Tank Closure Without Tears: An Inspection's Safety Guide

Companion Booklet for
Underground Tank Closure Video

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New England Interstate Water Pollution Control Commission
85 Merrimac Street, Boston, Massachusetts 02114

Written and Illustrated by
Jennie Bridge, Environmental Scientist, NEIWPCC

with *special thanks* for technical guidance to
Guy Colonna, Marine Field Service Engineer, NFPA
and for technical review to
Bruce Bauman, Marketing Dept., API

This booklet was prepared with a grant from US EPA, Office of Underground Storage Tanks, as a companion for a 30 minute videotape, **Tank Closure Without Tears: An Inspector's Safety Guide.**

NEIWPCC is distributing two copies of the video/booklet set to each of EPA's regional offices, and one free copy to the lead agency responsible for the UST program in each state.

Copies of the video and companion booklet can also be:

- *borrowed* from NEIETC, 2 Fort Road, South Portland, ME 04106, for the prepaid *charge* of $15.00, or
- *purchased* from NEIWPCC, 85 Merrimac Street, Boston, MA 02114 for the prepaid cost of $35.00 for the set, or $5.00 for the booklet alone.

Background

Underground storage tank (UST) regulations are being adopted at federal, state, and local levels of government. Inspectors representing fire departments, environmental and health agencies are faced with a need to know more about tank closure, more about procedures for both tank removal and abandonment in place that promote:

- environmental protection,
- public health, and
- personal safety.

The following is a companion booklet to the NEIWPCC video on closure safety, **Tank Closure Without Tears: An Inspector's Safety Guide**. Please realize that this material is being presented as a *training guide for inspectors*, not a how-to manual on tank closure for contractors. Inspectors need to be aware of the different practices that might be encountered during site visits. These written materials provide general outlines of procedures (some more appropriate than others) that are now used during tank closures.

Tank closure is a task for which no definitive guidelines have been established. People involved with this work should be knowledgeable of reference materials published by API, NFPA, NIOSH, OSHA, etc. as well as applicable federal, state or local regulations. These published materials do not always agree on the best procedures to use. Any safety and testing equipment used during tank closure should be operated by qualified people who understand how to use and maintain the equipment.

Introduction to Tank Closure

The UST inspector should focus on the following **major objectives** during the inspection of a tank closure.

- See if there has been an *previous or current contamination,*

- Make sure the tank, if abandoned in place, is *cleaned and filled properly to prevent future contamination,* and

- *Recognize* the potential *dangers of explosion* - and stop a bad situation, if necessary.

For training purposes, we are presenting the two major tank closure issues of **safety** and **site assessment** separately. As an inspector, you will have to be concerned with both issues at the same time. Both are essential to a successful tank closure.

SAFETY During TANK CLOSURE

GATHER TANK AND SITE INFORMATION

Inspectors should gather as much information on the tank and site as possible, before the site visit. Much of the following list is necessary for an environmental site assessment. Knowledge of some items, such as tank age, type of material stored, location of underground utilities, and the contractor's planned removal procedure are especially important from a safety perspective, too.

- Tank data: Age, size (diameter, length & capacity), material, type & internal configuration (are there internal baffles?), substances store, is the tank anchored?, any tightness test results, probability or evidence of failure.
- Site Information: Plot plan, blueprints, and/or contact person with knowledge of the tank installation and location, depth of installation, depth of water table, proximity to street, buildings & basements (houses?, schools?, hospitals?), store drains, utilities (electric, gas, water, sewer), drinking water supply watersheds, public or private wells.
- Contacts: contractor's name, tank owner's name, addresses & telephone numbers.
- Logistics: plans for removal procedure (purging or inerting?), plans for soil disposal or on-site treatment (if necessary), plans for tank disposal.

The local fire department needs to be aware of all tank removals.

WHAT CAUSES FIRES AND EXPLOSIONS?

Most UST removals will involve flammable vapors from products stored in the tank and from accumulated residues left in the tank even after it has been pumped dry. Be aware of the basic **fire triangle: fuel, oxygen, ignition source**. All three points of the triangle are necessary to support combustion. These three elements need to be recognized, evaluated, and controlled to make a safe work place and a void disaster. Safe tank removal requires continuous attention to these potential hazards to eliminate or reduce the risk of explosion.

PREPARE A SAFE WORK PLACE - before the tank is approached or excavation begins.

1. An inspector needs to make sure that the contractor prepares a safe work place by **eliminating all potential sources of ignition** before heavy equipment is used for handling the tank, or used in the surrounding area of the tank (vapor hazard area). Sources of ignition include any heat, flame, or spark-producing action:

- Ban smoking in the area
- Shut down all open flame and spark-producing equipment within the vapor hazard area. (Orange County, CA, specifies a 50' setback distance from the tank.)
- Remove electrical and internal combustion equipment unless it is designed to be "explosion-proof". This special apparatus is enclosed in a case which is capable of withstanding an explosion from within, and of preventing ignition of the vapor surrounding the enclosure.
- Make sure only non-sparking tools are used to expose tank fittings and prepare for the vapor-freeing procedures. (Caution: even these tools are not risk free; pieces of metal imbedded during previous use may cause a spark!)
- Control static electricity:

  a. Minimize agitation or static-producing movement if possible. Static electricity is generated by moving liquids, air, or solids. For example, static results from: liquid dropping into a tank during product deliveries, from liquid flowing through a hose when product is pumped from the tank, from compressed gas or air being released into the tank atmosphere, from the high speed rolling of pneumatic rubber tires on a pavement under dry conditions. If eliminating the static-producing movement is not possible, then...

  b. Provide a conductive path for the continuous, "safe" discharge of static electricity by either bonding or grounding equipment and vehicles. Equipment is "bonded" by connecting it with a wire to something that is grounded (such as the tank, if the tank is still in contact with the earth). Equipment is "grounded" by connecting it to earth or some conducting body which services in place of the earth.

Mississippi One-Call service will inform the contractor of the location of the underground electrical, gas, and water lines.

- Make sure the area is roped off from pedestrian and vehicular traffic since both are unpredictable potential sources of ignition. (Pedestrians may have lighted cigarettes; vehicular traffic can build up static charges.) Roping off the area also protects pedestrians from exposure to on-site hazards.

2. Be sure all utility, gas, and water lines on site are located and marked (and avoided during excavation!)

3. Make sure the contractor demonstrates a knowledge, capability, and understanding of the product stored in the tank, or **stop the job**. Tanks containing products other than petroleum should be given special consideration. (For example, MEK, methyl ethyl ketone, has a dangerously low flash point; other products might contain carcinogens.) If you need advice, call the fire dept., OSHA, or state environmental office in your area.

4. Check the meteorological conditions. If it's a still day and the air isn't moving, vapors might accumulate at ground level. Under such conditions, consider delaying the removal or take additional precautions (such as ventilating the work area with "explosion-proof" high capacity fans).

5. For your own protection during inspections, wear a hard hat, safety shoes (with steel toes), and have safety glasses and a combustible gas indicator (for testing ambient air conditions) available.

PREPARING THE TANK

1. When the piping is disconnected and the product in the piping drained, make sure the contractor takes precautions to avoid any spillage (a bucket can be placed at the end of the exposed pipe). The emptied product piping must be capped or removed.

2. When product and residues from the tank are removed, explosion-proof or air-driven pumps should be used. Pump motors and suction hoses must be bonded to the tank (or otherwise grounded) to prevent electrostatic ignition hazards.

Caution: Avoid using plastic (PVC) pick-up tubes on the stripping lines of vacuum trucks. The plastic tubes are especially prone to accumulating static charges; explosions from their use have resulted in major loss of life and property.
Although vacuum trucks are usually used during product removal, it may be necessary to use a hand pump to remove the bottom few inches of liquid. Again, make sure the contractor observes grounding and bonding procedures.

3. If a vacuum truck is used for removal of liquid or residues, the area of operation for the vacuum truck must be vapor-free, and the truck should be located upwind from the tank and outside the probable path of vapor dispersion. The vacuum pump exhaust gases should be discharged through hose of adequate size and length, downwind of the truck and tank area. (See API Publication 2219).

4. Residual product and solid must be disposed of properly.

5. Air is roughly 21% oxygen and 79% nitrogen by volume. Once the tank is emptied and exposed to the air, the atmosphere inside the tank is a mixture of product vapor and air. As long as no source of ignition is introduced, combustion cannot occur with this potentially dangerous mix of flammable vapors and oxygen. **However**, it is difficult at an excavation site to eliminate all potential sources of ignition (striking the tank with the backhoe could produce a spark). Before the tank is handled with large equipment, flammable vapors in the tank must be controlled.

GETTING RID OF FLAMMABLE VAPORS

The tank can be made “safe” either by purging or inerting the potentially explosive atmosphere in the tank. These two methods control different points of the fire triangle. These methods and the appropriate monitoring equipment will be discussed in greater detail following this brief description:

Purging or ventilating the tank replaces or dilutes the flammable vapors in the tank with air, reducing the flammable mixture of fuel and oxygen by dealing with the *fuel* point of the triangle.

Remember, it is the flammable vapor given off by the liquid fuel, rather than the liquid fuel itself, that combusts. Most petroleum products (gasoline, kerosene, fuel oil) have a **flammable range** of 1-10% by volume in air. This range is imply the amount of fuel vapor necessary to become flammable in the presence of oxygen and an ignition source. Below the fuel vapor level of 1% (the **lower explosive limit** or **LEL**), the mixture of fuel and oxygen is too lean to support combustion (above 10%, the mixture is too rich). The goal of purging a tank is to reduce flammable vapors in the tank is to reduce the flammable vapors in the tank well below the lower explosive limit.

Inerting displaces the oxygen (and some of the fuel vapor) in the tank with an inert or non-reactive gas such as nitrogen or carbon dioxide. This reduces the flammable mixture of fuel and oxygen by dealing with the *oxygen* point of the triangle. The goal of inerting a tank is to reduce the level of oxygen in the tank to below the 12-14% oxygen by volume needed by most petroleum products to support combustion.

The success of these two vapor-freeing methods must be checked with different types of monitoring equipment. Read on for details...

Caution: *In air purging, with plenty of oxygen present, the concentration of vapors in the tank may start out in the flammable range, or may go from too rich, down through the flammable range before a safe atmosphere is reached. It is especially important to ensure that all ignition sources have been removed from the area before this process begins!*

Purging - controlling the fuel in the fire triangle

1. After the tank is empties of product, the concentration of flammable vapors in the tank can be reduced or eliminated by purging the tank with air, using the following two methods:

• A **diffused-air blower** pumps air into the tank through the extended fill pipe (drop tube). Since petroleum vapors are heavier than air, air must be introduced as low into the tank as possible so that product vapors are stirred up sufficiently to be moved out of the tank.

If the drop tube is removed, air can be pumped through an air-diffusing pipe. This new pipe must be properly bonded (to the tank, for example) to prevent static build-up.

To avoid rupturing the tank, air pressure in the tank must not exceed 5 psi, so the contractor must take into account the size of the vent opening as well as the rate at which air is pumped into the tank.

• An **eductor-type air mover**, typically driven by compressed air, draws vapors out of the tank and fresh air into the tank. The fill (drop) tube should remain in place to ensure ventilation of the tank bottom. For this reason, the eductor-type method is good for tanks with nonremovable fill (drop) tubes. The air mover should be bonded properly to prevent the generation and discharge of static electricity.

• **Not recommended:** The use of steam (as opposed to hot water sprays) to purge & clean the tank is not recommended. Steam, under greater pressure than hot water, is more likely to create static electricity. Charges can build up on the steam nozzle, and on insulated objects on which the steam impinges or condenses.

If steam is to be used for either purging or cleaning a tank or other equipment, all isolated conductors and objects subject to impingement or condensation, as well as the discharging hose or nozzle, should be properly bonded (to the tank or equipment) or grounded. (See NFPA 327, API 2015).

2. Exhaust fumes from purging should be vented at a minimum height of 12 feet above grade and 3 feet above any adjacent roof lines. The atmosphere at ground level should be tested periodically while purging is in progress to be sure the vapors are being vented effectively into the upper atmosphere, and are not collecting at ground level.

Caution: *Purging is a temporary procedure. Product trapped in bottom sludge and wall scale regenerates flammable vapors inside the tank.* ***TEST the %LEL FREQUENTLY*** *inside the tank, in the excavation and any other below grades areas, and at ground level, especially near the vent!*

Test with a Combustible Gas Indicator (CGI) - to measure the reduction in the concentration of flammable vapors when purging:

1. Readings from most combustible gas indicators (CGIs), or explosion meters, give the **percentage of the lower explosive limit (%LEL)** of the vapors present in an atmosphere. The meter reads from 0 to 100% of the LEL.

   As mentioned before, the **lower explosive limit (LEL)** depends on the product's **flammable range**, or the mixture of product and oxygen necessary to produce fire or explosive in the presence of an ignition source. LEL is expressed as the percent of product vapor by volume in air.

   For example, gasoline's flammable range is 1.4 - 7.6% by volume in air. Therefore, 1.4% is the LEL for gasoline. (Below 1.4%, not enough fuel vapors are available to burn.) Therefore, 100% LEL on the CGI meter corresponds to 1.4% gasoline vapor by volume.

2. When purging a tank, the goal is to reduce the concentration of flammable vapors to **zero**, or as close to zero as possible. The lowest reading possible gives a margin of safety in the time it will take for flammable vapors to regenerate from product trapped in the sludge and the walls of the tank. CGI readings of 10-20% are considered within the petroleum industry to be practical target readings. For readings above 10-20% LEL, keep purging and testing!

3. After the tank has been purged for a while, the contractor should test the tank vapor space by placing the CGI probe into the fill opening with the drop tube removed. Readings should be taken at the bottom, middle, and upper levels of the tank. If the tank is equipped with a non-removable fill tube, readings should be taken through another opening.

The instrument should be cleared after each reading. Move away from the vapor hazard area, move fresh air through the instrument, and reinitiate the start-up procedure (calibrate the instrument). If you can't zero the LEL, consider the possibility that you have poisoned the sensor (see below).

The CGI should not be used to test the tank atmosphere before the tank has been emptied of product and purged, at least partially. Liquid product will foul the probe. If the sensor becomes coated with a high concentration of vapor in the flammable range, calibration of the meter may be affected, although the temporary coating may eventually burn off. Substances such as tetra-ethyl lead and silicon can "poison" the sensors by permanently coating the wire (and will not burn off). Volatile substances containing halogens can affect the sensitivity and calibration of the instrument.

4. The CGI needs to be calibrated, checked and maintained according to the manufacturer's instructions. If the sensor won't calibrate, replace it or send it back to the manufacturer! Inaccurate CGI readings can give a false sense of security and lead to accidents!

Inerting - controlling the oxygen in the fire triangle

1. The concentration of oxygen in the tank can be reduced to a level insufficient to support combustion by replacing the oxygen with an inert gas such as the following:

- **Carbon Dioxide** gas can be generated by crushing and distributing **dry ice** evenly over the greatest possible area in the bottom of the tank, before the openings are plugged. Recommended amounts vary (from 15-20 pounds per 1,000 gallons of tank capacity). The dry ice will release carbon dioxide gas as it warms. With this method, there is no momentum for vapors in the tank to move toward the vent, so inerting takes longer and may be less effective than inerting with nitrogen. Avoid skin contact with dry ice because it may produce burns.

• **Nitrogen gas** can be pumped into the tank from a hose that passes through the fill hole to the bottom of tank. Nitrogen is lighter than air, so its introduction low in the tank is essential to effective inerting. Care must be taken handling the bottle of compressed nitrogen. Bonding or grounding the nozzle or hose to prevent static build-up is recommended.

In some cases, this alternative of inerting may be more expensive than using dry ice, but better distribution of the inert gas within the tank can be achieved by pumping in nitrogen than by the dry ice method.

• **Not recommended:** Inerting with compressed carbon dioxide gas may be dangerous. The contents are under pressure and static electricity can build up during discharge of the gas. More importantly, the compressed CO_2 has a much larger temperature difference with the outside atmosphere than bottled nitrogen. This difference leads to condensation which increases the generation of static electricity. If CO_2 cylinders are used, the nozzle should be properly bonded or grounded, and the gas should be introduced slowly to reduce static.

CO_2 fire extinguishers should definitely not be used for inerting flammable atmospheres. Since solid as well as gaseous CO_2 is discharged from the nozzle, this "two phase flow" generates static electrical charges.

2. It is important to understand that the inert gas (whether CO_2 or nitrogen), does not "neutralize" the flammable vapors; the inert gas displaces the oxygen, and perhaps some of the flammable vapors. Any vapors remaining in the sludge or trapped in the wall scale will still present an explosion hazard if oxygen is reintroduced into the tank.

3. Oxygen may be reintroduced into the tank unless all holes are effectively plugged **except for the vent line.**

4. How fast and how effectively oxygen in the tank is replaced by the inert gas will depend on how well

the inert gas is distributed throughout the tank; how much gas flow or movement and mixing occurs.

5. Since the inert gas displaces some of the flammable vapors along with the oxygen in the tank, the same venting precautions for the exhaust must be followed as for a purging operation:
Exhaust fumes from inerting should be vented at a minimum height of 12 feet above grade and 3 feet above any adjacent roof lines. The atmosphere at ground level should be tested periodically to be sure any vapors are being vented effectively into the upper atmosphere, and are not collecting at ground level.

Test with an Oxygen Indicator - to measure the effectiveness of the inerting procedure.

1. An oxygen meter should be used to determine when a tank has been successfully inerted. Testing is important because the time required to inert a tank varies a great deal and depends on many factors (method of inerting, extent of inert gas mixing & distribution within the tank, temperature, etc.). Readings from most oxygen meters give the percent oxygen by volume.

2. When inerting a tank, the goal is to reduce the oxygen to below the level necessary to support combustion. The theoretical limit below which combustion will not occur is 11% oxygen. Most petroleum products need at least 12-14% oxygen by volume for combustion. Oxygen readings of 1-10% are safe for most petroleum products. A more conservative safety rule of thumb is to target a reading that represents 50% of the lowest level of oxygen necessary to support combustion. This would give a target meter reading of 6-7% oxygen for inerted tanks having contained most petroleum products. (To put all this in perspective, the normal atmosphere is 21% oxygen; the safe breathing range is 19.5-21%.)

3. Readings should be taken at three levels in the tank (bottom, middle, and top), and at the ends as well as the middle.

4. After inerting, the tank should not be entered unless very specific safety procedures for working in

confined spaces are followed. If the tank is to be entered later for any reason, such as cleaning, breathing apparatus for workers must be provided since the tank will be oxygen deficient. Sometimes, the tank is inerted, excavated, and pulled from the ground, then ventilated with air before and during entry.

5. The oxygen meter must be calibrated, or recalibrated, appropriately, depending on its intended use. To judge the effectiveness of inerting the tank, the meter should be calibrated for the low range (1-10%). To determine if enough oxygen is present for breathing, the meter should be calibrated for the breathing range (19.5-21%).

Vapor-Freeing a Tank with Water

Besides purging or inerting, a tank can be made temporarily "safe" by filling the tank completely with water which will displace flammable vapors and may remove some of the liquid gasoline left in the tank. Since the water must be pumped from the tank before the tank is removed from the ground, sludge and vapor regeneration are still a problem.

Caution: Once the water is removed, and air is reintroduced into the tank, flammable vapors may regenerate over time. Keep testing with a **CGI!**

This method may be impractical for larger tanks because the water must be disposed of properly; treatment and disposal of large volumes of wastewater is costly. Some states may consider the waste water a hazardous waste. Check state or local requirements.

This method is inappropriate for suspected leakers because the water may force contamination further into the soil through holes in the tank.

Interchanging Control Mechanisms

So far, we have been working with the fire triangle to avoid fire & explosion by making sure at least one point of the triangle is controlled at a time. First, sources of ignition were removed or controlled so product could be pumped from the tank. Then, the mixture of flammable vapors was controlled (by controlling either the fuel or oxygen point of the triangle) so potential ignition sources such as heavy equipment could be moved into the hazard area for tank excavation and removal.

Throughout the tank closure, the contractor should be interchanging, or switching back and forth among these control mechanisms appropriately, depending on what work needs to be done. The bottom line in judging when to use which control mechanism is to keep testing, and...

Know When and How to Use Monitoring Equipment

1. *Once the tank is "safe" for handling, the tank can be approached by heavy equipment for excavation, removal, cutting and cleaning...but* ***KEEP TESTING*** *for the flammable concentration of vapors both in and around the tank until the tank has been cleaned on-site, or loaded for transport to be cleaned off-site!*

2. Remember, a combustible gas indicator (CGI) measures the concentration of flammable vapors in the atmosphere; an oxygen meter is used to measure the success of an inerting procedure. A CGI should not be used to test the effectiveness of the inerting process, even though the inerting process displaced flammable vapors as well as oxygen. The CGI is designed to function at normal atmospheric levels of oxygen (21%). The CGI burns a sample, creating resistance which is converted to electrical energy, which is calibrated against the LEL scale. The %LEL readings may be misleading where the atmosphere contains less than about 5-10 percent by volume of oxygen (as in an inerted container). In general, the readings in any oxygen-lean atmosphere will be on the high or safe side because the inefficient burning of the sample creates higher resistance.

Relative Risk of Explosion for Different Products

You may be asking, "If the lower explosive limits (LEL's) for most petroleum products are so similar (1% by volume), why does gasoline present more of an explosion hazard than fuel oil?" The relative risk of explosion for different products also depends on their **flashpoints**: the lowest temperature at which the liquid product gives off sufficient vapors to support combustion (in the presence of enough oxygen and an ignition source).

Gasoline gives off vapors sufficient to support combustion at -40EF; fuel oil must be heated to a temperature between 110-190EF (depending on the grade of oil) before sufficient vapors are released to reach the LEL of the flammable range.

While the flashpoint of diesel and heating oils is much higher than gasoline, vapors from these fuels can still accumulate in confined spaces at temperatures well below their flashpoints. If an ignition source of sufficient energy is present, an explosion may occur.

Furthermore, sun beating down on a small black tank can easily raise the temperature within the tank to 140EF, turning a potential risk into a real hazard. Within the confined space of a tank, factors such as temperature and pressure are much too difficult to control.

CLEAN OUT SLUDGE

1. Remember, any vapor-freeing technique is temporary! If the tank is to be removed from the ground, product trapped in the sludge at the bottom of the tank, or absorbed in the tank walls, or trapped under the scale, is a continuous source of flammable vapor regeneration. Cleaning the tank will decrease the amount of vapor regeneration. If the tank is to be closed in place, cleaning the tank will minimize the risk of release and future environmental contamination.

2. Deciding whether the tank should be cleaned on- or off-site can be approached as a risk assessment. The benefits of having a clean, safe tank during transport need to be weighed against the risks of additional vapors being released into the environment, and the effect of an explosion at the site location. The primary safety considerations have to do with physical surroundings, air flow and population in the area. Is the air flow on that day sufficient to allow dilution and dispersion of explosive vapors? Are buildings and

people far enough away to minimize the risk of damage if an explosion were to occur? There may be local requirements on this issue.

3. **If cleaning is done on-site:**

- After the tank is purged or inerted to make it safe for handling, the tank can be tipped, jet rinsed with water, and the sludge can be washed to one end of the tank and pumped out while the tank is still in the excavation.
- If the scale is stubbornly caked on, the contractor may have to enter the tank for manual cleaning. Make sure appropriate safety procedures are followed (breathing support, safety line, buddy system), and a continuous stream of fresh air is introduced into the tank.
- Make sure the contractor blocks the tank to prevent any movement.
- Make sure the contractor rechecks the atmosphere in the tank.
- Make sure the contractor disposes of the sludge and rinse water properly.

CLOSING IN PLACE

1. Check state and local regulations regarding closure in place. Concerns over past and future environmental contamination, and potential cleanup liability are prompting more and more states to require tank removal with few exceptions (i.e. structural damage to an overlying building would be caused by the tank removal). Requirements for environmental testing, fill material, etc., also vary state-to-state. Some areas require that documentation of an in-place closure be recorded in the property deed, with a description of the exact location of the closed tank (including its depth), product contained, and the closure method.

2. The tank and piping are initially prepared for closure in place in the same manner as for a tank removal. (See the sections on preparing a safe work place, preparing the tank, getting rid of flammable vapors, and cleaning out sludge). After *thorough tank cleaning* and an effort to make sure that the site is *free from contamination*, one or more holes may have to be

cut in the tank top if existing tank openings are not big enough for the introduction of the inert fill material (cement slurry, sand, etc.). The tank should be filled as full as possible to minimize any subsequent settling of the fill material.

3. After filling, all tank openings should be plugged or capped unless it was necessary to cut open the tank top.

4. The vent line should be disconnected and capped or removed. The tank can then be backfilled.

THINK SAFETY WHILE INSPECTING

1. **Before excavation:**
   - Make sure the contractor demonstrates sufficient knowledge of tank removal procedures, including vapor-freeing techniques.
   - Make sure the monitoring equipment has been warmed up and zeroed in an uncontaminated atmosphere.
   - Make sure the contractor monitors routinely for vapors in the excavation and other below grade areas on-site, at ground level, especially near the vent, and in the tank (after vapor freeing procedures have begun).
   - After the tank has been purged or inerted, and before it is removed from the excavation, make sure all accessible h oles are plugged or capped. One plug should have a 1/8 inch vent hole to compensate for excessive pressure differential caused by the temperature changes.

2. **During excavation:**
   - Stay out of reach of the machine arm's swing by standing at the end of the excavation, not the sides; this area is also less likely to cave in.
   - There is no need for you to enter the excavation; ask the machine operator to dig down for a soil sample and place it at ground level for inspection. Be aware that OSHA is preparing new trenching guidelines.

3. **During removal:**

- Make sure that the equipment available is appropriate for the tank pull.
- Sand well out of the way and behind stable objects until the tank has been lifted onto the ground and blocked, or onto the transport truck and secured. Cables and chains can snap and fly out in any direction.
- Tanks should not be dragged at any time.
- If a tank explodes, the weakest points of steel tanks are the ends, so stay away from them.

4. **Safety concerns in case of a leak:**

- Determine nearby potential destinations of dangerous vapors or product: buildings, houses, basements, storm drains, sewers.
- Evaluate the potential for explosion, and make sure the local fire department is notified.

READY TO TRAVEL

1. Before the tank is removed from the site, the tank atmosphere should be rechecked to ensure that the flammable vapor concentration does not exceed safe levels for transport.

2. Recheck to make sure any corrosion holes in the tank are plugged with screwed (boiler) plugs for transport, and that the 1/8 inch vent plug is on the top of the tank for transport and storage.

3. Tanks should be labeled with information about the former contents, present vapor state, vapor-freeing treatment and date, warning against certain types of reuse (See API 1604). Check for state and local labeling and transportation requirements.

4. Tanks should be secured and removed from the site as soon as possible, preferably on the day the tank is removed from the excavation. If a tank remains at a site overnight or longer, vapor may be regenerated from residues in an uncleaned tank.

TANK DISPOSAL

1. Make sure you know that the tank will be safely and properly disposed of. Check state and local disposal requirements. Whether sold to a scrap dealer or disposed of at an acceptable tank yard, some areas require an unprotected steel tank to be cut, or punctured sufficiently to render it unfit for future use as an underground storage tank.

2. If reuse of tanks is permitted, make sure there are plans to certify that the tank is tight, structurally sound, and will meet all the requirements for a new installation.

CHECKING FOR SOIL & GROUNDWATER CONTAMINATION

A second video and companion booklet for state and local UST inspectors will be produced which will cover assessing a tank closure site for signs of contamination. The set should be available from NEIWPCC during the winter of 1988.

SAFE REMOVAL CHECKLIST

- U Gather preliminary tank & site history.
- U Think safety on the site - stop a bad situation!
- U Check the contractor's procedures.
- U Be familiar with the need for and use of product vapor and oxygen monitoring equipment.
- U Know when to call in other experts.
- U Check the tank disposal plan, and state and local regulations.

REFERENCES

Other resources to check for information related to safety during tank closure include:

1. American Petroleum Institute's (API) Recommended Practice 1604, **Removal and disposal of Used Underground Petroleum Storage Tanks,** 1987.

2. API's Recommended Practice 1631, **Interior Lining of Underground Storage Tanks,** 1987.

3. API Publication 2015, **Cleaning Petroleum Storage Tanks,** 1985.

4. API Publication 2217A, **Guidelines for Work in Inert Confined Spaces in the Petroleum Industry,** 1987.

5. API Publication 2219, **Safe Operating Guidelines for Vacuum Trucks in petroleum Service,** 1986.

6. Occupational Safety & Health Administration (OSHA) 2226, **Excavation & Trenching Operation,** 1990.

7. National Institute for Occupational Safety and Health (NIOSH), **Criteria for Recommended Standard... Working in Confined Spaces,** 1979.

8. NIOSH Publication 87-113, **A Guide to Safety in Confined Spaces,** 1987.

9. National Fire Protection Association (NFPA) 69, **Explosion Prevention Systems,** 1986.
   (table with minimum oxygen levels necessary to support combustion for various products)

10. NFPA 7, **Static Electricity,** 1988.

11. NFPA 327, **Cleaning or Safeguarding Small Tanks and Containers,** 1987.

12. NFPA 306, **Control of Gas Hazards on Vessels,** 1988.
    (practical procedures for vapor-freeing tanks and testing guidance)

13. National Leak Prevention Association (NLPA) Standard 631, **Spill Prevention, Minimum Ten Year Life Extension of Existing Steel Underground Tanks by Lining Without the Addition of Cathodic Protection.**
    (Cleaning procedures)