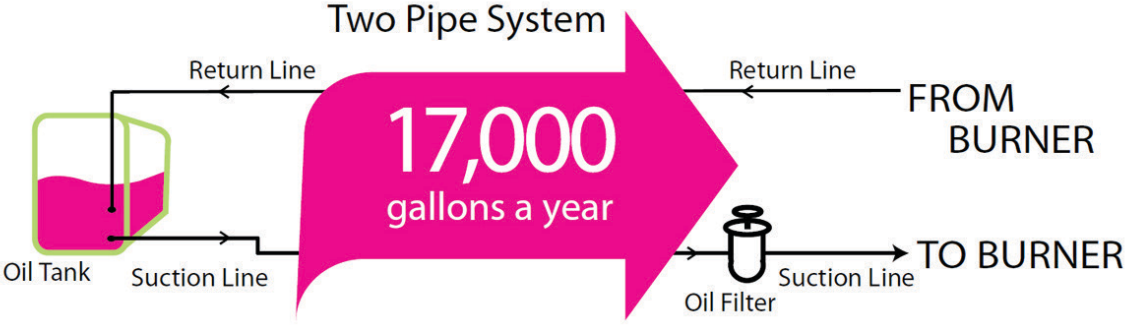
NORA recommends one-pipe installations whenever possible. It's easy to see that a one pipe system sends far less fuel through filter and strainer on the way to the burner to get the same job done.

One Pipe System

Many systems currently operating two-pipe can operate just as well, if not better, when converted to a one-pipe system. One-pipe installations offer several advantages over two-pipe systems, including:

- elimination of the potential liability of leaking return lines. Unlike suction line leaks, which cause burner troubles, return line leaks often go unnoticed. In many situations a return line leak can continue for extended periods of time and is only discovered when there appears to have been a dramatic increase in consumption





- greater sensitivity to air ingress helps identify slight leaks in the line or fittings
- reduced fuel degradation due to less circulation of product
- reduced clogging of fuel filters and pump strainers. One pipe systems move over 90% less fuel through the fuel line, filter and strainer than two pipe systems, so filters and strainers last much longer on one pipe systems
- cleaner combustion

Line de-aerator

Fuel line de-aerators can be useful in converting burners to one-pipe systems as the fuel line piping at the pump is not changed and it continues to operate with the advantages offered by a two pipe system

Supply Piping From the Top vs. the Bottom of Tank

When the fuel lines are installed to connect the AST to the burner, use of a one-pipe system with the supply line piped to the tapping at the tank bottom is recommended. When the tank is installed with the proper pitch, this is very useful for drawing off small amounts of water that fall to the bottom of the tank. The water is drawn into the line and then collected (trapped) by the fuel filter.

When using the tank bottom tapping for the fuel line connection, the installer should try to position the shut off valve and line beneath the tank to protect these components from possible damage from instances such as objects falling on the piping or people standing on the piping.

Fuel lines installed to connect the AST to the burner can also be installed through a bushing in the top of the tank. The system can be piped in either a one-pipe configuration or a two-pipe configuration, though the one-pipe system is preferred. Outdoor ASTs are often connected with the piping installed through the top of the tank to prevent the impact of water accumulated in the bottom of the tank, which can disrupt the flow of fuel should the water freeze.

When using a two-pipe system, it is important for the fuel return line to terminate at the top of the tank to prevent a siphon effect should a fitting or line leak occur. The fuel supply line should terminate several inches above the tank bottom. It is also important the fuel lines be properly supported, secured and protected from damage. Outdoor exposed lines should be properly insulated.

When above ground tanks utilize piping through a bushing at the top of the tank, it is important the installer include provision for both checking the tank for water and for removing the water. If the tank does not have a direct fill, a liquid-tight access for gauging the tank may be considered. Additionally, the tank bottom tapping should be configured to facilitate draining the tank of accumulated water. This could include use of a 'freeze resistant'


Top draw line should be insulated on outdoor installation.

valve that will not crack or break when water within it freezes. The valve should be installed so it is situated beneath the tank with the tank providing protection from damage. The valve should be left closed and plugged with the handle removed.

An example of a frost free drain valve can be found at: *morbros.com/sites/default/files/128-SS-New-01_0.pdf*

If fuel lines and/or filters repeatedly clog up with sludge, there is usually a serious problem in the tank. If the filter clogs with sludge more than once a year the customer should be advised to have tank and lines cleaned or replaced.

Maintenance

Properly installed fuel lines require very little maintenance. Accessible fuel lines should be inspected periodically, at least during each tune-up, and replaced as necessary.

Floating Fuel Lines

Floating fuel lines are designed to provide the burner with clean fuel drawn from a level that is above any sludge and/or water accumulation in the tank. They are attached through the top of the tank and include a "float" that sits on top of the fuel, connected to this float is an attachment that draws fuel into a line located a few inches below the top surface of the tank.

Unless the fuel level in the tank is allowed to get very low, this location allows fuel to be drawn from an area well above any contamination on the tank bottom and below any debris floating on the surface. Floating fuel lines only provide a temporary fix. Any microbial action associated with the sludge continues to occur. Floating fuel lines should only be employed until action can be taken to properly remedy or remove the sludge accumulation.

Floating oil line continually draws from the top level of the fuel

Floating lines help to reduce sludge-related service calls, but it's important to remember that when they are used, the tank bottom must be checked periodically for water. Water accumulation left in the tank may lead to service issues and premature tank failure.

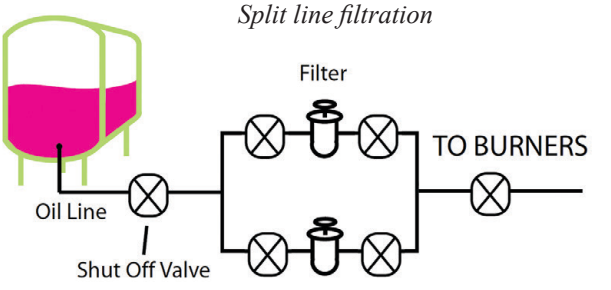
Chapter 6

Filtration

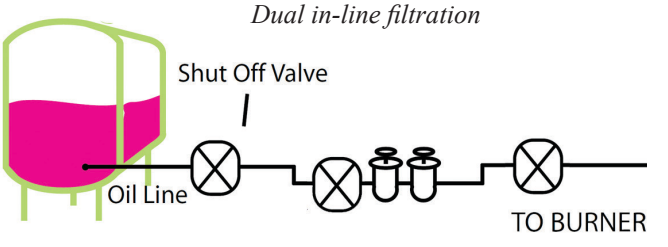
The best way to ensure that clean fuel is delivered to the nozzle is by installing a quality fuel filter on every burner. Fuel filters capture abrasive, blocking, corrosive and biological contaminants that have the ability to cause a multitude of operational problems.

Nozzle sizes keep getting smaller as equipment manufacturers continue to improve the efficiency of modern appliances. These smaller nozzles clog more easily than larger ones and therefore require better filter performance.

Split line filtration



Dual in-line filtration



Options

Currently, fuel filters fall into one of two broad categories: spin-on filters and cartridge filters. Several manufacturers are now supplying corrosion resistant filter housings and canisters to address the issue of filter failure from rust. Installers should consider the benefits a corrosion resistant material may provide.

In addition to standard configurations, two types of dual-filtration are now common.

Split line filtration – The suction line is split into two separate lines, each with its own filter to double the filter capacity and allow fuel to flow even as the filter medium becomes clogged. The lines are rejoined after the filters before feeding into the burner.

Dual in-line filtration – Two filters are piped in series. The primary filter removes the bulk of the contaminants. The secondary filter removes contaminants that pass through the primary or flake off the fuel line between the filters. The secondary filter also removes yarn, felt or fibers that break off from the primary filter.

For both types of dual filtration, NORA recommends both filters always be replaced at the same time.

A variation of dual filtration is to install a sludge/water isolator (SWI) before the filter.

The SWI removes condensation, rust, bacteria, algae and bottom sediment before it reaches the filter. These "filters" do not get replaced. A service technician simply removes a plug, opens a valve and drains the unit until clean fuel passes through.

Filter Locations

For inside tank installations, fuel filters can be located at the tank, at the burner or at both the tank and the burner.

Traditionally, it was common to install the fuel filter at the tank to clean the fuel before it got into the fuel line. As more and more homeowners finished basements and "boxed in" tanks, it became more common to install the filter at the burner.

For outside installations the fuel filter can be installed where the lines enter the building or at the burner.

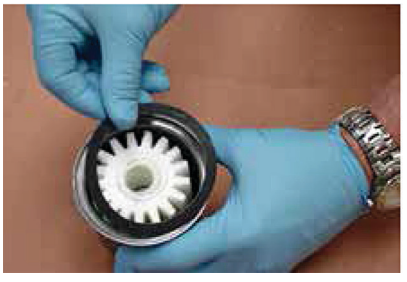
Whatever location works for your company and your customer is fine, as long as you have a readily accessible filter in the suction line. It should be in an area where it's not likely to be damaged or exposed to freezing temperatures.

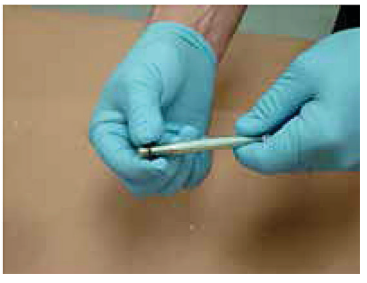
NORA recommends that oil filters NEVER be installed outside the premises or in any area where they will be subject to freezing temperatures.

Filtration Maintenance

When replacing fuel filters, always follow manufacturers' instructions. If these instructions are not available, then the following procedures are recommended:

Spin-on filters — remove the filter, remove the center O ring and replace it with a new one. Remove the outside gasket, apply a thin coat of petroleum jelly to both sides and carefully replace it. Fill the cartridge with clean fuel and spin it onto the filter head and tighten it ¾ of a turn past snug.





Cartridge type filters — remove the old cartridge, remove the gasket and the center bolt gasket. Thoroughly wipe out the can with a clean cloth, inspect the can for corrosion and replace it if necessary. Install a new cartridge, a new can gasket and a new gasket on the bolt.

Chapter 7

Fuel Valves & Accessories

There are a number of valves and accessories that are available for use on heating systems. This chapter briefly examines the most common components likely to be encountered in the field, including:

- Oil safety valves/pressure reducing valves
- Anti-siphon valves
- Check valves
- Foot valves
- Thermal shut off (fusible) valves
- Solenoid fuel valve
- Fuel de-aerators
- Nozzle line heaters

Oil Safety & Pressure Reducing Valves

Oil safety valves (OSV), such as the Suntec PRV38, the Webster OSV and the Oventrop Oilstop F are designed to:

- Prevent the flow of oil in the event a leak occurs in the oil line between the OSV and the burner
- Prevent excess pressure on the inlet and seal of the fuel unit on systems with pressurized supply lines

These valves require a sustained vacuum on the outlet side of the valve for fuel to flow, any leak (fitting, line, filter, etc.) that prevents vacuum from being exerted on the outlet of the valve will prevent the flow of oil.

On those systems with a booster or supply pump, the valve also operates as a pressure reducer, with supply line pressure on the inlet side of the valve and fuel unit vacuum on the outlet port.

Location, orientation and height of the valve in relation to the fuel unit and/or lowest point in the fuel line varies by manufacturer. Always refer to the manufacturer's instructions for specific information.

NORA recommends that the use of an OSV be considered on AST installations.

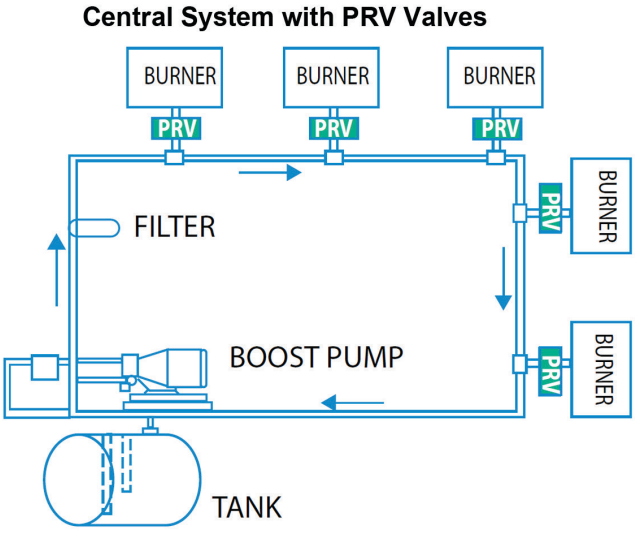
Manufacturers' instructions can be found at these websites:

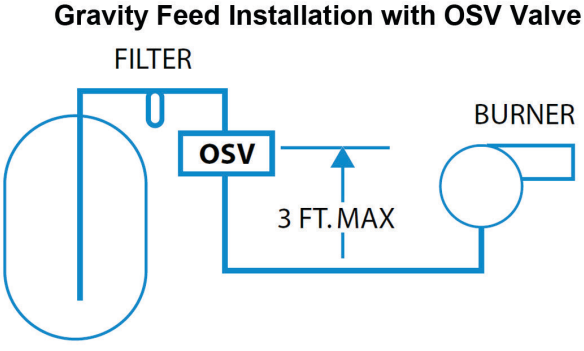
Suntec: *suntecpumps.com*

Webster: *websterfuelpumps.com*

Oventrop: *oventrop.co.uk*

Gravity feed installation example, central system with PRV Valves - OSV valve





Most OSVs must be mounted no more than three feet (3') above the lowest point in the oil line connecting the OSV to the fuel unit!

Anti-siphon Valves

Anti-siphon valves are similar to fuel safety valves in that they reduce fire hazards and prevent fuel spills caused by fuel being siphoned from the tank. Anti-siphon valves automatically shut off the fuel flow in the event that a leak occurs in the fuel line between the anti-siphon valve and the burner.

These valves are NOT designed to reduce pressure on systems with booster pumps.

Anti-siphon valves should be considered when an UST has been replaced with an outdoor AST and the burner is in a basement.

For additional information see manufacturers' instructions:
Oventrop: *oventrop.co.uk*
Preferred: *preferredutilities.com*

Check Valves

Check valves are designed to eliminate the reverse flow of fuel in a line and are not normally needed on properly operating heating systems.

Check valves were often used to compensate for deficiencies in fuel lines such as suction leaks due to bad, porous, loose or leaky fittings. They are sometimes installed on jobs where the unit "lost prime" for a variety of reasons.

It was also a common practice to install check valves when two burners were connected to a single fuel line.

In general, check valves should not be needed to maintain a primed pump. The majority of systems operate on a 'gravity' flow. For sites that have a lift, the internal check of the fuel pump should be sufficient to hold prime unless the lift is excessive. If the pump experiences lost prime, it is typically an indicator of a line leak or a bad pump.

Check valves should NOT be used with gravity feed systems!

There are several disadvantages associated with check valves:

- they increase vacuum and reduce the distance that fuel supply lines can be run
- depending on where they are located, they can cause turbulence and strip air from the fuel resulting in dirty and noisy combustion
- when used in single pipe systems or systems supplied by boost pumps, they can cause fuel leaks due to thermal expansion. In these situations, a thermal relief valve may be required. See below for additional information

Check valves are normally available in two styles:

HCV, identified by its silver cap, incorporates a soft elastomer seat and is recommended for a tight shut-off needed to eliminate reverse flow.

CV, identified by its brass cap, is the hard seat model that utilizes a stainless steel ball and is not designed for absolute reverse shut-off.

Foot Valves

Foot valves are designed to assure that pump suction lines remain "primed" by preventing the flow of fuel back to the tank when the pump is inoperative. Foot valves are installed inside fuel tanks at the bottom of the suction line.

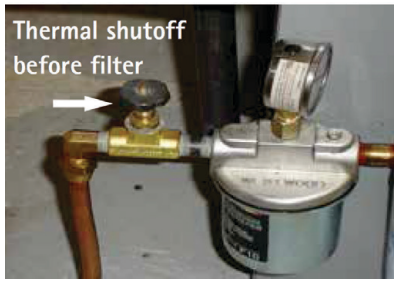
Foot valve are sometimes found in use with older buried fuel tanks, they are no longer commonly found in residential tanks because the internal check valve of the fuel unit is generally sufficient to hold the prime in fuel lines.

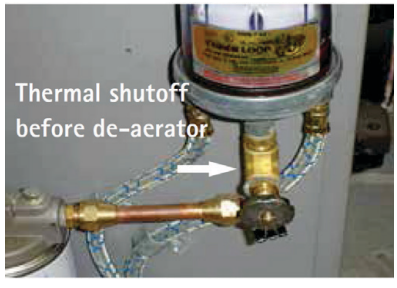
The possible presence of a foot valve is one of several reasons why CO_2 cartridges should never be used to clean clogged lines.

Thermal Shut Off

(Fusible) Valves

Fusible valves minimize fire hazards by automatically closing when ambient temperature reaches potentially hazardous levels.





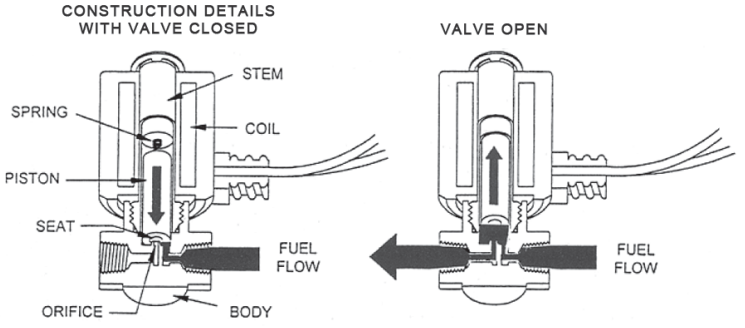
They employ a fusible element in the hand wheel that "melts" at 165°F, closing the valve and preventing the flow of fuel. Fusible valves look like a small globe valve and can be operated as a manual shutoff for servicing the system. They are utilized at tanks, filters, fuel units, de-aerators and where lines from outside tanks penetrate the building.

NFPA 31 requires that fusible valves be installed on all oilheat systems.

Solenoid valves

Solenoid valves are sometimes referred to as magnetic fuel valves or delayed fuel valves and there are several types that a service technician is likely to encounter.

External solenoid valves are available either with or without a delay feature that prevents fuel from being delivered to the nozzle for a period of time after burner startup. The delay enables cleaner startups by allowing the motor and fan to get fully up to speed before the valve opens and allows fuel to be pumped through the nozzle.



On shutdown, these valves close and immediately stop fuel flow to the nozzle providing a cleaner flame cutoff.

Integral solenoid valves are built into the burner's fuel unit. There are two types of these currently available:

- "*Blocking*" valves operate the same way as external solenoid valves do, opening when powered and closing on shutdown
- "*Dumping*" valves control the flow to the nozzle by diverting fuel flow inside the fuel unit. On startup the valve closes opening the piston and allowing fuel to flow to the nozzle. On shutdown the valve opens closing the piston and shutting off the fuel flow to the nozzle

An advantage of both external and blocking solenoid valves is that they provide an additional fuel shutoff. In the event that the fuel unit's piston "hangs up", these solenoid valves will prevent fuel from dripping into the fire chamber after shutdown.

Nozzle Line Heaters

Nozzle line heaters clamp onto the burner's drawer assembly and maintain the fuel temperature at approximately 140°F. Keeping the fuel heated lowers the viscosity, enables better atomization and cleaner startups, improves efficiency and decreases the production of smoke and soot.

Additional information is available at: *beckettcorp.com/support/tech-bulletins/what-are-the-benefits-of-nozzle-line-oil-heaters/*

Fuel De-aerators

De-aerators remove the air and gas bubbles from fuel so that these bubbles don't cause problems with the burner such as noise, rumbling, pulsation and noisy shutdowns.

In addition to eliminating problems caused by air and gas bubbles, de-aerators enable systems that would normally require two-pipe operation to operate with a single line from the tank to the burner. **See diagram on next page as an example.**

As mentioned in an earlier chapter, one pipe applications offer several advantages:

- they eliminate the potential problems of leaking return lines
- they dramatically reduce the clogging of fuel filters and pump strainers
- they enable cleaner combustion

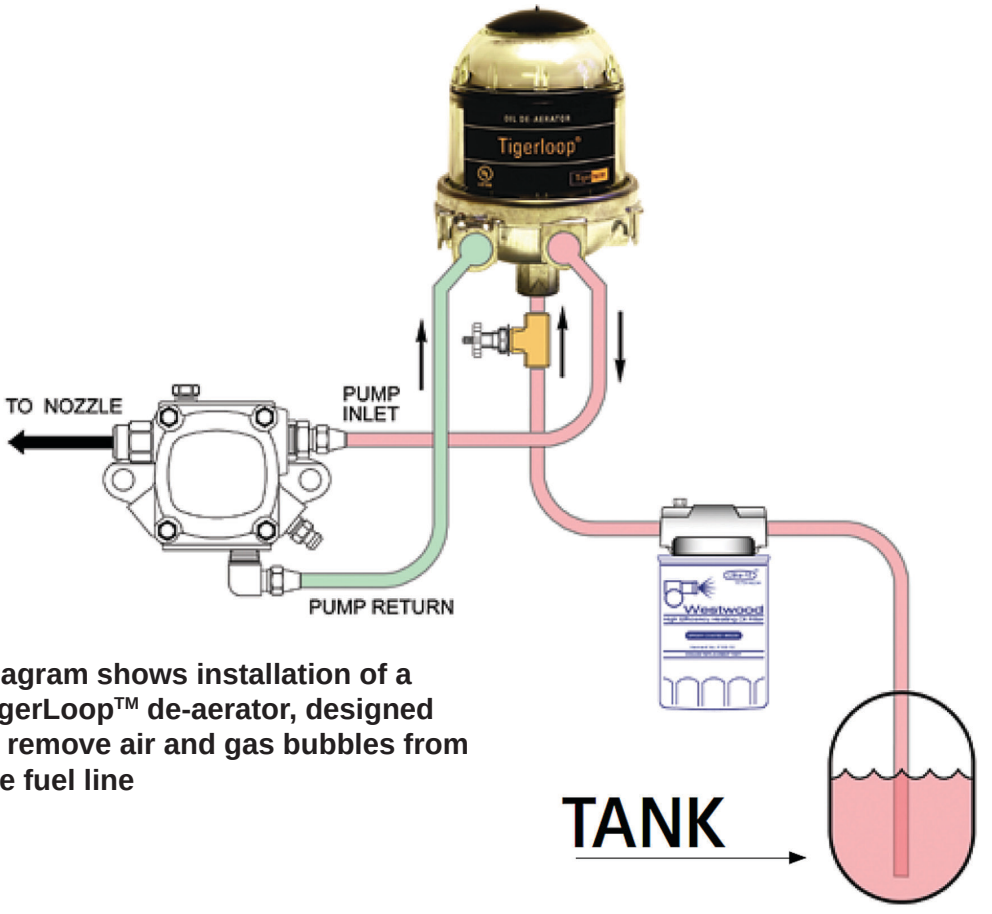


Diagram shows installation of a TigerLoop™ de-aerator, designed to remove air and gas bubbles from the fuel line

Thermal relief valves

When fuel is trapped within a closed section of fuel line (such as between a check valve and a fuel unit or solenoid valve) and the fuel temperature rises, the thermal expansion can cause dramatic pressure rise which can damage heating equipment. This can easily occur when the fuel is stored outside, either above or below ground. Anytime a check valve is installed in a fuel line, a thermal relief valve should be installed to avoid leaks in fittings and damage to equipment.

For more information see: *earthsafe.com/LP-Thermal-Expansion-In-Fuel-Oil-Piping*

Chapter 8

Tank Inspection & Maintenance Procedures

Regular inspection of tanks can be a useful means to identify and correct potential problems that may affect the tank longevity or the performance of the heating equipment.

The following pages contain suggested inspection procedures for **initial inspections**, **routine inspections** and **pre-delivery inspections** as well as general maintenance recommendations. Sample checklists are provided in Appendix I to assist companies in inspecting tanks. Local codes and/or company policies may require changes to these forms.

Initial inspections

NORA recommends that all tanks be inspected and approved for delivery before the first delivery is made to a new customer or to a new tank.

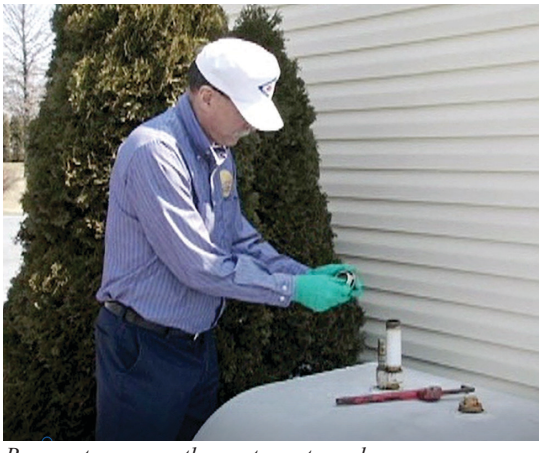
For ASTs, an initial exterior inspection provides the opportunity to:

- identify staining or wet spots which may indicate flaws in the shell and/or seams
- observe impacts of corrosion on the tank and the piping
- identify signs of defects with the related components

This may help avoid problems in making deliveries and helps ensure the fill is properly identified and the vent piping is adequate.

Inspecting tanks before accepting a new customer also protects your company in those cases where the prospective customer is switching suppliers because their current company has recommended essential equipment upgrades that the customer does not want to make. Checking the tank for water should be included whenever feasible.

Inspection of USTs is generally very limited. In addition to accessible components of the fill and vent piping, inspection of the fuel line piping inside the building is needed.



Be sure to remove the vent cap to make sure a screen is in place!

Commonly used vent caps with screens in place.

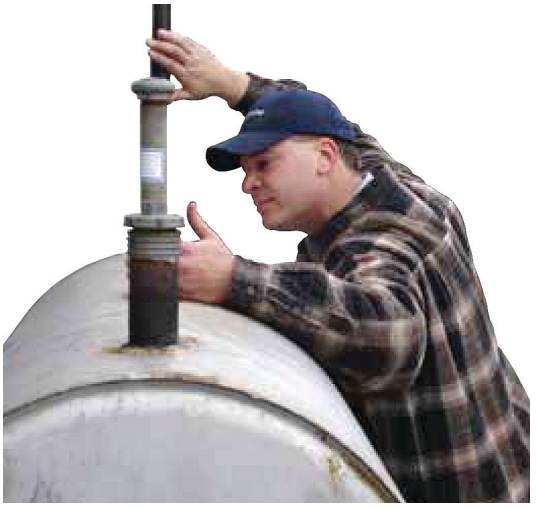
When a new above ground tank is installed for a customer, NFPA recommends the tank be inspected during the first delivery to verify there are no visible leaks in the tank or the piping. This also provides the opportunity to be certain any unused fill and/or vent piping associated with a prior tank has been removed.

NORA recognizes that inspecting prior to the first delivery may not always be possible because of customer unavailability or unavailability of employees. In those cases, the inspection should occur as quickly as possible after the first delivery, and the delivery person should be alerted that the tank has not been inspected. The delivery person should perform as thorough an inspection as possible prior to delivering.

NORA provides a tank inspection checklist (found in Appendix I) to serve as a step by step guide for making a limited assessment of the tank. If this inspection identifies a potential problem, management should be alerted and a decision made on whether to notify the customer that correction of the problem is required or if the replacement of the tank is required.

Routine Inspections

Routine inspections of above ground tanks are important and aid in early detection of problems associated with corrosion or



associated with impacts of weather when tanks are outdoors. For example, tanks can settle over time or components may become damaged from falling ice or snow.

While these inspections may not be as rigorous as the initial inspection conducted when accepting a new customer's tank for delivery, routine inspections help detect changes in the tank condition and problems that may have begun only recently.

The inspection of the accessible components of underground tanks is important. Defective fill risers, boxes, caps and gaskets can provide means for water ingress. Vent caps and the vent pipe risers present additional points of water ingress and should be inspected to the extent possible.

Above ground tanks should be evaluated to determine if the fuel line configuration or the tank pitch are such that water can accumulate in the tank undetected. In these cases routine tank inspections should include checking the tank for water if practical.

NORA recommends that routine tank inspections be conducted as an integral part of the equipment preventative maintenance tune-ups.

Routine inspections afford the opportunity to find and correct problems with the fill pipes, vent pipes and caps, tank legs, fuel lines, tank gauges, tank bottoms, etc. Many of these problems can be easily repaired or remedied preventing releases which can cause financial, environmental and customer-relations problems.

Appendix I at the end of this book can assist companies with tank inspection programs. Local codes or company policies may dictate changing or customizing this form.

Pre-Delivery Inspections

Fuel delivery personnel should perform a brief visual inspection before and after each delivery. While this inspection normally isn't documented, it's important that fuel drivers understand the need to verify addresses and check tank components accessible from the fill location for obvious defects before and after delivery. NORA provides a sample *Delivery Report* (see Appendix I at the end of this book), only to be used when defects are discovered.

With USTs and basement tanks, some of the following may not be practical. For example, only those components outside would be inspected when the tank is located inside a home or building. In those cases the inspection procedure should cover as many of the steps on the form as possible.

Before beginning to deliver:

- Verify the address, delivery instructions and tank location
- Confirm that the tank, fill and vent caps, gauge, legs and pad or foundation are in satisfactory condition, as appropriate for the tank installation site
- Make sure that unused openings are properly plugged

NORA recommends a "No Whistle—No Fill" policy!

This is an example of a house where the tank was removed and the fill and vent pipes were left in place. An expensive cleanup ensued because a driver continued to make a fuel delivery when there was "no whistle!"

During delivery:

- Verify that the vent alarm is working properly

After delivery:

- Check the tank and exposed fuel line for leaks

Report any discrepancies to the office immediately.

General Maintenance

Tank maintenance involves correcting deficiencies identified during tank inspections. This can help prevent minor issues such as cracked gauges or missing fill caps from contributing to larger issues if left uncorrected.

If for any reason the tank must be moved during maintenance (or at any other time,) make sure it's empty before attempting to move it.

The exterior coating of some above ground tanks should be repainted as necessary. Follow manufacturer's instructions for rust removal and specific tank maintenance.

Presence of water in tanks

With a properly pitched above ground tank with a bottom fuel feed, water will normally flow from the tank and be collected by the filter.

For improperly pitched above ground tanks or tanks with ‘top draw’ fuel lines that are not piped with a bottom draw off, check the tank for water by applying water finding paste to a tank stick and inserting it to the bottom of the tank.

If a situation is encountered where a plug or gauge needs to be removed to measure the tank, great care is required to be certain the tank top is maintained leak-free when service is completed.

A tank maintenance program should include periodic inspection for water accumulation. The initial tank inspection process can aid in identifying tanks that are more susceptible to water accumulation due to the piping configuration, the tank location or the tank pitch.

Certainly, in cases where the presence of water is identified during heating fuel equipment servicing, checking the tank for water is an appropriate next step. However, above ground tanks that have ‘top draw’ fuel lines or are improperly pitched can store an amount of water without it becoming evident when equipment service is performed and filter canisters or pump strainers may be inspected.

A good tank maintenance program to monitor and address the accumulation of water in tanks is essential to maintaining fuel quality and should be a part of a comprehensive maintenance program.

For most underground tanks, gauging for water does not present an issue. Simply insert a tank stick with water finding paste through the fill pipe. However, a UST that is not pitched toward the fill may contain water that can’t be detected by gauging.

Also, small or “trace” amounts of water may not be possible to remove from UST’s.

USTs are also susceptible to water ingress which can lead to fuel quality and service problems. Most often, water identified in below ground tanks has entered through defective fill components or vent components. Undetected, this water can contribute to sludge build up in the tank. In rare cases, water ingress can be an indicator of a breach in the tank shell.

USTs installed in areas of elevated groundwater, less than 4' below grade, could be susceptible to water intrusion when the fuel level in the tank is low. Fuel suppliers should develop a procedure designed to investigate

the cause of water ingress for any tank and to monitor for the reoccurrence of water ingress once water has been removed from a tank.

The accumulation of water in an underground fuel tank is usually due to issues with the fill cap or corrosion of the swing joint at the vent riser and not an indicator of a breach of the integrity of the tank shell.

The inspection of below ground tanks for the presence of water is a good component of an fuel company's maintenance program as it is integral to maintaining fuel quality and to the reduction of service issues that arise from the water contributing to the formation of sludge.

Any time the presence of water is identified in a fuel tank regardless of location; it is important that the customer is notified.

Any water found during an inspection should be removed as quickly as possible to minimize the damage to the tank, the filter, the fuel pump and the system. Any water and sludge removed must be disposed of properly. Remember, removing the water is just the first step in a process—find out where the water is coming from and take action to prevent the situation from reoccurring.

sti-P3 Tanks

In addition to periodically checking for and removing water in the tank, the anodes installed on sti-P3 tanks must be tested upon installation and in three-year intervals. The test can be performed quite easily by trained individuals. A list of individuals certified to perform this test is maintained by the Steel Tank Institute to aid tank owners in locating qualified testers.

Cleaning

There is no clear consensus regarding if and/or when fuel tanks should be "cleaned." Condensation, sludge and rust accumulate in tanks and cause serious operational problems, yet, the debate continues on the best means to address these problems.

Some industry professionals believe that tanks should never be cleaned. Concerns are that tank cleaning may cause damage to the tank, that the cleaning process is inadequate to remove the sediments, the cleaning fails to eradicate the microorganisms or that tank cleaning entails expense and sacrifices clean fuel.

While a major advantage of having tanks cleaned is that the cleaning process usually does a very good job of removing the water that accumulates in tank bottoms; the jury is still out on just how good a job can be done to remove the sludge that accumulates on tank walls. Most fuel tanks don't have openings that are large enough to facilitate a thorough inspection of the tank's interior. With that said, cleaning a problem tank normally won't hurt the situation and getting the accumulated water out of the tank offers many advantages that justify the cost.

Some fuel companies routinely clean their customer's problem tanks and then treat them with an additive to help prevent clogged oil lines, filters, pump strainers and nozzles and to reduce the resumption of microbial activity.

For information on tank cleaning systems visit the following websites:

HamcoTanksystems.com

velcon.com

Chapter 9

Abandonment

Photo by Tank Solutions www.oiltanksolutions.com

Normally, fuel tanks that are permanently out of service should be removed from the property and disposed of properly. However, in some situations it may be impossible or extremely expensive to remove the tank and it must be abandoned in place.

Companies performing closure of underground storage tanks are required to be registered and certified in many jurisdictions.

In areas where it is legal to abandon oil tanks in place, the guidelines of the local authority having jurisdiction must be followed. The requirements generally include the following procedures.

Above Ground Tanks

NORA recommends the guidelines of NFPA 31 be followed whenever an aboveground storage tank is being abandoned.

Above Ground Tanks Abandonment Procedure

- Remove liquid and residue from the tank and connecting lines and keep a record of removal
- All waste products removed must be disposed in accordance with all local, state and federal regulations with the records retained
- All connecting supply lines must be disconnected, removed and properly disposed of
- Fill pipe and tank gauge must be removed and properly disposed of
- All tappings except the vent tapping must be securely plugged
- Tank must be rendered free of vapors and provision must be made for natural breathing to ensure the tank remains vapor free
- Tank should be stenciled with the date of abandonment
- Tank must be protected from flotation in accordance with good engineering practices

Underground Tanks

NORA suggests dealers consider using licensed and certified contractors for the closure of underground tanks.

NORA recommends the guidelines of NFPA 30 be followed whenever an underground storage tank is being abandoned or removed.

The NFPA 30 Annex suggests: "Closure of underground tanks either in place or by removal requires owners and operators to measure for the presence of a release where contamination is most likely."

Underground Tanks Abandonment Procedure

- Remove liquid and all residual material from the tank and connecting lines
- Dispose of waste products in accordance with all local, state and federal regulations
- Disconnect and remove all connecting lines
- Empty the tank of all residual material
- Purge and inert the tank
- Test the tank atmosphere
- Remove fill pipe and vent pipe
- Cut holes in the tank as necessary
- Fill the tank to capacity with solid inert material such as clean sand, concrete slurry or other approved material. All voids in the tank must be filled
- Completely backfill the area to grade

NORA cautions that closure of fuel storage tanks requires preparation of a safe workplace and requires adherence to OSHA safe work practices, including proper confined space entry and the use of individuals certified as competent persons in excavation as applicable.

For abandonment of an in-ground tank NORA recommends an environmentally safe and solid inert media be placed inside the tank. Use media that will not contribute to the deterioration of the tank, will not shrink over time, and will not emit any hazardous substances during or after abandonment.

It is important to understand that it is very difficult to assess the site for evidence of a release when in-ground tanks are abandoned in place.

In areas where it has been approved, the abandonment of tanks using a non-shrinking foam that can be installed through the fill pipe offers several advantages:

- The damage to the customers' property is minimized
- The chance of leaving voids or partially filling a tank is minimized
- The chance of ground settlement is minimized
- If the tank has to be removed later, it's easier than removing tank filled with sand or slurry

For further information regarding tank abandonment see:

NFPA 30 - *nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=30*

API 1604 - *global.ihs.com* Search API rp1604

Chapter 10

Service Guides

The following pages contain recommendations and procedures for service technicians to follow when they encounter certain situations. They are intended to to help resolve those situations in an efficient, cost effective, and customer friendly manner.

Service technicians should always protect the customer's property so that the work area is as clean after the service call is completed as it was before the job was started. Protecting the work area with newspaper or builders paper takes just a few minutes and can make the cleanup much easier.

Anytime that a filter, pump or fuel line fitting is disassembled, drip pans or trays should be placed underneath to prevent any leaked fuel from staining or damaging the floor and leaving an odor.

It is typical for customers to judge the quality of the work performed by the cleanliness of the work area at completion. After the job is finished and the work area is clean, take a minute to wipe down the heating equipment with a clean rag or cloth. Don't use dirty rags for this purpose as they can leave an odor and possibly result in a callback.

Always protect the customer's property

Before leaving the premises, let the customer know what was done and advise them of any recommended follow up work.

The following pages contain:

A. Sludge Call Guide

B. Out of Fuel Guide

C. Fuel Line Leak Guide

D. Cold Temperature Guide

When a clogged fuel line, filter and/or pump strainer is discovered the following procedures are recommended:

Examine the filter cartridge, canister and the fuel assembly components for evidence of water. Whenever water is detected, it should be removed from the tank, to the extent practicable, and properly disposed.

Then, whenever possible: *(note: if the filter is located at the tank, start with step #2)*

1. Disconnect the fuel line from the inlet of the filter, connect a push-pull pump to the line and draw fuel through the line until clean fuel flows freely.
2. Replace the filter element & gaskets. (or spin-on filter)
3. Disconnect the fuel line from the fuel

If a sludge problem persists, fuel testing/treatment and tank cleaning/replacement should be considered.

unit, connect a push-pull pump to draw fuel through the line until clean fuel flows freely between the filter and the fuel unit.

4. Clean or replace the pump strainer, completely remove the existing fuel unit cover gasket and install the correct new gasket.

5. Reconnect the fuel line and bleed air from the fuel unit.

6. Check the running vacuum. Compare the reading to the expected operating vacuum calculated using the following formula:

- 1" for every foot of vertical lift
- 1" for every ten feet of horizontal run
- 1" for the filter
- 2"- 4" for an OSV valve

If the reading exceeds calculated vacuum, there may be a restriction in the line. Inspect the exposed line to see whether it has been damaged, kinked or crushed. If a defect is found, replace the line. Never attempt to repair a damaged fuel line. If the line appears to be in good condition, try using the push-pull pump again and re-check running vacuum after clearing the obstruction.

If the unit is part of a two-pipe system, consider converting it to a one-pipe system. Doing so will reduce the amount of fuel being filtered by over 90%. This can reduce the need for filter replacement. When converting a fuel unit to one-pipe operation, be sure to remove the bypass plug if the pump has one and consider installing a fuel de-aerator.

For an installation that is operating on a one pipe system—if the filter needs replacement more than twice a year, a more permanent remedy may warrant consideration.

Filter clogging may be a symptom of bacteria in the fuel which can cause microbiologically induced corrosion. If the sludge problem persists after the tank has been cleaned, the fuel should be tested and treated as needed. Options include initiating a designed fuel treatment program and tank replacement.

B. Out of Fuel Guide

When an automatic delivery customer's tank is out of fuel, it is extremely important to determine why the tank is empty before making a delivery.

First, the technician should measure the tank to determine that it actually is "dry." Knocking on the side of the tank doesn't work; get out the measuring stick and make sure!

Once it is established the tank is empty, office personnel should research when the tank was last filled and determine if it was currently due for delivery.

If the tank was due for delivery, a service technician can deliver enough fuel to restore operation until a delivery can be made.

But if the tank is reported to have been recently filled or wasn't due for a delivery, additional research is required. Could a recent delivery have been made to a different tank or customer? Next, evaluate the last delivery data. Was a less than anticipated amount of fuel delivered? Is it possible a 'short fill' was made and not considered when calculating when more fuel would be required?

The investigation should continue with a conversation with the customer to determine if there have been any changes which might have caused fuel consumption to increase.

For example:

A new baby – With the arrival of a baby in the home, the family often keeps the thermostat higher and uses more hot water increasing their fuel usage.

Additional people living in the home – If more people have moved into the home consumption will increase. Check to see if family members have returned home from college or gotten married and moved home or if parents or other people have moved into the household.

A change in lifestyle – If the family is spending more time at home consumption will normally increase. Check to see if a family member who was working outside the home has recently retired or is now working from home.

Home additions – People often don't realize that they'll consume more fuel when they build additions on to their homes. With additional heated living space, consumption will increase. "Energy savers," such as a new fireplace can also increase fuel consumption.

Additional appliances – Adding pool heaters and other appliances can increase fuel usage dramatically.

If it's determined during the customer interview that there's a logical explanation for the increased consumption, the service technician should provide enough fuel to maintain heat until a delivery can be made. The customer's K factor should also be adjusted to prevent future run-outs.

However, when a determination for the cause of the out of fuel call cannot be made, consideration must be given to the possibility that the tank and/or fuel lines may be leaking. In that case, filling the tank can make an existing problem much worse.

The situation must be thoroughly investigated to establish that the fuel storage system is sound. In cases where the customer requires more fuel be delivered before the situation can be fully examined, a temporary tank should be employed or a minimal volume delivery made.

It is important the customer then proceed with having the tank and the fuel lines checked. In some cases, the fuel supplier can check for a leaking fuel tank or lines.

Exposed USTs and fuel lines can be visually inspected. If a leak is found, company policies and jurisdictional guidelines must be followed.

If the tank and/or fuel lines are not exposed, testing of the tank and lines is warranted prior to making deliveries. When an outside provider is conducting the testing, obtain copies of any reports for retention in the customer file.

C. Fuel Line Leak Guide

Fuel line leaks can develop over time, especially in unprotected fuel lines that are buried in concrete. Sudden leaks can also occur as the result of activities that have nothing to do with the heating system, such as the building settling or contractors working on the property accidentally damaging the line. Workers who were landscaping, gardening, exterminating, installing underground sprinkler systems or performing other activities may have damaged fuel lines without knowing it.

Leaking suction lines do not always cause the burner to stop operating because they are sometimes operating on gravity or siphon flow and leaks go undetected. However, slight suction line leaks can lead to service problems including: rough starts, rough stops, noise, after drip, etc.

Unfortunately, leaking return lines cause no such problems – but they can cause serious environmental damage. Since leaking return lines do not affect burner performance they can go undetected for a long period of time before being discovered. While suction lines can be checked for leaks by following the procedure outlined below, return lines can't always be checked with confidence because they often terminate above the fuel level in the tank.

NORA recommends that systems be operated on one pipe whenever possible.

To Check For A Fuel Line Leak:

1. First perform a visual check to look for signs of fuel leaks along the path of the fuel line and at the filter.
2. Next verify the fuel unit holds vacuum by performing the following procedure:
   - Disconnect the inlet line and fitting from the suction port of the fuel unit
   - Apply pipe joint compound to a vacuum gauge and install it into the suction port
   - If the unit is connected as a two-pipe system, remove the return line fitting and by-pass plug. Apply pipe joint compound to a plug and install it in the return port
   - Turn on the burner and open the air bleeder
   - Close the bleeder when the vacuum reaches 15"
   - Turn off the burner
   - The vacuum should hold for 5 minutes, if it doesn't, repair or replace the fuel unit and perform the same test on the new or repaired unit
   - If the unit holds vacuum, remove the vacuum gauge, apply pipe joint compound to the inlet line fitting, reinstall it and reconnect the suction line
   - This process verifies the fuel unit will hold vacuum, is NOT leaking and is suitable to use for testing of the fuel line

The following procedure can then be used to check for a leak in the piping between an AST and the burner or in the line between the burner and the shutoff where the line from a UST enters the building.

3. Shut off the fuel valve at the tank (or wall) and disconnect the fuel line
4. Connect a "plug" to the disconnected fuel line
5. Start the burner
6. Once the vacuum reaches 20" turn off the burner
7. The vacuum should hold for 30 minutes

If it doesn't, there is a leak in the fuel line, filter or fittings.

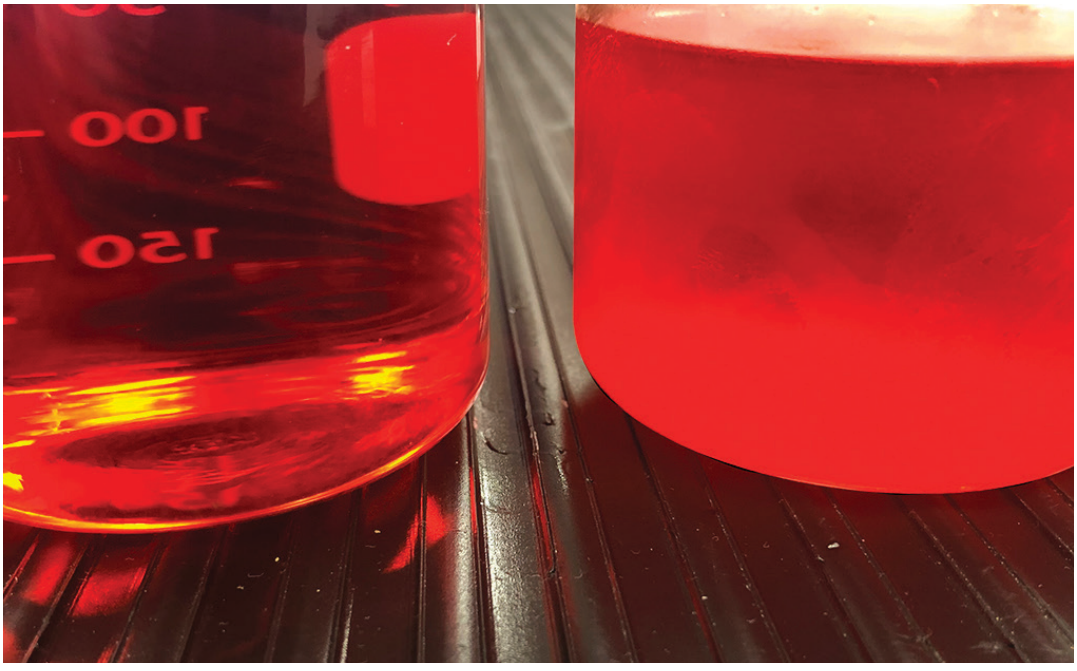
8. Once you've double-checked the filter(s) and valve(s) to establish that they are not the cause of the leak, change the fuel line. When installing new copper fuel lines be sure to use tubing that is polyethylene-coated and/or sleeved in protective tubing if the line will contact dirt or concrete.
9. Perform the same test on the new line.
10. If the line checks out, remove the "plug" then reconnect the line to the fuel tank and open the fuel valve.
11. Be sure that all air has been bled out of the line.
12. Let the unit run through several cycles while you clean the work area and complete your paperwork.

Alternative To Using The Fuel Unit To Check Fuel Lines

A vacuum test of the fuel line can also be performed using a manual vacuum pump, sometimes referred to as a "push-pull" pump. Since the check valves on these pumps often become weak over time, a ball valve should be threaded into the suction side internal check valve. If the hand pump does not have a vacuum gauge on it, install one in the flare fitting on the line at the tank. Then, instead of running the burner to generate vacuum, simply pull the handle of the pump until the desired vacuum is reached and close the ball valve to tightly close the line. If the vacuum holds for 30 minutes, the fuel line is not leaking.

D. Cold Temperature Guide

As fuel is chilled below a certain temperature it becomes cloudy due to the formation of wax crystals. These crystals affect the fuel's



Wax crystals forming in the fuel that has been exposed to temperatures well below its cloud point

ability to flow through the lines, pass through the filter and be fully atomized in the nozzle. As the fuel becomes even colder it begins to gel, leading to what is commonly called "frozen" fuel lines.

Free water trapped in fuel lines can also freeze and clog the fuel line. Outdoor ASTs with fuel lines that are run from the bottom of the tank are most susceptible to icing problems.

It is much easier to prevent frozen lines than to treat them. There are several additives available commonly referred to as 'cold-flow improvers," that lower the temperature at which the fuel in the tanks and lines "freezes."

Most of these products do a very good job of preventing waxing and gelling problems but are far less effective when added to a tank that already has a problem. Two good ways to dispense these products is to have them automatically dispensed with each delivery or to manually add the proper dose to each tank before delivery. Typically, pouring a dose into an already frozen tank does not solve the problem.

Another method of dealing with cold flow problems is to use kerosene either instead of, or blended with the fuel. Kerosene dissolves wax and flows better in very cold temperatures.

As more and more USTs have been replaced with outdoor ASTs, cold flow problems have become more common. Too many tanks have been installed outside without sufficient thought being given to potential service problems. Outside tanks should be encased in enclosures and exposed fuel lines should be insulated to protect them from the elements.

When an outside tank does "freeze" it's the service technician's job to get the system up and running so the rest of the house doesn't also freeze. Once the technician has determined that the lines are frozen the following procedures are recommended:

- Check the tank connection. If the fuel line is pulled off the bottom of the tank, reroute the line to pull through a tapping at the top and set the line at least 6" off the bottom. Be sure to fully close and plug the valve at the tank bottom. Never assume that the valve is closed. There have been instances of tanks thawing and draining through a "closed" tank valve when temperatures increased
- Use a manual push-pull pump to be sure the line is clear all the way to the burner
- Insulate the line from the tank to the location where it enters the building
- Advise the customer about the advantages of a tank enclosure and encourage them to add one
- In addition to frozen lines, cold fuel causes other problems. Cold fuel doesn't atomize well and as its viscosity increases, more fuel flows through the nozzle. In areas where outside tanks are exposed to cold temperatures, it's advisable to consider:
- Installing a fuel de-aerator to warm the fuel before it reaches the nozzle
- Installing a fuel line heater to improve combustion
- Inform the customer on the advantages of an inside tank

Chapter 11

Conclusion

Proper installation and maintenance procedures can help minimize or prevent the number and severity of service and environmental issues associated with fuel storage.

It requires the technician:

Diligently follow manufacturers' installation procedures

Each tank manufacturer supplies installation instructions. The instructions may vary and the most current versions can be found on the manufacturer's website.

Do not transfer the fuel from a tank being replaced into a new tank

The sources of many service problems including premature tank failure, are sludge, water and bacteriological contaminants. Fuel pumped from an old tank to a new one accelerates the process. Even when a filtration system is used, contaminants from the tank being replaced can end up in the new tank. Whenever possible, schedule tank replacement when the usable fuel is depleted.

Inspect storage tanks and fuel lines before delivery to all new customers

Although operational pressures often make it inconvenient to inspect a new customer's tank before the first delivery is made, it is worth the effort. A thorough inspection of each tank helps avoid spills and the costly environmental cleanups that can result. Refer to the recommended inspection procedures and the *Initial Storage Tank Evaluation* form. (Appendix I)

Conduct tank & fuel line inspections during preventative tune-ups

Storage tanks have a useful life span. Conduct regular inspections of customer tanks to detect early signs of the tank being due for replacement. Refer to the recommended inspection procedures and the *Routine Storage Tank Evaluation* form. (Appendix I)

Perform a brief inspection each time a tank is filled

Make it a standard practice to conduct a brief inspection before starting each and every delivery. Refer to the recommended inspection procedures and the *DeliveryReport* form. (Appendix I)

Avoid applying "band aid" type solutions to problem tanks

Raising suction lines by several inches or installing floating suction lines may help to avoid plugged nozzle and filter service, However, these are an indicators that maintenance of the tank bottoms may be needed.

During the heating season, a short-term solution may be warranted, but schedule the tank for future action. A tank with a buildup of water and/or sludge causes service problems that are not remedied by raising the lines. Leaving the water on the tank bottom can shorten the life of a steel tank.

Fix the problem, not the symptom. Evidence indicates microbiological growth is linked to corrosion of tanks and lines. A plugged nozzle or filter is often a signal of a microbiological growth which needs to be addressed.

Implement a pro-active tank replacement program

Properly manufactured, installed and maintained tanks can last 30 years or more. However, replacement of a tank a year too early is far better than replacing a tank a single day too late. Like all components of the home, fuel tanks age and should be replaced before problems arise.

Incorporate tank installation, inspection & maintenance into your company's training schedules

Tank designs have changed over the years and the causes of tank failure are now better understood. Service technicians and fuel delivery personnel should be updated on current fuel storage tank installation, inspection and service recommendations and procedures.

Appendix I

Storage Tank Inspection Forms

The NORA recommended tank inspection form templates, designed to address the most common tank configurations, can be found at *NORAweb.org/storage-tanks.*

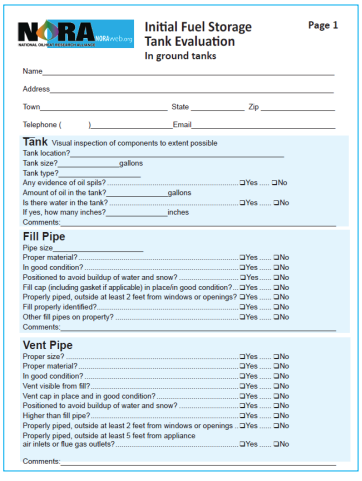
Companies are encouraged to use these forms and modify if necessary, to meet their specific policies and procedures.

When a problem situation is noted, the customer should be advised and recommendations and/or a proposal for corrections should be provided.

Download at:

NORAweb.org/storage-tanks

Initial Evaluation (in ground)



Initial Fuel Storage Tank Evaluation
In ground tanks

Page 1

Name
Address
Town State Zip
Telephone ( ) Email

Tank Visual inspection of components to extent possible

Tank location?
Tank size? gallons
Tank type?
Any evidence of oil spills? ❑Yes ❑No
Amount of oil in the tank? gallons
Is there water in the tank? ❑Yes ❑No
If yes, how many inches? inches
Comments:

Fill Pipe

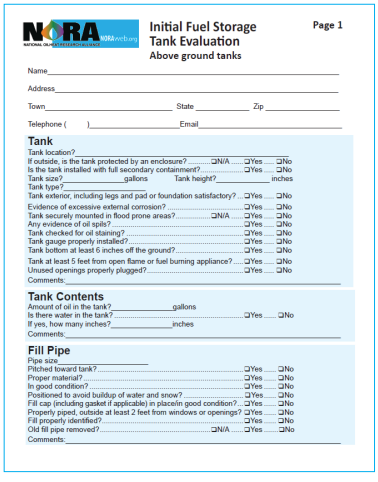
Pipe size
Proper material? ❑Yes ❑No
In good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Fill cap (including gasket if applicable) in place/in good condition? ❑Yes ❑No
Properly piped, outside at least 2 feet from windows or openings? ❑Yes ❑No
Fill properly identified? ❑Yes ❑No
Other fill pipes on property? ❑Yes ❑No
Comments:

Vent Pipe

Proper size? ❑Yes ❑No
Proper material? ❑Yes ❑No
In good condition? ❑Yes ❑No
Vent visible from fill? ❑Yes ❑No
Vent cap in place and in good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Higher than fill pipe? ❑Yes ❑No
Properly piped, outside at least 2 feet from windows or openings ❑Yes ❑No
Properly piped, outside at least 5 feet from appliance air inlets or flue gas outlets? ❑Yes ❑No

Comments:

Initial Evaluation (above ground)



Initial Fuel Storage Tank Evaluation
Above ground tanks

Page 1

Name
Address
Town State Zip
Telephone ( ) Email

Tank

Tank location?
If outside, is the tank protected by an enclosure? ❑N/A ❑Yes ❑No
Is the tank installed with full secondary containment? ❑Yes ❑No
Tank size? gallons Tank height? inches
Tank type?
Tank exterior, including legs and pad or foundation satisfactory? ❑Yes ❑No
Evidence of excessive external corrosion? ❑Yes ❑No
Tank securely mounted in flood prone areas? ❑N/A ❑Yes ❑No
Any evidence of oil spills? ❑Yes ❑No
Tank checked for oil staining? ❑Yes ❑No
Tank gauge properly installed? ❑Yes ❑No
Tank bottom at least 6 inches off the ground? ❑Yes ❑No
Tank at least 5 feet from open flame or fuel burning appliance? ❑Yes ❑No
Unused openings properly plugged? ❑Yes ❑No
Comments:

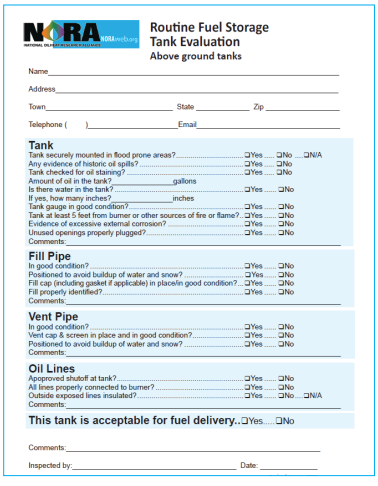
Tank Contents

Amount of oil in the tank? gallons
Is there water in the tank? ❑Yes ❑No
If yes, how many inches? inches
Comments:

Fill Pipe

Pipe size
Pitched toward tank? ❑Yes ❑No
Proper material? ❑Yes ❑No
In good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Fill cap (including gasket if applicable) in place/in good condition? ❑Yes ❑No
Properly piped, outside at least 2 feet from windows or openings? ❑Yes ❑No
Fill properly identified? ❑Yes ❑No
Old fill pipe removed? ❑N/A ❑Yes ❑No
Comments:

Routine Evaluation (above ground)



Routine Fuel Storage Tank Evaluation
Above ground tanks

Name
Address
Town State Zip
Telephone ( ) Email

Tank

Tank securely mounted in flood prone areas? ❑Yes ❑No ❑N/A
Any evidence of historic oil spills? ❑Yes ❑No
Tank checked for oil staining? ❑Yes ❑No
Amount of oil in the tank? gallons
Is there water in the tank? ❑Yes ❑No
If yes, how many inches? inches
Tank gauge in good condition? ❑Yes ❑No
Tank at least 5 feet from burner or other sources of fire or flame? ❑Yes ❑No
Evidence of excessive external corrosion? ❑Yes ❑No
Unused openings properly plugged? ❑Yes ❑No
Comments:

Fill Pipe

In good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Fill cap (including gasket if applicable) in place/in good condition? ❑Yes ❑No
Fill properly identified? ❑Yes ❑No
Comments:

Vent Pipe

In good condition? ❑Yes ❑No
Vent cap & screen in place and in good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Comments:

Oil Lines

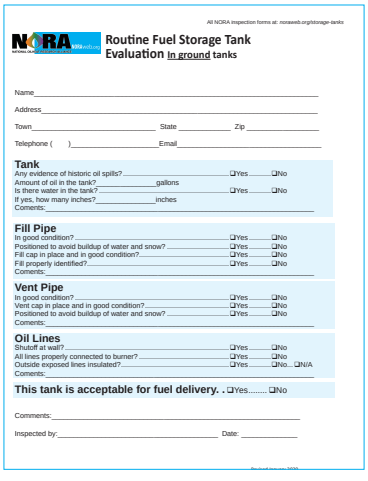
Approved shutoff at tank? ❑Yes ❑No
All lines properly connected to burner? ❑Yes ❑No
Outside exposed lines insulated? ❑Yes ❑No ❑N/A
Comments:

This tank is acceptable for fuel delivery. ❑Yes ❑No

Comments:

Inspected by: Date:

Routine Evaluation (in ground)



All NORA inspection forms at: noraweb.org/storage-tanks

Routine Fuel Storage Tank Evaluation In ground tanks

Name
Address
Town State Zip
Telephone ( ) Email

Tank

Any evidence of historic oil spills? ❑Yes ❑No
Amount of oil in the tank? gallons
Is there water in the tank? ❑Yes ❑No
If yes, how many inches? inches
Comments:

Fill Pipe

In good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Fill cap in place and in good condition? ❑Yes ❑No
Fill properly identified? ❑Yes ❑No
Comments:

Vent Pipe

In good condition? ❑Yes ❑No
Vent cap in place and in good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Comments:

Oil Lines

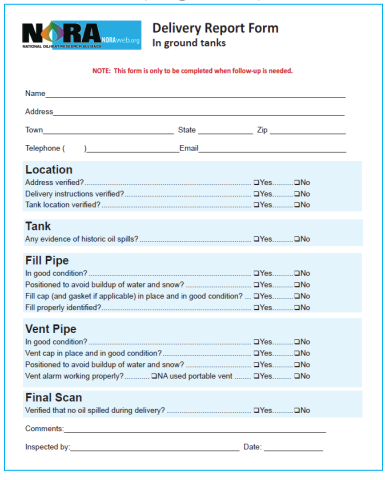
Shutoff at wall? ❑Yes ❑No
All lines properly connected to burner? ❑Yes ❑No
Outside exposed lines insulated? ❑Yes ❑No ❑N/A
Comments:

This tank is acceptable for fuel delivery. ❑Yes ❑No

Comments:

Inspected by: Date:

Delivery Report (in ground)



Delivery Report Form
In ground tanks

NOTE: This form is only to be completed when follow-up is needed.

Name
Address
Town State Zip
Telephone ( ) Email

Location

Address verified? ❑Yes ❑No
Delivery instructions verified? ❑Yes ❑No
Tank location verified? ❑Yes ❑No

Tank

Any evidence of historic oil spills? ❑Yes ❑No

Fill Pipe

In good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Fill cap (and gasket if applicable) in place and in good condition? ❑Yes ❑No
Fill properly identified? ❑Yes ❑No

Vent Pipe

In good condition? ❑Yes ❑No
Vent cap in place and in good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Vent alarm working properly? ❑NA used portable vent ❑Yes ❑No

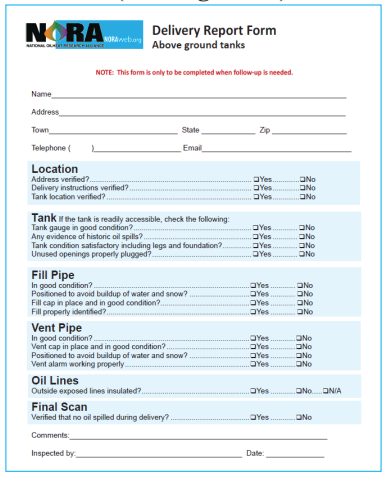
Final Scan

Verified that no oil spilled during delivery? ❑Yes ❑No

Comments:

Inspected by: Date:

Delivery Report (above ground)



Delivery Report Form
Above ground tanks

NOTE: This form is only to be completed when follow-up is needed.

Name
Address
Town State Zip
Telephone ( ) Email

Location

Address verified? ❑Yes ❑No
Delivery instructions verified? ❑Yes ❑No
Tank location verified? ❑Yes ❑No

Tank If the tank is readily accessible, check the following:

Tank gauge in good condition? ❑Yes ❑No
Any evidence of historic oil spills? ❑Yes ❑No
Tank condition satisfactory including legs and foundation? ❑Yes ❑No
Unused openings properly plugged? ❑Yes ❑No

Fill Pipe

In good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Fill cap in place and in good condition? ❑Yes ❑No
Fill properly identified? ❑Yes ❑No

Vent Pipe

In good condition? ❑Yes ❑No
Vent cap in place and in good condition? ❑Yes ❑No
Positioned to avoid buildup of water and snow? ❑Yes ❑No
Vent alarm working properly ❑Yes ❑No

Oil Lines

Outside exposed lines insulated? ❑Yes ❑No ❑N/A

Final Scan

Verified that no oil spilled during delivery? ❑Yes ❑No

Comments:

Inspected by: Date:

Initial Fuel Storage Tank Evaluation <u>In ground</u> tanks

Name_____

Address_____

Town_____ State _____ Zip _____

Telephone ( )_____Email_____

Tank Visual inspection of components to extent possible

Tank location?_____
Tank size?_____gallons
Tank type?_____
Any evidence of oil spils? .....❑Yes ..... ❑No
Amount of oil in the tank?_____gallons
Is there water in the tank? .....❑Yes ..... ❑No
If yes, how many inches?_____inches
Comments:_____

Fill Pipe

Pipe size_____
Proper material? .....❑Yes ..... ❑No
In good condition? .....❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? ..... ❑Yes ..... ❑No
Fill cap (including gasket if applicable) in place/in good condition?...❑Yes ..... ❑No
Properly piped, outside at least 2 feet from windows or openings? ❑Yes ..... ❑No
Fill properly identified?.....❑Yes ..... ❑No
Other fill pipes on property? .....❑Yes ..... ❑No
Comments:_____

Vent Pipe

Proper size? .....❑Yes ..... ❑No
Proper material?.....❑Yes ..... ❑No
In good condition? .....❑Yes ..... ❑No
Vent visible from fill?.....❑Yes ..... ❑No
Vent cap in place and in good condition?.....❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? .....❑Yes ..... ❑No
Higher than fill pipe?.....❑Yes ..... ❑No
Properly piped, outside at least 2 feet from windows or openings ..❑Yes ..... ❑No
Properly piped, outside at least 5 feet from appliance
air inlets or flue gas outlets?.....❑Yes ..... ❑No

Comments:_____

Revised January 2020

Oil Lines

Line size?_____

Inside lines in contact with concrete or dirt protected against corrosion? .....❑Yes ..... ❑No

Any evidence of oil spils? .....❑Yes ..... ❑No

Shutoff at wall? .....❑Yes ..... ❑No

OSV installed?.....❑Yes ..... ❑No

Lines properly connected back to burner? .....❑Yes ..... ❑No

Any compression fittings visible?.....❑Yes ..... ❑No

Oil filter properly installed? .....❑Yes ..... ❑No

Fusible valves properly located? .....❑Yes ..... ❑No

Comments:_____

This tank is acceptable for fuel delivery..❑Yes.....❑No

This tank **will be** acceptable for delivery **once** the following defects are **corrected:**

- _____
- _____
- _____
- _____
- _____
- _____

Inspected by:_____ Date: _____

Company:_____ Phone: _____

Town:_____

Revised January2020

Initial Fuel Storage Tank Evaluation Above ground tanks

Name_____

Address_____

Town_____ State _____ Zip _____

Telephone ( )_____Email_____

Tank

Tank location?_____
If outside, is the tank protected by an enclosure? .....❑N/A .....❑Yes ..... ❑No
Is the tank installed with full secondary containment?.....❑Yes ..... ❑No
Tank size?_____gallons Tank height?_____ inches
Tank type?_____

Tank exterior, including legs and pad or foundation satisfactory? ...❑Yes ..... ❑No
Evidence of excessive external corrosion? .....❑Yes ..... ❑No
Tank securely mounted in flood prone areas?.....❑N/A .....❑Yes ..... ❑No
Any evidence of oil spils? .....❑Yes ..... ❑No
Tank checked for oil staining? .....❑Yes ..... ❑No

Tank gauge properly installed?.....❑Yes ..... ❑No
Tank bottom at least 6 inches off the ground?.....❑Yes ..... ❑No
Tank at least 5 feet from open flame or fuel burning appliance?.....❑Yes ..... ❑No
Unused openings properly plugged?.....❑Yes ..... ❑No
Comments:_____

Tank Contents

Amount of oil in the tank?_____gallons
Is there water in the tank? .....❑Yes ..... ❑No
If yes, how many inches?_____inches
Comments:_____

Fill Pipe

Pipe size_____
Pitched toward tank?.....❑Yes ..... ❑No
Proper material?.....❑Yes ..... ❑No
In good condition? .....❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? .....❑Yes..... ❑No
Fill cap (including gasket if applicable) in place/in good condition?...❑Yes ..... ❑No
Properly piped, outside at least 2 feet from windows or openings? ❑Yes ..... ❑No
Fill properly identified?.....❑Yes ..... ❑No
Old fill pipe removed?.....❑N/A .....❑Yes .....❑No
Comments:_____

Revised January 2020

Vent Pipe

Proper size? ..... ❑Yes ..... ❑No
Pitched toward tank? ..... ❑Yes ..... ❑No
Proper material? ..... ❑Yes ..... ❑No
In good condition? ..... ❑Yes ..... ❑No
Vent visible from fill? ..... ❑Yes ..... ❑No
Vent alarm installed? ..... ❑Yes ..... ❑No
Vent cap in place and in good condition? ..... ❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? ..... ❑Yes ..... ❑No
Higher than fill pipe? ..... ❑Yes ..... ❑No
Properly piped, outside at least 2 feet from windows or openings .. ❑Yes ..... ❑No
Properly piped, outside at least 5 feet from appliance air inlets or flue gas outlets? .... ❑Yes ... ❑No
Comments:_____

Oil Lines

Line size?_____
Proper material? ..... ❑Yes ..... ❑No
Oil lines encapsulated? ..... ❑Yes ..... ❑No
Working shutoff at tank? ..... ❑Yes ..... ❑No
OSV installed? ..... ❑Yes ..... ❑No
Lines properly connected back to burner? ..... ❑Yes ..... ❑No
Outside exposed lines insulated? ..... ❑NA ..... ❑Yes ..... ❑No
Any compression fittings? ..... ❑Yes ..... ❑No
Oil filter properly installed? ..... ❑Yes ..... ❑No
Fusible valves properly located? ..... ❑Yes ..... ❑No
System checked for oil leaks? ..... ❑Yes ..... ❑No

Comments:_____

This tank is acceptable for fuel delivery.. ❑Yes..... ❑No

This tank **will be** acceptable for delivery **once** the following defects are **corrected:**

- _____
- _____
- _____
- _____
- _____
- _____

Inspected by:_____ Date: _____

Company:_____ Phone: _____

Town:_____

Revised January2020

Routine Fuel Storage Tank Evaluation <u>In ground</u> tanks

Name_____

Address_____

Town_____ State _____ Zip _____

Telephone ( )_____Email_____

Tank

Any evidence of historic oil spills? ..... ❑Yes ..... ❑No
Amount of oil in the tank?_____gallons
Is there water in the tank? ..... ❑Yes ..... ❑No
If yes, how many inches?_____inches
Coments:_____

Fill Pipe

In good condition? ..... ❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? ..... ❑Yes ..... ❑No
Fill cap in place and in good condition?..... ❑Yes ..... ❑No
Fill properly identified?..... ❑Yes ..... ❑No
Coments:_____

Vent Pipe

In good condition? ..... ❑Yes ..... ❑No
Vent cap in place and in good condition?..... ❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? ..... ❑Yes ..... ❑No
Coments:_____

Oil Lines

Shutoff at wall? ..... ❑Yes ..... ❑No
All lines properly connected to burner? ..... ❑Yes ..... ❑No
Outside exposed lines insulated?..... ❑Yes ..... ❑No... ❑N/A
Coments:_____

This tank is acceptable for fuel delivery. . ❑Yes..... ❑No

Comments:_____

Inspected by:_____ Date: _____

Revised January 2020

Routine Fuel Storage Tank Evaluation Above ground tanks

Name_____

Address_____

Town_____ State _____ Zip _____

Telephone ( )_____Email_____

Tank

Tank securely mounted in flood prone areas?.....❑Yes ..... ❑No ....❑N/A
Any evidence of historic oil spills?.....❑Yes ..... ❑No
Tank checked for oil staining? .....❑Yes ..... ❑No
Amount of oil in the tank?_____gallons
Is there water in the tank? .....❑Yes ..... ❑No
If yes, how many inches?_____inches
Tank gauge in good condition?.....❑Yes ..... ❑No
Tank at least 5 feet from burner or other sources of fire or flame?..❑Yes ..... ❑No
Evidence of excessive external corrosion? .....❑Yes ..... ❑No
Unused openings properly plugged?.....❑Yes ..... ❑No
Comments:_____

Fill Pipe

In good condition? .....❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? .....❑Yes..... ❑No
Fill cap (including gasket if applicable) in place/in good condition?...❑Yes ..... ❑No
Fill properly identified?.....❑Yes ..... ❑No
Comments:_____

Vent Pipe

In good condition? .....❑Yes ..... ❑No
Vent cap & screen in place and in good condition?.....❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? .....❑Yes ..... ❑No
Comments:_____

Oil Lines

Apoproved shutoff at tank?.....❑Yes ..... ❑No
All lines properly connected to burner? .....❑Yes ..... ❑No
Outside exposed lines insulated?.....❑Yes ..... ❑No....❑N/A
Comments:_____

This tank is acceptable for fuel delivery..❑Yes.....❑No

Comments:_____

Inspected by:_____ Date: _____

Revised January 2020

Delivery Report Form
In ground tanks

NOTE: This form is only to be completed when follow-up is needed.

Name_____

Address_____

Town_____ State _____ Zip _____

Telephone ( )_____Email_____

Location

Address verified?..... ❑Yes.....❑No
Delivery instructions verified?..... ❑Yes.....❑No
Tank location verified?..... ❑Yes.....❑No

Tank

Any evidence of historic oil spills?..... ❑Yes.....❑No

Fill Pipe

In good condition?..... ❑Yes.....❑No
Positioned to avoid buildup of water and snow?..... ❑Yes.....❑No
Fill cap (and gasket if applicable) in place and in good condition? ... ❑Yes.....❑No
Fill properly identified?..... ❑Yes.....❑No

Vent Pipe

In good condition?..... ❑Yes.....❑No
Vent cap in place and in good condition?..... ❑Yes.....❑No
Positioned to avoid buildup of water and snow?..... ❑Yes.....❑No
Vent alarm working properly?..... ❑NA used portable vent ..... ❑Yes..... ❑No

Final Scan

Verified that no oil spilled during delivery?..... ❑Yes.....❑No

Comments:_____

Inspected by:_____ Date: _____

Revised January 2020

Delivery Report Form
Above ground tanks

NOTE: This form is only to be completed when follow-up is needed.

Name_____

Address_____

Town_____ State _____ Zip _____

Telephone ( )_____ Email_____

Location
Address verified?..... ❑Yes.....❑No
Delivery instructions verified?..... ❑Yes.....❑No
Tank location verified?..... ❑Yes.....❑No

Tank If the tank is readily accessible, check the following:
Tank gauge in good condition?..... ❑Yes ..... ❑No
Any evidence of historic oil spills?..... ❑Yes ..... ❑No
Tank condition satisfactory including legs and foundation?..... ❑Yes ..... ❑No
Unused openings properly plugged?..... ❑Yes ..... ❑No

Fill Pipe
In good condition? .....❑Yes ..... ❑No
Positioned to avoid buildup of water and snow? .....❑Yes ..... ❑No
Fill cap in place and in good condition?.....❑Yes ..... ❑No
Fill properly identified?.....❑Yes ..... ❑No

Vent Pipe
In good condition? .....❑Yes .....❑No
Vent cap in place and in good condition? .....❑Yes .....❑No
Positioned to avoid buildup of water and snow? .....❑Yes .....❑No
Vent alarm working properly.....❑Yes .....❑No

Oil Lines
Outside exposed lines insulated?.....❑Yes .....❑No.....❑N/A

Final Scan
Verified that no oil spilled during delivery? .....❑Yes .....❑No

Comments:_____

Inspected by:_____ Date: _____

Revised January 2020

Recommended Practice for
Home Heating Oil Tank Flood Resistance

During severe flood events, such as those occurring from Hurricane Irene and Super-Storm Sandy, many coastal and low elevation inland areas were subjected to high water conditions. As a result, a number of outdoor above-ground home heating oil tanks were dislodged and, in some cases, caused property damage.

In response to the combined effects of these events, the Oil Heat Institute of Long Island (OHILI) and the National Oilheat Research Alliance (NORA), in collaboration with local government agencies and oil heat industry experts, have developed this ***Recommended Practice*** *(RP) in an effort to mitigate these problems in future flood events.*

The research, testing and approval of this RP went through the National Fire Protection (NFPA) 31 Technical Committee and was balloted successfully for publication as a reference document.

This RP should be used as guidance when installing new tanks or upgrading existing installations.

This RP is intended to provide recommended installation guidelines for small heating oil tanks to resist floating and mitigate spills under severe static flood conditions. Guidance information of what tank owners should do before and after flood events occur is also provided.

This RP is intended for use by homeowners, businesses, oil tank installers, regulators or others who either have small heating oil tanks on their property, may install or maintain these tanks or have various government or regulatory responsibilities for such tanks.

This RP was developed around the most common types of heating oil tanks typically used in small heating systems, and reflects practical solutions using widely available construction components. This RP may also be used for similar tanks storing similar Class II liquids.

Design Parameters

The following are the heating oil tank and system details upon which this RP was developed. For tank types, foundations, hold-downs and flood conditions that differ from these parameters, a professional engineer should be consulted to design equivalent flood resistant solutions.

Tank Types:
- Steel UL80 or UL142 obround shapes, max 330 gal.
- Tanks located above ground outdoors or indoors.
- Welded supports or attached legs of min. 1.25" sch 40 steel pipe.

Tank Foundations:
- Existing concrete slabs or structures, such as garages or patios.
- Concrete slabs designed in accordance with this RP per (Figure 1).
- Structural steel floors meeting applicable building code requirements.

Tank Hold-Downs:
- Foot flanges in combination with pipe legs per (Design A1 or A2).
- Concrete anchor (Design B1 or B2) in combo with hold-down (Design D1 or D2).
- Earth auger ure(Design C1 or C2) in combo with hold-down (Design D1 or D2).

Fig. 1 – *General photo of assembled tank and slab before anchoring - Note all photos are of ½ size horizontal obrounds tested, but the hold down methods apply to vertical obrounds.*

Flood Conditions:
- Still water in Flood Zones 1-4 with tank at 40% fill level.
- Flood height of 2.0' above tank shell top for Flood Zone 1.
- Two day submersion in fresh or salt water.

Miscellaneous Assumptions:

- The tank and supports are in good condition without damage or corrosion.
- Annual damage and corrosion check of the flood resistant components used.
- Maintenance or repair of the flood resistant components if needed.
- All work is done by a licensed contractor.

Disclaimers

Please be aware that the following tanks, installations or flood conditions are not specifically covered by this RP:

- Underground tanks of any type, material or size.
- Rectangular steel tanks, and any nonmetallic tanks (plastic or fiberglass).
- Installations above 1st floor levels or basements one level below grade.
- Dynamic flood conditions, such as wave action, storm surge or river flows.
- Excessive wind loads, such as those from tornadoes or hurricanes.

- Impacts from large debris driven by high winds or water flows.

Prior to selecting and installing a suitable design to prevent tank uplifting, the following are minimum requirements for different types of common tank supports and surfaces upon which the tank shall be placed.

- **Tank Supports** – Tank supports shall be either (a) types that are included under the tank Listing (steel saddles welded to tank), or (b) 1.25" diameter Schedule 40 steel pipe legs <= 12" long with threaded ends connected to leg brackets (welded to the tank shell). Any supports not structurally connected to the tank (welded, bolted, threaded) are not suitable.

- **Existing Surfaces** – Existing concrete foundations (such as garage floors or patio slabs) are suitable provided they at least (a) extend 3' beyond the tank footprint or have a minimum weight to resist the tank buoyant force (Table 2) and (b) are of 4" thick structural concrete with metal reinforcement (wire or bars). The concrete shall be free of cracks.

- **New Pads** – New concrete pads shall be monolithic (single unbroken) types that at least (a) extend 6" beyond the tank footprint, and (b) are made of structural concrete with metal reinforcement (wire or bars) in the thickness necessary to resist the tank buoyant forces per Table 2, but not less than 6". Extension of new pads over old ones is permitted if the design is engineered to resist separating under the expected forces.

- **Undersized Pads** – Undersized concrete pads may be used provided the pad is no less than ½ the required minimum weight to resist the tank buoyant force per Table 2 and is used in combination with the earth auger or stake design as described in the tank securement methods.

- **Steel Surfaces** - For steel floors of substantial construction (structural grating or min. 0.93 in thick plate) used in commercial shops or pre-fabricated buildings, integral tank supports and legs with or without foot flanges shall be welded to these surfaces.

Notes- 1. For outdoor constructions, the surface of the concrete pad shall have a crown or slope to prevent water from collecting around the supports and other securement components at grade.

2. For new constructions, at least twenty one days between pouring any concrete and installation of the tank is recommended to ensure high strength and crack resistance.

Tank Securement Methods

After determining that the tank support and concrete pad surface meets the minimum criteria above, one of the following pre-engineered designs to prevent tank uplifting should be installed based on the combination of tank support and surface. (See Figure 1 and specific Designs for details.)

The following applies to steel UL 80 and UL 142 tanks only. See manufacturer's instructions for other tanks.

- **Foot Flanges** – For tanks with pipe legs on new or existing surfaces without the need for hold-down straps, foot flanges with threaded ends shall be connected to mating pipe end. Each foot shall then be secured to the supporting surface with concrete bolts or screws. See Designs A1 or A2 for details of the minimum specs for foot flanges and concrete bolts or screws.

- **Concrete Anchors** – For tanks with saddles or pipe legs for new surfaces in combination with hold-down straps, concrete anchors with a means for attaching the strap end shall be cast in the concrete. The anchors shall be positioned at +/- 4" of the tank support centerline and +/- 4" of the tank width or diameter centerline. See Design B1 or B2

Table 1.
Flood Zones Table

Flood Zones	FEMA Hurricane Storm Surge Zones	Flooding Potential (*)
0		Water below any recognized flood zones
1	Category 1	Water 1-2 ft above grade (approx 1/4 tank height)
2	Category 2	Water 2-3 ft above grade (approx 1/2 tank height)
3	Category 3	Water 3-4 ft above grade (approx 3/4 tank height)
4	Category 4	Water 4-5 ft above grade (water at/above tank top)

* based on 275 gal vertical obround tank with 12" legs at ground level.

Table 2.
Pad Size Requirements
(Vertical Obround Steel Tanks)

Tank capacity & Size	Flood Zone #	Pad Size	Bouy-ancy Force
120g 30" x 23" x 46"	0	48" x 35" x 6"	-499
	1	48" x 35" x 6"	-293
	2	48" x 35" x 6"	17
	3	48" x 35" x 6"	326
	4	48" x 35" x 9"	532
130g 30" x 27" x 44"	0	48" x 39" x 6"	-544
	1	48" x 39" x 6"	-317
	2	48" x 39" x 6"	38
	3	48" x 39" x 6"	394
	4	48" x 39" x 10"	631
220g 49" x 27" x 44"	0	61" x 39" x 6"	-850
	1	61" x 39" x 6"	-472
	2	61" x 39" x 6"	95
	3	61" x 39" x 7"	662
	4	61" x 39" x 11"	1041
230g 60" x 22" x 44"	0	72" x 34" x 6"	-896
	1	72" x 34" x 6"	-501
	2	72" x 34" x 6"	92
	3	72" x 34" x 6"	685
	4	72" x 34" x 11"	1080
240g 60" x 23" x 46"	0	72" x 35" x 6"	-935
	1	72" x 35" x 6"	-523
	2	72" x 35" x 6"	96
	3	72" x 35" x 7"	715
	4	72" x 35" x 11"	1127
275g 60" x 27" x 44"	0	72" x 39" x 6"	-1042
	1	72" x 39" x 6"	-568
	2	72" x 39" x 6"	138
	3	72" x 39" x 8"	848
	4	72" x 39" x 12"	1320
330g 72" x 27" x 44"	0	84" x 39" x 6"	-1236
	1	84" x 39" x 6"	-669
	2	84" x 39" x 6"	182
	3	84" x 39" x 8"	1032
	4	84" x 39" x 12"	1599

for additional details and minimum specs for anchor types, and information below for hold-down strap options.

- **Earth Augers** - For tanks with saddles or pipe legs for undersized pads in combination with hold-down straps, earth augers with a means for attaching the strap end shall be installed under the concrete slab. The augers shall be positioned at +/- 4" of the tank support centerline and +/- 4" of the tank width or diameter centerline. See Design C1 or C2 for additional details and minimum specs for auger types, and information below for hold-down strap options.

- **Hold-Down Straps** – Hold-down straps for use with concrete anchor or earth auger designs shall have a means at each end to connect to fixed attachment points and shall have a means to tighten the strap, such as a turnbuckle. The straps shall be positioned over the tank at the anchor points, but shall not interfere with used openings. (See Design D1 or D2 for additional details, options and minimum specs for wire rope and metal strap options).

- **Tank Saddles** – When tank saddles are provided with the tank, either the tank manufacturer or a mechanical engineer shall be consulted to provide a recommended method of securing the saddle to the supporting surface that is suitable for the installation type, and sufficient to resist the buoyant forces with a safety factor of at least 1.15.

Notes – **1**. Threaded connections between the pipe leg, tank bracket and/or foot flange shall be fully engaged without stripping. All bolts, screws or similar hardware shall use the manufacturers recommended torque or other assembly specifications.

2. Only stainless, galvanized, or similar corrosion resistant metal types should be used for all hardware components. Concrete adhesives shall be used in tap holes for screws.

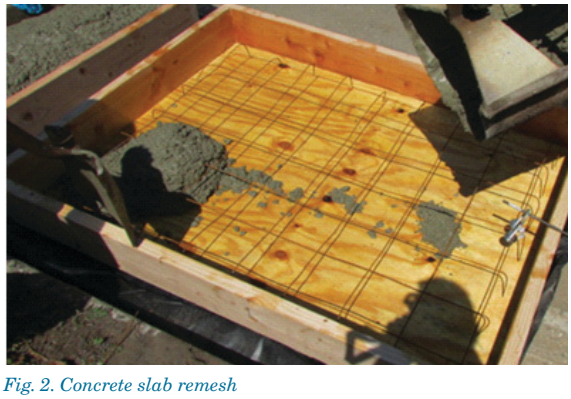


Fig. 2. Concrete slab remesh

Fig. 3. Concrete slab

3. To prevent accelerated corrosion in pipe legs, installers should NOT seal the foot; they should, however, cap the top ends or create a weep hole in the concrete under the foot.

When pouring a new slab

Remesh (Fig. 2) - Grade 40 Steel wire mesh min. 0.1" diameter x max 6.0" squares. See Design C1 or C2 details for any other components intended to be imbedded in the remesh and slab before pouring. Note cast in anchor in mesh.

Concrete (Fig. 3) - Single slab sized per Table 2 for tank dimensions & capacity using Sakrete (or equivalent) standard 4000 psi compression strength mix with remesh cut to slab size and centered in form.

Tank Securement Designs

CR = Corrosion Resistant, such as stainless steel or plated steel rated for outdoor use.

Fig. 4. Adding adhesive to the drilled hole

Designs A1 and A2 (Fig. 4) – Details of foot flange with bolt or screw options using similar flange, hole drilling and hole preparation. There is a difference with the anchoring method (bolt or screw).

Design A1 (Fig. 5) – Foot Flange & Concrete Bolt Photo detail of small diameter flange and one bolt combo for new or existing slabs before and after assembly:

Foot Flange – Mueller Model 511-606HN (Home Depot SKU# 182141) or equivalent 1.25" Floor Flange – 2.75" diameter galvanized iron with pipe threads screwed onto tank pipe leg and secured with one concrete bolt/foot.

Concrete Bolt – CR Steel Concrete Bolt (permanent expansion type) minimum 3/8" diameter x 3.5" long rated for at least ½ the buoyant force (Table 2) and installed in drilled hole min. 2.5" deep.

Design A2 (Fig. 6)– Foot Flange and Concrete Screw Photo detail of large diameter flange and 2-screw combo for new or existing slabs before and after assembly:

Fig. 5. Design A1 foot flange with bolt

Fig 6. Concrete screws installed after hole has been cleaned and adhesive added

Foot Flange – Mueller Model 301-F114 (Home Depot SKU# 564311) or equivalent 1.25" Floor Flange – 3.50" diameter black iron w pipe threads and four holes screwed onto tank pipe leg and secured with two concrete screws/foot into opposite holes

Concrete Screw – CR Steel Concrete Screw (removable or permanent expansion type) min. 1/4" diameter x 2.5" long rated for at least ¼ the buoyant force (Table 2) and installed in drilled hole min. 2.0" deep.

Cleaning the hole and adding concrete adhesive is strongly recommended!

Design B1 or B2 –Detail of eye or U anchor options for casting in new concrete slabs and connection to hold-down and connection options. Four required-each positioned +/- 4" off leg/support centrally.

Fig. 7. Eye-Anchor

Fig. 8 U-Anchor

Eye-Anchor (Fig. 7) – CR Steel Eye-Bolt min. 3/8" diameter x 6.0" long w mating large diameter washer & nut fixed under Remesh and cast into concrete min. 4.0" deep rated for at least ½ the buoyant force.

U-Anchor (Fig. 8) – CR Steel U-Bolt min. 1/4" diameter x 5.0" long w mating plate and nuts fixed under Remesh and cast into concrete min. 3.5"

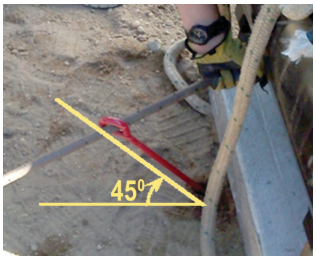


Fig 9. Thirty inch anchor at 45⁰ angle

deep rated for at least ½ the buoyant force.

Design C1 or C2 (Fig. 9 & 10) – Earth Auger Photos detail of earth auger options for casting in new concrete slabs and connection to hold-down and connection options. 4 required-each positioned +/- 4" off leg/support centrally.

Earth Auger – CR steel min. 1/2" diameter shaft and with auger screw and eye end with approx. 4-6" eye end bent vertical after installation to connect with hold down brackets.

Grainger 4LVK4 or equiv 30" long with 3" diameter auger screwed in earth under slab at a 45 degree angle, from horizontal, minimum 24" deep.


Fig. 10. 40" length and 30" length earth augers

OR

Grainger 4LVK5, 40" long with a 4" diameter auger screwed in earth under slab at a 60 degree angle, from horizontal, minimum 34" deep.

Design D1 or D2 (Fig. 11, 12 & 13) – Wire Rope or Metal Band and Connection Option Photos details of rope and band options cut to size for tank height and fitted with loops at each end for connection through turn buckle and/or quick link as needed for the designs used.

Wire Rope (Fig.11) – Dayton Model 2VJN6 Coated Steel Cable (Granger Item # 2VJN6) or equivalent 1/4" diameter galvanized steel 7 x 19 strand w UV resistant vinyl jacket rated min. 1400 lb.

Rope Ends – CR metal fittings with thimbles sized for wire rope diameter and secured by (a) steel cable


Fig. 11. CR metal wire rope with u-clamps and quick link

U-clamp or (b) metal crimp sleeve rated min. 1400 lb.

OR

Metal Band (Fig 12) – Band-It Model C206BB Steel Band Kit (Granger Item # 13E234) or equivalent 3/4" W x .030" thick stainless steel band and crimp


Fig. 12. CR metal band & Clamp with D ring and turnbuckle

clamp rated min. 1500 lb. Crimp tool and plastic spacer between band and tank are needed.

Band Ends – CR metal D-ring or bow shackle sized for metal band width and added to loop ends prior to crimping, rated min. 1500 lb.

AND

Turn Buckle – CR Steel Turnbuckle (eye/hook or 2X hook) min. 3/8" diameter w 3/8" opening/loop space rated for at least ½ the buoyant force.

OR

Quick Link – CR Steel Quick Link w threaded closure min. 1/4" diameter w 3/8" opening/loop space rated for at least ½ the buoyant force.

Fig. 13. Installer performing wire rope tie-down.

ADDITIONAL PRECAUTIONS

When installing hold down systems, additional precautions include, but are not limited to:

- **Checking with the tank manufacturer to see if anchoring recommendations are available for your specific tank type, size and installation.**
- **Checking to ensure gas or power lines are not in the area of planned earth augers, or if digging is required for the concrete slab.**

Water Ingress Prevention

In addition to preventing tank uplifting during floods, the following steps should be taken in flood zone 4 to resist water from entering the tank through the top openings and piping

- **Vent Openings** - Extended the vent pipe at least 24" above the tank top and secure a vent cap to the vent pipe top.
  Do not plug vent openings!
- **Fill Openings** – Install a leak proof fill pipe cap (such as Beckett 13100G or Philfair 93-2), or extend the fill pipe at least 24" above the tank top.
- **Gauge and Other Openings** - Ensure liquid level gauges are leak proof, and seal all unused tank top openings with threaded steel plugs.
- **Sealing Compounds** – Use water/oil resistant pipe sealing compounds, on all threaded connections.

Pre and Post Storm Recommended Actions

BEFORE FLOOD EVENTS

Recommended steps that should be taken to reduce the risk of tank damage and spills before an expected flood event include:

- Inspection of the tank, supports and flood resistance method used to ensure they are not corroded or otherwise damaged, and all connections are tight.
- Inspection of the tank piping and other tank openings to ensure they are leak-tight.
- Ensure the bottom outlet is fitted with a shut-off valve before connecting to other component
- Shut off the oil supply valve(s) at the tank and burner prior to leaving the property.

AFTER FLOOD EVENTS

Recommended steps that should be taken prior to returning the tank to service after a flood event has occurred include:

- Inspection of the tank, supports, foundation, piping, lines and other tank components for damage, and if found make appropriate repairs.
- Inspection of the tank for any entry of water, with water finding paste, and if found, contact a licensed contractor.
- If any fuel oil has spilled on your property from your tank or another tank, contact the appropriate authorities.

Appendix - Vertical Obround Steel Tanks

Tank capacity & Size (gal) (L" x W" x H")	Flood Zone #	(Tank %V Disp) – (Oil W + Tank W) = Net Buoyant Force (lbs)	Pad Size & Weight (L" x W" x H") (lbs)
120 30 x 23 x 46	0	(0%V) – (345 + 154) = -499	48 x 35 x 6.00 NA*
	1	(20%V = 206) – (499) = -293	x 6.00 NA*
	2	(50%V = 515) – (499) = +17	x 6.00 NA*
	3	(80%V = 825) – (499) = +326	x 6.00 NA*
	4	(100%V = 1031) – (499) = +532	x 8.89 612
138 30 x 27 x 44	0	(0%V) – (396 + 158) = -554	48 x 39 x 6.00 NA*
	1	(20%V = 237) – (554) = -317	x 6.00 NA*
	2	(50%V = 593) – (554) = +38	x 6.00 NA*
	3	(80%V = 948) – (554) = +394	x 6.00 NA*
	4	(100%V = 1185) – (544) = +631	x 9.46 726
220 49 x 27 x 44	0	(0%V) – (632 + 218) = -850	61 x 39 x 6.00 NA*
	1	(20%V = 378) – (850) = -472	x 6.00 NA*
	2	(50%V = 945) – (850) = +95	x 6.00 NA*
	3	(80%V = 1512) – (850) = +662	x 6.83 761
	4	(100%V = 1890) – (850) = +1041	x10.74 1197
230 60 x 22 x 44	0	(0%V) – (660 + 236) = -896	72 x 34 x 6.00 NA*
	1	(20%V = 395) – (896) = -501	x 6.00 NA*
	2	(50%V = 988) – (896) = +92	x 6.00 NA*
	3	(80%V = 1581) – (896) = +685	x 6.86 788
	4	(100%V = 1976) – (896) = +1080	x10.83 1242
240 60 x 23 x 46	0	(0%V) – (689 + 246) = –935	72 x 35 x 6.00 NA*
	1	(20%V = 412) – (935) = -523	x 6.00 NA*
	2	(50%V = 1031) – (935) = +96	x 6.00 NA*
	3	(80%V = 1650) – (935) = +715	x 6.96 822
	4	(100%V = 2062) – (935) = +1127	x10.97 1296
275 60 x 27 x 44	0	(0%V) – (790 + 252) = -1042	72 x 39 x 6.00 NA*
	1	(20% V = 472) – (1042) = -568	x 6.00 NA*
	2	(50% V = 1180) – (1042) = +138	x 6.00 NA*
	3	(80% V = 1890) – (1042) = +848	x 7.41 975
	4	(100%V = 2362) – (1042) = +1320	x11.53 1518
330 72 x 27 x 44	0	(0%V) – (948 + 288) = -1236	84 x 39 x 6.00 NA*
	1	(20%V = 567) – (1236) = -669	x 6.00 NA*
	2	(50%V = 1418) – (1236) = +182	x 6.00 NA*
	3	(80%V = 2268) – (1236) = +1032	x 7.74 1187
	4	(100% = 2835) – (1236) = +1599	x11.89 1839

(Tank %V Displacement) and its associated upward buoyant force is a function of the % volume in water, where Zones 1, 2, 3 & 4 approximate flood heights to 25%, 50%, 75% & 100% of the tank height, with corresponding "obround" volumes of 20%, 50%, 80% & 100%.

(Oil W + Tank W) combines the downward forces of the oil and tank weight, which is consistent, regardless of the flood level, which only affects the buoyant force. Oil weight is calculated @ 40% fill, and the tank weight is from manufacturer data.

(Pad Size & Weight) of the concrete pad is calculated, after determining the Net Buoyancy Force with a 15% safety factor, by using an area extending 6" beyond the tank footprint, and adjusting for the depth.

*Note 6" is a NFPA 31 minimum pad thickness.

The (+) or (-) of Net Buoyancy Force indicates an upward or downward force.

Special Notes - Calculations for vertical obround tanks are based on, or assumes:

a) 12 ga. steel and typical dimensions (most common types are similar),
b) tank weight & oil weight based on manufacturer averages & volume charts,
c) tank is 40% filled with #2 heating oil @ 0.86 spg (7.18 lb.gal),
d) flooding is in salt water (worst case vs fresh water),
e) concrete pad L&W extend 6.0" beyond the tank footprint,
f) concrete density is 145 lb/cuft (represents common types),
g) short legs provide minimal tank/pad clearance (worst case), and
h) safety factor is +15%, applied to the net buoyancy force

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