Ignition Hazards and Safe Work Practices for Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service

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FOREWORD

API Recommended Practice 2027, *Ignition Hazards and Safe Work Practices for Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service*, was prepared under the auspices of the API Safety and Fire Protection Subcommittee. It is intended for use by API member companies and others to develop safe practices and procedures for the abrasive blasting of the exteriors of aboveground atmospheric petroleum storage tanks that contain liquid hydrocarbons. A number of additional API standards, recommended practices and other publications, noted in the reference section, provide supplemental information applicable to the requirements and components of this recommended practice.

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Suggested revisions are invited and should be submitted to the standardization manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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1 General

1.1 SCOPE

This recommended practice provides safe work practices for the prevention and control of ignition and other potential hazards during abrasive blasting of aboveground storage tanks in liquid hydrocarbon service at atmospheric pressure. It is generally recognized in the petroleum industry that the preferable method is to empty, vapor free and clean aboveground petroleum storage tanks before starting abrasive blasting work. However, this may not be practical or even possible, and may actually increase the risk of an undesirable hazard or incident in some situations. It is therefore necessary to understand the potential ignition and safety hazards when planning abrasive blasting and implement the appropriate safeguards before starting this work.

This recommended practice does not cover all of the precautions that may be required to safely perform abrasive blasting. Owners/operators and contractors shall conduct a thorough hazard analysis and pre-job start-up safety and health review for each specific abrasive blasting job to assure that all necessary precautions and safeguards have been identified and implemented prior to beginning work.

1.2 APPLICABILITY

This recommended practice applies to safe work practices required for abrasive blasting of exterior shells and exterior roofs of all aboveground atmospheric storage tanks in liquid hydrocarbon service. It also applies to safe work practices for abrasive blasting conducted on the roofs and inner portions of the exposed surfaces of shells (that portion of the shell above the roof level) on open-top (external) floating roof tanks.

- Vacuum vessels and tanks under vacuum.
- Process vessels.
- Underground storage tanks.
- Storage tanks containing heated hydrocarbons. (Note: If the tank heating system is isolated and the temperature of the hydrocarbon in the tank is at or near ambient temperature, then the tank shall not be considered to contain heated products and is covered by this recommended practice).

Although this recommended practice does not specifically cover these tanks and vessels, many of the abrasive blasting recommendations and safe practices included herein would be applicable to these operations. Employers (owners/operators and contractors) shall develop and implement specific procedures for abrasive blasting on tanks and vessels not covered by this recommended practice.

1.5 OTHER HAZARDS AND APPLICATIONS NOT COVERED

This recommended practice does not cover specific physical, health or environmental hazards that are associated with abrasive blasting of aboveground storage tanks. It does not cover the hazards associated with the use of and exposure to abrasive grit and the dust, rust, scale, paint, and other material removed by abrasive blasting. This recommended practice does not provide any information for classification of tanks and tank roofs as confined spaces and entry into confined spaces, although such entry may be required for abrasive blasting on top of the floating roofs and interior shells of floating roof tanks.

This recommended practice does not and cannot cover every possible unique hazard or situation that may arise during abrasive blasting on aboveground, atmospheric storage

1.3 IGNITION SOURCES

This recommended practice also covers recognition and control of ignition hazards that are specific to and which may be present during abrasive blasting of aboveground storage tanks in liquid hydrocarbon service at atmospheric pressure. The ignition sources covered in this recommended practice include static electricity, internal combustion engines, electric motors, friction sparks, hot metal surfaces and external (to the work) ignition sources.

1.4 NON-APPLICABILITY

This recommended practice does not apply to the abrasive blasting of the following types of tanks or vessels:

- Pressure vessels and high and low pressure tanks.
- Cryogenic or refrigerated vessels or tanks.

recommended practice is intended to be consistent with applicable codes and standards in effect at the time of publication, the most recent edition of each code, standard or publication that is applicable, should be consulted, as appropriate, to assure compliance.

API[1]

Std 653	*Tank Inspection, Repair, Alteration and Reconstruction*
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 2026	*Safe Access/Egress Involving Floating Roofs of Storage Tanks in Petroleum Service*
Publ 2207	*Preparing Tank Bottoms for Hot Work*
Publ 2216	*Ignition Risk of Hydrocarbon Vapors by Hot Surfaces in Open Air*
RP 2220	*Improving Owner and Contractor Safety Performance*

NFPA[2]

—	*NFPA Fire Protection Handbook*
NFPA 30	*Flammable and Combustible Liquids Code*
NFPA 77	*Static Electricity*
NFPA 326	*Safeguarding of Tanks and Containers for Entry, Cleaning or Repair*

2.2 US DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION[3]

ing abrasive blasting on aboveground, atmospheric storage tanks in liquid hydrocarbon service. These site specific, product specific and tank specific hazards and situations shall be identified and addressed by employers (owner/operators and contractors), using appropriate principles and considerations provided in this recommended practice and other applicable regulations, codes, standards, recommended practices and publications, when developing and implementing safe abrasive blasting procedures.

2 References

2.1 CODES, STANDARDS, AND RELATED PUBLICATIONS

The following industry standards, codes, and publications referenced herein provide information related to abrasive blasting of aboveground petroleum storage tanks. While this

29 CFR 1910.120	*Hazardous Waste Operations and Emergency Response*
29 CFR 1910.132	*Personal Protective Equipment*
29 CFR 1910.134	*Respiratory Protection*
29 CFR 1910.146	*Permit-Required Confined Spaces*
29 CFR 1910.147	*The Control of Hazardous Energy*
29 CFR 1910.1000	*Subpart Z, Toxic and Hazardous Substances (PELs)*
29 CFR 1910.1200	*Hazard Communication*
29 CFR 1926.62	*Lead Exposure, Construction Industry*

2.3 OTHER PUBLICATIONS

ILO Encyclopedia of Occupational Health and Safety, 2nd Edition, Volume 2, *Sandblasting and Shot Blasting*, B. W. Farrell, D. Forster and D. M. F. English. International Labour Office, CH-1211, Geneva, 22, Switzerland

National Institute for Occupational Safety and Health, Publication 92-102, *Preventing Silicosis and Death from Sandblasting*, NIOSH, 125 Bakers Drive, Morgantown, WV 26505.

3 Definitions

3.1 GENERAL

The following definitions are applicable to abrasive blasting of aboveground petroleum storage tanks as described in this recommended practice.

3.2 DEFINITIONS

3.2.1 abrasive blasting: The removal of rust, deposits and/or residue from tank surfaces by using compressed air or water pressure to apply abrasive particles against the surface.

Although this recommended practice is intended to be consistent with applicable laws and regulations in effect at the time of publication, it is the responsibility of employers to consult the most recent edition of applicable government standards or regulations to assure compliance. The following OSHA Standards provide information related to abrasive blasting of atmospheric petroleum storage tanks in the United States.

29 CFR 1910.94 *Ventilation*

29 CFR 1910.106 *Flammable and Combustible Liquids*

[1]American Petroleum Institute (API), Publications Department, 1220 L Street NW, Washington DC 20005-4070 (www.api.org).
[2]National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269-9101 (www.nfpa.org).
[3]OSHA Standards available from the U.S. Government Printing Office, Washington, DC 20402 (www.osha.gov).

3.2.2 abrasive grit: An approved silica-free and arsenic-free, abrasive blasting material.

3.2.3 bonding: The joining of metal parts to form a low resistance electrically conductive path that ensures electrical continuity and has the capacity to safely conduct any current likely to be generated.

3.2.4 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).

3.2.5 Class I liquid: A hydrocarbon liquid having a closed cup flash point below 100°F (37.8°C). (NFPA flammable liquid.)

Class II liquid: A hydrocarbon liquid having a closed cup flash point equal to or greater than 100°F (37.8°C) and less than 140°F (60°C).

Class III liquid: A hydrocarbon liquid having a closed cup flash point equal to or above 140°F (60°C).

3.2.6 confined space: Any tank or space that *meets all three* of the following requirements is a confined space:

tank that is (1) within 5 feet (1.5 meters) of the rim of the tank; (2) has been tested by a qualified person and found to be vapor, gas and toxic substances free; (3) has unrestricted egress and (4) the criteria for being classified as a non-confined space have been specified in the employer's confined space program).

3.2.7 deposits: See *residue*.

(1) Is large enough and so configured that an employee can bodily enter and perform assigned work, and

(2) 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

(3) Is not designed for or meant to be continuously occupied by employees.

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

(1) Contains or has the potential to contain a hazardous atmosphere.

(2) Contains a material with the potential to engulf an entrant.

(3) 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.

(4) Contains any other recognized serious safety or health hazard.

non-permit required confined space: A non-permit required confined space is a tank (confined space) that meets all three of the confined space characteristics but has been checked, inspected and its atmosphere tested by a qualified person who assures that it *does not have* (or does not have the potential to have) any of the characteristics required for the space to be classified as a *permit required* confined space.

3.2.8 employer: Any owner, operator, contractor or subcontractor whose respective employees are performing a task or activity described in this recommended practice.

3.2.9 empty: A tank that has no (measurable) product remaining in the tank. (Note: An empty tank may still contain a heel or pocket of hydrocarbon liquid or residue that has the potential to produce flammable or toxic vapors).

3.2.10 entry: The action by which an entrant passes through an opening into a confined space or enters upon a floating roof classified as a permit required or non-permit required confined space.

3.2.11 entry permit (confined space): The written or printed document that provides the site information, potential hazards and work specific information necessary to control and authorize entry into a permit-required confined space.

3.2.12 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.

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.

3.2.13 flash point: The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with air. Flash point is a direct measure of a liquid's volatility (vaporization) and flash point temperatures are lowered as atmospheric pressure is reduced.

3.2.14 fixed (cone) roof tank: A tank with a self-supporting external fixed (cone) roof with or without internal support columns.

non-confined space: A tank (space) that does not meet any of the preceding requirements for a confined space and has been classified as a non-confined space following the employer's confined space program requirements. A non-confined space may also be a space that was previously classified as a permit required confined space or a non-permit required confined space and which no longer meets any of the requirements for either a permit required confined space or a non-permit required confined space. Note: An example of a non-confined space would be the roof of an open-top (external) floating roof

3.2.15 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.

3.2.16 flammable vapor indicator: See *combustible gas indicator*.

3.2.17 flash point: The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with the air near the surface of the liquid or within the vessel as determined by the appropriate test procedure (see NFPA 30). (Note: Flash points of hydrocarbon liquids may be found in Material Safety Data Sheets and other product information sources).

3.2.18 floating roof: A cover that floats on the surface of the liquid stored in an atmospheric storage tank and moves up and down as the liquid level changes. A floating roof limits the vapor space to the small area between the liquid level and the lower portion of the roof.

3.2.19 floating roof tank: Any aboveground, vertical atmospheric storage vessel with an internal or external float-

(4) 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.

(5) Any other atmospheric condition immediately dangerous to life or health.

3.2.22 hazardous material: Any material that has the potential to harm people, other materials, property or the environment. These substances may be liquid, solid or gaseous and toxic, corrosive, flammable, reactive or otherwise

ing roof. The types of floating roof tanks are as follows:

open-top (external) floating roof tank: A tank with an uncovered roof that floats on the surface of the liquid contained inside the tank (except when the tank is empty).

covered open-top floating roof tank: An open-top (external) floating roof tank that has been provided or equipped with a permanently attached cover (geodesic dome or similar weather protection) over the top of the tank.

internal floating roof tank: A tank that has a fixed (cone) roof over the top of the tank and an internal floating deck (or cover) that rests on the surface of the liquid inside the tank (except when the tank is empty).

3.2.20 hazard: Any situation or condition that causes harm or adverse effects.

3.2.21 hazardous atmosphere: An atmosphere that has the potential to expose workers to the risk of death, incapacitation, impairment of ability to self-rescue (escape unaided from a permit required confined space), injury or illness from one or more of the following causes (OSHA 29 CFR 1910.146):

(1) Flammable gas, vapor or mist in excess of 10% LEL.

(2) Airborne combustible dust at a concentration that meets or exceeds its LEL. [A condition where dust obscures vision at a distance of 5 feet (1.5 meters) or less].

(3) Atmospheric oxygen concentration different from ambient. An oxygen level below 19.5% signifies an oxygen deficiency and a level above 23.5% hazardous.

3.2.23 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.

3.2.24 hot work permit: The employer's (owner/operator and contractor) written authorization to perform hot work or use equipment (including, but not limited to, abrasive blasting) capable of producing a source of ignition.

3.2.25 instruments: The oxygen monitors, combustible gas indicators and toxic substance analyzers used to test (or sample) atmospheric conditions.

3.2.26 isolation: The process by which the liquid hydrocarbon stored within the tank is protected from movement (such as product receipt into the tank or delivery out of the tank, mixing, circulating, heating, etc.) during abrasive blasting. This may be accomplished by isolation (lockout or tag-out of all product line valves, mechanical and electrical connections, and by blocking, sealing or otherwise protecting relief valves, vents, hatches and other openings to preclude the release of vapors).

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 or a tank that has been cleaned and certified to be lead free. Alternately, a tank that has been cleaned according to ANSI/API Standard 2015, tested for lead-in-air and found to have an internal atmosphere below the applicable limit for exposure to organic lead. In addition, a tank that has never been painted with lead paint or any lead paint has been previously

an oxygen deficiency and a level above 23.5% signifies an excess of oxygen.

completely removed.

3.2.28 material safety data sheet (MSDS): Written or printed material prepared in accordance with applicable regulations and standards. MSDS's provide physical and chemical properties, safety, fire prevention and protection, personal protection, health data, and other information.

3.2.29 may: Is used in this recommended practice to provide information on procedures and practices that are optional and are not required (see *shall* and *should*).

3.2.30 non-confined space: *See confined space.*

3.2.31 owner/operator: The company or person responsible for the facility wherein the storage tank is located.

3.2.32 product: The liquid petroleum (hydrocarbon) stored in a tank. (Note: The term "Product" as used in this recommended practice, does not refer to sour water, asphalt, sulfur, spent acid, or other non-hydrocarbon liquids that may typically be stored in tanks in petroleum processing facilities).

3.2.33 qualified person: A person assigned by the employer (owner/operator and contractor) who is trained,

4 General Requirements and Procedures

4.1 GENERAL REQUIREMENTS

This recommended practice provides requirements and safe practices intended to assist employers (owners/operators and contractors) to develop operating procedures that provide for hazard recognition, safe work and significantly reduce ignition risks during abrasive blasting of hydrocarbon storage tanks in service that may contain or have the potential to develop a flammable atmosphere in the vapor space.

Abrasive blasting is the process wherein small particles of hard abrasive grit are projected by air, water steam or centrifugal force against the metal surface to remove rust, coatings, residue and deposits preparatory to maintenance, painting, coating and repair. Abrasive blasting grit used in tank cleaning may be applied by a number of methods, however the following two methods are most prevalent:

1. Air Blasting—Dry abrasive grit is projected by compressed air.

2. Wet Blasting—Wet abrasive grit is projected by compressed air or abrasive grit (wet or dry) is projected by water pressure.

educated, certified or otherwise qualified (such as by experience) to perform specific tasks.

3.2.34 residue: Undesirable or potentially flammable, toxic and/or hazardous material (such as rust, dirt, scale, paint scrapings, pyrophoric iron sulfide deposits, etc.), on the inside of tanks (see *deposits*).

3.2.35 risk: A measure of the probability and severity of a potential or actual hazard.

3.2.36 safe (cold) work: Any work associated with abrasive blasting that does not have the potential to create a source of ignition.

3.2.37 shall: The term "shall" is used to designate requirements in this recommended practice that are mandatory.

3.2.38 should: The term "should" is used to designate procedures or practices in this recommended practice that are recommended but are not mandatory.

3.2.39 testing: The process, by which actual and potential hazards that may be encountered before and during abrasive blasting are identified, verified and evaluated through actual measurement.

3.2.40 work: Any work performed on tanks in accordance with this recommended practice.

In addition, employers shall be aware of the possibility that dust, resulting from either the material used for abrasive blasting or from the material being removed, could be a potential health hazard or explode under certain conditions, should a source of ignition be present. The potential for a dust explosion to occur depends on the dust particle size, the concentration of the dust in air, the material involved and other factors. Therefore, control of ignition sources when dust is present during abrasive blasting, is an appropriate safety precaution.

4.3 SAFETY, HEALTH AND ENVIRONMENTAL HAZARDS

This recommended practice is limited to providing safe work procedures and practices required to prevent, mitigate and control sources or vapor and ignition hazards during abrasive blasting of atmospheric storage tanks in liquid hydrocarbon service. This recommended practice does not cover requirements for personal safety such as use of scaffolding, protection from flying particles, hearing conservation, confined space classification and requirements for entry onto floating roofs and on top of or into tanks. The recommended practice does not address requirements for personal protective equipment including hoods, gloves, abrasive or fire protective clothing and supplied air respiratory protection. Finally, this recommended practice does not cover requirements for regulatory permits, reports, record keeping or similar activities associated with abrasive blasting.

In addition, this recommended practice does not address health and environmental hazards resulting from abrasive blasting, including those created by the abrasive blasting grit, dust and the materials being removed from the surface of the tank. Employers, however, shall be aware of potential abrasive blasting health hazards. One of these potential hazards is

4.2 POTENTIAL IGNITION HAZARDS

Employers shall be aware that it is generally preferable to conduct abrasive blasting when tanks are out of service and have been cleaned of flammable liquids and vapors. However, because of operating requirements, it is not always feasible, and sometime impossible, to empty, clean and remove tanks from service to conduct abrasive blasting of the exterior of the tank. Indeed, in certain situations, taking the vapor space in a tank through the flammable range for vapor freeing and during refilling can actually be more hazardous than conducting abrasive blasting on the tank while it is in service. Abrasive blast cleaning of the exterior of tanks that are in service can be safely performed provided that hazards are recognized and specific operating practices and precautions are established and implemented to minimize the ignition hazards and control the presence of vapor and dust.

Employers (owners/operators and contractors) shall identify actual and potential ignition hazards and potential sources of flammable vapors as the first step in developing safe abrasive blasting operating procedures. When conducting abrasive blasting, employers shall determine potential sources of hydrocarbon vapors and ignition and establish and implement appropriate control measures. Even if all ignition sources are identified and controlled during abrasive blasting, the presence of flammable vapors in the working area, such as vapors resulting from filling a nearby storage tank, shall be avoided.

Note: See Section 7 for specific requirements.

Employers shall also be aware of potential ignition sources that may be present during abrasive blasting including but not limited to, the following:

1. Sparks (at an incendiary temperature) resulting from friction when abrasive grit strikes the metal of the tank.

2. Hot metal tank surfaces (at an incendiary temperature) resulting from the friction of the abrasive grit striking against the tank metal when there is no liquid present to absorb heat.

3. External sources such as lightning, other hot work in the area or open flames, heaters, furnaces, etc. in nearby areas, etc.

4. Pyrophoric iron sulfide that ignites upon exposure to the air during abrasive blasting.

5.2 STATIC ELECTRIC DISCHARGE

A significant potential ignition hazard during abrasive blasting is the generation and accumulation of enough static electricity to product an incendiary charge. Static electricity is generated by abrasive grit flowing through the blasting machine, hose and nozzle and striking the surface being cleaned. Tests have shown that as much as 30,000 volts of electrostatic potential can build up on an electrically isolated piece of metal subjected to sandblasting[4]. Since static electric discharge is enhanced by a dry atmosphere and the dissipation of such charges is favored by damp, humid atmosphere, whenever possible, it is preferable to conduct abrasive blasting under such favorable conditions. (See API Recommended Practice 2003 for additional information on generation and control of static electricity.)

exposure to sand, a material containing crystalline silica (and often arsenic). Sand, which was formerly used in abrasive blast cleaning (sandblasting), is generally prohibited in many jurisdictions and has been replaced by other approved, arsenic-free and silica-free, non-hazardous abrasive materials. Employers shall also recognize another potential abrasive blasting health hazard, which is exposure to toxic lead dust when blasting lead based paint from tanks.

5 Potential Ignition Sources and Controls

5.1 POTENTIAL IGNITION SOURCES

Employers shall be aware of ignition sources that are always present during abrasive blasting including, but are not limited to, the following:

1. Static electric charge generated as the abrasive grit passes through the blasting hose.

2. Internal combustion or electrically driven air compressor engines.

The most effective method of reducing static discharge ignition hazards is to provide proper grounding (earthing) and bonding. Providing a low resistance electrical path (bonding) between the nozzle and the surface subject to blasting will prevent accumulation of a hazardous electrostatic potential, particularly when the grounding path is uncertain. In addition, an ignition due to a static discharge in the blasting stream is unlikely, because the sweeping effect of the air stream prevents flammable vapor-in-air concentrations from occurring within the stream pattern.

The use of conductive blasting hose with securely fastened metallic hose couplings and other metal connections shall be required to provide inherently electrically continuous metal-to-metal contact throughout the system. Bonding and grounding connections shall be inspected by a qualified person prior to the start of each day's work and whenever the abrasive blasting equipment is repositioned during work so as to

[4]H. P. Bradley, "Tanks Can be Sandblasted Safely While in Service," *Petroleum Refiner*, Jan. 1961, Vol. 40, No.1, pp135–138.

assure that metal to metal connections are tight and bonding cables are unbroken and in good condition.

The blasting nozzle, blast shield, conductive hose, blasting machine and compressor shall be bonded to the work surface (tank). The tank (floating roof) and the blasting machine shall (tank). The tank (floating roof) and the blasting machine shall be properly grounded (earthed). Workers shall be aware that sparks can jump from non-conductive hose to grounded objects during abrasive blasting. The use of approved, wire wrapped conductive hose shall be required to provide bonding between the blasting machine and the nozzle and provide effective grounding (earthing) for the nozzle through the tank and blasting machine.

Note: Testing may be conducted by using an approved ohmmeter. A blasting hose is considered conductive if the resistance from one point of the hose to either the blasting machine or a grounded nozzle is less than one mega ohm.

See Figure 1, Bonding and Grounding during Abrasive Blasting of Atmospheric Storage Tanks.

5.3 INTERNAL COMBUSTION ENGINES AND ELECTRICAL MOTORS

A potential source of ignition during abrasive blasting is the use of internal combustion engines or electrically driven motors operating the blasting machine, vehicles, compressors and other equipment in the area. Gasoline or diesel powered equipment shall preferably be located outside the dike in an unclassified area or on top of the tank dike. Internal combustion equipment that is permitted to be located inside the dike area, shall be positioned a minimum of 50 feet (15 meters) upwind from the tank and at least 3 feet (1 feet (15 meters) upwind from the tank and at least 3 feet (1 meter) above ground level (grade) to minimize contact with flammable vapors.

A hot work permit shall be issued before starting any internal combustion engine. Refueling of any internal combustion engines, regardless of type or location, shall not be permitted while the engine is operating or hot or while abrasive blasting is being conducted in the approximate area. Gasoline and diesel driven engine exhausts and intakes shall be equipped with spark arrestors. Testing shall be conducted by a qualified person to assure that flammable vapor-in-air levels in the area surrounding internal combustion equipment are within acceptable limits as established by the hot work permit.

Electrical motors shall be approved by the facility owner/operator prior to their use in abrasive blasting. Electric motors shall be inspected before use by a qualified person and confirmed to be intrinsically safe (i.e., approved explosion proof motors have not been damaged so as to void their ability to contain an explosion internally) and approved for the area's electrical zone or classification. Electrically driven equipment shall also be located a minimum of 50 feet (15 meters) upwind from the tank and at least 3 feet (1 meter) above

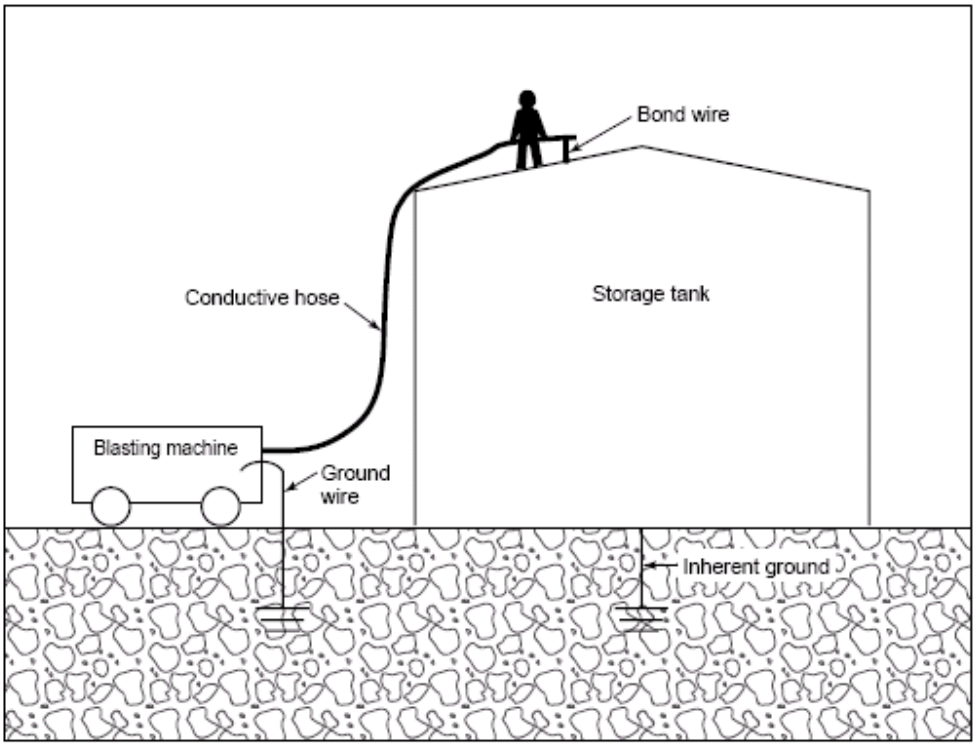

Figure 1—Bonding and Grounding During Abrasive Blasting of Atmospheric Storage Tanks

ground level (grade) to minimize contact with vapors. Electrical motors shall be grounded and bonded to any abrasive blasting and other equipment they are powering.

To provide for easy access and stability, the blasting machine shall be located at ground level (grade), unless it is a combination compressor/blasting unit. Use of abrasive blasting equipment in electrically classified areas or in any area where the potential for flammable vapors exists, shall require the issuance of a hot work permit. Receipt of flammable hydrocarbons into nearby tanks that are less than 50 feet from where equipment is located or where abrasive blasting is being conducted, shall be prohibited or restricted and controlled to prevent the release of flammable vapors during abrasive blasting.

5.4 FRICTION SPARKS

An area of potential concern during abrasive blasting is whether or not the sparks created by the friction of the abrasive grit striking against the tank metal are capable of igniting flammable vapors. Sparks generated by abrasive blasting are typically not considered to be ignition sources as they are relatively low in heat energy and are cooled by the stream of blasting air or water. The blast stream also tends to disperse and dilute any flammable vapors present in the area where sparks occur, further reducing the potential ignition hazard.

Friction sparks are those that result from the rapid oxidation of steel particles after the particles have been chipped off of the tank by the abrasive grit. Tests conducted as early as 1941 have shown it is unlikely that hydrocarbon vapors can be ignited by sparks produced by contact of steel with steel, by an abrasive wheel and even by power driven equipment[5]. Subsequent testing, performed 20 years later, determined that sparks formed during sandblasting would not ignite flammable vapors[6].

In addition, no evidence exists to indicate that metal, heated by abrasive blasting, can ignite flammable vapors inside tanks that are initially at or near ambient temperatures. (Information on the ignition temperatures of various dusts is available from the U.S. Department of Interior, Bureau of Mines). In testing conducted (1960) on a simulated sandblasting operation, the maximum observed temperature of the metal being blasted was 288°F (142°C), when the ambient temperature was 74°F (23°C). This temperature is less than the published ignition temperature of common hydrocarbons. Additional testing and experience has shown that in open air, the surface temperature of the metal must be significantly higher than the ignition temperatures of flammable hydrocarbon vapors, in order for ignition to occur from contact of vapors outside the tank with a hot metal surface (See ANSI/API Recommended Practice 2216 for additional information on hot metal surfaces).

Pyrophoric deposits may prevent tank walls or roofs from dissipating heat generated by the friction of blasting particles against the tank shell. When tanks contain significant residue or deposits of carbonaceous or pyrophoric materials on their interior surfaces, the temperature increase of the outer surface may be greater due to reduced heat transfer efficiency and oxidation of residue may occur rapidly with resultant ignition.

5.6 POTENTIAL EXTERNAL IGNITION SOURCES

Other potential external sources of ignition during abrasive blasting include, but are not limited to, other hot work in adjacent areas, open flames, heaters, furnaces or fires inside and outside the work area and lightning. Another potential ignition source is pyrophoric deposits (that may have formed on tanks storing crude oil and heavy fuel oil containing sulfur) that ignite when exposed to air as a result of abrasive blasting.

5.5 HOT METAL SURFACES

Another potential ignition source may occur when the metal surface of the tank is heated from the friction of the abrasive grit blasting against the tank. However, the temperature increase (as a result of the abrasive action) is usually minimal because the metal tank wall will normally absorb and dissipate any heat that is generated. This ability of the tank wall to absorb and transfer heat is improved when hydrocarbon liquid is present inside the tank area where blasting occurs. In addition, the blasting air or water stream also cools the tank and helps to prevent the tank metal from overheating.

[5]M. B. Anfenger and O. W. Johnson, "Friction Sparks", *API Proceedings*, Volume 22, Section 1, API, Washington DC, 1941, pp. 54–56.

[6]H. P. Bradley, "Tanks Can be Sandblasted Safely While in Service," *Petroleum Refiner*, Jan. 1961, Vol. 40, No.1 pp135-138.

5.7 STOPPING WORK

Abrasive blasting shall immediately stop and the hot work permit shall be cancelled in the event that there is a potential for any of these and similar activities constituting sources of ignition, to occur.

6 Tank Preparation

6.1 GENERAL REQUIREMENTS

Whenever possible, prior to starting abrasive blasting, the tank should be emptied, vapor freed and cleaned. If the tank is not emptied due to facility operations or other reasons, it shall be filled as close as possible to its maximum normal working capacity. Filling a tank reduces the vapor space above the liquid in fixed (cone) roof tanks and above the roof in internal floating roof tanks and covered open top floating roof tanks. Filling an external (open top) floating roof tank minimizes the

distance from the rim of the tank to the tank roof and provides maximum ventilation on top of the roof deck.

Employers (owners/operators and contractors) shall establish requirements for testing the atmosphere above the floating roofs of tanks in service to assure that flammable vapors have been sufficiently dispersed, dissipated or diluted to allow abrasive blasting to begin.

e. All sewers, vents, drains, and catch basins in the area of the tank shall be covered or protected to prevent vapors from entering the abrasive blasting area and to prevent grit and debris from entering into sewers and drains and to prevent a flashback through these lines into other process or storage areas in the event of an ignition.

Should the facility require product to be moved into the tank during abrasive blasting, the permits shall be cancelled, abrasive blasting shall immediately stop and work shall not resume until product movement is completed, safe working conditions have been re-established and the permits have been reissued.

Should the facility require product to be withdrawn from the tank during abrasive blasting of the external tank roof, floating roof or internal tank shell walls, the permits shall be cancelled, abrasive blasting shall immediately stop and work shall not resume until product movement is completed, safe working conditions have been re-established and the permits have been reissued.

Should the facility require product to be withdrawn from the tank during abrasive blasting of the external tank walls, the movement shall be controlled so that the product level within the tank remains at least 3 feet (1 meter) above the level where abrasive blasting is occurring on the external shell of the tank. If this is not accomplished, permits shall be cancelled, abrasive blasting shall immediately stop and work shall not resume until product movement is completed, safe working conditions have been re-established and the permits have been reissued.

6.2 ISOLATION

Employers shall assure that tanks are isolated, during abrasive blasting, as follows:

a. Incoming lines shall be isolated to prevent flammable liquid product from entering the tank and (subsequent) vapors from being expelled from the tank, during abrasive blasting.

b. Lines to vapor recovery, flare, flame arrestors or similar systems shall be isolated or controlled in order to assure that vapors above the approved Lower Explosive Limit (LEL) do not enter the work area during abrasive blasting.

6.3 TANK ROOFS

Prior to beginning abrasive blasting, employers shall assure that a qualified person inspects the tank roof to confirm that it is structurally sound and will support the weight of workers and abrasive blasting equipment. (See API Recommended Practice 2026 for information on entering floating roofs). The qualified person shall also assure that gauge hatch covers are securely closed, roof drains are plugged and covered and roof vents and similar appurtenances are covered or protected in order to prevent vapors from being discharged in the vicinity of abrasive blasting before the hot work permit is issued.

Note: When abrasive blasting is completed at the end of the day or when abrasive blasting is suspended for any period of time over 2 hours, vents shall be uncovered to prevent a vacuum condition in the tank as it cools at night and to provide for pressure relief during sunlight. If there is a possibility of rain, the qualified person shall assure that roof drains on open-top (external) floating roof tanks that have been opened are closed and plugged before abrasive blasting recommences.

Employers shall assure that abrasive blasting is not conducted near vents that are not properly protected and could expel vapors. When abrasive blasting is conducted on floating roof tanks, a low resistance (metallic) bond shall be connected from the roof ladder to both the tank shell and the floating roof to provide for electrical continuity. (Note: The shunts that carry lightning charges from the roof to the shell of a floating roof tank are not considered as providing an adequate electrical bond for dissipation of static charges). To prevent overloading and sinking the roof, abrasive blasting material and debris shall not be allowed to accumulate on roofs. (See above.)

6.4 LEAKS AND SEEPAGE

Employers shall assign a qualified person to inspect the tank shell and roof to assure that there are no excessively corroded areas, holes, leaks or seepage. All holes shall be patched and seeping or weeping seams and rivets shall be

c. All mixers, heaters, etc. shall be isolated to prevent product movement during abrasive blasting.

d. Lines for withdrawing product from the tank shall be isolated or monitored to control planned product withdrawals from the tank. Product withdrawal, if permitted, shall be controlled so that product levels inside the tank do not fall below a level that is 3 feet (1 meter) above the level where abrasive blasting is being conducted.

caulked (or similarly protected) to prevent vapors from escaping from the tank. Employers shall be aware that patches that are not properly bonded to the tank can act as static accumulators and that abrasive blasting of such surfaces should not be permitted until it is assured that any vapor space under the patch is not in the flammable range. If holes or leaks are such that repair is not feasible, the tank shall be taken out of service, cleaned (if necessary) and vapor freed before exterior abrasive blasting is permitted. After repair and prior to starting

abrasive blasting, combustible gas testing shall be performed by a qualified person to assure that repairs are satisfactory.

6.5 ABRASIVE GRIT

The type of abrasive blasting grit to be used shall be approved by the employer in accordance with owner/operator and regulatory requirements. Abrasive blasting materials shall be arsenic-free and silica-free and consist of approved nontoxic materials such as iron, carborundum or malleable grit. A copy of the Material Safety Data Sheet(s) (MSDS) or other appropriate information covering the abrasive material(s) to be used shall be reviewed by the employer for potential hazards and appropriate controls prior to the start of work and shall be available at the work site for employee review. Appropriate measures shall be taken to prevent or minimize abrasive materials, dust and debris from entering the atmosphere by the use of approved collection systems and shield-

protection, before starting abrasive blasting. Employers shall assure that responsibilities for compliance with confined space classification; hot, safe and entry permits; regulatory reporting and permit; and record keeping requirements are determined prior to commencing abrasive blasting and are complied with during operations.

As a minimum, abrasive blasting shall always require issuance of a hot work permit. Abrasive blasting may also require an entry permit for entry onto an open top (external) floating roof depending on the employer's confined space program and the classification of the tank or floating roof at the time of blasting. Abrasive blasting upon open-top (external) floating roofs or on the inside shells of open-top (external) floating roof tanks when the floating roof is more than 5 feet (1.5 meters) below the rim of the tank, shall always require an entry permit in addition to a hot work permit. (See ANSI/API Standard 2015 for information on classification of tanks and floating roofs as permit required confined spaces.)

ing. When possible, on-the job recycling (reuse) of abrasive grit will minimize the amount required for abrasive blasting and to facilitate disposal of any grit considered to be hazardous waste.

7 Abrasive Blasting Precautions

7.1 GENERAL PRECAUTIONS

Employers shall assure that supervisors, qualified persons and employees follow the precautions, procedures and safe work practices required by this section in order to minimize ignition hazards associated with abrasive blasting of atmospheric aboveground storage tanks in hydrocarbon service.

Prior to commencing work, a Pre-Start Safety Review, Job Safety Analysis (JSA) or similar potential hazard identification procedure shall be conducted by the tank owner/operator, the contractor and the abrasive blasting supervisor and workers. The safety review shall be re-examined whenever abrasive blasting supervisors, workers or the work conditions change.

Employers shall assure that all manually operated abrasive blasting equipment is provided with positive shut-off ("dead man") controls. The employer shall assign a qualified person to check that metal scaffolding used for abrasive blasting is correctly assembled and bonded to the tank to prevent static discharge.

Employers shall provide and require the use of appropriate approved personal protective equipment and respiratory protection, depending on the atmospheric exposures and nature of the residue being removed and the materials used for abrasive blasting.

7.2 PERMITS AND OTHER REQUIREMENTS

Employers shall identify actual and potential hazards and establish safe work procedures, including requirements for permits, testing, personal protection and respiratory

floating roofs as permit required confined spaces.)

In the event that a thunderstorm is anticipated in or near the work area, the permit shall be cancelled, all abrasive blasting on any tank in Class I or II service shall be halted and the tank vents checked to prevent vacuum collapse. The permit shall be reissued and the work resumed only after the storm has passed.

7.3 CONTROL OF VAPOR RELEASES

When abrasive blasting is being conducted on the exterior of a cone (fixed) roof tank that is in service, or on the exterior of an internal floating roof tank that is in service, employers shall assure that each side wall and roof vent has been tightly sealed. At least one vent, located as far from the area of abrasive blasting as possible, shall be fitted with a vertical stack (at least 8 feet (2.4 meters) high above the roof level) to permit atmospheric tank breathing. Whenever possible, abrasive blasting and other work shall be performed to the windward side of vents and other appurtenances to reduce exposure to gas and vapors. Abrasive blasting shall not be conducted closer than 6 feet (1.8 meters) from side wall and roof vents, gage hatches and other openings, including small, uncovered rust holes above the liquid level. The remaining area within 6 feet (1.8 meters) around the openings shall be cleaned by wire brushing or hand scraping.

7.4 TESTING AND MONITORING REQUIREMENTS

Immediately prior to starting work, the vapor space between the internal floating roof and the fixed roof or between the floating roof and cover of a covered, open-top (floating roof) tank shall be tested by a qualified person with an approved, calibrated and adjusted combustible gas indicator. The vapor space (above the liquid level) of cone (fixed) roof tanks containing Class II and III Liquids shall also be tested. The pontoons on external floating roof tanks shall be tested to ensure flammable vapors have not accumulated within the pontoons.

Abrasive blasting shall be permitted to begin only if the vapor-in-air levels within the vapor space of the tank are less than 10% of the lower explosive limit (10% LEL) for the product contained. The vapor space inside the tank near the area where abrasive blasting is being conducted shall be monitored and tested periodically during abrasive blasting to assure that the vapor-in-air levels in the atmosphere remain below 10% of the lower explosive limit (10% LEL).

The atmosphere in the area around the outside of the tank where abrasive blasting is being conducted shall also be tested to assure that vapor-in-air levels are 0% lower explosive limit (0% LEL) prior to the start of abrasive blasting. These areas shall be monitored and tested periodically during abrasive blasting to assure that vapor-in-air levels do not rise above 10% lower explosive limit (10% LEL). The work permit shall be cancelled and the abrasive blasting shall be stopped anytime the flammable vapor level in the atmosphere in the work area rises above 10% of the lower explosive limit (10% LEL). A qualified person shall determine the cause of the rise in the vapor- in-air levels and the hazard shall be mitigated before the supervisor reissues the hot work permit to resume abrasive blasting.

7.5 FIRE PROTECTION

Employers shall assure that a minimum of two dry chemical 40:BC fire extinguishers, charged and ready for use, are available at the work site during abrasive blasting. If water is available for firefighting, a charged fire hose shall also be available at the work site provided that employees are trained in its use. A fire watch shall be established to observe for hazards that could arise in the area around the workers actually performing the abrasive blasting.

7.6 ABRASIVE BLASTING OF TANK ROOFS

7.6.1 General

7.6.1 General

Abrasive blasting of the exterior roofs of internal floating roof tanks and floating roofs of open-top (external) floating roof tanks containing Class I, II, or III liquids and the exterior roofs of cone (fixed) roof tanks containing Class II and III liquids shall be permitted, following the requirements of this recommended practice.

Before abrasive blasting begins, internal floating roof tanks and open-top (external) floating roof tanks shall be filled to their maximum working capacity to minimize the space between the roof level and the top of the tank. Owners/operators shall provide sufficient time between the final product receipt and the time abrasive blasting is scheduled to start, for any vapors above the floating roof level to disperse.

Abrasive blasting on top of the roof of an open-top (external) floating roof tank that is more than 5 feet (1.5 meters) below the top of the tank rim shall be considered as working in a confined space and shall require issuance of an entry permit in addition to a hot work permit. In addition to following all of the abrasive blasting requirements of this recommended practice, employers shall also comply with applicable testing, classification, entry and safe work requirements for working in confined spaces. (See ANSI/API 2015 and API 2026 and OSHA 29 CFR 1910.136 for confined space requirements.)

7.6.2 Abrasive Blasting Restrictions for Internal and Covered Open-Top Floating Roofs

Abrasive blasting of internal floating roofs and covered open-top floating roofs of tanks in any hydrocarbon service shall not be permitted. Abrasive blasting of roofs of cone (fixed) roof tanks (without internal floating roofs) containing Class I liquids shall not be permitted.

7.6.3 Preparation

Abrasive blasting on top of roofs of open-top (external) floating roof tanks and the exterior roofs of internal floating roof tanks shall not be permitted until the employer has inspected the roof and determined that it is in good condition. The employer shall assure that tank seals are in good condition and all spaces or gaps between the seals and the tank shell that may allow vapors to pass through are sealed or plugged before starting work. Roof vents, hatches, openings for roof support legs, water drains, etc. shall also be sealed to prevent release of vapors. Where provided, pontoons shall be checked for liquids and pontoon hatchways shall be securely closed and protected.

A minimum distance of 2 feet (0.6 meters) shall be maintained between the open-top (external) floating roof seal and the area subject to abrasive blasting. The remaining area shall be cleaned by wire brushing or hand-scraping. As an alternative, employers may establish and implement appropriate control measures to protect the seal from damage.

7.6.4 Atmospheric Testing

Before starting work, the atmosphere above open-top floating roofs or exterior roofs of internal floating roof tanks shall be tested with an approved, calibrated and adjusted combustible gas indicator. Abrasive blasting shall be permitted to begin only if the vapor-in-air level within the space on top of the roof is not above 0% of the lower explosive limit (0% LEL) and all toxic exposure limitations have been met prior to the start of abrasive blasting. The atmosphere above the floating roof near the area where abrasive blasting is being conducted shall be monitored continuously to assure that the vapor-in-air levels remain below 10% of the lower explosive limit (10% LEL).

The area around the outside of the tank where abrasive blasting is being conducted shall be tested prior to abrasive blasting and monitored and tested periodically during abrasive blasting to assure that vapor-in-air levels do not exceed 10% lower explosive limits (10% LEL).

The work permit shall be cancelled and the abrasive blasting shall be stopped anytime the flammable vapor level in the atmosphere in the work area or in the area around the tank rises above 10% of the Lower Explosive Limit (10% LEL). A qualified person shall determine the cause of the rise in the vapor- in-air levels (LEL) and the hazard shall be mitigated before the supervisor reissues the hot work permit to resume abrasive blasting.

7.7 ABRASIVE BLASTING OF EXTERIOR SHELLS OF TANKS

7.7.1 General

Abrasive blasting of the exterior shells of tanks containing Class I, II and III liquids shall be permitted, following the requirements of this recommended practice. (See Section 7.9 for specific requirements for tanks containing Class I, II and III Liquids.)

Before abrasive blasting begins, tanks shall be filled to their maximum working capacity to minimize the space between the product level and the top of the tank. Owners/ operators shall provide sufficient time between the final product receipt and the time abrasive blasting is scheduled to start, for any vapors to disperse.

7.7.2 Abrasive Blasting Exterior Shell Restrictions

Abrasive blasting of the exterior shells of tanks containing Class I liquids shall not be permitted within 3 feet (1 meter) of the product level or in the vapor space between the product level and the fixed or floating roof (see Section 7.8).

7.7.3 Preparation

Abrasive blasting on tank exterior shells shall not be permitted until the employer has inspected the tank and determined that it is in good condition. The employer shall assure that tank seals are in good condition and all spaces or gaps between the seals and the tank shell that may allow vapors to pass through are sealed or plugged before starting work. Roof vents, hatches, openings for roof support legs, water drains, etc. shall also be sealed to prevent release of vapors. Where provided, pontoons shall be checked for liquids and pontoon hatchways shall be securely closed and protected. A minimum distance of 2 feet (0.6 meters) shall be maintained between any vents, overfills, areas of leakage or other potentially unsafe areas (such as thin tank shell) and the area subject to abrasive blasting with the remaining area cleaned by wire-brushing or hand-scraping.

7.7.4 Atmospheric Testing

Before starting work, the atmosphere around the tank shall be tested with an approved, calibrated and adjusted combustible gas indicator. Abrasive blasting shall be permitted to begin only if the vapor-in-air level is not above 0% of the lower explosive limit (LEL) and all toxic exposure limitations have been met prior to the start of abrasive blasting. The atmosphere near the area where abrasive blasting is being conducted shall be monitored continuously to assure that the vapor-in-air levels remain below 10% of the lower explosive limit (10% LEL). The area around the outside of the tank where abrasive blasting is being conducted shall be tested prior to abrasive blasting and monitored and tested periodically during abrasive blasting to assure that vapor-in-air levels do not exceed 10% lower explosive limits.

The work permit shall be cancelled and the abrasive blasting shall be stopped anytime the flammable vapor level in the atmosphere in the work area or in the area around the tank rises above 10% of the Lower Explosive Limit (10% LEL). A qualified person shall determine the cause of the rise in the vapor- in-air levels (LEL) and the hazard shall be mitigated before the supervisor reissues the hot work permit to resume abrasive blasting.

7.8 ABRASIVE BLASTING OF THE INSIDE EXPOSED PORTIONS OF SHELLS OF OPEN-TOP (EXTERNAL) FLOATING ROOF TANKS IN SERVICE

Abrasive blasting of the interior portions of any enclosed tank, including cone (fixed) roof tanks, internal floating roof tanks and covered open-top floating roof tanks, shall be conducted only after the tank has been emptied, cleaned and vapor free (and lead-free if previously in leaded service). (See ANSI/API Standard 2015 and ANSI/API Recommended Practice 2016 for information on entering and cleaning tanks.) Employers shall follow the applicable requirements of this recommended practice when conducting abrasive blasting inside tanks.

In order to conduct abrasive blasting on the inside of the shell above the level of the roof of an open-top (external) floating roof tank while the tank is in service, the product in the tank shall be brought down to the lowest level possible with the roof still remaining floating on top of the product. Employers shall assure that all tank seals, openings and appurtenances are protected from grit and debris and from release of vapor. All connections, relief vents, hatches and openings shall be sealed to prevent vapor release.

Atmospheric vapor-in-air levels within the tank shall be tested before starting work and continuously during abrasive blasting to assure they do not exceed 0% Lower Explosive Limit (0% LEL). Atmospheric vapor-in-air levels outside the tank shall be tested before starting work and periodically during abrasive blasting to assure they do not exceed 10% Lower Explosive Limit (10% LEL). Testing for toxic substance, including lead-in-air concentrations, shall be conducted before work and monitoring shall be conducted during work to assure safe exposure requirements are satisfied.

All other requirements for abrasive blasting on open top (exterior) floating roofs shall apply to abrasive blasting of the

inside shells. Abrasive blasting on the interior of the tank shell shall be permitted from the top of the tank to within 2 feet (0.6 meters) of floating roof seals, with the remaining area cleaned by wire brushing or hand-scraping.

CAUTION: The floating roof shall not be standing on its legs during abrasive blasting on the roof top or internal shell unless the tank has been emptied, vapor freed and cleaned.

7.9 PRODUCT PRECAUTIONS FOR ABRASIVE BLASTING OF TANKS IN SERVICE

7.9.1 Tanks Containing Class III Liquids

Abrasive blasting of the exterior shells and roofs of all tanks and the interior shells above the level of the roof on open-top (external) floating roof tanks containing Class III Liquids that are not heated above their flash points, shall be permitted following the requirements of this recommended practice. If a Class III liquid is heated to a temperature within 25°F (14°C) of its flash point, it shall be considered to be a Class I product for abrasive blasting purposes and the requirements of this recommended practice (see Section 7.8.3) applicable to Class I (flammable) liquids shall apply.

7.9.2 Tanks Containing Class II Liquids

Abrasive blasting of internal floating roofs and covered open-top (external) floating roofs of tanks containing Class II Liquids that are in service, shall not be permitted.

Abrasive blasting of the interior shells of open-top (external) floating roof tanks and the exterior shells and roofs (including open-top (external) floating roofs) of all tanks containing Class II Liquids (that are not heated above their flash points), shall be permitted according to the requirements of this recommended practice, with the following exceptions:

Exceptions: Class II Liquids shall be considered to be Class I Liquids and the requirements of Section 7.9.3 shall be applicable under the following conditions:

(1) If the flash point of a Class II product in the tank is within 25°F (14°C) of the ambient temperature at the time abrasive blasting is to be conducted, the product shall be considered to be an NFPA Class I Liquid. For example, if the Class II product flash point is 113°F (45°C) and the outside temperature is 95°F (35°C), Class I Liquid requirements apply.

(2) Class II Liquids stored at higher altitudes whose flash points are lowered to within 25°F (14°C) of the ambient temperature due to an increase in liquid volatility caused by reduced atmospheric pressure, shall be considered to be NFPA Class I Liquids for abrasive blasting purposes.

(3) If a Class II liquid is heated to a temperature within 25°F (14°C) of its flash point, it shall be considered to be a Class I product for abrasive blasting purposes and the requirements of this recommended practice applicable to Class I liquids shall apply.

7.9.3 Tanks Containing Class I Liquids

Abrasive blasting of roofs of cone (fixed) roof tanks (without internal floating roofs) in service containing Class I liquids shall not be permitted.

Abrasive blasting of internal floating roofs and covered open-top (external) floating roofs of tanks in service containing Class I Liquids shall not be permitted.

Abrasive blasting of roofs of cone (fixed) roof tanks (with internal floating roofs) and floating roofs of open-top (external) floating roof tanks in service containing Class I liquids shall be permitted following the requirements of this recommended practice.

Abrasive blasting of only the lower portions (below the liquid level) of exterior shells of tanks containing NFPA Class I Liquids (hydrocarbons with flash points at or below 100°F (38°C), shall be permitted, in accordance with the requirements of this recommended practice and the following additional requirements:

(1) Abrasive blasting of the exterior shell shall be permitted only if the tank is filled to its maximum working capacity. This is to assure that the vapor space is above the upper explosive (flammable) limit (too rich to burn) and remains there throughout the abrasive blasting operation.

(2) Abrasive blasting of the exterior shell shall be limited to an area no higher than 3 feet (1 meter) below the liquid product level inside the tank. At no time shall abrasive blasting be permitted closer to or above the product level.

(3) In order to permit abrasive blasting, the temperature of the hydrocarbon liquid in the tank shall be checked to assure that it is at least 25°F (14°C) above the upper liquid storage flammable vapor temperature limit for the specific product, as determined by the owner/operator. For example, a tank of gasoline can emit vapors that may be in the flammable range when the liquid temperature is between –70°F (–58°C) and 20°F (–7°C), (even though gasoline has a flash point of approximately –45°F (–43°C). Therefore, abrasive blasting would not be permitted unless the temperature of the gasoline stored in the tank was above 45°F (7.3°C) (regardless of the ambient temperature).

See Table 1, Flammability of the Vapor Space in Cone Roof Tanks Containing Various Flammable Liquids with Vapor-Air Mixture in Equilibrium.

Table 1—Flammability of the Vapor Space in Cone Roof Tanks Containing Various Flammable Liquids with Vapor-Air Mixture in Equilibrium*

Flammable Liquid	Approximate Flash Point		Explosive Limits % by Volume		Atmospheric Liquid Storage Temperature Range in which Tank Vapor Space is in the Explosive Range	
	°C	°F	Lower	Upper	°C	°F
Crude Oil	–18	0	1.0	6.0	–18 to 4	0 to 40
Motor Gasoline	–46	–50	1.4	7.6	–57 to –7	–70 to 20
Aviation Gasoline	–35	–30	1.1	7.2	–40 to –1	–40 to 30
Kerosine/JP 1	44	110	0.7	6.0	38 to 99	100 to 210
Xylene	28	83	1.0	6.0	26 to 60	78 to 140
Methyl Alcohol	11	52	6.0	36.5	7 to 41	45 to 105