Interior Lining and Periodic Inspection of Underground Storage Tanks

API STANDARD 1631
FIFTH EDITION, JUNE 2001

REAFFIRMED, DECEMBER 2010

AMERICAN PETROLEUM INSTITUTE

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Downstream Segment

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FOREWORD

API Standard 1631 provides recommendations for lining the interior of existing steel and fiberglass reinforced plastic underground petroleum storage tanks and periodic inspections of lined steel tanks. This standard was prepared under the auspices of the API Manufacturing, Distribution and Marketing Department and is based upon the experience of knowledgeable members of the petroleum industry and lining manufacturers. This standard is intended for use by API member companies and others to develop safe practices and procedures for lining and inspecting underground tanks storing petroleum products. A number of additional API standards and recommended practices as well as government and industry regulations and publications, noted in the reference section, provide supplemental information applicable to the requirements and components of this standard.

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Interior Lining and Periodic Inspection of Underground Storage Tanks

1 General

1.1 SCOPE

This standard provides minimum recommendations for the interior lining of existing steel and fiberglass reinforced plastic underground tanks and periodic inspection of steel underground tanks used for the storage of petroleum-based motor fuels and middle distillates. These recommendations include procedures to be followed and operating conditions to be maintained by contractors, workers and engineers preparing, inspecting, testing and lining the interiors of existing underground storage tanks. Requirements for vapor-freeing tanks, removing sediment and cleaning interior surfaces of steel and fiberglass tanks as well as guidelines to identify tanks that are suitable for lining, are also included. All work associated with the interior lining and periodic inspection of underground storage tanks shall be accomplished in accordance with applicable federal, state, and local regulations, including applicable environmental and safety requirements.

1.2 APPLICABILITY

The methods described in this standard are applicable to steel and fiberglass-reinforced plastic tanks used for the storage of petroleum-based motor fuels and middle distillates. The procedures are applicable to tanks installed in typical retail service station outlets but may also be used for tanks installed at other types of facilities.

1.3 EPA TECHNICAL STANDARDS

The U.S. Environmental Protection Agency (EPA) issued its Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST) (herein referred to as "Technical Standards") in 1988. These regulations can be found in the *Code of Federal Regulations* at 40 *CFR* Part 280. In addition, legislation and regulations on all aspects of underground storage tank management have been developed by state and local jurisdictions that may have requirements other than those specified in the EPA Technical Standards. Therefore, employers should consult the appropriate government agencies responsible for implementing an approved underground storage tank program within a geographic area of interest, and determine the applicable requirements before any action recommended or suggested by this standard is taken.

The EPA Technical Standards allow this standard to be used as a guide for compliance with EPA's requirements for interior lining and periodic inspection of underground storage tanks. In some respects, the requirements of this standard may be more stringent than the EPA Technical Standards. In addition, this standard is not intended to cover all of the subjects included in the EPA Technical Standards. While substantial effort has been made to ensure that none of this standard's requirements contradict those of the EPA Technical Standards, the API is not undertaking to interpret the EPA Technical Standards and cannot guarantee that the recommendations in this standard are completely in accord with them. Also, the API makes no representation that the requirements of this standard conform with any requirements imposed by state and local agencies.

2 References

2.1 GENERAL

The following government regulations and standards and industry and consensus standards, codes, and publications referenced herein* provide information related to safe entry, vapor freeing, ventilation, cleaning, lining and inspection of underground petroleum storage tanks. While this standard is intended to be consistent with applicable codes and standards in effect at the time of publication, the most recent edition of each regulation, code, standard or publication that is applicable, should be consulted, as appropriate, to assure compliance.

2.2 INDUSTRY AND CONSENSUS CODES, STANDARDS AND PUBLICATIONS

API

RP 651	*Cathodic Protection of Aboveground Storage Tanks*
RP 652	*Lining of Aboveground Petroleum Storage Tank Bottoms*
RP 1604	*Closure of Underground Petroleum Storage Tanks*
RP 1615	*Installation of Underground Petroleum Storage Systems**
RP 1632	*Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems**
RP 2003	*Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents*
Std 2015	*Safe Entry and Cleaning of Petroleum Storage Tanks*
RP 2016	*Entering and Cleaning Petroleum Storage Tanks*
Publ 2027	*Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service*
Publ 2217A	*Guidelines for Work in Inert Confined Spaces in the Petroleum Industry*
Publ 2219	*Safe Operating Guidelines for Vacuum Trucks in Petroleum Service*

RP 2220 *Improving Owner and Contractor Safety Performance**

ACGIH[1]

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices and Documentation (2000)

ANSI[2]

Z117.1 *Safety Requirements for Confined Spaces*

ASTM[3]

D543 *Test Method for Resistance of Plastics to Chemical Reagents*

D790 *Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*

D2583 *Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor*

D2794 *Test Method for Resistance of Organic Coatings on the Effects of Rapid Deformation (Impact)*

D4541 *Test Methods for Pull-Off Strength of Coatings Using Portable Adhesive Testers*

FTPI[4]

T-95-02 *Remanufacturing of Fiberglass Reinforced Plastic (FRP) Underground Storage Tanks*

KWA[5]

Recommended Practice for Inspecting Buried Lined Steel Tanks Using a Video Camera

NACE[6]

RPO 386-97 *Application of a Coating System to Interior Surfaces of Covered Steel Hopper Rail Cars in Plastic, Food, and Chemical Service. Item No. 21033*

RPO 288-94 *Inspection of Linings on Steel and Concrete. Item No. 21039*

RPO 295-95 *Application of a Coating System To Interior Surfaces of new and Used Rail Tank Cars. Item No. 21070*

1/SSPC—SP5 *White Metal Blast Cleaning (RPO 494-2000). Item NO. 21065*

2/SSPC—SP10 *Near White Metal Blast Cleaning (RPO 594-2000). Item No. 21066*

3/SSPC—SP6 *Commercial Blast Cleaning (RPO 694-2000). Item NO. 21067*

NFPA[7]

NFPA 326 *Safeguarding Tanks and Containers*

NFPA 329 *Handling Releases of Flammable and Combustible Liquids and Gases*

NFPA 70 *National Electrical Code*

NFPA 77 *Static Electricity*

SSPC[8]

SP 7 *Brush Off Cleaning* (NACE No. 4)

SP 10 *Near White Metal Blast Cleaning* (NACE No. 2)

UL[9]

Std. 58 *Steel Underground Tanks for Flammable and Combustible Liquids*

Std. 1316 *Glass Fiber Reinforced Underground Storage Tanks for Petroleum Products, Alcohol and Alcohol-blended Mixtures, etc.**

*Note: Although these publications and standards are not referenced within this document, the information provided may be useful when lining underground storage tanks.

2.3 UNITED STATES GOVERNMENT REGULATIONS AND STANDARDS

EPA[10]

EPA Regulations 40 *CFR* Part 280

Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks

OSHA[10]

OSHA 29 *CFR* Part 1910

Subpart L *Hazardous materials*

Subpart I *Personal protective equipment*

Subpart J *General environmental controls*

Subpart Z *Toxic and hazardous substances*

[1]American Conference of Governmental Industrial Hygienists, Building D-5, 6500 Glenway Avenue, Cincinnati, Ohio 45211.

[2]American National Standards Institute, 11 West 42nd Street, New York, New York 10036.

[3]American Society for Testing Materials, 100 Barr Harbor Dr., W. Conshohocken, Pennsylvania 19428.

[4]Fiberglass Tank and Pipe Institute, 11150 S. Wilcrest Dr., Suite 1, Houston, Texas 77099-4343.

[5]Ken Wilcox Associates, 1125 Valley Ridge Dr., Grain Valley, Missouri 64029.

[6]NACE International, (formerly the National Association of Corrosion Engineers),1440 South Creek Drive, P.O. Box 218340, Houston, Texas 77218-8340

[7]National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02269.

[8]Steel Structure Paint Council, 40 24th St., Pittsburgh, Pennsylvania 15222.

[9]Underwriters Laboratories, Inc. 333 Pfingsten Rd, Northbrook, Illinois 60062.

[10]OSHA and EPA Codes of Federal Regulations are available from the U.S. Government Printing Office, Washington, D.C. 20402.

3 Definitions

3.1 GENERAL

The following definitions are applicable to underground tank lining and inspection as described in this standard.

3.2 DEFINITIONS

3.2.1 air supplied respirators: A respirator that provides a supply of safe breathing air from a tank (either a self contained breathing apparatus portable tank or an air line supply tank) or from a source of fresh air (approved breathing air compressor) not subject to potential contamination.

3.2.2 attendant: A qualified employee stationed outside one or more permit required confined spaces who monitors the entrants and who performs all attendant's duties in accordance with the employer's (owner/operator and contractor) permit required confined space program. Attendants may also perform the duties of standby personnel when entrants use respiratory protective equipment.

3.2.3 bonding: The joining of metal parts to form an electrically conductive path that ensures electrical continuity and has the capacity to safely conduct any current likely to be generated. (See alternate definition, "*bond*").

3.2.3.1 bond: The adhesion of the lining to the metal surface of the tank.

3.2.4 clean (cleaning): The removal of all product, vapor, sludge and residue from a tank and washing, rinsing and drying a tank so that no product or residue remains on any tank surfaces (shell, bottom, piping, appurtenances, etc.).

3.2.5 combustible gas indicator: An instrument used to sample the atmosphere to indicate if any flammable (combustible) vapors/gases are present, determine the composition of hydrocarbon gas and air mixtures and indicate the concentration of vapor/gas present in the atmosphere as a percentage of the lower explosive (flammable) limit (LEL).

3.2.6 combustible liquid: A liquid having a closed cup flash point equal to or greater than 100°F (37.8°C).

3.2.7 confined space: Any underground tank that meets *all three* of the following requirements:

- Is large enough and so configured that an employee can bodily enter and perform assigned work, and
- Has limited or restricted means for entry or exit (for example, tanks and vessels, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry or exit) and
- Is not designed for or meant to be continuously occupied by employees.

3.2.7.1 permit-required confined space: A confined space that meets *all three* of the confined space requirements and also has *one or more* of the following four characteristics:

- Contains or has the potential to contain a hazardous atmosphere.
- Contains a material with the potential to engulf an entrant.
- Has an internal configuration such that an entrant could become trapped or asphyxiated by inwardly converging walls or by floors that slope downward, tapering to smaller cross-sections.
- Contains any other recognized serious safety or health hazard.

3.2.7.2 non-permit required confined space: A confined space (a space that meets all three of the confined space characteristics) but has been checked and inspected and its atmosphere has been monitored and it *does not have* (or does not have the potential to have) any of the characteristics required to be classified as a *permit required* confined space.

3.2.8 degassing: The process of collecting, oxidizing or treating vapors and gases expelled from an underground tank so as to prevent or reduce the amount of organic volatile compounds released into the atmosphere during vapor freeing operations.

3.2.9 electrical division classification of hazardous (classified) locations: The division classification system is used to designate locations where fire or explosion hazards may exist due to the potential for the presence of flammable gases, vapors or liquids.

Note: These classifications are identical to those defined by NFPA 70, The National Electric Code.

3.2.9.1 Class I, Division 1: A location wherein any one of the following conditions applies:

- Ignitable concentrations of flammable gases or vapors exist under normal operating conditions.
- Ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage.
- Ignitable concentrations of flammable gases or vapors might be released by breakdown or faulty operation of equipment or processes that might cause electrical equipment to simultaneously fail in such a manner as to become a source of ignition.

3.2.9.2 Group D Location: A division classified location wherein a specific level of protection is required for flammable and combustible liquid vapor or gas that may burn or explode when mixed with air and exposed to a specific ignition source.

3.2.9.3 Group A, B and C Locations: Some petrochemical products require higher levels of protection than

Group D, including, but not limited to, acetylene (Group A), hydrogen (Group B) or ethylene (Group C) (see NFPA 70, Article 500, Hazardous Classified Locations, and NFPA 30, Flammable and Combustible Liquids, for additional information).

3.2.10 electrical zone classification of hazardous (classified) locations: the zone classification system is an alternate system (to division classification) for locations where fire or explosion hazards may exist due to flammable gases, vapors or liquids.

3.2.10.1 Class I, Zone 0 Location: is a location wherein either of the following conditions apply:

- Ignitable concentrations of flammable gases or vapors are present continuously
- Ignitable concentrations of flammable gases or vapors are present for long periods of time.

3.2.10.2 Class I, Zone 1 Location: is a location wherein any of the following conditions apply:

- A location where ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions.
- A location where ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage.
- A location where equipment is operated or processes conducted in such a manner that breakdown or faulty operations could result in a release of ignitable concentrations of flammable gases or vapors and simultaneously cause failure of equipment so as to create a source of ignition.
- A location that is adjacent to a Class I, Zone 0 location from which ignitable concentrations of flammable gases or vapors could be communicated unless such communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

3.2.11 emergency: Any occurrence or event (including, but not limited to, failure of hazard control or monitoring equipment) internal or external to a confined space, that could endanger entrants or negatively impact on the tank lining operation.

3.2.12 employer: An owner, operator, contractor or subcontractor whose respective employees are performing a task or activity described in this standard.

3.2.12.1 owner/operator: The company or person responsible for the facility in which the tank to be lined is located.

3.2.12.2 contractor: A company or person selected and hired by the owner/operator to conduct tank lining operations and activities in accordance with the contract and tank lining agreements. There may be more than one contractor on a job at the same time.

3.2.12.3 sub-contractor: A company or person selected and hired by a contractor to conduct specific tank lining related operations and activities in accordance with sub-contract agreements. There may be more than one sub-contractor on a job at the same time.

3.2.13 empty: A tank that has no (standing) product remaining in the tank and is ready for vapor freeing and cleaning.

3.2.14 entrant: A qualified person who is authorized by the entry supervisor to enter a confined space.

3.2.15 entry: The action by which an entrant passes through an opening into a confined space. Entry includes ensuing work activities in both permit required confined spaces and non-permit confined spaces, and is considered to have occurred as soon as a part of the entrant's body breaks the plane of an opening into the confined space.

3.2.16 entry permit (confined space): The written or printed document provided by the employer (owner/operator or contractor) and issued by an entry supervisor that provides the site, potential hazard and work specific information necessary to control and authorize entry into a permit-required confined space including conditions canceling the permit and requirements for safeguarding or returning the space to service following termination of entry.

3.2.17 entry supervisor: The qualified person (employee, foreman, supervisor, crew chief, etc.) designated by the employer (owner/operator and contractor) to be responsible for determining the requirements and whether or not acceptable entry conditions exist at permit required confined spaces and non-permit required confined spaces, where entry is contemplated. Entry supervisors shall authorize entry, oversee entry operations and terminate entry as required by the permit or conditions. An entry supervisor, who is properly qualified, trained and equipped, may serve as an attendant or as an entrant. The duties of entry supervisor may be passed from one entry supervisor to another entry supervisor, during the course of an entry operation.

3.2.18 explosive (flammable) range: The range of concentrations of flammable vapor-in-air, between the lower explosive (flammable) limit (LEL) and the upper explosive (flammable) limit (UEL) that will propagate flame if ignited.

3.2.18.1 Lower Explosive (flammable) Limit (LEL): The minimum concentration expressed as a volume (percentage) of a vapor-in-air below which propagation of flame does not occur on contact with an ignition source; generally considered to be "too lean to burn".

3.2.18.2 Upper Explosive (flammable) Limit (UEL): The maximum concentration expressed as a volume (percentage) of a vapor-in-air above which propagation of flame does not occur upon contact with an ignition source; generally considered "too rich to burn".

3.2.19 flammable liquid: A liquid having a closed cup flash point below 100°F (37.8°C).

3.2.20 flammable vapor: The gaseous phase of a substance that is a liquid at normal temperature and pressure and is capable of igniting and burning when mixed with air (oxygen) in the proper proportion and subjected to a source of ignition. Under normal ambient temperatures, Class IA and Class IB liquids generate sufficient vapors to create flammable vapor concentrations at all times. Vapors from flammable and combustible liquids are heavier than air.

3.2.21 flammable vapor Indicator: (see combustible gas indicator).

3.2.22 hazardous atmosphere: An atmosphere that has the potential to expose entrants to the risk of death, incapacitation, impairment of ability to self-rescue (escape unaided from a permit required confined space), injury or acute illness from one or more of the following causes:

- Flammable gas, vapor or mist in excess of 10% LEL.
- Airborne combustible dust at a concentration that meets or exceed 80% of its LEL.
- Atmospheric oxygen concentration different from ambient. An oxygen level below 19.5% signifies an oxygen deficiency and a level above 23.5% signifies an excess of oxygen.
- Atmospheric concentration of any substance for which a dose or permissible exposure limit is published in applicable government regulations, Material Safety Data Sheets, standards or other publications or internal documents, and could result in employee exposure in excess of the substance's dose or permissible exposure limit (PEL).
- Any other atmospheric condition immediately dangerous to life or health (IDLH).

3.2.23 hazardous (substance) material: A substance or material that is capable of harming people, other materials, property or the environment. These substances may be liquid, solid or gaseous and toxic, corrosive, flammable, reactive or otherwise hazardous.

3.2.24 hot work: Any work that has the potential to produce enough thermal energy to provide an ignition source in an area where a potential exists for a flammable gas or vapor-in-air atmosphere in the explosive (flammable) range to occur, such as abrasive blast cleaning the inside of a tank.

3.2.25 instruments: The oxygen monitors, combustible gas indicators and toxic substance analyzers (measuring equipment) used to test (or sample) atmospheric conditions and determine, indicate, measure and monitor the amount of oxygen in the atmosphere and presence of hazardous substances, including percentage of flammable gas or vapor-in-air and concentrations of toxic substances.

3.2.26 isolation: The process by which a permit required confined space or non-permit confined space is removed from service (decommissioned) and completely protected against the release of energy or material into the space. Isolation includes, but is not limited to, blanking or blinding; breaking, misalignment of, opening or removing sections of lines or pipes; using a double block and bleed system; lockout or tagout of all sources of energy; locking, sealing and tagging all valves; and blocking and disconnecting all mechanical linkages (see lockout/tagout).

3.2.27 lead free tank: A tank that has been certified by the owner/operator as never having been used to store leaded gasoline, lead additives or products that have contained lead. Alternately, a tank that has been cleaned according to API Std 2015, tested for lead-in-air and found to have an internal atmosphere below the applicable limit for exposure to organic lead. Entry supervisors shall be aware of applicable regulatory requirements for exposure to lead (such as US DOL OSHA 29 *CFR* 1910.1000). At the time of publication of this standard, the OSHA permissible exposure limit was 0.075 milligrams of organic lead per cubic meter (2 micrograms of organic lead per cubic foot.

3.2.28 lining: A coating that adheres and bonds to the interior surface of the shell of an existing underground tank.

3.2.29 lockout/tagout: The condition when electrical and mechanical switches are open in the de-energized position and locked out and/or mechanical linkages are set, tagged and sealed or locked out to preclude the input of product or energy into the permit required confined space, non-permit confined space or non-confined space (see isolation).

3.2.30 Material Safety Data Sheet (MSDS): Written or printed material prepared in accordance with applicable regulations and standards (for example, OSHA 29 *CFR* 1910.1200) concerning hazardous chemicals. MSDSs provide physical properties, safety, fire prevention and protection, personal protection and health data.

3.2.31 may: Is used in this standard to provide information on procedures and practices that are optional (see "*shall*" and "*should*").

3.2.32 middle distillate: A combustible liquid petroleum product (i.e.: kerosine or heating oil).

3.2.33 motor fuel: A flammable liquid petroleum product such as gasoline or a combustible liquid petroleum product such as diesel fuel.

3.2.34 oxygen deficient atmosphere: An atmosphere containing less than 19.5 percent oxygen by volume.

3.2.34.1 oxygen enriched atmosphere: An atmosphere containing more than 23.5 percent oxygen by volume

3.2.35 oxygen monitor: A device capable of detecting, monitoring and measuring the concentration of oxygen in the atmosphere.

3.2.36 Permissible Exposure Limit (PEL): US Department of Labor, OSHA's designated limit of exposure to any airborne contaminant to which an employee may be subjected. The PEL may be expressed as an 8-hour time-weighted average, a ceiling value, a short-term exposure limit or a skin exposure designation.

3.2.37 permit program: The employer's (owner/operator or contractor) overall program for controlling and regulating safe (cold) work, hot work and entry into permit required confined spaces, to protect entrants from permit required confined space hazards and, where appropriate, to control employees access to and entry into permit required confined spaces.

3.2.38 permit system: The employer's (owner/operator or contractor) written procedure for preparing and issuing permits for entry, hot work and cold (safe) work. The employer's (owner/operator and contractor) written procedure for preparing and issuing permits for entry into permit required confined spaces shall include the safety and health related requirements for issuance of the permit, conditions for canceling or suspending the permit and requirements for safeguarding or returning the space to service following termination of entry.

3.2.39 product: The liquid petroleum hydrocarbon or other material stored in tanks.

3.2.39.1 recoverable product: Usable product removed from the tank and returned to storage.

3.2.39.2 non-recoverable product: Non-usable product removed from the tank that needs further treatment in order to be usable product or requires disposal.

3.2.40 qualified person: A person designated by an employer (owner/operator and contractor) as having the necessary training, education and competence to perform assigned tank cleaning and entry related tasks or activities in accordance with the employer's (owner/operator and contractor) policy, procedures, and programs.

3.2.41 rescuers: The personnel designated to rescue entrants from the permit required confined space.

3.2.42 residue: Undesirable (potentially flammable, toxic and/or hazardous) material (including but not limited to, rust, dirt, scale, paint scrapings, pyrophoric iron sulfide deposits, etc.), removed from the inside of tanks during the cleaning process (see Sludge).

3.2.43 retrieval system: The equipment (including retrieval lines, chest or full body harness, wristlets and lifting devices or anchors) used for non-entry rescue of persons from permit required confined spaces.

3.2.44 safe (cold) work: Any work that does not have the potential to create a source of ignition.

3.2.45 shall: Is used to designate requirements presented in this standard that are mandatory.

3.2.46 should: is used to designate procedures or practices in this standard that are recommended.

3.2.47 sludge (tank bottoms): Undesirable materials that accumulate in the bottom of underground tanks and are removed for disposal, usually consisting of heavy petroleum products or a mixture of hydrocarbons, residue and water, that may be flammable, hazardous and/or toxic (see Residue).

3.2.48 standby person: A qualified person assigned to control and oversee supplied air operations.

3.2.49 tank tightness test: The procedure(s) used to insure the absence of air pockets, leaks or pin holes in the tank lining and to determine the presence of any holidays in the lining.

3.2.50 testing: The process by which the potential hazards that may be encountered when entering a permit required confined space, a non-permit required confined space or a non-confined space are identified and evaluated. Testing includes specifying the type of testing to be performed, the instrument(s) to be used for testing, the classification of the space and the permissible limits for safe entry into the space.

3.2.51 Threshold Limit Value (TLV): The maximum airborne concentration of hazardous substances to which, it is believed, nearly all workers may be repeatedly exposed day after day without adverse effects, as determined by the appropriate regulatory agencies and employer (owner/operator and contractor) policies, including, but not limited to, exposure limits developed by the responsible committees of the American Conference of Governmental Industrial Hygienists.

3.2.52 toxic materials (substances): Any material or substance whose properties are such that they can cause injury to a biological system, depending on exposure concentration, time of exposure and means of exposure.

3.2.53 vapor freeing: The removal of flammable or toxic vapors from a tank by displacement or the reduction of the percentage of vapors in the tank to a safe level by dilution with fresh air.

3.2.54 ventilation: Providing fresh air inside a tank to maintain an atmosphere within acceptable permit limits and provide the required number of air changes per hour. Ventila-

tion occurs after flammable vapors, toxic vapors and gases, dusts, fumes or mists have been displaced or diluted by vapor and gas freeing (degassing).

3.2.55 work (operations): Any work performed on tanks in accordance with this standard.

3.2.56 worker: A qualified person working in or around a tank during tank cleaning, ventilating, preparation and lining operations. A worker, working inside a tank, may or may not be an entrant depending on the classification of the tank.

3.3 USE OF OTHER UNITS (CONVERSION)

If a value for a measurement given in this standard is followed by an equivalent value in other units, the first value shall be the required value and the equivalent value shall be considered to be approximate.

4 Objectives, Requirements and Specifications

4.1 OBJECTIVES

The objectives of this standard covering underground storage tank interior lining and inspection, are as follows:

a. To ensure compatibility between the products to be stored and the proposed storage tank lining material.

b. To protect the interior surfaces of steel and fiberglass tanks.

c. To upgrade and extend the life of a tank whose tank shell has been evaluated and determined to be structurally sound, by meeting the guidelines in this standard for preparing the interior of the tank prior to application of the lining.

d. To assure proper tank lining application, inspection and installation and continued lining integrity and serviceability, by meeting the guidelines of this standard.

Note: Underground tanks that have been opened, lined, inspected and tested according to this standard, shall be upgraded, where required, to meet any additional requirements of EPA and applicable local or state laws and regulations.

4.2 PERMIT AND TRAINING REQUIREMENTS

4.2.1 Contractors shall be approved by tank owners and by local authorities, where required. Contractors shall obtain all applicable permits before any work begins.

4.2.2 Contractors shall certify to owners that their workers and subcontractors (responsible for tank cleaning, vapor freeing, entry, abrasive blasting and tank lining, testing and inspection work) have been trained and are qualified in the following:

a. The hazards, personal protection, handling and disposal requirements of products, residue and deposits, including those containing benzene, tetraethyl lead and lead by-products and any other potentially hazardous materials.

b. The safe procedures and use of instruments, tools and equipment and personal protective equipment required for testing, inspecting, cleaning, vapor freeing and ventilating underground petroleum storage tanks.

c. All applicable regulatory, contractor and tank owner safety and personal protection requirements for entering and working in confined spaces.

d. The potential hazards and requirements for the safe application, installation, handling and inspection of the tank lining materials and the lining processes.

4.2.3 Contractors shall certify that their employees and subcontractors are familiar with the codes, standards, regulations and publications listed in the reference Section 2 of this standard.

4.2.4 All appropriate safe work procedures and practices and equipment necessary to comply with the applicable safety rules and regulations shall be used.

4.3 TANK LINING SPECIFICATIONS

4.3.1 Tank Lining Materials

Materials used for the interior lining of underground tanks may be epoxy-based resins, glass fiber/epoxy resins, isophathalic vinyl ester resins or other acceptable tank lining materials.

CAUTION: Some tank lining materials are not acceptable due to their incompatibility with petroleum products or product additives. Acceptable tank lining materials shall satisfy the requirements of Section 4 of this standard and those of the lining material manufacturer.

4.3.2 Tank Lining System Adhesion

While the tank is in its designated service, the lining (when correctly applied to a properly prepared steel or fiberglass reinforced plastic tank surface in accordance with the requirements of Section 6 of this standard), shall maintain its bond to the tank for the length of time the tank remains in service.

4.3.3 Coefficient of Thermal Expansion

The coefficient of thermal expansion of the tank shell and lining shall be compatible to ensure that temperature changes will not cause inordinate stresses.

4.3.4 Immersion Tests

4.3.4.1 Representative lining material samples shall be tested to determine their compatibility with potential stored products. Samples shall be immersed in the liquids listed below either for periods of 1-, 3-, and 6-month periods at 100°F (38°C) or for periods of 1-, 3-, 6-, and 12-month peri-

ods at 74°F (23°C). It should be noted that these tests are only an approximation of field conditions. Care should be taken in evaluating the results.

The following liquids shall be used:

a. ASTM Reference Fuel C.
b. Unleaded gasoline with and without 15% by volume methyl-tertiary-butyl-ether (MTBE).
c. Leaded gasoline (limited availability).
d. No. 2 fuel oil or diesel fuel.
e. Toluene.
f. Xylene.
g. Gasoline/alcohol blended fuels (such as 90% gasoline and 10% ethanol; 15% gasoline and 85% ethanol; or 90% gasoline and 10% methanol with appropriate co-solvent) that may be stored in the tank.
h. Distilled water.

Note: A warranty certifying chemical compatibility shall be provided to the owner by the tank lining manufacturer before storage of liquids other than those listed is permitted.

4.3.4.2 Upon completion of each immersion period, testing of the samples shall verify (in accordance with the following standards) that the tank lining has not substantially deteriorated:

a. ASTM D790 (flexural strength).
b. ASTM D2794 (impact resistance).
c. ASTM D2583 with Barber Coleman GYZJ 935-1 (Barcol hardness).
d. ASTM D543 Procedure 1 (film integrity).
e. ASTM D4541 (bonding strength).

4.3.4.3 The physical properties of the tested samples after their final immersion period in toluene, xylene and distilled water shall be no less than 30% of their original physical properties before immersion, with a stable trend that indicates little or no further long-term deterioration. The physical properties of the tested samples after their final immersion period in all other listed materials shall be no less than 50% of their original physical properties before immersion.

5 Preparation for Opening the Tank

5.1 SAFETY PRECAUTIONS

5.1.1 Contractors shall establish and supervisors shall implement the programs, practices and procedures required by API Std 2015, RP 2016, Publ 2217A; EPA 40 *CFR* Part 280; OSHA 29 *CFR* 1910.146; and NFPA 326 for tank cleaning, entry and lining.

5.1.2 Supervisors shall assure that tank lining operations are performed safely in accordance with the contractor's programs, applicable regulations, standards and requirements for tank cleaning, vapor freeing and ventilation, confined space entry and any hot work.

5.1.3 A minimum of two portable A:B:C type fire extinguishers each having a rating of at least 80 B:C shall be provided by the contractor at the tank site. Contractor employees shall be trained or educated in the use of extinguishers for incipient fire fighting.

5.1.4 The contractor shall assure that a means of communication is available in the event that emergency response if required and that employees know who and where to call.

5.2 SOURCES OF IGNITION

5.2.1 Supervisors shall not permit work to commence if the wind direction might cause vapors expelled from the tank to be carried into areas where there are sources of ignition or where a potential may exist for hazardous conditions, such as toxic exposures.

5.2.2 Supervisors shall assure that all sources of ignition are either controlled or removed from the area surrounding the tank and tank vents whenever the potential exists for flammable vapors to be expelled into the atmosphere during tank preparation and lining application.

5.2.2.1 All open flame and spark-producing equipment within the vapor hazard area (50 ft around the tank) shall be shut down.

5.2.2.2 Electrical equipment used in the area shall be explosion proof (Class I, Division I, Group D or Zone 1) as specified by NFPA 70 and shall be inspected by a qualified person and approved by the contractor for use in potentially hazardous environments. Ground fault interrupters shall be provided for portable electric equipment.

5.2.2.3 Contractors shall take precautions to prevent or control the accumulation and discharge of static electricity. Before lining fiberglass tanks, contractors should check tank grounding (earthing) capacity by determining the structure to soil electrical potential. See API RP 651 for cathodic protection information.

5.2.3 Supervisors shall assign a qualified person to use approved, properly calibrated and adjusted indicator equipment to test for hazardous flammable vapors around and downwind from the tank during the period that vapor freeing is conducted. The oxygen content needs to be determined before taking gas vapor reading or said latter reading may be inaccurate. See 29 *CFR* Part 280 discussions.

5.3 TANK ISOLATION

5.3.1 Before any work on the exterior surface or appurtenances of a tank begins, the tank shall be inspected by a qualified person and a determination shall be made as to how it is to be isolated from the remainder of the underground storage and dispensing system.

5.3.2 If the tank is equipped with a manifold vent, fill line or siphon assembly, the supervisor shall assure that appropriate measures are taken to isolate the tank. The vent for the tank being lined shall be isolated from vents of other tanks that may still be in service.

Note: This may require a providing a temporary separate vent for the tank being lined).

5.3.3 Supervisors shall assure compliance with the contractor's or owner's lockout/tagout program (and OSHA 29 *CFR* Part 1910.147) to ensure that no equipment is inadvertently energized during cleaning, vapor freeing, ventilation and tank lining operations. The supervisor shall assure that all electrical switches supplying electrical current to submerged pumps and other electrical equipment connected to the tank being lined are disconnected, locked, and tagged in accordance with the applicable lockout/tagout program.

5.4 REMOVAL OF LIQUID PRODUCT

5.4.1 Before vapor freeing commences, as much product, water, and sediment as possible, shall be removed from the tank using (preferably) air-driven pumps or (alternately) approved explosion proof electrical pumps. A small quantity of water may be pumped into the tank to float the product to a level where it can be pumped from the tank. Where possible, fill (drop) tubes should be removed to allow for maximum removal of all liquid and to provide additional ventilation.

5.4.2 Supervisors shall assure that pump motors and suction hoses are both grounded (earthed) and bonded to the tank to prevent electrostatic ignition hazards as specified in API RP 2003, Std 2015, RP 2016 and Publ 2219.

5.4.3 Contractors shall assure that usable product, waste product, sludge, residue, water and deposits removed from the tank are handled, stored, transported, and disposed of according to applicable regulations and employer requirements.

5.5 REMOVAL OF FLAMMABLE VAPORS (VAPOR-FREEING) AND VENTILATION

5.5.1 After the tank is emptied of all product, it shall be vapor freed and ventilated with fresh air to remove flammable vapors from the tank's interior atmosphere and from any residue remaining inside the tank that is capable of emitting flammable vapors. Contractors shall establish procedures, as specified in API RP 2003, Std 2015, RP 2016; NFPA 326 and NFPA 77, to be implemented by supervisors to safely vapor free and ventilate the tank. State and/or local air quality regulatory agencies may have additional requirements.

5.5.2 Supervisors shall assure that appropriate precautions are taken to control and prevent all ignition sources, such as the discharge of static electricity and internal combustion engines, during vapor-freeing and ventilation operations. All employees shall be aware that the concentration of flammable vapors in the tank's atmosphere will initially be above the upper explosive limit. As vapor freeing progresses, the vapor-in-air mixture in the tank will enter and pass through the explosive range before sufficient vapors are removed and a safe atmosphere is attained.

5.5.3 Contractors shall review API Std 2015 and RP 2016; OSHA 29 *CFR* 1910.146; and NFPA 326, and develop and implement appropriate procedures for safely vapor freeing and ventilating underground tanks. Tank vapor freeing and ventilation shall be accomplished by one of the following methods:

5.5.3.1 An eductor-type air mover (see Figure 1), preferably driven by compressed air, may be used to vapor-free and ventilate a tank. The supervisor shall assure that the compressor and eductor are grounded (earthed) and properly bonded to the tank to prevent generation and discharge of static electricity. When this method is used, the eductor draws the vapors from the bottom of the tank. The fill (drop) tubes shall remain in place, allowing fresh air to be drawn into the tank in order to ensure ventilation of the tank bottom. Tanks equipped with non-removable fill (drop) tubes should be vapor freed and ventilated by this method.

5.5.3.2 An approved air driven, diffused-air blower (see Figure 2) may alternately be used to vapor free and ventilate a tank. When this method is used, the supervisor shall assure that the air blower, compressor and air-diffusing pipe are grounded and properly bonded to the tank to prevent generation and discharge of static electricity. The fill (drop) tubes shall be removed to allow proper diffusion of the air in the tank. The air shall be supplied from a compressor that has been checked by a qualified person to ensure that it provides a clean air supply that is free from toxic and volatile vapors. The supervisor shall assure that the air pressure in the tank does not exceed a maximum of 5 psig (34.47 kPa) [or 3 psig (20.68 kPa) for 12 ft. (3.66 m) diameter tanks].

5.5.4 When blowing air into a tank, supervisors shall assure that precautions are taken to assure that the tank is not over-pressurized. The air pressure inside the tank shall not exceed 5 psig (34.47 kPa) [or 3 psig (20.68 kPa) for 12 ft (3.66 m) diameter tanks]. When air is educted from a tank, supervisors shall assure that a vacuum is not created, thereby collapsing the tank. The vent line shall be checked by a qualified person to assure it is free from obstructions and traps to prevent excess air pressure or a vacuum in the tank.

5.5.5 Where local jurisdictions permit vapors to be expelled into the air, supervisors shall assure that an extension is used to discharge vapors a minimum of 12 ft (3.66 m) above grade level, into a safe area, down wind from any sources of ignition. Where local jurisdictions restrict discharge of vapors into the atmosphere, degassing, in accordance with the requirements of API Std 2015 and RP 2016, shall be implemented. The contractor shall obtain all applicable permits prior to starting vapor freeing operations.

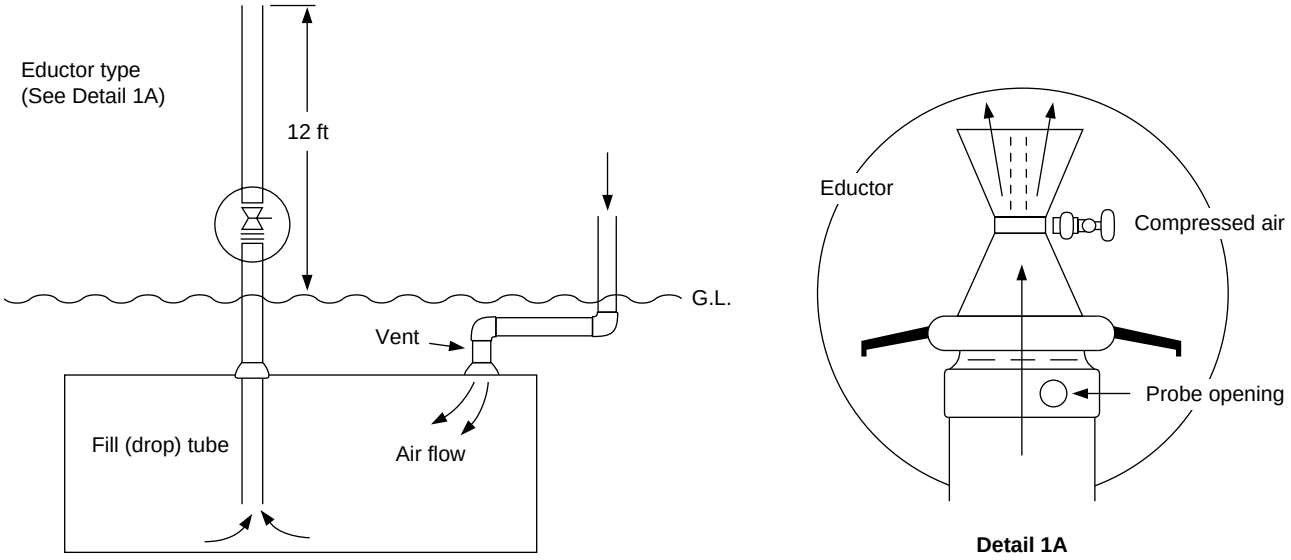

Figure 1—Eductor-Type Air Mover

5.6 TESTING FLAMMABLE VAPOR CONCENTRATIONS

5.6.1 An important preparatory step prior to entry into a tank (or into the excavation around the tank), is testing for flammable vapor-in-air concentrations in the excavated area and inside the tank. The supervisor shall assure that testing is conducted by a qualified person using an approved combustible gas indicator that is properly adjusted and calibrated using the appropriate calibration gas recommended by the instrument manufacturer (for the product/vapor to be tested). The instrument shall be thoroughly checked and maintained by a qualified person in accordance with the manufacturer's instructions and OSHA 29 *CFR* 1910.146, EPA 40 *CFR* Part 280, Appendix B, API Std 2015 and API RP 2016.

5.6.2 During tank vapor freeing and ventilation, the tank's atmosphere shall be tested with the combustible gas indicator to determine the amount of vapor remaining in the tank.

5.6.2.1 If the tank is equipped with a non-removable fill tube, vapor-in-air readings shall be taken through the eductor probe opening (see Figure 1), while the eductor is operating.

5.6.2.2 If the tank is equipped with a removable drop tube, it shall not be removed when testing through the eductor probe hole to assure that the vapors being tested are drawn from the bottom of the tank.

5.6.2.3 When a diffused air blower is used, the vapor-in-air levels shall be tested at the vent riser (see Figure 2). If the fill opening is used for testing, the drop tube shall be removed. When a diffused air blower or eductor is used, the vapors should be initially tested while the air mover is in operation and vapor freeing or ventilation is in progress.

5.6.3 When vapor freeing is nearly completed, supervisors shall assure that the air blower or eductor is shut off before the atmosphere inside the tank is tested for vapors prior to entry. Vapor freeing (ventilation) shall be stopped for approximately 5 minutes to allow the atmosphere within the tank to reach equilibrium. The indicator probe shall be placed into the fill opening with the fill (drop) tube removed. Readings shall be taken at the bottom, middle, and upper portions of the tank, and the instrument shall be cleared in fresh air after each reading. No liquid product should be allowed to enter the combustible gas indicator probe.

Note: The probe hole shown in Figure 1 shall be located where it will provide access to test the vapors being removed from the tank's bottom before the vapors being removed mix with the eductors' compressed air discharge.

5.6.4 The qualified persons responsible for testing shall know the nature and hazards of the vapors being tested, how to use, calibrate and adjust the combustible gas indicator and how to interpret its readings.

5.6.5 Readings of 10% or less of the lower explosive (flammable) limit (10% LEL) inside the tank and at the vent riser shall be obtained before the tank can be safely opened and the supervisor can issue entry permits.

6 Tank Entry

6.1 PROVIDING A TANK OPENING

6.1.1 If there is no manhole on the tank, it is recommended that a manhole of a minimum of 22 in. (55.88 cm) in diameter be installed. Alternately, an opening with the minimum

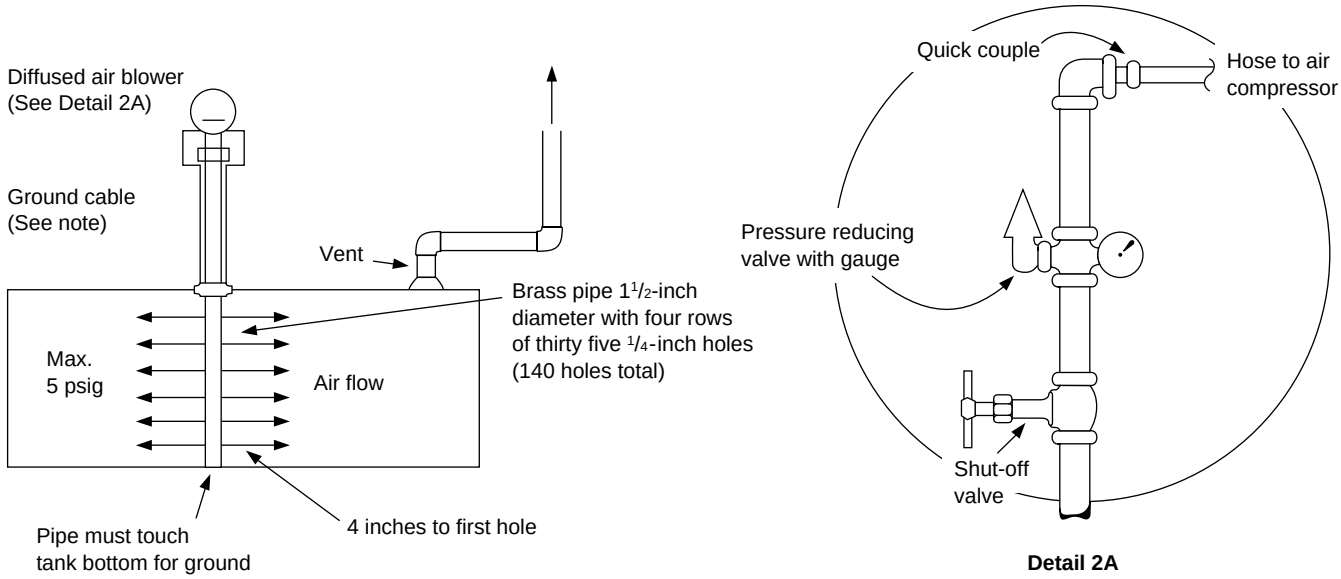

Figure 2—Diffused Air Blower

dimensions of 22 in. × 22 in. (55.88 cm × 55.88 cm) may be cut in the tank top.

6.1.2 Supervisors shall issue a hot work permit and assure that cutting into the tank is accomplished using appropriate, safe work procedures and approved air-driven equipment.

6.1.3 The manhole (section) fabrication seams should be marked with chalk and a small hole drilled with an explosion proof (air or water driven) drill at the edge of the manhole (or at one corner of the section). After the hole has been drilled, a qualified person using the combustible gas indicator shall test the tank's atmosphere in the area of the hole for vapors. The tester shall insert the indicator probe into the drilled hole to verify that the vapor concentration of the atmosphere within the tank does not exceed 10% of the lower explosive (flammable) limit (10% LEL).

CAUTION: During the tank cutting operation, when a diffused air blower is being used, a minimal air pressure of less than 5 psig (34.47 kPa) [or 3 psig (20.68 kPa) for 12 ft (3.66 m) diameter tanks] should be maintained to prevent the tank from rupturing.

6.1.4 The supervisor shall issue a hot work permit and assure that a qualified person, using an approved air or water driven saw or snipper, cuts the tank manhole (section). Lubricating oil or water shall be used during the cutting operation to reduce friction, provide cooling and to prevent sparks. Before the final cut, the plate shall be supported to prevent its falling into the tank.

WARNING: A cutting torch or an abrasive cutting wheel shall not be used for cutting an opening into a tank unless authorized by the employer and a hot work permit is issued by the supervisor. Before permitting use of a torch or wheel, the supervisor shall assure that the inside of the tank has been liquid and vapor freed so that no residue remains within or upon the tank.

6.2 TANK ENTRY PRECAUTIONS

6.2.1 Employers shall be familiar with the requirements and procedures described in API Publ 2217A, Std 2015 and RP 2016; ANSI Z117.1; applicable sections of 29 *CFR* Part 1910; NFPA 326 and NFPA 77 for cleaning, vapor freeing, ventilating and entering tanks. Employers shall establish written confined space entry programs, tank cleaning programs and tank lining procedures and have copies available at the work site. Supervisors shall assure that the requirements of the established programs, procedures and work practices have been implemented before workers enter a tank, to ensure their safety.

6.2.2 After all available product has been removed from the tank and before entry is permitted, initial tank cleaning shall be conducted from the outside of the entry hole, using a petroleum absorbent. Petroleum absorbent should be spread under the entry hole and as far as possible within the tank (through the entry hole) to absorb any liquids remaining on the tank bottom.

CAUTION: Supervisors and workers shall be aware that any extension of the body beyond the opening of the tank is considered to be confined space entry and requires that the supervisor issue an entry permit.

6.2.3 A qualified person shall test the atmosphere within the tank. The atmosphere inside the tank shall meet the established confined space entry criteria for vapors, oxygen and toxic exposures before the entry supervisor issues an entry permit. Entrants (or their representatives) shall have the opportunity to observe the testing.

6.2.4 Upon initial entry, entrants should spread the petroleum absorbent away from the entry area to absorb any remaining liquids in the tank. The petroleum-absorbent sludge and residue mixture shall be removed, handled, stored and disposed of in accordance with established procedures before any other work commences within the tank.

6.2.5 All employers, supervisors and workers shall be familiar with the safety procedures and requirements of the contractor's confined space entry program, tank cleaning program and tank lining procedures.

6.2.5.1 Contractor programs shall meet the requirements of API Publ 2217A, Std 2015 and RP 2016; NFPA 326; OSHA 29 *CFR* Parts 1910.132 through 1910.138, and 1910.146; and EPA 40 *CFR* Part 280.

6.2.5.2 Contractors shall document employee training and knowledge using API 1631—Form A (or similar).

6.2.6 Entry into the tank, using approved, positive pressure air supplied respirators (or self contained breathing apparatus), shall not be permitted unless vapor-in-air levels in the tank's atmosphere are below 10% of the lower explosive (flammable) limit (10% LEL).

6.2.6.1 All entrants shall be equipped with approved positive pressure air-supplied respirators (or self contained breathing apparatus) with full-face enclosure until such time that the tank has been cleaned and vapor freed so that flammable vapors levels are 0% LEL; toxicity levels are at or below established TLVs and the oxygen concentration in the tank's atmosphere is between 19.5% and 23.5% so that entry without supplied air is permissible.

6.2.6.2 All entrants shall wear an approved safety harness connected to a safety line that is securely attached outside of the tank's entry opening. Once the tank has been cleaned and vapor freed so that flammable vapors levels are 0% LEL; toxicity levels are at or below established TLVs and the oxygen concentration in the tank's atmosphere is between 19.5% and 23.5%, entry without safety harnesses is permissible provided alternate means of rescue is available.

6.2.6.3 All entrants shall wear approved personal protective equipment including, but not limited to, oil and water-resistant boots and gloves and non-static or static-dissipating disposable protective clothing, compatible with and impervious to the stored product. Protective clothing shall cover the arms, legs, torsos, and heads of entrants. Entrants conducting tank cleaning and lining operations shall wear grounding devices and static control apparel.

6.2.6.4 Personal clothing and equipment saturated with the stored product shall be removed immediately, air dried away from sources of ignition and thoroughly cleaned before reuse.

6.2.7 Supervisors shall not permit anyone to enter a tank unless an attendant is stationed immediately outside the tank opening and a standby person is assigned to control and monitor the air supply. The attendant shall have available a self contained breathing apparatus, or a respirator that has an air supply different from that used by the entrants. (See API 2217A, Std 2016 and RP 2016; and 29 *CFR* Parts 1910.134 and 1910.146 for additional information concerning respiratory protection.)

6.2.8 The supervisor shall assure that atmospheric monitoring is conducted continuously or periodically inside the tank to be sure that the vapor, oxygen and toxic gas content of the atmosphere within the tank are in the safe range in accordance with the requirements of the entry permit. A written record of said readings and the times actually taken (Military time) shall be maintained on site until project completion and acceptance. Supervisors, entrants and attendants shall be aware that if the tank is perforated, product or vapors that have leaked into the soil may reenter the tank through a perforation. This may cause the vapor-in-air concentration inside the tank to rise above the permitted safe entry level and even reach the explosive range. (See API Publ 2217A, Std 2015, RP 2016; NFPA 326; OSHA 29 *CFR* 1910.146; and 1910.Subpart Z for additional information.)

6.2.9 The vapor freeing, ventilation and testing shall continue throughout the entire lining and inspection operations to ensure that the vapor-in-air levels in the atmosphere within the tank remain below 10% of the lower explosive (flammable) limit (10% LEL). If vapor-in-air levels should rise above 10% LEL at any time during tank cleaning, preparation, lining or inspection, entrants shall immediately exit the tank and the source of the vapors shall be determined and controlled. Ventilation shall continue and the entry permit shall not be reissued until the vapor-in-air levels have fallen below 10% LEL and all other entry conditions have been satisfied.

6.2.10 Supervisors shall assure that continuous ventilation is provided during entry and the vent line remains clear and unobstructed to allow continuous ventilation. All other lines and openings (except the manhole or entry and the blower or eductor openings) shall be plugged or capped off to ensure that no liquids or vapors enter the tank during the lining operation. Any time work on the tank interior is suspended for more than 5 minutes, including forced air ventilation, no tank re-entry should be permitted until vapor freeing and safe atmosphere readings inside the tank are re-established.

6.2.11 Supervisors shall assure that only approved lighting, including, but not limited to, low voltage, portable lights, explosion-proof flashlights or explosion-proof lighting that meets the requirements of NFPA 70 (Class I, Division I, Group D or Zone 1) is used inside the tank during tank cleaning, preparation and lining operations.

6.2.12 The employer (contractor) shall develop and implement an emergency response and rescue program that provides for emergency response and rescue service in accordance with the requirements of API Std 2015 and OSHA 29 *CFR* 1910.146.

6.3 POTENTIAL TOXICITY AND HEALTH HAZARDS

6.3.1 General Precautions

6.3.1.1 Employers shall assure that supervisors, entrants, attendants, standby persons, rescuers and workers are aware of the following general health precautions:

a. Avoid skin and eye contact with petroleum substances, sludge, residue and deposits and avoid breathing of vapors.
b. Keep petroleum liquids, sludge, residue and deposits away from eyes, skin, and mouth as these can be harmful or fatal if inhaled, absorbed through the skin, or ingested.
c. Keep work areas inside and around tanks, clean and well ventilated.
d. Clean up spills promptly and handle and dispose of product, sludge, residue, deposits and cleaning and lining materials in accordance with applicable government and employer safety, health, and environmental regulations and procedures.
e. Use soap and water, or approved waterless hand cleaner, to remove any petroleum product, sludge, residue or deposits that are in contact with skin. Do not use gasoline or similar solvents to remove oil and grease from skin.
f. Petroleum soaked or contaminated clothing and personal protective equipment shall be air dried, away from sources of ignition, and then promptly washed. Avoid using petroleum-soaked or contaminated leather goods. Properly dispose of rags and cleaning materials.
g. Observe established personal exposure limits and use proper protective clothing and equipment.

6.3.1.2 Supervisors, entrants, attendants and workers shall be aware that when high concentrations of petroleum hydrocarbon vapors are inhaled, symptoms of intoxication may result. These symptoms, ranging from simple dizziness to excitement or unconsciousness, are similar to those produced by alcohol or anesthetic gases. If such effects occur, the affected individual shall be immediately moved to fresh air. For minor effects of exposure, breathing fresh air or oxygen results in rapid recovery. If breathing has stopped, artificial respiration shall be applied promptly, and medical attention shall be immediately obtained in accordance with the employers emergency response procedures.

6.3.2 Hazardous and Toxic Substance Information

Employers shall obtain information concerning safety and health risks and proper precautions with respect to controlling exposures to particular products, substances, materials and conditions from the owner/operator, the manufacturer or the supplier's material safety data sheet or similar sources. Hazardous and toxic substance information may also be available from government agencies. This information shall be made available on-site to tank lining supervisors, workers, and regulatory officials.

6.3.3 Permissible Exposure Limits

For permissible exposure limits (PELs), employers shall consult the most recent edition of the Occupational Safety and Health Standards, 29 *CFR*, Part 1910, Subpart Z, "Toxic and Hazardous Substances." Employers shall also consult the most recent edition of ACGIH's Threshold Limit Values and Exposure Indices and the specific substance MSDS for the product contained in the tank and for the materials used for cleaning, adhesion and lining.

6.3.4 Precautions with Respect to Particular Materials

All employers, supervisors and workers shall be aware of the potential hazards of exposure to common hazardous and toxic substances that may typically be found in underground petroleum storage tanks, including, but not limited to, the following:

6.3.4.1 Benzene

Benzene is a component of gasoline. Adverse health effects can result from exposure to benzene through contact with the skin, breathing vapors or swallowing. There may be long-term (chronic) health effects of varying severity from repeated, short-term exposure to benzene. Occupational exposure to benzene has been associated with various human blood disorders, including an increased risk of leukemia. Very high levels of benzene have also been known to affect the central nervous system. Indications of systemic effect may include confusion and dizziness, tightening of leg muscles and pressure over the forehead progressing to a stage of excitement. Significant overexposure can result in coma and death.

WARNING: Benzene is a known human carcinogen. Tests have shown that prolonged or repeated exposure to some petroleum substances in liquid or vapor form may cause serious illness, including cancer, in laboratory animals. Although the significance of these test results to human health is not fully understood, exposure to petroleum substances should be minimized.

6.3.4.2 Tetraethyl Lead

Tetraethyl lead is found in tanks that contain (or have contained) leaded gasoline. Traces of tetraethyl lead will be found in sludge, residue, deposits and rust on the inside of tanks that were formerly in leaded gasoline service and have never been cleaned, vapor freed, thoroughly dried and ventilated and tested to be lead-free. Exposure to tetraethyl lead can cause diseases of the central and peripheral nervous systems, the kidney, and the blood. Skin absorption and breathing organic lead compound are major routes of entry into the body. Indications of overexposure may include insomnia, restlessness, anxiety, nausea and vomiting, loss of appetite, and symptoms of mental disturbance (seizure, delirium, mania, or coma). Biological monitoring is essential for personnel safety.

WARNING: Tetraethyl lead is a toxic material. See API Std 2015, RP 2016; and OSHA 29 *CFR* Part 1910.1000, Subpart Z and Table Z-1, for additional information.

6.3.4.3 Lining Materials and Epoxy Compounds

The most commonly encountered toxic effects associated with the use of lining materials and epoxy compounds are dermatitis (resulting from irritation or sensitization), eye irritation and pulmonary irritation. Systemic effects in humans are uncommon.

WARNING: Some epoxy compounds have produced tumors in laboratory animals, generally by dermal application.

7 Preparation of the Tank Interior

7.1 SLUDGE REMOVAL

Supervisors shall assure that sludge, residue and deposits accumulated inside the tank are removed using hand tools or approved air driven equipment and placed in tightly sealed, approved containers for disposal. All equipment and compressors shall be bonded to the tank. After the sludge, residue and deposits have been removed, a petroleum adsorbent should be spread on the entire tank bottom to remove all traces of liquids. Supervisors shall assure that sludge, residue, deposits and spent adsorbent material are handled safely and disposed of in accordance with local, state, and federal regulations, which may require mandatory testing and documentation as well as safe disposal.

7.2 POTENTIAL TOXIC EXPOSURES

7.2.1 Sludge, Residue, Deposits and Scale

Tank sludge, residue, deposits and scale are potentially hazardous because they may contain tetraethyl lead or benzene that can be inhaled or absorbed through the skin. If deposits and scale are removed from the internal surface of the tank by abrasive blasting or scraping, the tank's atmosphere may contain harmful quantities of tetraethyl lead and benzene. A qualified person shall test and analyze the tank's atmosphere during these operations and the supervisor shall assure that appropriate personal protective and precautionary safety measures are established and implemented.

7.2.2 Epoxy Compounds

Epoxy compounds that are constituents of tank lining materials may also be hazardous to personnel working with them. Supervisors and workers shall be aware of the potential hazards associated with handling and applying tank lining materials and assure that appropriate personal protection and safety precautions are taken. Workers shall handle and apply tank lining materials in accordance with the manufacturer's requirements and the appropriate MSDS information.

Note: See Section 6 for specific toxicity information and precautions.

7.3 TANK INSPECTION

7.3.1 General

7.3.1.1 Supervisors shall issue entry permits for tank inspections. Employers shall assure that all personnel involved in tank inspection are qualified, trained as entrants and familiar with the requirements and potential hazards associated with confined space entry into underground storage tanks.

7.3.1.2 Before permitting entry into a tank for inspection, the atmosphere within the tank shall be checked by a qualified person using an approved, properly adjusted and calibrated, combustible gas indicator, to ensure that vapor, oxygen and toxic substance levels are satisfactory for entry.

7.3.1.3 Ventilation shall be continued and the atmosphere shall be tested, continuously or at appropriate times, as required, whenever entrants are inside the tank.

7.3.2 Lighting Equipment

Supervisors shall assure that the entire interior surface of the tank is thoroughly examined using approved lighting, including, but not limited to, low voltage, portable lights, explosion-proof flashlights or explosion-proof lighting that meets the requirements of NFPA 70 (Class I, Division I, Group D or Zone 1).

7.3.3 Steel Tanks

7.3.3.1 For steel tanks, the inspection shall identify those areas where corrosion has taken place and metal thickness has been reduced to $^1/_8$ in. (0.32 cm) or less. Corrosion may take the form of uniform metal loss (general deterioration of a surface area) or may leave a pitted appearance (irregular sur-

face deterioration). Uniform corrosion may be difficult to detect and may require the use of nondestructive techniques, in addition to the destructive methods described below, to ensure metal thickness of at least 1/8 in. (0.32 cm).

7.3.3.2 Pitted surface thickness may be difficult to detect when there is a question about the original metal thickness. As a result, thickness determinations in non-pitted areas are also necessary to establish an original thickness benchmark for comparison with the pitted areas. Metal thickness determinations may be made by either destructive or nondestructive methods. Nondestructive metal thickness determinations may be made by ultrasonic or radiographic testing methods.

7.3.3.3 A destructive test method involves the use of a brass ball-peen hammer to tap the entire tank shell (a minimum of one tap in every 1 ft^2 (0.093 m^2) area and sound for thin areas. If a thin area is detected, the metal should be holed with the hammer or a drill to determine the metal thickness. The thin metal shall be removed until a minimum metal thickness of 1/8 in. (0.32 cm) at the edge of the hole is obtained. This method is often used to inspect underground tanks because corrosion typically takes the form of pitting rather than deterioration over a surface area.

Note: It may be preferable to conduct wire brushing or abrasive grit blasting (see SSPC SP 7 and SP 10) of the internal surface of the tank prior to inspection.

7.3.3.4 The following guidelines shall be used to identify a steel tank that is suitable for lining:

a. A tank with a perforation no larger than 1 1/2 in. (3.81 cm) in diameter, except under the gauging opening where the perforation may be no larger than 2 1/2 in. (6.35 cm) in diameter.
b. A tank with less than 5 perforations [none larger than 1/2 in. (1.27 cm) diameter] in a 1 ft^2 (0.093 m^2) area.
c. A tank with less than 20 perforations [none larger than 1/2 in. (1.27 cm) in diameter] in a 500 ft^2 (46.45 m^2) area.

7.3.3.5 Steel tanks that exceed any of the guidelines in this section shall not be interior lined unless approved by the tank owner and the authority that has jurisdiction. To determine adherence to these guidelines, perforations shall be brass ball peen hammered (before and after abrasive blasting) to remove any thin metal and to obtain structurally sound edges. Perforations shall be reamed until the metal thickness at the edges of the holes is a minimum of 1/8 in. (0.32 cm.). Steel tanks meeting the criteria set forth in 7.3.2 shall be prepared as described in 7.4.1.

7.3.4 Fiberglass Tanks

Fiberglass tanks, like steel tanks, can also be internally lined. Before lining, fiberglass tanks shall be checked visually for damage, signs of structural failure, chemical attack of the shell or internal lining, cracks, holes, shell wall buckling or flattening, excessive deformation of original tank diameters, and leakage around seams where the shells are joined. The tank manufacturer or a qualified person shall be consulted for appropriate inspection, testing, and lining procedures for fiberglass tanks. (See FPTI T95-02, *Standard for Fiberglass Tank Repair Criteria*.)

7.3.5 Tank Closure

If a steel tank does not meet these requirements as being suitable for lining, it shall be removed from service and closed in place (or physically removed from the site). If a fiberglass tank does not meet these requirements as being suitable for lining, it shall be repaired and/or reinforced using designs approved by a qualified engineer, or it shall be removed from service and closed in place or physically removed from the site. For detailed procedures for closure of underground storage tanks, see API RP 1604, *Closure of Underground Petroleum Storage Tank*s.

7.4 SURFACE PREPARATION

7.4.1 General

7.4.1.1 Employers shall assure that all personnel involved in interior tank surface preparation are familiar with the potential confined space hazards and recommended confined space entry and safe work practices described in API Std 2015 and RP 2016, as well as NFPA 326 and OSHA 29 *CFR* 1910.146.

7.4.1.2 Before permitting entry into a tank to start abrasive blasting, the atmosphere within the tank shall be checked by a qualified person using an approved, properly adjusted and calibrated, combustible gas indicator, to ensure that vapor, oxygen and toxic substance levels are satisfactory for entry.

7.4.1.3 Ventilation shall be continued and the atmosphere shall be tested, continuously or at appropriate times, as required, whenever entrants are inside the tank.

7.4.2 Steel Tanks

7.4.2.1 Employers shall assure that all personnel involved in surface abrasive blasting are familiar with the potential hazards associated with abrasive blasting of the interior of storage tanks (see API Publ 2027). All perforations in the tank shall be plugged with boiler plugs or hydraulic cement prior to abrasive blasting.

7.4.2.2 Abrasive grit-blasting operations shall not be conducted on surfaces that are wet after cleaning or wet before application of lining material. Also, abrasive grit blasting operations shall not be conducted when the surface is less than 5°F (–15°C) above dew point or when the relative humidity of the ambient air is greater than 85%, unless special equipment is used to control the atmospheric conditions within the tank. It may be preferable to conduct a preliminary

wire brush (see SSPC SP 7) of the internal surface for inspection purposes before starting abrasive blasting operations.

7.4.2.3 Abrasive blast operators shall wear approved helmets with positive pressure, air supplied respirators, that are connected to approved sources of clean air. The blasting nozzle shall be bonded to the work surface and grounded to provide protection from static charges.

7.4.2.4 The entire internal tank surface shall be abrasive grit blasted until it is completely free of scale, rust, and foreign matter. As a minimum, a near white metal blast is required to prepare the shell surface for lining (see SSPC SP 10). The lining material shall be applied within 8 hours of shell surface preparation (see manufacturer's specifications). Alternately, a seal coat shall be applied within 8 hours or other approved means shall be used to control humidity and prevent rust. Contractors shall remove the seal coat or rust proofing before installing the lining unless there is assurance that such coating will not negatively affect the adhesion of the lining to the tank shell.

7.4.2.5 When the abrasive blasting operation has been completed, the surface shall be brushed with a clean hair-, bristle-, or fiber-brush; blown with compressed air; and vacuumed. Separators and traps shall be used to remove oil and water from compressed air.

7.4.2.6 Boiler plugs and hydraulic cement plugs shall be covered with a laminate using material compatible with the stored product that shall overlap all sides of the plug by at least 6 in. (15.24 cm). If perforations are present in a seam, the perforations shall be sealed with hydraulic cement and then covered with fiberglass cloth and resin that shall overlap the perforation by 6 in. (15.24 cm).

7.4.3 Fiberglass Tanks

The surface of a fiberglass tank shall be roughened by surface abrasion to expose the glass fibers to provide a proper bond before the lining is applied. The manufacturer or a qualified person shall be consulted for appropriate surface preparation procedures. All repairs shall be made according to FTPI T-95-02.

8 Application of Lining

8.1 ENTRY AND SAFE WORK REQUIREMENTS

8.1.1 Personnel safety, protective equipment and clothing shall comply with the requirements of this standard, employer policy and applicable regulations.

8.1.2 The contractor shall complete and provide a copy of API 1631—Form A to the owner attesting that all supervisors, entrants, testers, attendants and standby persons are trained and familiar with the contractor's confined space program and the OSHA regulations covering confined space entry.

8.1.3 Entry permits shall be issued for application of the lining inside the tank. A qualified person shall test the atmosphere inside the tank for flammable vapors, oxygen content and hazardous or toxic substances prior to entry and continuously or at appropriate times during work, to assure entrant safety. Entrants shall be allowed the opportunity to monitor the initial testing prior to entry. (See API Std 2015 for confined space entry requirements.)

8.1.4 Contractors shall provide or arrange for rescue service in accordance with OSHA requirements.

8.2 LINING REQUIREMENTS

8.2.1 Only those lining materials meeting the both specifications in this standard and the requirements of the owner shall be used. The manufacturer's instructions on the handling and mixing of resin compounds shall be followed.

8.2.2 Following the manufacturer's specified method of application, the approved lining compounds shall be applied to the entire interior surface of the tank by the manufacturer or the designated applicator or installer.

8.2.3 The lining shall be applied within the recommended application temperature and humidity. If a heater is used to accelerate the curing process, a hot work permit shall be issued and all other work that might release flammable vapors in the work area shall be halted. The heating unit shall be attended whenever it is in operation.

8.2.4 The lining shall be applied to the designated thickness. The lining system dry film thickness shall be a minimum thickness of 100 mils with a nominal thickness of 125 mils in order to provide a solid structural barrier that can bridge any holes that may develop in the outer steel tank shell due to external corrosion.

8.3 STEEL TANKS

8.3.1 After the application of lining material, $^1/_4$ in. (0.64 cm) steel reinforcing plates that have been rolled to the contour of the tank and whose dimensions are at least 8 in. × 8 in. (20.32 cm × 20.32 cm), shall be installed under the fill (drop) tube, gauging tube and any other usable opening in the tank. These plates shall be attached to the lining using fiberglass mat and resin according to FTPI T-95-02 or the lining manufacturer's striker plate installation specifications.

8.3.2 The blast-cleaned tank surface shall be lined, seal coated or another approved means used to control humidity or prevent rust, within 8 hours after the abrasive blasting was conducted and before any visible rusting occurs.

8.4 FIBERGLASS TANKS

8.4.1 Lining materials and their application shall be in accordance with the lining manufacturer's specifications or tank manufacturer's specifications (see FTPI T-95-02).

8.4.2 After the application of lining material, reinforcing plates shall be installed under the fill (drop) tubes, gauging tubes, and any other usable opening in the tank. A striker plate shall be attached to liner using fiberglass mat and resin according to FTPI T-95-02 or manufacturer's specifications.

Note: Any structural problem areas in the fiberglass shall be repaired and/or stabilized prior to lining using repair designs approved by a qualified engineer.

8.5 LINING TESTING

8.5.1 The tank lining shall be cured thoroughly to the manufacturer's specifications and checked by a qualified person with a Holiday detector to ensure the absence of air pockets, leaks and pinholes in the lining. (If the lining system cannot be holiday tested, it shall be tested according to manufacturers' specifications to ensure system integrity.) Any defects that are found shall be repaired by the contractor to the manufacturer's specifications.

8.5.2 The contractor shall protect the coated surfaces from foreign matter contamination. The thickness of the tank lining shall be checked with a magnetic, non-destructive lining thickness gauge or other acceptable instrument with a minimum accuracy of plus or minus 10%. The lining shall be tested for hardness with a hardness tester to ensure compliance with the manufacturer's specifications for product storage.

8.5.3 Any failures shall be corrected in accordance with the manufacturer's specifications and retested to assure test requirements of this section are satisfied. Final test results shall be obtained for either single or double wall tanks using inert gas on air pressure of 3–5 psig with a soapy solution or other appropriate test method to insure a leak free tank. Backfill and yard repair should not commence until the modified tank is verified 'tight'. The contractor shall provide the owner with certification of the tank lining testing using API 1631—Form B.

9 Returning Tanks to Service

9.1 STEEL TANKS

9.1.1 Tank Openings

If a single layer lining is used, the tank opening cover plate shall be sealed or a permanent manhole shall be installed. (Note: Manholes may be required for other than single layer linings) If a permanent manhole is installed, it shall be installed to meet to UL 58 requirements. If an opening has been cut into a tank, the tank opening cover plate shall be sealed using one of the methods described below.

9.1.2 Tank Cover Plates

A steel cover plate of approved thickness, rolled to the contour of the tank shall be prefabricated and the bolt holes shall be punched in the cover during the prefabrication. The cover shall be made to overlap the hole in the tank by at least 2 in. (5.1 cm) on each side. For example, if the hole that was cut is 22 in. × 22 in. (56 cm × 56 cm), the cover plate shall measure at least 24 in. × 24 in. (61 cm × 61 cm).

Note: In certain instances, it may be appropriate to use a $^{3}/_{16}$ in. (0.48 cm) steel cover plate if the plate is abrasive grit blasted and coated on both sides. In addition, there may be instances where it is appropriate to use a heavier gauge cover plate. (To confirm the appropriate gauge based on the gauge, diameter, and length of the existing tank, see Underwriters Laboratories' Standard UL 58.)

Either one of the following methods can be used to seal the cover plate:

9.1.2.1 The first method is as follows:

a. Hold the cover in place over the tank opening, mark the location of the pre-punched bolt holes, and drill $^{3}/_{4}$ in. (1.91 cm) diameter holes through the tank wall. The holes should be neither more than 5 in. (12.70 cm) center-to-center nor more than 1 in. (2.54 cm) from the edge of the cover.
b. Abrasive grit blast the cover plate (as described in 7.4) to near white metal on both sides, and coat the entire inside and exterior surface with approved tank lining material (as described in 8.2).
c. After the tank lining has cured, grind a 4 in. (10.16 cm) edge around the inside cover and apply a fast-setting epoxy to act as a gasket. Before the epoxy on the cover has cured, fasten the cover to the tank using $^{1}/_{2}$ in. (1.27 cm) [minimum] diameter bolts. The bolt shafts are to be placed through the holes from the inside of the tank and held in place by spring clips and then fastened with locking washers and nuts as illustrated in Figure 3.
d. The underside of the cover plate surface shall be tested in the same manner as the internal tank lining (see 8.5).

9.1.2.2 The second method is as follows:

a. Hold the cover in place over the tank opening, mark the location of the pre-punched bolt holes, and drill $^{5}/_{16}$ in. (0.79 cm) diameter holes through the cover and tank wall. The holes should be neither more than 5 in. (12.70 cm) center-to-center nor more than 1 in. (2.54 cm) from the edge of the cover.
b. Abrasive grit blast the cover plate (as described in 7.4) to near white metal on both sides and coat the entire inside and exterior surface with approved tank lining material (as described in 8.2).
c. The underside of cover plate surface shall be tested in the same manner as the internal tank lining (see 8.5). After the tank lining has cured, grind a 4 in. (10.16 cm) edge around the inside cover and apply a fast-setting epoxy to act as a

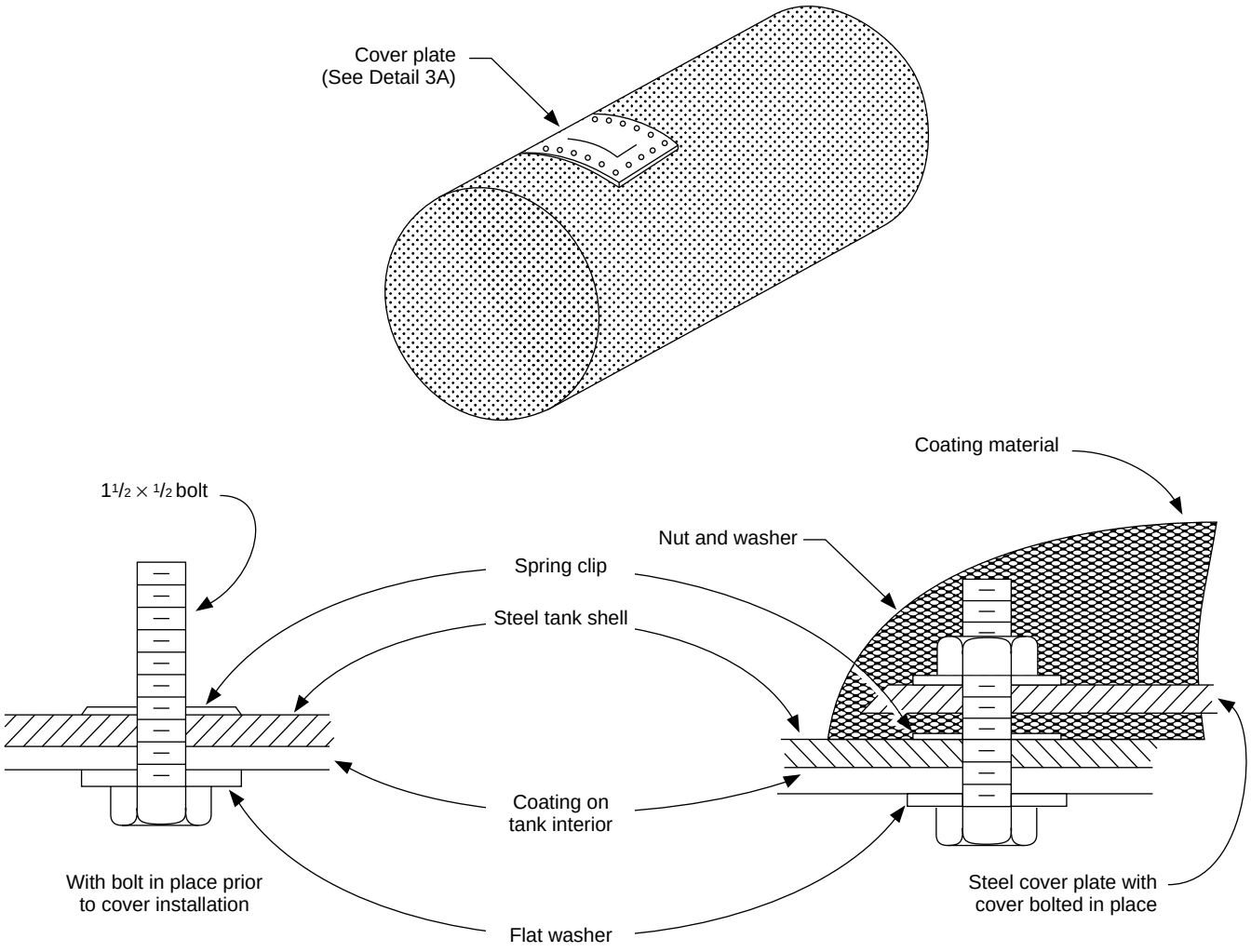

Figure 3—Method for Installation of Tank Cover Plate

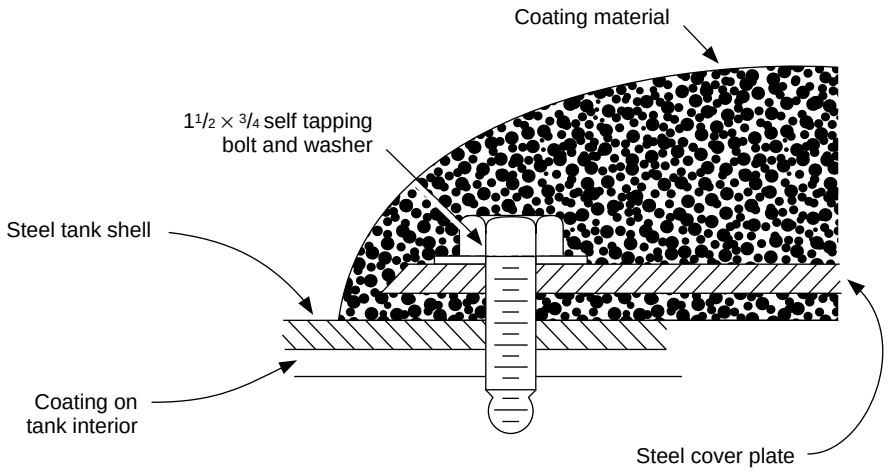

Figure 4—Alternate Cover Plate Installation Detail

gasket. Before the epoxy on the cover has cured, fasten the cover to the tank using 3/8 in. (0.95 cm) [minimum] diameter self-tapping bolts as illustrated in Figure 4.

9.1.3 After the cover has been bolted to the tank, the cover plate and surrounding tank surface should be touched up with tank lining material in accordance with manufacturer's specifications and the tank lining should be allowed to cure before the tank is air tested and back-filled.

9.1.4 The cover plate seal shall be tested for tightness prior to covering the backfill and paving. This can be accomplished by performing an air pressure test of the tank at 5 psig (34.47 kPa) [or 3 psig (20.68 kPa) for 12 ft (3.66 m) diameter tanks] and by applying a soap solution to the cover and inspecting for bubbles.

Note: An air pressure test shall be performed only if the tank does not contain petroleum product liquid or vapors). Otherwise, pressure must be applied using an inert medium such as nitrogen or carbon dioxide gas.

9.2 FIBERGLASS TANKS

After work has been completed, the entry hole shall be plugged by replacing the tank wall section that was previously removed (see 5.1) or by closing the manhole. The tank manufacturer or a qualified person shall be consulted for appropriate procedures for closing and sealing the entry hole. A recommended alternative is to add a permanent manhole according to the manufacturer's specifications.

9.3 TANK TIGHTNESS TESTING

9.3.1 Before the tank excavation is back filled, the tank shall be tightness tested in accordance with 40 *CFR* 280.43(c), EPA's Technical Standards for Owners and Operators of Underground Storage Tanks.

9.3.2 If required, air tightness testing of the piping may be conducted from the inside of the tank before closing.

10 Periodic Inspections of Previously Lined Steel Tanks

10.1 GENERAL

10.1.1 Purpose

Inspections of interior linings of steel tanks shall be conducted periodically after installation to assure the linings are performing according to manufacturer's specifications, to determine if lined tanks are still structurally sound and to determine if structurally sound, lined steel tanks are suitable for upgrading by the installation of cathodic protection or may be returned to service without upgrading.

10.1.2 Regulatory Requirements

EPA *CFR* Part 280, 21 (b) (1) (ii) requires that lined tanks without cathodic protection be internally inspected to ensure that the lined tank is structurally sound and that the lining is still performing according to original design specifications. Inspections shall be conducted within 10 years after installing the lining and every 5 years thereafter. When combining interior lining with cathodic protection at the same time, in accordance with EPA 40 *CFR* Part 280.21 (b) (3), no future tank inspections are required. If a cathodic protection system is installed on a tank that has been previously lined, and inspected thereby ensuring that the tank has been determined to be structurally sound and free of corrosion holes, no further inspections are required.

10.1.3 Inspection Certification

The qualified person (and contractor) performing the required tank inspection and re-inspection(s) shall complete API 1631—Form C and provide a copy to the tank owner who shall maintain the certificate on file as evidence of the periodic lining inspection.

10.2 TANK PREPARATION

10.2.1 The contractor performing the inspection shall certify to the tank owner that the contractor's employees are aware of the potential hazards to be expected and are trained and knowledgeable in permit required confined space entry and safe work procedures. The contractor shall provide a completed copy of API 1631—Form A to the tank owner.

10.2.2 Tank cleaning personnel shall obtain any required permits and follow all procedures, precautions and requirements noted in this standard and API Std 2015 covering tank cleaning, testing, preparation and closure. The contractor, tester and inspection personnel shall follow all confined space entry, safe work and hot work requirements.

10.2.3 For visual inspection requiring entry into tank, after the tank has been emptied the interior shall be vapor freed, cleaned and ventilated, as required. The atmosphere shall then be tested to assure satisfactory conditions before issuing an entry permit to conduct inspection and testing.

10.2.4 For non-invasive inspections using video equipment, after the tank has been emptied it shall be purged using an approved inert gas, such as carbon dioxide or nitrogen. The tank shall be continuously or periodically tested for vapor-in-air and oxygen to assure that a safe atmosphere is maintained during the inspection. Workers shall be aware of the hazards of working with inert gas and shall take appropriate precautionary measures.

10.3 VIDEO INSPECTIONS OF TANK LININGS

10.3.1 Video inspections of internal tank linings shall be conducted by a qualified person using an approved intrinsically safe, internal video camera.

Note: If the video inspector breaks the plane of the manhole with any part of the body, it is considered to be physical entry into the tank and therefore requires an entry permit and adherence with all confined space entry requirements of this standard.

10.3.2 Before video inspecting the tank, a tank tightness test in accordance with EPA 40 *CFR* 280.43 (c) shall be performed. If the tank fails the tightness test, video inspection is not permitted.

10.3.3 When using the video camera inspection method, contractors shall follow KWA *Recommended Practice for Inspecting Buried Lined Steel Tanks Using a Video Camera*. A qualified person shall systematically record the visual inspection of all internal tank surfaces.

10.3.4 The lining shall be sufficiently free of product, sludge, residue or other materials that would impede visual inspection and at least 98% of the lining shall be visible for inspection.

10.3.5 When inspecting using a video camera, the atmosphere outside the tank around the video and support equipment shall be continuously or periodically tested to assure that vapor-in-air levels remain at 0% LEL. Should vapor-in-air levels rise above 0% LEL, all equipment and sources of ignition shall be shut down until the source of vapors is eliminated or controlled and vapor-in-air levels are at 0% LEL. Oxygen levels inside the tank shall be maintained at or below 5% in order for video inspection to be permitted.

10.3.6 Prior to beginning video inspection activity, the supervisor shall assure that the tank has been emptied and isolated and shall issue a safe work permit for purging the tank.

10.3.7 All video and support equipment shall be grounded and bonded to the tank.

10.3.8 A qualified person (i.e., a NACE Certified Corrosion Specialist or Professional Engineer) shall evaluate the findings of the inspection to determine if evidence of corrosion or coating deterioration is evident and if, so, if a complete examination is required.

10.4 PHYSICAL INSPECTIONS—TANK LINING REQUIREMENTS

10.4.1 If video inspection is not permitted or available, or if the tank fails to pass the video inspection, internal tank lining inspections shall be conducted by a qualified person who physically enters the tank.

10.4.2 Physical entry shall require an entry permit and adherence with all confined space entry requirements of this standard. Atmospheric monitoring shall be conducted to assure the atmosphere both inside and around the tank is safe for operations.

10.4.3 Upon entering the tank for a physical internal inspection, a qualified person shall visually inspect the lining for evidence of peeling, blistering, wrinkled surface or surface roughening of the lining material. The inspector shall also look for pitting, rusting, physical damage, water leakage, cracks, streaking, discoloration or other signs of structural instability.

10.4.4 The lining shall be tested according to 8.5 of this standard to ensure that it continues to meet the manufacturer's specifications for thickness and hardness and passes the holiday test.

10.4.5 If a lined tank fails the lining inspection, repairs are required provided state and local regulations do not prohibit repairs to linings. Any deficiencies shall be repaired according to the manufacturer's specifications. The repaired lining shall meet the requirement of Section 8 of this standard.

10.4.6 If a lined tank fails the inspection and is not repaired, it shall be closed in accordance with the requirements of API RP 1604.

10.5 PHYSICAL INSPECTION—TANK METAL THICKNESS REQUIREMENTS

10.5.1 Following the physical inspection of the tank lining, the tank metal thickness shall be physically determined as specified in this standard. The original tank metal thickness shall be obtained from the tank manufacturer or established in accordance with the requirements of UL Standard 58, Section 3.6 and Table 3.1.

10.5.2 The internal tank cylinder wall shall be divided in 3 foot square (9 ft^2) sections. Tank ends (heads) shall be divided into four equal quadrants and each quadrant then divided into 3 foot square (9 ft^2) sections. Any remaining areas less than 3 ft × 3 ft in size shall be considered to be additional sections.

10.5.3 Thickness gauging measurements shall be taken at the center of each tank wall and tank end (head) section. Thickness readings greater than 75% of the original tank metal thickness shall be recorded on API 1631—Form A as the measurement for each specific section.

10.5.4 Any sections with thickness readings of 75% or less of the original metal thickness shall be subdivided into 9 subsections and require additional gauging at the center of subsection. These readings shall be recorded on API 1631—Form B. If the average of the 9 measurements is less than

75% of the original tank metal thickness, that section may be strengthened in accordance with this standard.

10.5.5 The average tank metal thickness and the average thickness of a designated thin wall area, shall be at least 75% of the original thickness in order to pass inspection.

10.5.6 The contractor performing the inspection shall provide the thickness gauging reports and a copy of API 1631—Form C to the tank owner. These reports (or the information contained therein) shall be maintained on file by the tank owner and the person performing the tests for the life of the tank.

10.6 TANK CLOSURE OR UPGRADING

10.6.1 Tanks that do not meet the wall thickness requirements shall be closed in accordance with applicable local, state and federal regulations and company procedures.

10.6.2 If the average tank metal thickness is determined to be between 75% and 85% of the original metal thickness, a cathodic protection system shall be installed within 6 months of the inspection. No further internal inspections are required following installations of a cathodic protection system. Cathodic protection is not required when the average tank metal thickness is greater than 85%.

API 1631—FORM A
CONTRACTOR'S EMPLOYEE CONFINED SPACE ENTRY & SAFETY TRAINING CERTIFICATION

TO: OWNER OF UNDERGROUND STORAGE TANK DESIGNATED BELOW:

Name/Address of Work Location _____

City_____State_____Zip_____E-Mail _____

Person Authorizing Work_____Telephone _____

Tank Identification & Location_____Tank Size _____

Work to be Performed _____

_____

Contractor Name_____Telephone_____

Address_____City_____State_____Zip _____

Sub-Contractor Name_____Telephone: _____

Contractor Supervisor at Work Location_____

Qualified persons (Employee's name and job assignment) assigned to work at the location

_____

_____

_____

This certifies that the above named supervisor(s) and assigned workers are qualified persons designated by the contractor listed above as trained, educated and capable of anticipating, recognizing and evaluating actual and potential exposure to hazardous substances and unsafe conditions in a permit required or non-permit required confined space. The assigned workers are knowledgeable of the Material Data Safety Sheet disclosures covering all applicable products stored in the tank and materials that may be used performing the work described. The assigned supervisor(s) are capable of specifying necessary controls, personal protective equipment, safe work procedures and protective measures to ensure safety.

I do hereby swear and attest that the above supervisors and assigned personnel have been trained and educated, are familiar with OSHA requirements for working in a confined space and are knowledgeable of all the safety procedures and requirements contained in API Standard 1631. We/I, the employer, are maintaining written records of training, including confined space entry, safety drills and rescue operations; instrument calibration and testing; and equipment inspection and maintenance. The records are available for review by the State Implementing Agency or Tank Owner, upon request.

SWORN TO AND SIGNED THIS _____DAY OF _____ 200 _____

Contractor Officer/Owner _____Title _____

Witness/Notary _____Date _____

API 1631—FORM B (SIDE 1)
INSPECTION AFFIDAVIT

UNDERGROUND STORAGE TANK OWNER_____

TANK LOCATED AT _____

TANK NUMBER OR IDENTIFICATION _____

TANK CLEANING, REPAIR, LINING, TESTING AND INSPECTION AFFIDAVIT

I, _____, the undersigned, hereby swear and attest that all work performed on the above designated tank was in accordance with API Standard 1631 as follows:

1. The tank met the structural qualifications and repair criteria (if repaired) of EPA and API Standard 1631.

2. The entire interior of the tank was blast cleaned to a near-white metal finish in accordance with the requirements of API Standard 1631 and 90 psi minimum air pressure was maintained at the blast nozzle and compressor during abrasive blasting.

3. The lining was holiday tested and determined to be free of holidays in accordance with the requirements of API Standard 1631.

4. The Barcol hardness of the tank lining met the lining manufacturer's Barcol hardness specifications and testing was performed in accordance with the requirements of API Standard 1631.

5. The final lining had a nominal thickness of 125 mils and a minimum thickness of no less than 100 mils as determined in accordance with the requirements of API Standard 1631.

UNDER APPLICABLE U.S. FEDERAL LAW, IT IS THE RESPONSIBILITY OF THE OWNER OF THE UNDERGROUND STORAGE TANK TO DETERMINE THAT THE TANK MEETS ALL REQUIREMENTS FOR VALID UPGRADE. THE TANK OWNER IS THEREFORE RELYING UPON THE UNDERSIGNED CONTRACTOR TO PERFORM THE INSPECTION AND WORK PROPERLY AND COMPLETELY. THE CONTRACTOR AND THE QUALIFIED OR CERTIFIED PERSON PERFORMING THE WORK SHALL SIGN THIS AFFIDAVIT ATTESTING COMPLETENESS AND COMPLIANCE.

SWORN TO AND SIGNED THIS _____DAY OF _____ 200 _____

Certified or Qualified Person _____ Cert. No. _____

Contractor Officer/Owner _____Title _____

Witness/Notary _____Date_____

API 1631—FORM B (SIDE 2)
INSPECTION AFFIDAVIT

UNDERGROUND STORAGE TANK OWNER ____

TANK LOCATED AT ____

TIGHTNESS TEST CERTIFICATION

I, ____________________ (inspector or qualified person) hereby swear and attest that I performed a tightness test in accordance with API Standard 1631 on the above designated tank and certify that:

(1) The tank was "tight" and in compliance with EPA 40 *CFR* 280.33 (d) (1) and

(2) The tank passed the precision tightness test.

Signed ____________________ and dated ____________________200 ____

- -

MATERIAL AND PERFORMANCE CERTIFICATION

I, ____________________ (inspector or qualified person) hereby swear and attest that the following specified materials and quantities of materials were used in performing the work on the above designated tank.

Lining Material Manufacturer ____

Address:____________________City____________________State__________Zip __________

Lining Material Name ____________________ Amount used ______________gals.

Type or name of grit____________________Grit size ______________Amount used ______________ lbs.

Signed ____________________ and dated ____________________200 ____

- -

TANK OWNER'S VERIFICATION

By signing below, the tank owner or owner's designated agent attests and verifies that this Affidavit has been completed with all required signatures and acknowledges receipt of this affidavit. Owner may send a copy of this Affidavit to the lining material manufacturer for authentication and shall maintain the original signed Affidavit as part of the owner's permanent tank records.

Note: Under applicable state, local and U.S. federal laws and regulations it is the tank owner's responsibility to determine that the tank meets the requirements for valid upgrade and to maintain records that demonstrate that the tank is in compliance with regulatory and API Standard 1631 requirements.

Signed by Owner or Authorized Agent ____

Date ____________________200____

API 1631—FORM C
TANK RE-INSPECTION AFFIDAVIT

UNDERGROUND STORAGE TANK OWNER_____

TANK LOCATED AT _____

TANK NUMBER OR INDENTIFICATION_____

DATE TANK LINED_____DATE OF LAST INSPECTION _____
(Re-inspect tanks without cathodic protection within 10 years of initial lining and every 5 years thereafter)

- -

TIGHTNESS TEST CERTIFICATION Inspection Date _____200 ___

I, _____ (inspector or qualified person) hereby swear and attest that I performed a precision test in accordance with API Standard 1631 on the above designated tank and certify that:

(1) The tank was "tight" and in compliance with EPA 40 *CFR* 280.33 (d) (1) and
(2) The tank passed the precision tightness test.

- -

TANK RE-INSPECTION AFFIDAVIT Re-Inspection Date_____200 ___

I, _____, the undersigned, hereby swear and attest that I am trained and qualified in accordance with the requirements of API Standard 1631 and local jurisdictions to perform the re-inspection of the above designated tank. The entire interior of the tank was video inspected ( ) or physically inspected ( ) in accordance with the requirements of API Standard 1631, as follows:

1. The tank has been found to be structurally sound. There was no evidence of pitting, rusting, physical damage, water leakage, cracks, streaking, discoloration or other signs of structural instability of the tank or lining.

2. At least 98% of the lining was visible for inspection.

3. The lining is still performing according to original design specifications. There was no evidence of lining peeling, blistering, wrinkled surface or surface roughening.

4. A physical inspection of the tank lining was conducted. The lining was holiday tested and determined to be free of holidays in accordance with the requirements of API Standard 1631.The Barcol hardness of the tank lining met the lining manufacturer's Barcol hardness specifications and testing was performed in accordance with the requirements of API Standard 1631.

5. A physical inspection of the tank was conducted and the metal thickness was determined to meet the requirements of API 1631.

Note: Tanks that fail the lining inspection shall either be repaired (if not prohibited by state and local regulations) or closed in accordance with the requirements of API Standard 1631.

SWORN TO AND SIGNED THIS _____DAY OF _____ 200 ____

Contractor _____

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