INSTITUTE OF DEMOLITION ENGINEERS

A Systematic Approach for the Removal of Underground Storage Tanks

Produced by Perses Group

ABOUT PERSES

PERSES was formed in 2013 to provide consultancy services and training courses to the specialist demolition and asbestos removal sectors. It has since moved into providing health and safety advice and training courses to all sectors, including temporary works, safety awareness for construction, occupational health and safety, as well as demolition works.

PERSES is primarily a demolition consultancy with experienced demolishers working within the business capability and as a company and staff, has significant experience in dealing with the demolition process and giving advice to clients on the best approach to take on managing contracts.

RESEARCH TEAM

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ABOUT THE IDE

The Institute of Demolition Engineers (IDE) exists to promote and foster the science of demolition engineering.

The main objectives include the:

- promotion of use of more efficient techniques in the industry
- encouragement of safer methods of working
- provision of a qualifying body for the industry

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1. Introduction

The removal of underground storage tanks (USTs) necessitates dealing with dangerous chemicals. When such chemicals linger in the tank for a long time, they start to break the tank walls, and seep into nearby soil. Even after freeing the tank from such chemicals, any product trapped in the sludge at the bottom of the tank, or absorbed in the tank walls, represents a continuous source of flammable vapour regeneration. All these do not only make the removal process of USTs harder, but also pose serious risks to site operatives, and cause serious contamination to soil and groundwater, and at times, surface water. All this resulted in the development of publications such as the APEA Blue Book and PETEL 65/34, to provide guidelines on USTs removal. Such guidelines, however, are extensive and technical, which may be deemed difficult for the inexperienced to appreciate. Therefore, this research aims to provide a simplified explanation for the removal of USTs through proposing a systematic approach.

2. Targeted Audience

This work is principally aimed at clients (domestic and commercial), demolition contractors, groundworkers, and anyone involved in the removal of underground storage tanks. It provides a simplified, systematic approach to removing underground storage tanks as per figure (1).

3. Limitations

3.1 While this research provides a simplified version for underground storage tanks removal, it should not be used as a substitute for the industry standards in the Blue Book as published by the Association for Petroleum and Explosives Administration (APEA) and the Energy Institute.

3.2 This work cannot deal with every eventuality, and/or site condition and as such, it cannot offer recommendations on the methods described in this document for specific contracts.

3.3 All stakeholders should exercise their own knowledge, experience and judgement in all matters when carrying out this type of works.

3.4 Good practice can only be of value where it is applied to careful planning, and with sufficient attention paid to information, instruction, training, and competent supervision to control and monitor the works.

3.5 This enabling document is intended to be used as a guide to plan any works and not intended to replace a specific risk assessed method statement for any particular project and does not form a code of practice.

4. Underground Storage Tanks Removal

USTs are decommissioned either permanently or temporary. It is however, recommended to remove the tanks that are unlikely to be used again. This research divides the process of decommissioning a USTs to ten main stages, which are illustrated in figure (1), and are explained in further details in the following sections.

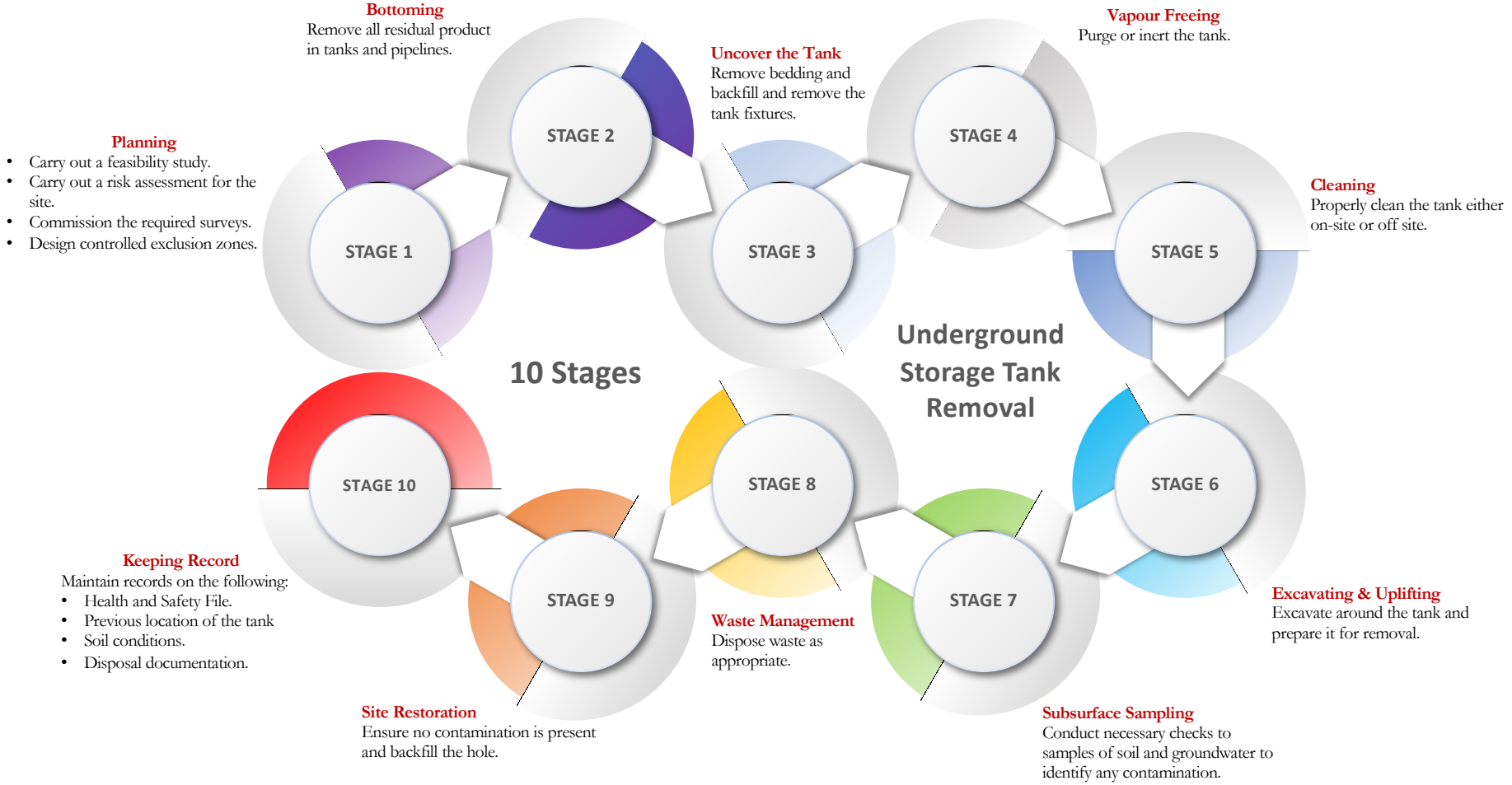

Figure 1: Underground Storage Tank Removal Procedures

4.1 STAGE 1: PLANNING

- The contractor must assume that all the surrounding soil has been contaminated either by leakage of the tank, or spillage, unless confirmed via site investigation report. Thus, the following precautionary measures should be observed:
  - Commission site investigation reports and other required surveys.
  - Display 'danger' signs in the vicinity.
  - Smoking and other ignition sources are not allowed in the vicinity.
  - Dampen the area using water supply to diminish the risk of sparking.
  - Secure the area from pedestrian and vehicular traffic.
  - Prevent rainwater from building up in the excavation.
- Carry out a thorough constraints analysis considering:
  - What is the best access to and egress from the site?
  - Are we in a dense area (adjacent structures, pedestrian traffic)?
  - What are our safety requirements?
  - What was the tank used for?
  - What is the size of tank?
  - Where is the tank located? (Do we need to demolish a structure to access it?)
  - Are there any live services in the vicinity? (e.g., underground, abandoned, gas line etc.).
- Carry out a full risk assessment taking into consideration health and safety and environmental issues.
- Design controlled exclusion zone / safe working spaces. Refer to BS 6187:2011 Clause 13 for further guidance.
- Figure out the critical path items (permits, permissions, etc.)

Note: Allow sufficient time to schedule for unanticipated problems.

4.2 STAGE 2: BOTTOMING

Bottoming is the removal of residual product in tanks and pipelines.

- Before the commencement of uncovering the tank, all liquids or residues must be removed from the tank. Before the bottoming process begins, pipework carrying fuel must be drained back to the tank.
- Bottoming could be done using explosion-proof or air-driven pumps. The use of a hand pump may be necessary to remove the last remnants of residue. A vacuum truck, if used, should be upwind from the tank, in an area that is vapour-free.
- If water was used, it must be disposed properly by transferring it to a waste treatment facility or discharging it to a foul sewer with the consent of the local sewerage undertaker.

4.3 STAGE 3: UNCOVERING THE TANK

- This can be carried out before the bottoming stage; this should be decided at the planning stage.
- Remove bedding and backfill.
- Remove the tank fixtures, temporarily plug all tank openings, except for the vent line, which should remain open until the tank is purged.

4.4 STAGE 4: VAPOUR-FREEING / INERTING

Freeing the tank of vapours could be achieved by either purging the tank or inerting it. Purging the tank deals with the fuel point of the fire triangle, see figure 2. Therefore, it aims to replace or dilute the level of fuel in the tank. On the other hand, inerting the tank aims to displace the oxygen in the tank with an inert or non-reactive gas, thus, it deals with the oxygen part of the fire

triangle. The level of oxygen must be less than 5% before commencing the excavation work. There are numerous methods for purging or inerting the tank, these include nitrogen gas, dry ice, water fill, and ventilation.

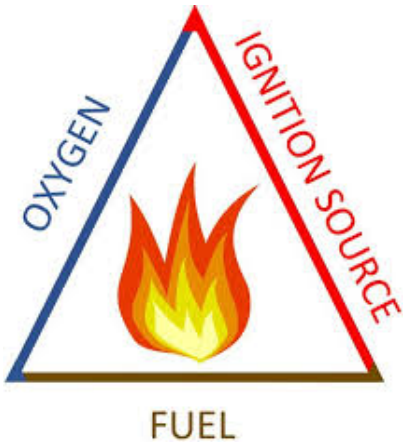

Figure 2: The Fire Triangle

Note:

- The success of these two vapour-freeing methods must be checked with different types of monitoring equipment.
- Some inerting methods, in addition to displacing the oxygen level in the tank, remove flammable vapours.

4.4.1 Nitrogen Gas

Nitrogen is introduced into the tank from one side, which displaces the air and vapour within the tank causing it to leave from the other side. If this inerting method is used, the following should be heeded:

- The tank(s) should be bottomed, and all openings sealed except those required for the inlet of nitrogen and for the exhaust outlet (vent pipe) to atmosphere.
- It is recommended that the nitrogen gas is introduced directly from an industrial gas supplier's road tanker, which is fitted with the necessary reducing valves and measuring equipment. This is to ensure a constant pressure when carrying out this process.
- Oxygen meter should be used to test the level of oxygen in the tank. The purging process must continue until a level of less than 5% is achieved.
- Note: As a rule of thumb, if approximately five times the tank volumes of nitrogen are used, the final level of oxygen will approximately be 1%.
- Once purging is complete, and before excavation begins, all remaining holes must be securely capped.
- If excavation takes place immediately after purging the tank, a vent should be left in the tank to allow excess pressure to escape.
- Nitrogen gas is one of the methods that is capable of removing flammable vapours and oxygen in the tank, two of the necessary components of combustion.

4.4.2 Dry Ice (carbon dioxide)

- The tank(s) should be bottomed, and all openings sealed except the ones required for the insertion of the dry ice.
- 2kg should be allowed for each 1000 litres of capacity.
  - **Note:** As a rule of thumb, the size of the dry ice pieces should not exceed the size of a walnut.

- Like nitrogen gas, the use of dry ice has the advantage of simultaneously removing both flammable vapours and oxygen.
- Caution: Skin contact with dry ice may produce burns; therefore, appropriate Personal Protective Equipment (PPE) must be worn at all times, especially when the ice is being broken to fragments.

Note: Using this inerting method is susceptible to encounter few difficulties due to stratification, absence of sufficient quantity of dry ice, or incomplete transformation of dry ice to gas. As a result, it is important to test the oxygen level in the tank at intermediate levels.

4.4.3 WATER FILL

- The tank should be completely filled with water. As the tank fills, flammable gasses will be expelled through other openings. Petroleum product will float on the surface of the water and can be siphoned off separately (this is called skimming).
- Extra care should be taken to ensure that any water or residual product does not overflow from the fill point.
- If water fill was used, then water should be emptied from the vessel prior to lifting out of the excavation and subsequently refilled if necessary.
- The following should be noted when using water fill:
  - This method might incur extra expenditures and might be detrimental to the environment as the volume of wastewater produced is significant, and must be dealt with appropriately.
  - Water fill method is impractical with larger sized tanks because water has to be disposed properly.
  - Water filling method is unsuitable when used on a single-skin tank that is likely going to leak. Therefore, extra checks must be conducted to ensure that the tank is in good condition and not badly holed.
  - Care should be taken to ensure that any contaminated material is not permitted to become mobile and migrate to other areas.

4.4.4 VENTILATION

- Once the tank is bottomed, the concentration of the flammable vapours in the tank can be reduced or eliminated by air ventilation using either eductor-type air mover or an air blower.
- The vapours may be sucked or forced out of the tank.

Note:

- To avoid damaging the tank, air pressure in the tank must not exceed 5psi, so the contractor must consider the size of the vent opening as well as the rate at which air is pumped into the tank.
- Purging is a temporary procedure that mostly lasts for 24 hours, because any remnants trapped in the bottom or on the walls of the tank could produce flammable vapours inside the tank. Therefore, it is essential to:
  - Keep on testing the lower explosive limit in the tank, excavation, ground level and near the vent.
  - Test with suitable tools to measure the concentration level of flammable vapours.
- More commonly on-site, after bottoming takes place, the tank will simply be split open using demolition excavators to prevent vapour build up and thus continually ventilating the tank, see figure 3.

Figure 3: Creating openings in the tank for ventilation

4.5 STAGE 5: CLEANING (IF REQUIRED)

Remember: Any vapour freeing technique is temporary. Any product trapped in the sludge at the bottom of the tank, absorbed in the tank walls, or trapped under the scale, is a continuous source of flammable vapour regeneration. Therefore, cleaning of the tank is necessary to decrease the amount of vapour regeneration, and to minimise the risk of contaminating the environment.

- Cleaning of the tank could take place before excavating and uplifting the tank from the ground, or after. To choose between cleaning the tank on-site or off-site depends on many factors:
  - Local requirements in the area.
  - The surrounding environment:
    - Is it a congested area?
    - Are people and adjacent buildings susceptible to any harm?
    - Nearby water streams or deposits?
  - Nearby cleaning facilities
  - Cost of transportation to the cleaning facility. Note this will add to the carbon footprint.
- See table 1 below, which compares four different cleaning methods that are currently utilised to clean USTs.

Table 1: Comparison between USTs cleaning methods

CLEANING METHOD	ADVANTAGES	DISADVANTAGES
Hand Cleaning	• The tank can be inspected simultaneously as cleaning takes place. • Difficult corners and crevices can be cleaned. • No extra power equipment is necessary.	• Physical entries are not always possible for smaller sized tanks • Personnel are subject to risks from toxic lead or petroleum vapour. • It might be prohibited by the local authority. • Confined space entry.
Low Pressure Water	• Accessibility and availability.	• Produces contaminated water. • May not be powerful enough to remove all residues.
High Pressure Water	• Capable of removing difficult residues.	• Weak or corroded parts of the tank wall are susceptible to

	• Faster than other methods; thus, reduces exposure.	damage by the high-water pressure. • Produces a huge quantity of contaminated water.
High Pressure Steam Cleaning	• Chemicals can be added to the steam for better results.	• Possibility of creating static electricity.

Note: If the tank was found to have already been filled with an inert, non-shrinking material and safely left in its place, then the process would be different. Tanks would normally be filled either with sand and cement slurry, hydrophobic foam, foamed concrete, or water (up to 12 months). In this case, a specialist must be brought in to assess the situation of the tank. First, any information available on the tank must be accessed. Such records normally contain information about the capacity of the tank, product it contains, method of decommissioning, and the date of decommissioning. If records are not available, then cold cuts could be used to make holes in the tank to collect information of the condition of the tank and the material in contains. If the tank is deemed safe, then it can be lifted promptly on-site and dismantled.

4.6 Stage 6: Excavating & Uplifting

- The use of chains and ropes to uplift the tank should be avoided to reduce the risk of sparks or sources of ignitions. Rather, the use of fabric straps with suitable strengths to lift the tank should be used where practicable.
- Written warnings should be clearly painted on each side of the tank
- Adhere with Lifting Operations and Lifting Equipment Regulations 1998 (LOLER). Consider:
  - Lifting plan.
  - Method statement for lifting.
    - What attachments to use?
    - What machine to utilise?

4.7 Phase 7: Subsurface Sampling

Checks on the condition of the soil and groundwater (if present) should be conducted after the tank has been removed. Advice on sampling of soil and groundwater are available from the Institute of Petroleum, the Agency and the British Standards Institution. If contamination is detected in the vicinity, the risks must be assessed, and additional investigations should be conducted to determine the extent of the contamination. Based on the investigations, remediation plans need to be put in place.

4.8 Stage 8: Waste Management

- Waste produced from tanks are classified under the Hazardous Waste Regulations for England and Wales, and the Special Waste Regulations for Scotland. Such include residual product, contaminated water, sludge, and decommissioning fill.
- Disposal of all waste must be in accordance with the Duty of Care.

4.9 Stage 9: Site Restoration

- Before backfilling the hole, it is important to conduct the necessary checks to detect any contamination in the soil. If contamination is found, further excavation is then required until clean soil is reached[1].

[1] Remember, compaction and CBR testing may be required of the backfilled material in the excavation.

- The material is chosen based on what the site is going to be used for in the future.

4.10 Stage 10: Keeping Records

- Maintain records of the condition the UST.
- Ensure to include information regarding the following:
  - Health & Safety File.
  - Previous location of the tank.
  - Soil conditions.
  - Disposal documentation.