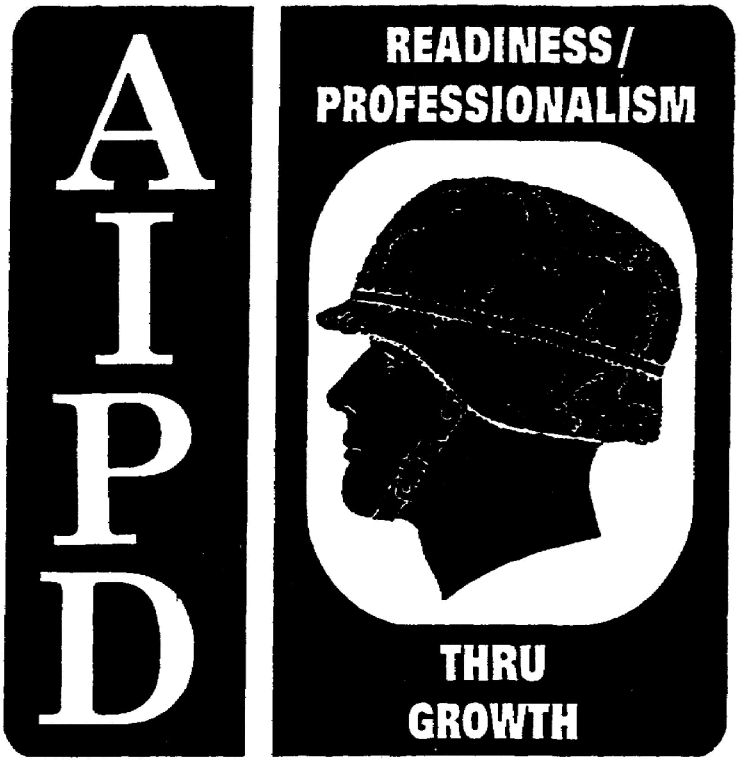
SUBCOURSE
QM5088

EDITION
1

PLAN AND DIRECT PETROLEUM STORAGE TANK CLEANING



THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

PLAN AND DIRECT PETROLEUM STORAGE TANK CLEANING

Subcourse QM5088
Edition 1

2 Credit Hours

United States Army Combined Arms Support Command
Fort Lee, VA 23801-1809

CONTENTS

INTRODUCTION

This subcourse is designed to train a 76W50 soldier on how to plan and direct petroleum storage tank cleaning. We will cover each part of the task and what your responsibilities are.

Supplementary Training Materials Provided: None.

Two credit hours will be awarded for successful completion of this subcourse.

LESSON

TASK: 101-519-5105. Plan and Direct Petroleum Storage Tank Cleaning. As a result of successful completion of this subcourse, you will be able to perform the following performance measures:

1. Plan the cleaning of storage tanks.

    a. Coordinate with the environmental engineer to obtain a safety permit.

    b. Instruct your personnel on the physical hazards of cleaning storage tanks.

    c. Have personnel use only explosionproof lights to reduce the possibility of fire.

    d. Verify that the lines to the tank have a positive shutoff, with either figure 8 blinds or a blind flange.

    e. Have personnel perform tests for vapor and hydrogen sulfide with the explosimeter before entering the tank.

    f. Direct all personnel to wear and use the correct equipment.

    g. Have personnel inspect the respirator equipment to make sure it is in good operating condition.

    h. Instruct personnel to leave the tank if the odor of gases becomes noticeable.

    i. Instruct personnel while they are inside the tank to follow all safety precautions.

2. Plan the disposal of sludge and deposits.

    a. Determine the equipment or area for disposing of sludge.

    b. Direct that the sludge be tested periodically while it is being removed.

    c. Follow guidelines in AR 200-1 when planning for disposal of sludge.

d. Have personnel inspect sludge to see that it is not more than 3 inches deep and is spread evenly if it is to be weathered.

e. Coordinate with the Environmental Protection Agency (EPA)(environmental engineer on sludge disposal).

f. Have personnel stencil the cleaning date on the cleanout door of the tank.

3. Instruct personnel not to use waste water from storage tank bottoms for dust control .

4. Have personnel record the Inspection date, services performed, and date of service on DA Form 4177.

CONDITION: Given this subcourse, you will be able to plan and direct petroleum storage tank cleaning.

STANDARD: You must answer 70 percent of the written exam questions correctly to receive credit for this subcourse.

CREDIT HOURS: See page ii, Introduction.

REFERENCES: FM 10-20, (Organizational Maintenance Military Petroleum Pipelines, Tanks, and Related Equipment), chapter 6 AR 200-1 (Environmental Protection and Enhancement), chapter 9.

LESSON TEXT

CLEANING AND MAINTAINING STORAGE TANKS

1. PURPOSE OF CLEANING. Many types of bulk petroleum storage tanks are found in military petroleum storage terminals. Cleaning this type of equipment is the responsibility of the using organization or unit. There are many hazards involved in tank cleaning and repair, and great care should be used before, during, and after the cleaning to avoid injury to personnel. It may be necessary to vapor free or clean storage tanks for three principal reasons: inspection, maintenance, and repair of equipment; removal of sediment, sludge, and corrosion from equipment; and change of the type of product to be stored. A change of the type of product may require tank cleaning because the presence of another petroleum product may contaminate the product to be stored.

2. PREPARATION FOR CLEANING. Preparations for the cleaning operations depend on the construction of the tank and the amount of sludge to be removed. Bolted steel tanks used by the military are provided with floor-level cleanout doors. A lined sump... should be prepared near the cleanout door to receive the flow of sludge and water when this type of tank is cleaned. Large permanently installed riveted or welded tanks are provided with manholes. The amount of sludge in the tank should be estimated then plans made for its disposal. A disposal area must be designated by competent authority; if (in wartime only) the sludge is to be buried, a pit or pits should be dug before removing sludge from the tank. If it is necessary to transport the sludge to a designated disposal area, suitable vehicles should be available. Prior to beginning any cleaning operations, you must coordinate with the local environmental engineer to obtain a safety permit.

3. HEALTH HAZARDS. Health hazards present in petroleum products should be pointed out to the cleaning detail before operation begins in order to avoid injuries, errors, and misuses of equipment and to increase efficiency. Two or more members of the cleaning detail should be trained and tested in artificial respiration and first aid and retrained periodically..

a. Dusts.. One of the most toxic dusts that results from cleaning and repairing tanks is tetraethyllead. Lead dust and fumes also result from removing paint by burning or sanding and from burning sludge from tanks contaminated by leaded fuel. Fibrosis-producing dust injures the lungs and may be generated when operating sanding and sandblasting equipment.

b. Gases and Vapors. The most poisonous gas or vapor found by cleaning personnel is hydrogen sulfide. Hydrocarbon vapors from gasolines and jet fuels are very narcotic and could result in respiratory failure. Tanks that have been unused for some time may be deficient in oxygen because of oxidation or rusting.

4. REMOVING SOURCES OF IGNITION. Rich combustible petroleum vapor is heavier than air and is capable of traveling for some distance when released. Depending upon ground and atmospheric conditions, the vapor may travel 100 yards or more; it tends to hug the ground, linger in low spots and diffuse slowly into the atmosphere. If such vapor is ignited, the flame could travel back to the tank. Flashback is usually fatal to anyone caught in it. If vapors from petroleum products are mixed with proper amounts of air, they form explosive mixtures within a limited range. If the vapor ignites in an open space where hot gases have plenty of room to expand, there is no explosion; if the mixture ignites in a confined space, an explosion takes place. All fires connected with petroleum products result from ignition of vapors. Before opening a storage tank, the supervisor should examine the area surrounding the tank for activities that could cause ignition and make sure these are removed before proceeding. Signs should be posted to warn against creating further hazards until the tank is vapor-freed. Operations must be stopped if an electrical storm is threatening. Some of the common sources of ignition (fig. 1) are outlined below.

a. Smoking and Matches. Smoking and matches are the greatest single common cause of fires. The area used for tank cleaning should be marked to prohibit smoking.

b. Housekeeping. High standards of housekeeping should be enforced at areas designated for tank cleaning. Weeds and grass should be eliminated by a nontoxic chemical solution, such as calcium chloride.

c. Sparks. Sources of friction sparks, such as tools, must be carefully controlled because of the possibility of igniting combustibles other than flammable vapors.

d. Electrical Equipment. Electrical equipment becomes a fire hazard through arcing, sparking, and overheating. Fixed or portable lights, power tools, and extension cords may become overloaded and heat up. All electrical equipment and lights used in the presence of possible flammable vapors must be explosionproof, and wiring and grounding must comply with the National Electric Code.

e. Static Electricity. Static electricity is stationary electric potential generated in the atmosphere by friction between unlike substances. Although static electricity cannot be prevented, accumulation of a charge can be prevented by proper grounding.

f. Spontaneous Heating. Heat-producing chemical action may produce spontaneous heating under certain conditions. Oily waste and rags should not be left exposed to the air but should be collected in airtight metal containers until disposed of.

g. Welding and Cutting. Fire hazards are present in the use of all methods of welding and in flame cutting. Storage tanks must be thoroughly cleaned and vapor-freed before hot work is done.

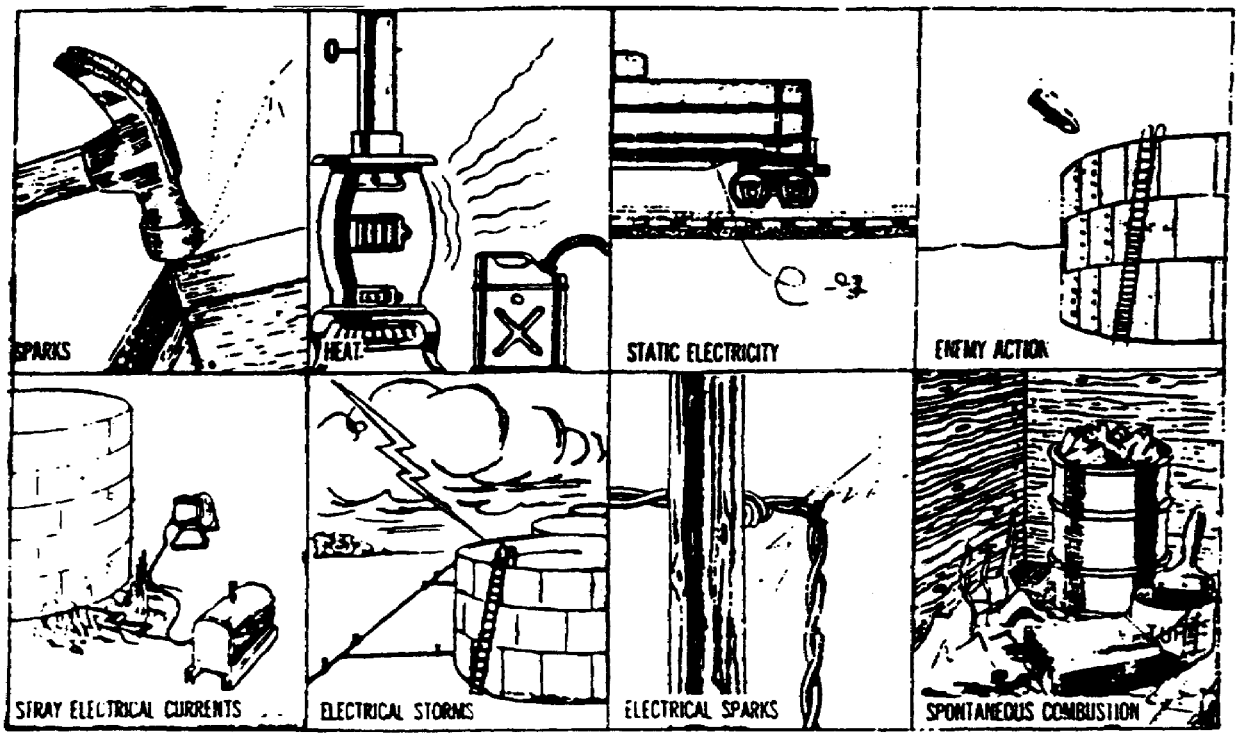


Figure 1. Causes of Petroleum Fires.

5. EXAMINING AND OPENING TANK. The supervisor should know what product is stored in the tank and the purpose of the cleaning operation. He should know the condition of the tank, its state of repair, and the approximate amount of corrosion and sludge. History of the tank should be determined, including type of products contained, date of last cleaning, and nature of cleaning performed. Such information could have a bearing on the method and extent of cleaning and affect the preparations for sludge removal and disposal. The supervisor should insure that cleaning personnel isolate the tank as described below. When this is completed and the sources of ignition have been removed, the tank may be opened. The men who open the tank must avoid breathing the vapor.

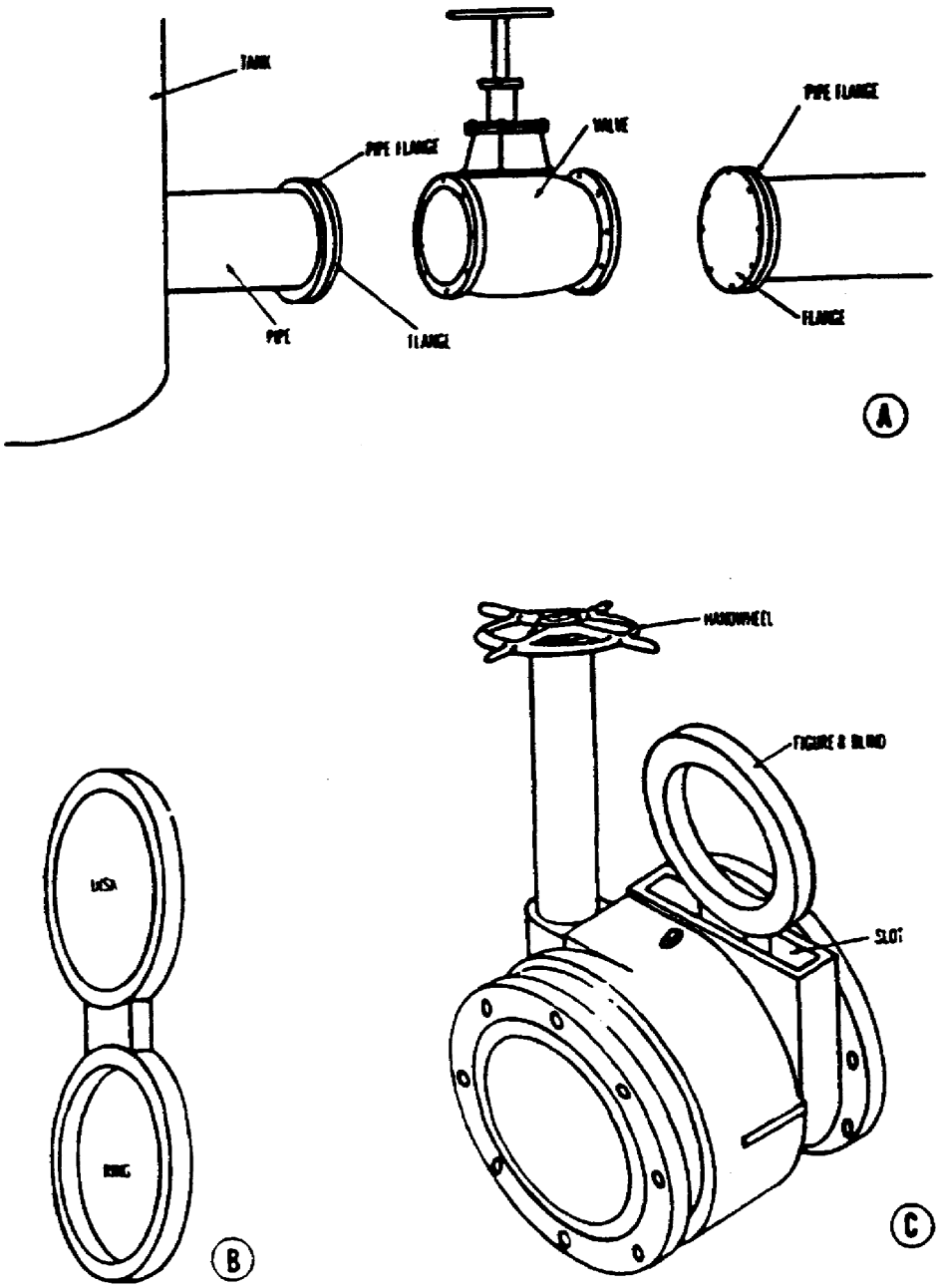
a. Removing the Product. Before the tank is opened the product should be pumped or drained off to the lowest possible level through the lowest tank connection. Pumping or draining may be helped by adding water through the water drain off line for floatation of remaining product provided no water is allowed to enter product lines. When all possible product has been removed, all valves in the lines outside the firewall should be closed, caution tags attached, and the water drawn off.

b. Blanking off the lines. Blanking off the lines, the final step, is done by closing all valves nearest the tank, breaking the connections, and placing blinds in all lines. Blanking off prevents vapors or product from entering into the operating area. The various items used for blanking off a line are described below.

(1) Blind flange. The blind flange (blank end) is attached to a pipe after its removal from a tank valve (A, fig. 2).

(2) Figure-8 blind. The figure-8 blind (8, fig. 2) is the simplest and most common positive shutoff device. It consists of a disk section and a ring section jointed to resemble the figure 8, as shown in the illustration. The operating condition of the pipeline is noted by observing which section of the blind is exposed. Flanged sections of pipelines must be unbolted in order to insert or reverse the figure-8 blind.

(3) Slip-joint blind. The slip-joint blind (C, fig. 2) is a device which is installed in pipelines to permit easy insertion or reversal of the standard figure-8 blind without unbolting pipeline flanges. The figure-8 blind, seated in an enclosed slot, is released or clamped by worm and ring gears controlled by an upright handwheel.



A. Blind (blank end) flange

B. Figure-8 blind

C. Slip-joint blind

Figure 2. Items Used to Blank Off a Line.

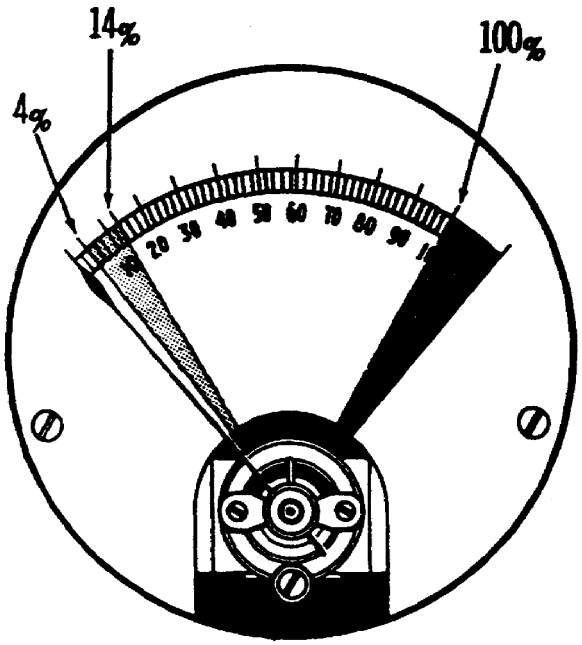
6. NEED FOR VAPOR TESTING AND VAPOR FREEING. The atmosphere of any tank that has held petroleum products should be tested to determine whether it is safe for the personnel doing the cleaning. The tank atmosphere should be tested for the presence of concentrations of vapors and should be examined for oxygen deficiency. Vapor freeing a tank is a hazardous operation, and the area should be vacated except when vapor testing is necessary to check on the progress of vapor freeing.

a. Petroleum Vapor. Petroleum or hydrocarbon vapor is found in all tanks which have product. The combustible range of any petroleum vapor is between 1 and 6 percent of any given volume, as indicated by chemical test. The toxic limit is 500 parts per million, or approximately 4 percent of the lower combustible limit. (See figure 3.) This concentration is safe for 8-hour exposures without respiration equipment. Other significant percentages are given in figure 3.

b. Tetra Ethyl Lead Vapor (TEL). Tetra Ethyl Lead vapor is present in all tanks used to store leaded gasoline. The toxic effect of this vapor exceeds that of petroleum vapor and is also cumulative. Ventilating and vapor freeing tanks used for leaded gasoline is not enough for the safety of personnel. These tanks are considered unsafe without respiration equipment until they are cleaned of all sludge, sediment, rust, scale, and dust, down to bare metal.

c. Hydrogen Sulfide. Hydrogen sulfide is rarely found in finished products but may be expected in tanks which have held crude products with a high sulfur content. Hydrogen sulfide is present if moistened lead acetate paper turns black. Concentrations of hydrogen sulfide vapor are measured by the hydrogen sulfide detector. Its combustible range is between 4.3 and 46.0 percent by volume. The toxic limit is only 20 parts per million, far below that of petroleum vapor (a above), and therefore hydrogen sulfide vapor is much more hazardous. The toxic effect of hydrogen sulfide is not cumulative as is TEL vapor.

d. Oxygen Deficiency. Because of oxidation, the atmosphere of an inactive tank may be deficient in oxygen even though the tank is empty and clean. Personnel should not enter such tanks without fresh-air respiration equipment or until the tanks have been properly ventilated.



4% OF THE LOWER COMBUSTIBLE LIMIT IS THE MAXIMUM FOR 8-HOUR EXPOSURES WITHOUT RESPIRATORY EQUIPMENT.

4% TO 14% OF THE LOWER LIMIT IS A SAFE RANGE FOR VERY BRIEF EXPOSURES.

OVER 14% OF THE LOWER LIMIT IS NOT SAFE. FOR ANY EXPOSURE, HOWEVER BRIEF.

100% MEANS THAT THE LOWER COMBUSTIBLE LIMIT HAS BEEN REACHED.

Figure 3. Percentages of Vapor Concentration and Exposure Limitations.

7. PROCEDURES FOR VAPOR TESTING. Gasoline and other petroleum product vapors except JP-4, which is always potentially dangerous, may be too rich to burn when mixed with air. However, as the amount of vapor in the tank decreases to the range of 1 to 6 percent vapor by volume, the vapor enters the flammable range. Safety requires a continuing knowledge of conditions within the tank vapor space at all times. Frequent tests should be made during ventilation or vapor freeing, and during subsequent cleaning. Original concentration of vapor and rate of ventilation govern the frequency of tests. Generally, a tank is considered to be vapor free if its atmosphere is free enough of petroleum vapor to be neither toxic nor combustible, and personnel can work within the tank without fresh-air respiration equipment. These conditions do not apply, however, to tanks which contain TEL vapor or hydrogen sulfide.

a. Equipment. Instruments for detecting and measuring petroleum vapor concentration are required for tank cleaning operations. These instruments are designated as vapor indicators, combustible-gas indicators, or explosimeters (fig. 4) and most of them operate by the same principle. Hydrogen sulfide detectors (fig. 5) are used to measure concentrations of hydrogen sulfide vapor.

b. Operations. The items of equipment mentioned above operate as follows.

(1) Explosimeter. A sample tank vapor is drawn into the instrument through the sampling line by means of a rubber aspirator bulb. The sample is drawn through an analyzer unit where it comes in contact with a heated platinum filament, on the detector filament. The surface of this filament is catalytically heated to burn the vapor on contact. This small flame is protected by a flame arrester which prevents ignition of the tank atmosphere. The burning of the vapor sample causes an increase in the temperature of the filament unit and a corresponding increase in its electrical resistance. The greater the concentration of vapor, the greater will be the proportional increase in resistance. The change in resistance affects the small current that flows from a dry-cell battery, and this is indicated by a galvanometer needle. Calibration of the instrument is such that the needle deflection is proportional to the concentration of vapor. The dial of the explosimeter indicates directly the vapor concentration as a percentage of the lower combustible limit but does not indicate percentage by volume. The lower combustible limit is 1 percent by volume. A reading of 100 percent on the explosimeter means that the tank atmosphere is 100 percent explosive, or that a vapor concentration of at least 1 percent by volume is present.

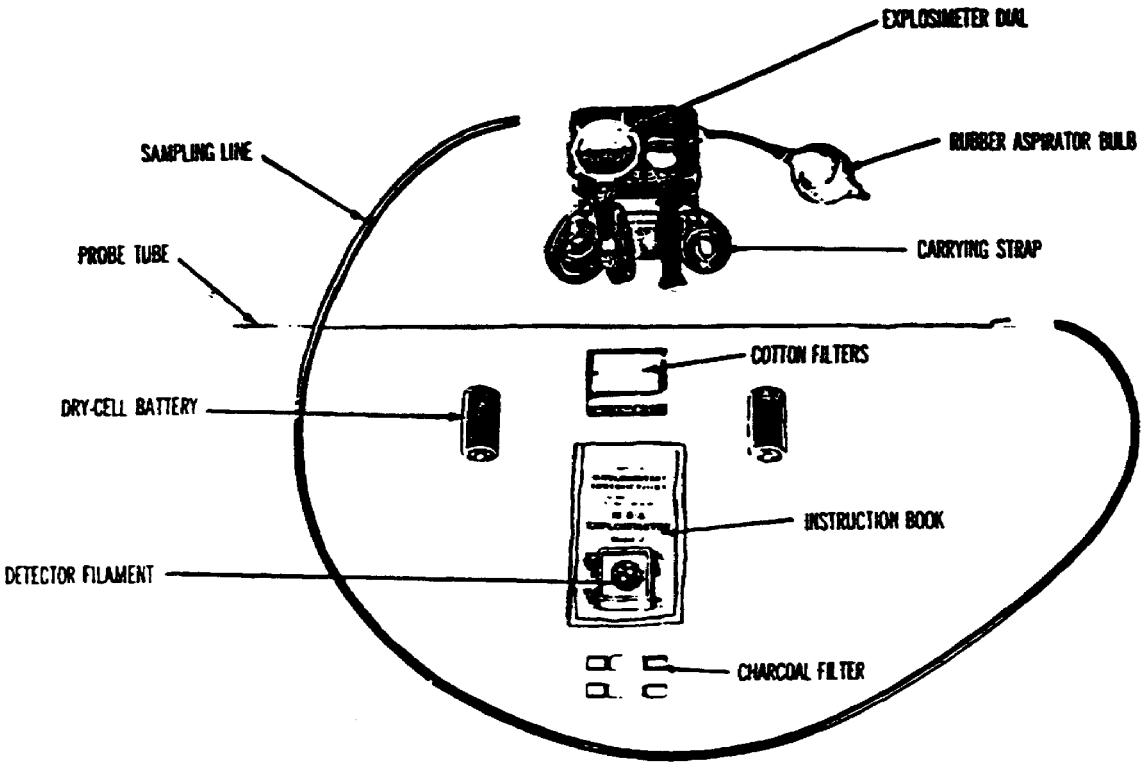


Figure 4. Explosimeter and Accessories.

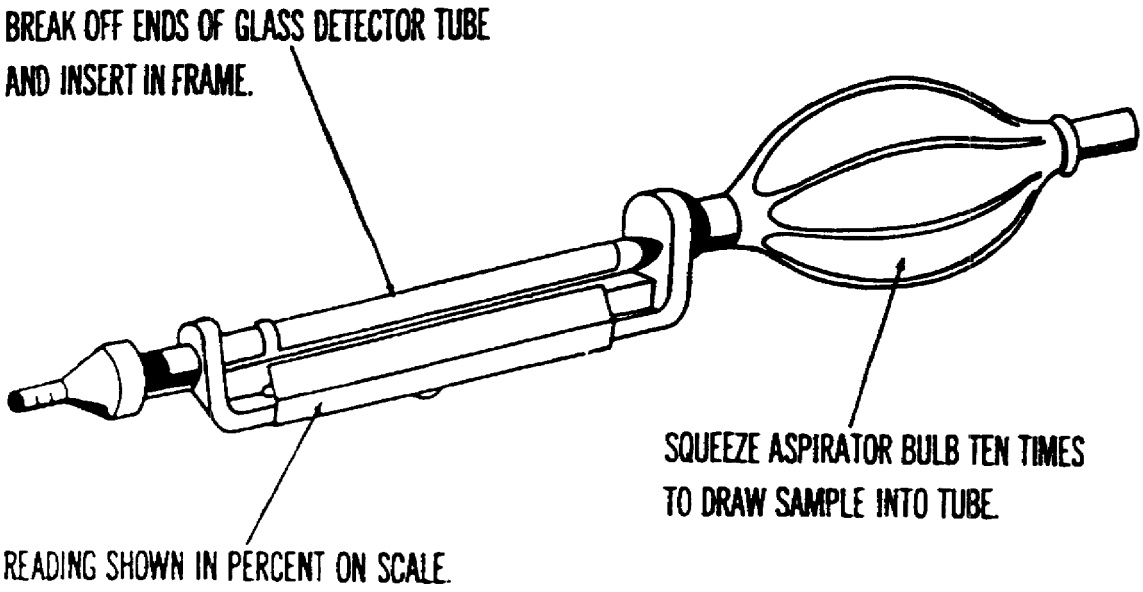


Figure 5. Hydrogen Sulfide Detector.

(2) Hydrogen sulfide detector. A hydrogen sulfide detector measures concentrations of hydrogen sulfide vapor. A sample is drawn into the tube of the detector by means of the aspirator bulb, and the reading is shown on the scale in percent by volume.

c. Frequency. While the tank is being ventilated, vapor concentration should be tested frequently where the vapor is leaving the tank (fig. 6). Ventilating and testing should continue until readings on the instrument show no more than 14 percent of the lower combustible limit where the vapor is leaving the tank. If the tank has contained lead, the tester enters the tank with respirator equipment. Readings should be taken at a level of about 1 foot above the sludge. If the tank is being vapor freed by forced ventilation, the ventilator should be turned off while testing to get a true sampling of the air. The interior of the tank is considered safe when a maximum reading is 4 percent of the lower combustible limit. This reading indicates the air is suitable for breathing without respiration equipment and is well below the combustible limit. After the tank has been found to be vapor free and cleaning operations can begin, periodic testing is continued.. Cleaning operations may generate additional vapors. Although a reading of 4 percent is considered safe for an 8-hour exposure and higher readings safe for very short periods, a reading in excess of 14 percent is not safe for any exposure. Cleaning personnel must leave the tank or wear respiration equipment if the explosimeter reading indicates concentration of 14 percent of more.

8. METHODS OF VAPOR FREEING. Large storage tanks can be vapor freed by natural ventilation or forced ventilation. They may also be vapor freed by water displacement if an unlimited supply of sea water is available. Tanks to be vapor freed by natural ventilation or forced ventilation must be opened at top and bottom, in that order. Personnel who open tanks should face away from the wind and avoid breathing vapors.

a. Natural Ventilation. Natural ventilation is the simplest but slowest method of vapor freeing. When this method is used alone, further operations should be stopped until tests indicate that a safe concentration of vapor has been reached.

b. Forced Ventilation. Forced ventilation is a faster way to vapor free a tank, and this may be done by either of the methods described below.

(1) Blowers. Blowers or fans produce a forced draft which can be applied to the bottom tank opening by means of canvas ducts. An electric motor, a gasoline engine, or a steam turbine may be used as the source of power to drive a blower. When using an electric motor (unless explosionproof) or gasoline engine, the blower must be set up upwind of the tank.

Figure 6. Testing for Vapors.

(2) Ejectors. Ejectors or air movers (sometimes called eductors or exhausters) are powered by steam or compressed air. They are applied to the top opening, where tank vapors are drawn out by suction (fig. 7). When ejectors are used for vapor freeing, the work of sludge removal can continue uninterrupted.

9. SAFETY PRECAUTIONS. Tank cleaning requires close supervision to assure a reasonable degree of safety. In addition to fire and health hazards, many other hazards, mostly physical, are also encountered in cleaning operations. Various physical hazards and applicable precautions are presented below.

a. Ladders and stairways should be secure.

b. Where roof plates have become thin, planks should be used to distribute the weight.

c. Line blanks should be strong enough to withstand pressures put on them.

d. After a tank has been vapor freed, there should be no loose members or fixtures that could be knocked down during cleaning operations.

e. Personnel should use care in moving about with hose and lifeline. Tank floors are very slippery. To avoid slipping or tripping, men should step over pipe and fittings and not on them.

f. Swing lines should be lowered when men are working in the tank to avoid accidental release of the lines.

g. Tools should be handled carefully and used only for their intended purposes.

h. Care should be used in walking on tank roofs, scaffolding, stairways, or on ladders, particularly when icy conditions exist.

i. Before a tank is entered, it should be properly lighted. Explosionproof lamps should be used, and the portable cords used with the lamps and electrically operated tools should be connected to a grounded third wire. Fixtures and wiring used in the presence of vapor should be examined for broken conductors or frayed insulation.

j. When men are inside a tank completing the cleaning process, a man should be available outside the tank to assist them in an emergency.

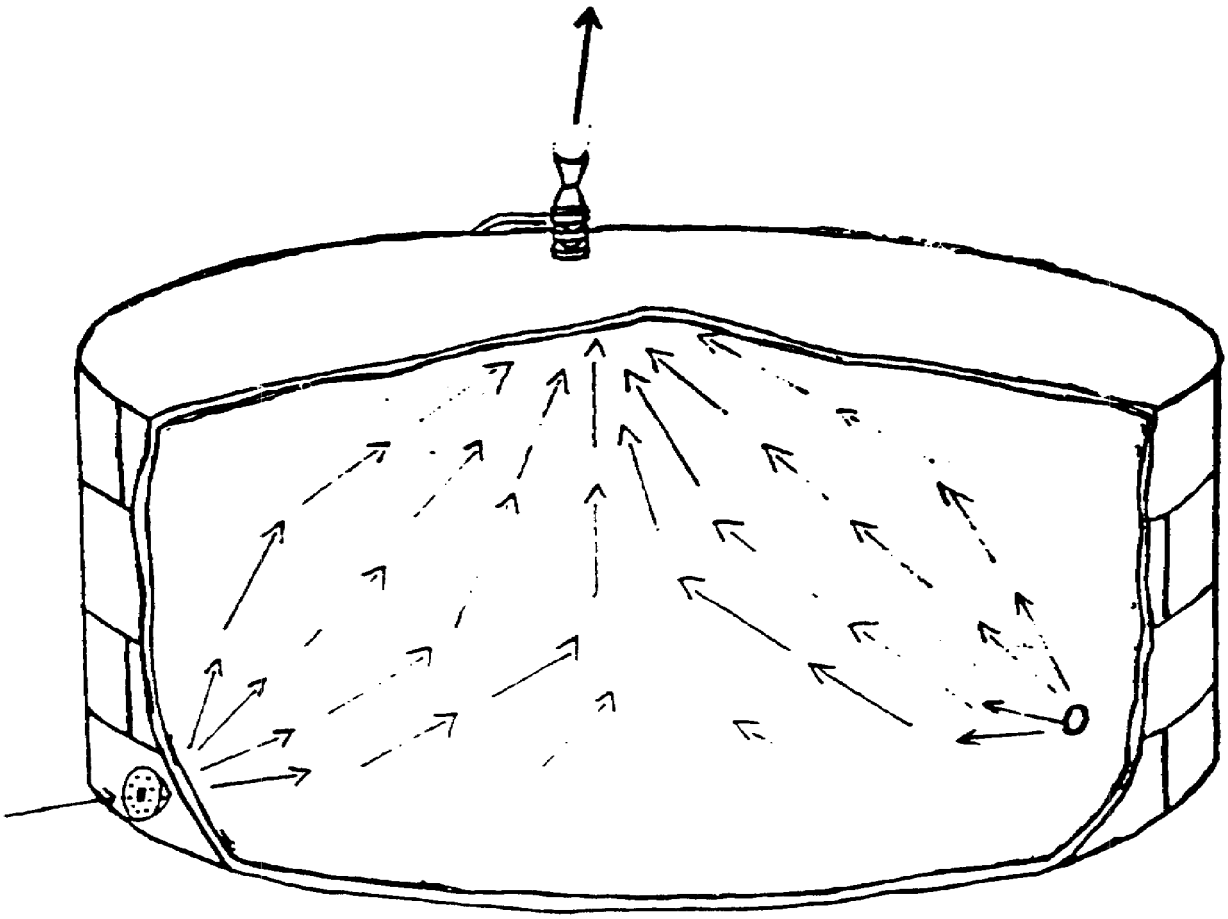


Figure 7. Use of Ejectors to Exhaust Tank Vapors.

10. SAFETY EQUIPMENT. Each person on the cleaning team should be given adequate protective clothing and equipment to provide maximum protection for their health and safety.

a. Safety Equipment Set. The safety equipment set (fig. 8) is a standard item that is provided for the safe cleaning of tanks. The set consists of two fresh-air respirators, one hand-operated centrifugal blower, necessary airhose, two leather harnesses, two lifelines, one explosimeter with accessories and instructions, two pairs of rubber boots, and two pairs of rubber gloves. A chest is provided with the set for ease of carrying and for safe storage of the equipment. The blower is permanently mounted in the chest for convenience of operation. A removable blower handle permits closing the chest lid, through which the blower is operated. A cutout in one end of the chest provides space for the two air lines.

b. Respiration Equipment. The fresh-air respirator, which is used with a blower, is the only equipment recommended for use inside of tanks which have not been vapor freed, in tanks which contain TEL vapor or hydrogen sulfide, or in active tanks which have not been ventilated. The fresh-air respirator provides an independent supply of fresh air delivered to the facepiece under positive pressure. The testing and use of respiration equipment must be supervised closely.

(1) Inspecting and testing. Respiration equipment must be tested frequently. It must always be inspected before use and before being stored. If repairs are needed, they should be made immediately. In case of an emergency, a man's life could depend upon the availability of spare equipment. To test the respirator for leaks, the user puts on the equipment. Chewing material in the mouth should be forbidden. With respirator in position and straps adjusted, the end of the connecting tube should be closed with the palm of the hand or by pinching the tube. If the facepiece collapses, there are no leaks and the fit is satisfactory. Connections on the air hose should be examined for tightness. Gaskets supplied with the set should be used.

(2) Using. Some precautions are necessary in using this equipment. Several of these are as follows:

(a) The blower should be set up to face the wind to insure that fresh air is delivered to the respirators.

(b) The blower must be attended constantly.

(c) When a man enters the tank, someone must tend his lines and keep him under constant observation. The person tending the lines must be properly equipped to enter the tank for immediate rescue work.

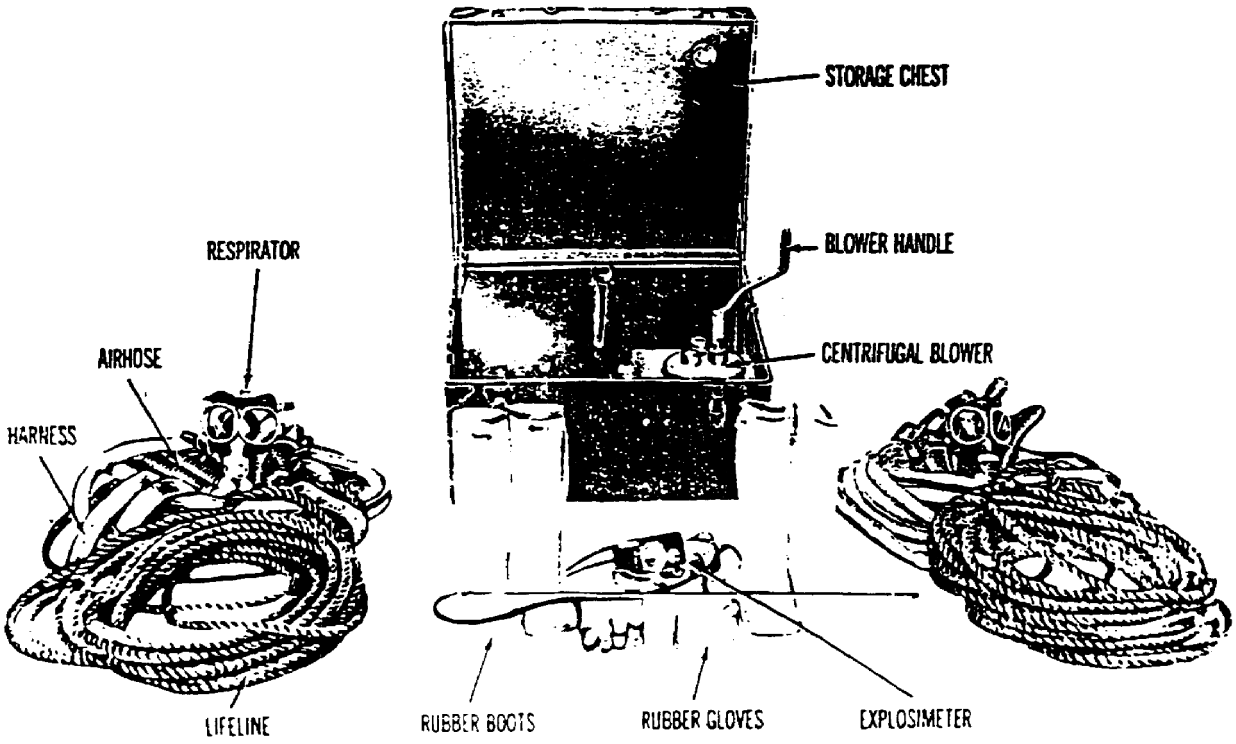


Figure 8. Safety Equipment Set.

(d) Hoses should be lifted over the edge of the manhole and not permitted to drag. Padding under the lines is recommended to prevent damage.

(e) Cleaning personnel must not remove respirators inside the tank. Even though the tank is vapor free, the facepiece could be contaminated.

(f) Cleaning personnel should leave the tank immediately if the odor of gasoline is noticed. They must not reenter the tank until the cause of the odor is determined and the problem is corrected.

(g) Men in the tank should not step over the hose lines. Connections may be loosened if the hose is pulled or twisted.

(h) Personnel should be cautioned about walking the line around columns or other obstructions because of the possible difficulty of escape in case of emergency.

(i) Enough men should be available for emergency duty. Should it be necessary to send rescuers into the tank, they must be equipped with respirators and lifelines and must be kept under constant observation.

(j) Men should be checked for physical condition and should be relieved frequently while on duty. Illness, fatigue, and overheating lessen resistance to toxic effects.

(k) Respirators should be washed with soap and water at the end of the day's work. Hose, harness, and lifelines must be thoroughly cleaned and dried naturally before they are stored.

c. Other Protective Equipment and Clothing. In addition to the equipment mentioned above, the following equipment and protective clothing may also be used in cleaning operations.

(1) Canister gas masks. Canister gas masks equipped with canisters approved for organic and acid gases (yellow) can be worn for protection outside the tank or in other hazardous outdoor areas. This mask is acceptable for use by personnel who blank the lines and open manholes of tanks which contain TEL vapor and hydrogen sulfide. Accurate time records must be kept when canister gas masks are used so that the canister safe life will not be exceeded.

(2) Goggles. Personnel who wipe down tank walls with solvent during the cleaning operations should wear tight-fitting goggles to protect the eyes. Also, personnel who enter the tank to knock down loose scale or other deposits with high-pressure hose or scrapers should wear goggles to protect the eyes from flying particles.

(3) Rubber boots and gloves. Rubber boots and gloves are necessary items of protection for cleaning tanks. Knee-length or hip-length boots with safety toes are preferred. Rubber gloves should be strong and long enough for adequate protection. Boots and gloves should be acidproof and should be resistant to gasoline, oil, and water. Personnel who wear boots and gloves are insulated. If the boots do not have copper rivets, they should be inserted in the heels to discharge any accumulating static electricity.

(4) Outer garments. Cotton clothing should be used to decrease the generation of static electricity in the clothing. White cotton coveralls and white cotton caps are recommended for personnel assigned to cleaning duty. A complete fresh change of clothing should be worn each day. Sludge or gasoline stains are more noticeable on white or light-colored clothing. If the clothing becomes wet, particularly with gasoline, it should be changed immediately.

11. SPECIAL PRECAUTIONS RELATED TO LEADED GASOLINE. If a tank that has held leaded gasoline must be entered for cleaning or repair work, the specific precautions below must be followed in addition to the general precautions already covered.

a. A tank used for leaded gasoline must have a warning stenciled above the cleanout door or near the manhole.

b. Sources of ignition should be removed, and the tank should be examined and isolated.

c. Personnel who enter the tank must wear respiration equipment. Respirators must be worn until all sludge, rust, and scale have been removed from sidewalls, bottom, and piping. Forced ventilation should be provided.

d. Necessary work within the tank should be performed in the shortest time possible, and all contact between tank liquids and the skin must be avoided. Unavoidable exposures to vapors should be brief and widely spaced because the toxic effect of leaded vapors is cumulative.

e. If the sludge is to be buried or spread out for weathering in a designated area, all absorbent materials used for removing sludge or drying the tank after it has been hosed should be disposed of with the sludge.

f. White cotton outer garments, white cotton underclothing, and rubber boots and gloves should be worn. Clothing should be laundered and the body bathed each day. If clothing should become soaked with gasoline or sludge, wet the clothes with water before you take them off. If there is not enough water at the site to wet the clothes thoroughly, ground yourself to a piece of grounded equipment by taking hold of it with both hands before you take off the fuel-soaked clothes. Then the clothing should be washed promptly and the body bathed before fresh clothing is put on.

g. Respirators, boots, gloves, and hose should be washed with soap and water at the end of each day. Boots and gloves should be washed before they are removed.

h. After the usual cleaning, if repairs are planned that involve heating the tank shell or that may result in dust, the part of the tank to be repaired should be cleaned further by sandblasting down to bare metal.

12. SPECIAL PRECAUTIONS RELATED TO HYDROGEN SULFIDE. Hydrogen sulfide attacks exposed interior parts of a tank .and forms a scale of iron sulfide. During galvanic action, which takes place between the scale and metal, a chemically generated electric current flows from the tank metal to the scale. Flexing of the tank roof causes pieces of the scale to break loose and fall to the bottom. The galvanic action then takes place on the bottom, often resulting in deep pitting and leaks. Iron sulfide scale is capable of spontaneous combustion. Rapid oxidation of the scale takes place when the tank is open for ventilation. Heat is generated to the point where the deposits actually glow, and combustible vapors could be ignited. Precautions presented below must be observed when hydrogen sulfide is present.

a. Personnel who blank lines and who open hatches and manholes should wear fresh-air respirators or canister gas masks approved for hydrocarbon vapors and acid gases (yellow). Field protective masks are not adequate.

b. Both the explosimeter and hydrogen sulfide detector must be used to test the tank atmosphere. Personnel must not enter the tank without fresh-air respirators until tests show no more than 4 percent of the lower combustible limit of petroleum vapor and no more than 20 parts per million of hydrogen sulfide.

c. Contact between air and iron sulfide scale should be prevented or the heat generated by oxidation should be dissipated until the tank atmosphere is below the combustible limit of hydrogen sulfide and petroleum vapor. When the tank can be steamed effectively, the iron sulfide on the roof and sidewalls will be adequately blanketed and soaked by condensate until the tank atmosphere is no longer combustible.

d. When the tank atmosphere is safe, a high-pressure water hose is used to knock down the scale into the sludge and water where it will be safe until it is removed with the sludge. To prevent spontaneous combustion after removal, the sludge. is kept wet until it is disposed of properly.

13. CLEANING TANKS. A number of cleaners designed to remove sludge, rust, and scale from tanks by chemical action are available on the commercial market. Currently, they are not standard items of issue in the Army supply system but may be obtained by local purchase. Some of them produce excellent results on steel bolted tanks, and save time and manpower in cleaning large permanent-type tanks. Chemical cleaners emulsify the sludge and film on the floor and sidewalls of the tank. The grease is loosened and suspended in the emulsion, similar to the action of soap and water when washing and is then washed away with water. To clean a tank, a solution of the cleaner is mixed in water according to the manufacturer's instructions and sprayed inside the tank. It is usually allowed to remain in the tank overnight. Then the walls and floor are hosed down with water and the emulsion flushed out the cleanout door into the sump.

14. CLEANING ABOVEGROUND TANKS NOT VAPOR FREED. Personnel should not be required to enter tanks that contain vapors if it can be avoided. However, cleaning without vapor freeing may be justified under certain circumstances. Some of these are: when TEL vapor and hydrogen sulfide are known to be absent; when facilities for vapor freeing are limited; when water is not available in sufficient quantities for vapor displacement and flushing; or when the quantity of sludge and corrosion is small. If a tank must be cleaned without being freed of vapors, all safety precautions should be followed, sources of ignition must be removed, and the tank must be examined and isolated. Liquid sludge is then pumped from the tank. Pumping can be facilitated and loose scale and rust removed by means of a high-pressure water hose directed from the outside. If a hose is used, the hose nozzle must be bonded to the tank shell. All personnel entering the tank must be equipped with fresh-air respirators, hose lines, lifelines, impermeable rubber boots and gloves, paddles or wooden scrapers, buckets, brooms and mops, rags, or other absorbent and lint-free materials. After the remaining sludge, rust, scale, and other deposits are removed from tank walls and floor by scraping, the sludge and other deposits are removed from the tank in the shortest time possible. The tank is rinsed by hosing and then mopped or wiped with cloths.

15. CLEANING UNDERGROUND TANKS. Underground petroleum storage tanks are usually of welded-steel or concrete construction. Underground steel tanks are similar to aboveground welded-steel tanks except that they are designed to withstand severe weight stresses. Most vertical steel tanks, and most horizontal steel tanks of 3,000-gallon capacity or over, are provided with manholes to permit entry of cleaning personnel. Interiors of steel tanks may be coated. A variety of shapes and designs of underground concrete tanks may be found in oversea areas; however, rectangular and cylindrical tanks are the most common. Rectangular tanks are usually installed horizontally, and cylindrical tanks are usually installed vertically. Most concrete tanks are provided with manholes to permit entry, and most are lined to prevent leakage and to provide a chemically inert barrier between the product and the concrete surface. Tanks that are used for heavy products are usually coated with

sodium silicate solution; those used for light products are usually surfaced with laminated linings of organic material, such as synthetic rubber sheets, synthetic rubber latex with membranous material, or synthetic resin. Some of these tanks are equipped with sumps for accumulation of water and sediment and may also have permanently installed pumps for removing liquid sludge from the sump. Some tanks may have a sludge disposal system which includes the pump and piping for evacuating the sludge to a disposal area.

a. Vapor Freeing. Underground storage tanks which do not have side openings are more difficult to vapor free than aboveground tanks. Because vapors tend to settle at tank bottoms, vapor freeing by natural ventilation is considered impracticable. Tanks should be tested for presence and concentration of vapors and vapor freed by one of the following methods.

(1) Forced ventilation. Blowers can be used for forced ventilation if roof manholes are opened and blowers are attached either to pipes leading into the tank near the bottom or to ducts or hose extending through the roof openings to the tank bottom. Pipes suitable for this purpose may be drain lines, lines used in a sludge disposal system, or product input or output lines. Ejector or air movers attached to roof openings can be used for forced ventilation if pipes leading into the tank near the bottom are opened to provide drafts to agitate accumulated vapors at the tank bottom.

(2) Water displacement. Underground tanks, except those used for aviation fuel, may be vapor freed by water displacement when suitable means for handling overflow water is provided. Any fuel removed by water displacement must be placed in drums or other suitable containers.

(3) Steam displacement. Small steel tanks may be vapor freed by steam displacement when steam generating equipment is available. Steam should never be used in concrete tanks because the high temperature is damaging to concrete and to tank linings and coatings.

b. Cleaning Procedures. Procedures for cleaning an underground tank are determined mainly by tank construction, that is, whether the tank is welded steel or concrete and whether or not it is provided with a manhole to permit entry of personnel. All applicable precautions must be observed when cleaning underground tanks.

(1) Tanks that permit entry of personnel. Tanks that are provided with manholes to permit entry should be cleaned by personnel working inside the tank. Procedures for the cleaning of aboveground tanks are followed. Vapor tests are taken frequently. Unfavorable changes in vapor concentration must be detected early because quick exit is more difficult through the roof manhole than through a side opening of an aboveground tank. Steam is never used as a cleaning agent for

concrete tanks. Water is applied under pressure and the tank interior is scrubbed with brushes and a suitable solvent, such as kerosene. Tank linings or coatings must not be damaged.

(2) Tanks that do not permit entry of personnel. 'Tanks that are not provided with maholes to permit entry and those that are so small that work within the tank would be impracticable must be cleaned by applying cleaning agents from the outside. The best cleaning agents for this purpose are steam and a combination of steam and a suitable solvent, such as kerosene. If a 50-g.p.m. pumping assembly is used to remove sludge and cleaning agents from the tank, the pumping assembly is placed front to the wind well away from the tank unless the pumping assembly has an explosionproof electric motor. The cleaning process is repeated until the tank is clean. Heavy deposits of sludge can sometimes be loosened by scrubbing the tank interior with brushes attached to long poles.

16. CLEANING THE PUMPING ASSEMBLY. When the 50-g.p.m. pumping assembly and hose have been used to remove sludge from the tank, the equipment is contaminated and should be cleaned as follows. When the sludge and water have been removed from the tank or sump, the suction hose should be inserted in a drum of clear water or coupled to a source of supply. The pump should be operated until the pump and its suction and discharge lines are thoroughly flushed. After the pump and lines have been flushed with water, they should be flushed with a gallon or two of solvent. The solvent from both hoses should be drained into the pump, and the solvent drained from the pump. The solvent should be examined to determine whether further flushing is necessary.

17. REMOVAL OF SLUDGE. Procedures for removing sludge from tanks are discussed below.

a. The liquid sludge should 'be pumped directly from the tank to the disposal area or to the tank vehicle (fig. 9). This can be done by inserting the suction hose of a 50-g.p.m. pumping assembly through the manhole or lower tank opening.

b. A high-pressure water hose can be used to knock down loose rust and scale and to wash material into the prepared sump. In addition to dumping the sludge out of the tank, the sludge can be shoveled into wheelbarrows or trucks and moved to the disposal area, or a 50-g.p.m. pump used to move the sludge from the sump to the tank vehicle (fig. 10).

c. Testing for vapor concentration should be continued. Agitating the sludge will probably release additional vapor. If vapor is being generated in excessive quantities, personnel should leave the tank until tests prove that the tank atmosphere is safe.

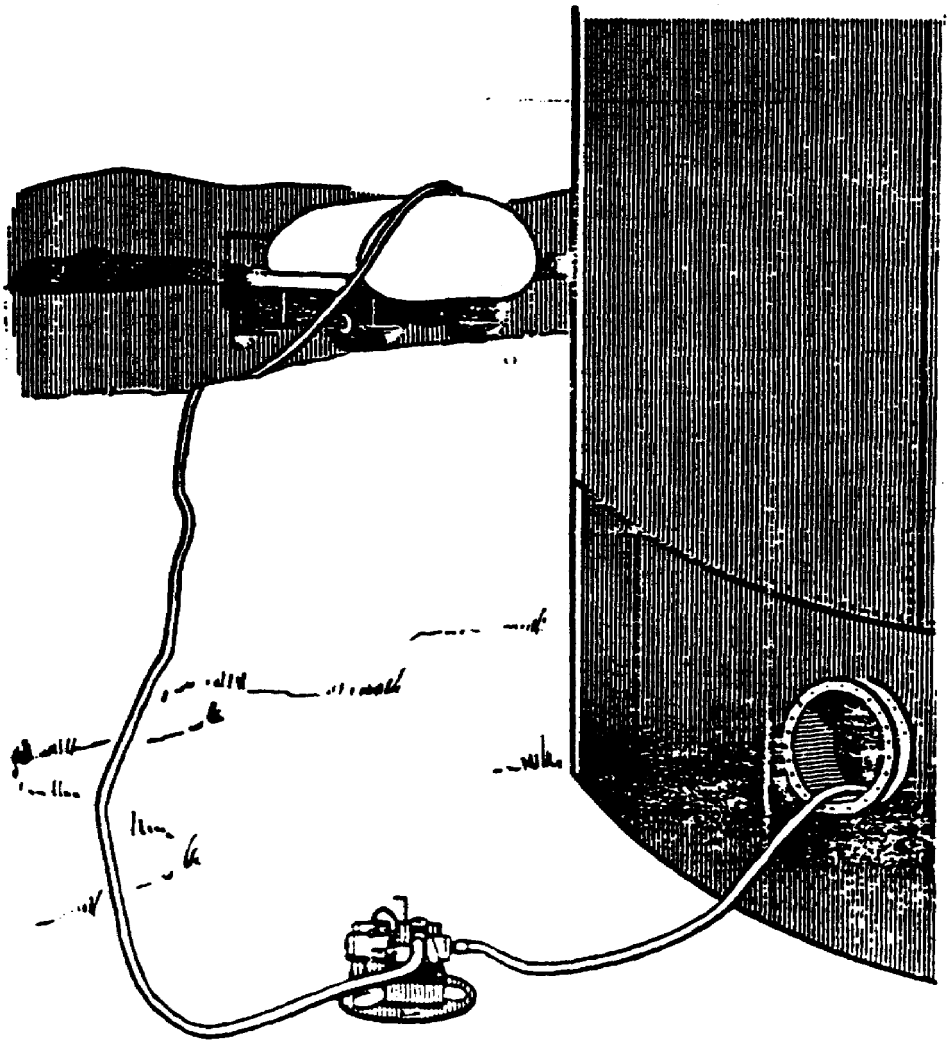


Figure 9. Pumping Sludge From a Tank to a Tank Vehicle.

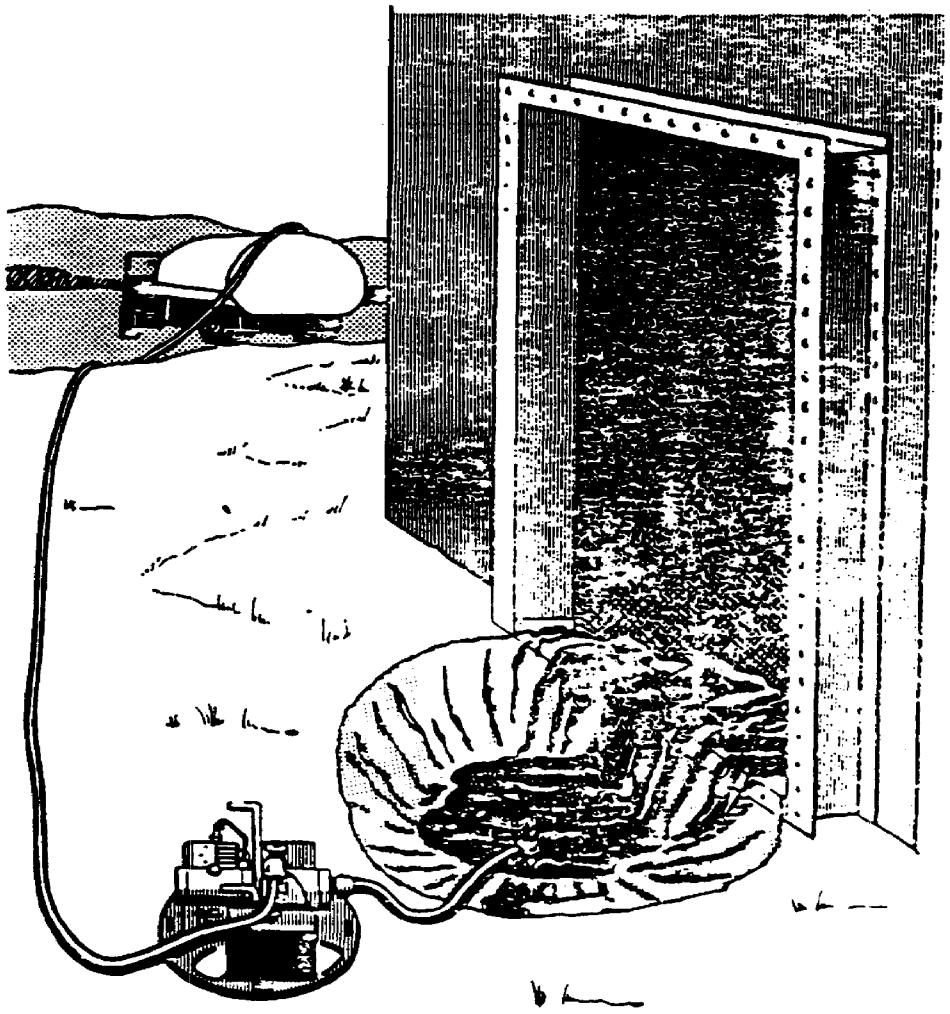


Figure 10. Pumping Sludge From the Sump to a Tank Vehicle.

d. Remaining sludge should be removed by scraping. It can be shoveled into buckets and handed through the manhole or cleanout door or loaded in wheelbarrows and removed through the lower tank opening of a permanently installed tank.

e. The remaining rust, scale, and other deposits can be removed with scrapers or wire or fiber brushes. In cases of extreme corrosion, sandblasting may be necessary. Scaffolding may be erected for work in the upper areas of the tank.

f. Deadwood should be freed of product, scale, and sludge. Holes may be drilled at the bottom of hollow roof supports to allow drainage and flushing from the top.

g. If necessary, walls and floor of the tank can be wiped down with kerosene.

h. The tank should be rinsed by hosing walls and floor. Moisture can be taken up by mopping or wiping with lint-free cloths.

i. The inspection date, services performed, and the cleaning date should be entered on a Utilities Inspection and Service Record (DA Form 4177). The cleaning date should be stenciled near the manhole, cleanout door or any other place that is easily seen.

18. SLUDGE DISPOSAL. The method of sludge disposal depends upon whether the sludge is leaded or unleaded and on the availability of disposal areas. Prior to disposing of sludge, coordinate with the local environmental engineer. Insure that disposal method complies with local, state and Federal laws on environmental protection as specified in AR 200-1.

a. Leaded Sludge. Leaded sludge may be disposed of through the Property disposal office (PDO). Otherwise leaded sludge should be kept wet until buried or spread out for weathering. Personnel should wear the same protective clothing utilized for tank cleaning. Respirators and masks are not needed unless vapors can be detected at face level.

(1) Burying. Sludge may be buried in pits in a designated area away from population concentrations. The sludge must be covered over and posted to prevent its being disturbed in future operations.

(2) Weathering. Decontamination of sludge by weathering offers a means of disposal where space for repeated burying is not available. The location should be remote, smooth, well drained and ventilated and if possible sunny. Sludge should be spread to a depth of 3 inches or less and the area roped off and posted. The sludge is left in place for a period of 4 weeks during which the temperature is above 32°F (0°C). If the temperature goes below freezing the weathering period should be extended for a corresponding length of time. After weathering, the sludge can be treated as any nontoxic waste or left in place, with ropes and signs removed.

b. Unleaded Sludge. Unleaded sludge may be buried or pumped into dry wells. It may also be destroyed by burning with high intensity furnaces.

REVIEW EXERCISE

The questions in this review exercise give you a chance to see: how well you have learned the material in this lesson. The questions are based on the key points covered in the lesson.

Read each question and write your answer on the line or lines provided for it. If you do not know or are not sure what the answer is, check the paragraph reference that is shown in parentheses right after the item; then go back and study or read once again all .of the referenced material and write your answer.

After you have answered all of the items, check your answers with the solution sheet at the end of this exercise. If you did not give the right answer to an item, erase it and write the correct solution. Then, as a final check, go back and restudy the lesson reference once more to make sure that your answer is the right one.

1. Cleaning bulk petroleum storage tanks is the responsibility of the _____ _____ or _____ . (para 1)

2. Two serious health hazards that can result from petroleum products are _____ dust and _____ gas. (para 3a, 3b

3. A _____ _____ is used to blank off a line when a tank valve is removed. (para 5b(1))

4. The range vapor concentration permissible for very brief exposures is _____ to _____ percent. (Figure 3)

5. The _____ is used to detect and measure petroleum vapor concentrations. (para 7)

6. When planning cleaning operations, have at l east _____ members of the team who are trained in artificial respiration. (para 3)

7. Storage tanks may be vapor freed using either _____ or _____ ventilation. (para 8)

8. The _____ _____ _____ is the only equipment recommended for use inside a tank that has not been vapor freed. (para 10b)

9. Canister gas masks can be worn for protection _____ the tank. (para 10c(1))

10. Personnel should leave a tank immediately if they notice an _____ _____ _____. (para 10b(2)(f))

11. Chemical cleaning solutions are usually left on tank walls _____ _____ then rinsed off. (para 13)

12. Liquid sludge can be pumped directly from a tank using a _____ _____ pumping assembly. (para 17a)

13. The method of sludge disposal will depend on whether the sludge is _____or _____ . (para 18)

EXERCISE SOLUTIONS

EXERCISE	SOLUTION
1.	using organization; unit
2.	tetraethyllead (TEL); hydrogen sulfide
3.	blind flange (or blank end)
4.	4; 14
5.	explosimeter
6.	two
7.	natural; forced
8.	fresh air respirator
9.	outside
10.	odor of gasoline
11.	overnight
12.	50-g.p.m.
13.	leaded; unleaded