METAL CLEANING

Table of Contents

Page

List of Figures

1.0 SCOPE

This data sheet covers fire and other associated hazards of metal cleaning using a spray or immersion in solvents, vapor degreasing, mechanical cleaning, and cleaning using corrosive solutions. Metal cleaning normally follows machining operations and precedes painting or applications of surface finishes or other protective coatings. For recommendations related to de-scaling metal using molten salts, see Data Sheet 7-41, *Heat Treating of Materials Using Oil Quenching and Molten Salt Baths.*

1.1 Changes

January 2022. Interim Revision. Lowered the flashpoint threshold of very high flashpoint liquids to be consistent with other ignitable liquid data sheets.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

Use FM Approved equipment, materials, and services whenever they are applicable. For a list of products and services that are FM Approved, see the *Approval Guide,* an online resource of FM Approvals.

2.1.1 Ignitable Liquid Hazard Scenario

Recommendations for passive and active fire protection features in this data sheet will vary depending on the severity of the potential fire hazard. The consequences of a fire involving solvent cleaning operations are dependent on a number of factors, including the following:

- The quantity and type of ignitable liquid involved
- Use conditions (e.g., temperature)
- Equipment arrangement
- Equipment location
- Equipment/pipe construction

In addition to a fire hazard, metal cleaning processes can also create an equipment explosion hazard if liquids with low flash points are used for dipping or liquids of any flash point are sprayed. Locating these types of operations in cut-off rooms along outside walls provides the best opportunity to mitigate equipment explosion hazards and limit the exposure to the facility. In addition to metal cleaning equipment, solvent recovery operations are sometimes installed next to the cleaning operation. Solvent recovery processes create the potential for room explosion hazards. See Data Sheet 7-2, *Waste Solvent Recovery,* for additional guidance.

The intent of this data sheet is to limit the amount of ignitable liquid that can become involved in a fire. Solvent cleaning processes may involve spraying and/or dipping operations. Properly designed equipment will quickly shut down spraying operations and prevent the release of additional solvent into the fire. In this case, basic sprinkler protection will be adequate for most expected fire scenarios. In cases where solvent pumping systems are not shut down in the event of a fire, however, even a small spray fire within the equipment can result in the loss of that equipment, regardless of fire protection available at the ceiling.

With regard to the dipping operation hazard, the exposed surface area of the immersion tank will impact the fire severity. The surface area and corresponding fire severity will be minimized if the solvent can be contained within the immersion tank. A small immersion tank that is properly designed (e.g., noncombustible equipment, piping, etc.) will present a minimal fire hazard due to the small surface area of the tank.

A larger immersion tank will result in an increased fire hazard, although damage can still be limited if the solvent can be confined to the tank. Safeguards, such as overflow drains or emergency bottom drains, may be provided for the equipment, designed to contain the liquid within the tank and piping systems. Damage to adjacent equipment will be minimized, while automatic sprinklers will limit damage to the building.

Regardless of tank size, if safeguards are not provided to confine the liquid to the equipment, the potential exists for the liquid to be released into the room, with the subsequent fire extending well beyond the equipment area. The fire size will grow exponentially, and the potential exists for a large fire that will operate all exposed sprinklers. Any equipment that is exposed to the burning pool will be damaged. However, if overflow from the tank is accounted for by designing the surrounding area as an ignitable liquid occupancy in accordance with Data Sheet 7-32, *Ignitable Liquid Operations*, damage may be effectively limited. The

includes containment and emergency drainage for the room area to limit the ignitable liquid fire exposure to the rest of the building, and properly designed automatic sprinkler protection that accounts for the larger pool fire outside the cleaning equipment.

2.1.1.1 Evaluate the potential for an equipment or room explosion hazard in accordance with Data Sheet 7-32, *Ignitable Liquid Operations.*

2.1.2 Liquid Evaluation

2.1.2.1 Where solvent cleaning is conducted, use a nonignitable liquid.

2.1.2.2 Where solvents are used in mechanical cleaning operations (e.g., tumbling), use nonignitable liquids.

2.1.2.3 Do not use ignitable solvents in vapor degreasing equipment. Part of the vapor space will be in the explosive range at all times and vapor may overflow the equipment, creating a hazardous condition within the building.

2.1.2.3.1 Liquids that exhibit only a flashpoint but no fire point may present an equipment explosion hazard that should be evaluated.

2.1.2.4 Where it is not possible to use a nonignitable liquid:

A. Use a solvent with as high a flash point as possible.

B. Provide additional safeguards to adequately protect the hazard, as outlined in this data sheet.

2.2 Constructon and Location

2.2.1 Provide noncombustible construction for all metal-cleaning equipment and enclosures.

2.2.2 Locate and arrange operations that use ignitable liquids in accordance with Data Sheet 7-32, *Ignitable Liquid Operations.*

2.2.2.1 Arrange storage of solvents in accordance with Data Sheet 7-88, *Ignitable Liquid Storage Tanks.*

2.2.2.2 Arrange solvent recovery operations in accordance with Data Sheet 7-2, *Waste Solvent Recovery.*

2.2.2.3 For solvent cleaning operations where parts are immersed in a tank of solvent, locate and arrange the equipment in accordance with the recommendations in Data Sheet 7-9, *Dip Tanks, Flow Coaters, and Roll Coaters.*

2.2.3 For small brushing and dipping operations that use FM Approved dip, wash, and rinse tanks, additional safeguards are not necessary. Keep the covers to these tanks closed when they are not in use. A small cleaning station is shown in Figure 1.

2.2.4 If solvents are heated or sprayed as part of a cleaning process, evaluate equipment or room explosion hazards according to Data Sheet 7-32, *Ignitable Liquid Operations.* Locate metal cleaning operations that create either an equipment and/or room explosion hazard in properly designed cut-off rooms along outside walls.

2.2.5 Locate vapor degreasers in a cutoff area away from storage or process areas containing high-value concentrations of materials that may be damaged by acid vapor. Such materials include polished machine parts or tools, die castings, and extruded metal products.

2.2.6 If ignitable solvents are used in vapor degreasing operations, evaluate equipment and room explosion hazards per Data Sheet 7-32, *Ignitable Liquid Operations.*

2.2.7 Where chemical cleaning is performed using corrosive solutions, use corrosion-resistant, noncombustible, or FM Approved plastic ducts to remove corrosive fumes. See Data Sheet 7-78, *Industrial Exhaust Systems,* for recommended safeguards.

2.3 Occupancy

2.3.1 Establish and implement a housekeeping program that adheres to the highest standards. Keep oil deposits to a minimum and clean up spills promptly. Keep waste materials in FM Approved waste cans. Remove waste at the end of every shift or at least daily. Do not store other combustibles in the area. Do not store any material in the area that might wash into or plug drains.

2.3.2 Develop and implement a housekeeping audit program completed at least semi-annually. Ensure facility management reviews audit reports and takes action to promptly address any identified issues.

2.3.3 Where ignitable solvent cleaning is performed, install ventilation systems in accordance with the recommendations in Data Sheet 7-32, *Ignitable Liquid Operations.*

2.4 Protection

2.4.1 Room Protection

2.4.1.1 For mechanical cleaning operations that do not use ignitable liquids, provide automatic sprinkler protection in accordance with Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*, based on the surrounding occupancy.

2.4.1.2 Protect solvent cleaning operations that use ignitable liquids in accordance with Data Sheet 7-32, *Ignitable Liquid Operations.*

2.4.1.2.1 For solvent cleaning operations where parts are immersed in a tank of solvent, additional protection guidance is provided in Data Sheet 7-9, *Dip Tanks, Flow Coaters, and Roll Coaters.*

2.4.1.3 Protect storage of solvents in accordance with Data Sheet 7-88, *Ignitable Liquid Storage Tanks.*

2.4.1.4 Protect solvent recovery operations in accordance with Data Sheet 7-2, *Waste Solvent Recovery.*

2.4.1.5 Provide automatic sprinklers under any obstruction that exceeds 3 ft (0.9 m) in width or diameter and 10 ft^2 (0.9 m^2) in area, and in all enclosures.

2.4.1.6 Provide automatic sprinkler protection of ducts in accordance with the recommendations in Data Sheet 7-78, *Industrial Exhaust Systems.*

2.4.1.7 Where applicable, provide FM Approved corrosion-resistant sprinklers.

2.4.2 Equipment Protection

2.4.2.1 Automatic sprinkler protection may be supplemented with an FM Approved fixed special protection system in accordance with Data Sheet 7-32, *Ignitable Liquid Operations,* to limit fire damage.

2.4.3 Chemical Cleaning Operations

2.4.4.1 Protect chemical cleaning operations in plastic or plastic-lined tanks with electric immersion heaters in accordance with the recommendations in Data Sheet 7-6, *Plastic and Plastic-Lined Tanks with Electric Immersion Heaters.*

2.4.4 Manual Protection

2.4.4.1 Provide portable fire extinguishers suitable for ignitable liquid fires. Refer to Data Sheet 4-5, *Portable Extinguishers,* to determine effective types, sizes, and locations for the extinguishers.

2.4.4.2 Where small hose (1½ in. [38 mm]) stations are provided, space them to allow full coverage of the area being protected. Add a water demand of 50 gpm (190 L/min) to the combined sprinkler and hydrant demand for a single hose station. Add a water demand of 100 gpm (380 L/min) when more than one hose station is provided.

2.5 Equipment and Processes

2.5.1 General

2.5.1.1 Design and construct cleaning equipment, measurement and observation instruments, piping systems, and transfer systems in accordance with the recommendations in Data Sheet 7-32, *Ignitable Liquid Operations.* Design and install equipment to confine solvent within the system, keep escaping material to a minimum, and prevent its spread.

2.5.1.2 Evaluate the potential for an equipment explosion hazard in accordance with the guidance provided in Data Sheet 7-32, *Ignitable Liquid Operations.*

2.5.1.2.1 Protect equipment that has an equipment explosion hazard using the guidance provided in Data Sheet 7-32, *Ignitable Liquid Operations.*

2.5.1.3 Design spray cleaning booths in accordance with Data Sheet 7-27, *Spray Application of Flammable and Combustible Materials.*

2.5.1.4 Protect mechanical cleaning operations that generate combustible dust in accordance with Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust Explosions and Fires*.

2.5.1.5 Provide automatic safeguards and interlocks arranged to shut down all ignitable liquid flow in the event of a fire.

2.5.1.6 Avoid heating solvents. Where solvents must be heated, provide the following:

A. Heat equipment using steam or hot water, or other means not requiring an open flame, fuel-fired equipment, or electrically-powered heaters.

B. Provide automatic temperature controls to maintain the liquid at desired working temperature, and at least 50°F (28°C) below the flash point of the liquid. Interlock the controls to provide an audible alarm and shut down the equipment. Design automatic controls to shut down on loss of operating electrical or air supply.

C. Provide a high-temperature limit switch independent of operating temperature controls. Set the limit switch slightly higher than the normal operating temperature and at least 50°F (28°C) below the flash point of the liquid. Interlock the switch to provide an audible alarm and shut down the heating system. A dual-contact limit switch may be used, arranged to actuate the alarm prior to other operations.

D. Provide a low-liquid-level-limit switch arranged to shut down the equipment and heating system if the liquid level approaches the heating element.

E. Where equipment is operated under vacuum, arrange the equipment to shut down upon loss of vacuum.

2.5.2 Automatic Conveyor Washing Units

2.5.2.1 Provide an interlock to shut down the ignitable liquid spray pump when ventilating fans are not in operation.

2.5.2.2 Provide safety/emergency shutoff valves and/or an automatically actuated means for shutting down the ignitable liquid spray pump in the event of fire. Automatic shutdown may be accomplished using one of the following methods:

A. Actuation by use of heat detectors located within the equipment enclosure.

B. Operation of the automatic sprinkler system. Arrange the system to permit protection system alarm testing without unwanted production shutdown by providing a push button switch that requires constant attendance to bypass the interlock.

C. Actuation by use of flame detection.

D. Operation of an FM Approved fire-safe fusible link operated valve. Install the safety shutoff valves to ensure the fusible link is exposed to the fire.

2.5.2.3 Where emergency overflow drains, emergency bottom drains, and/or salvage tanks are provided for immersion tanks, design them in accordance with the recommendations in Data Sheet 7-9, *Dip Tanks, Flow Coaters, and Roll Coaters.*

2.5.2.4 For immersion tanks are automatically filled, provide high liquid level switches to prevent overflow of the tank. Provide a high liquid level switch a maximum of 2 in. (51 mm) below the lip of the tank, arranged to sound an alarm. Provide a second switch at a higher level designed to shut down all ignitable liquid flow to the tank.

2.5.2.5 Provide one or more stop buttons or switches within the operation area (arranged for easy access by the operators and at points of egress from the building or structure) and at accessible remote locations (e.g., control room, security station, etc.) to allow for manual shutoff of the equipment.

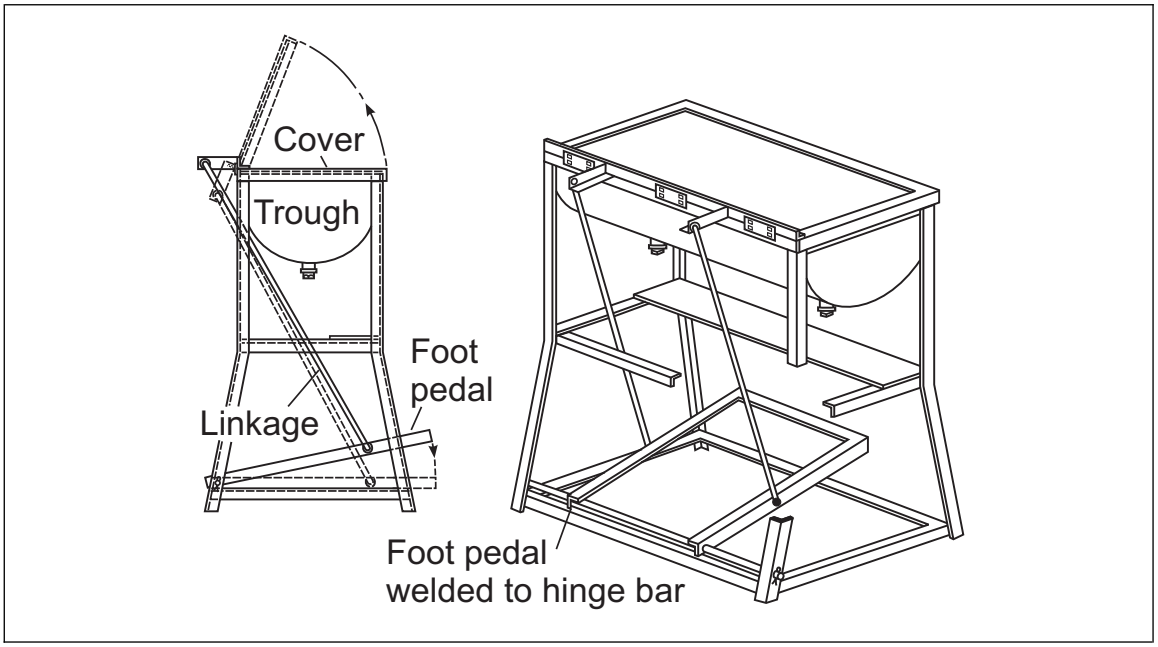

Fig. 1. Cleaning tank with self-closing cover. Constructed of 1-in. (25-mm) angle iron, sheet iron, and 3/8-in. (10-mm) rods.

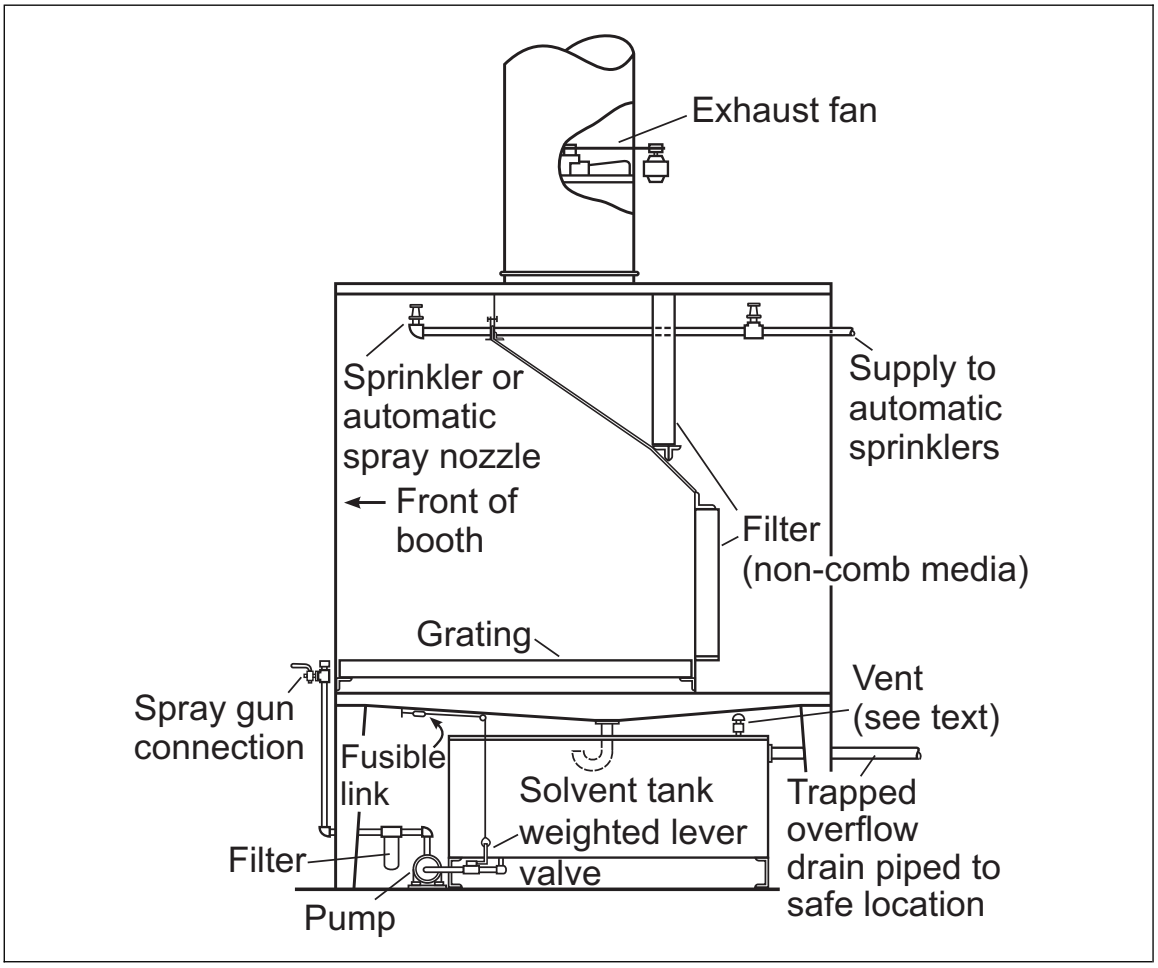

Fig. 2. Well-arranged spray-cleaning booth.

2.6 Operation and Maintenance

2.6.1 General

2.6.1.1 Operate, maintain, test, and inspect equipment and piping systems in accordance with the recommendations in Data Sheet 7-32, *Ignitable Liquid Operations,* and the manufacturer's instructions. Establish a complete preventive maintenance program designed to ensure equipment is operating as it has been engineered to operate. Refer to Data Sheet 9-0, *Maintenance and Inspection,* to evaluate existing programs or as a guide to developing new programs.

2.6.1.2 Develop and implement a formal operator audit procedure to ensure compliance with established standard operating and emergency response procedures. Conduct these audits at least semi-annually.

2.6.1.3 Implement a management of change program, which includes a full review of all planned changes to identify any potential hazards before a project begins. (see Data Sheet 7-43, *Process Safety*)

2.6.1.4 Create a series of routine checkpoints with normal condition limits to be inspected by the operator for prompt detection of abnormal conditions. Conduct frequent inspections to detect and repair leakage. Determine the frequency of the checks based on the process conditions and severity of the consequences of a process upset.

2.6.1.5 Test all system safety interlocks (e.g., low-liquid-level interlocks, temperature safety switches, etc.) in accordance with manufacturer recommendations or at least quarterly. Maintain records of these tests.

2.7 Ignition Source Control

2.7.1 General

2.7.1.1 Control ignition sources in solvent cleaning operations per Data Sheet 7-32, *Ignitable Liquid Operations.*

2.7.1.2 Where solvents with a flash point at or below 100°F (38°C) are in use, or where any solvent is heated above its flash point (including possible ambient temperatures), provide hazardous location-rated electrical equipment. Refer to Data Sheet 7-32, *Ignitable Liquid Operations.*

2.7.2 Mechanical Cleaning

2.7.2.1 Cool the parts being cleaned to a safe temperature (below 400°F [204°C]) before entering the shot-blast enclosure to avoid igniting rubber flap doors or linings with which in-process parts might be left in contact.

2.7.2.2 Carefully supervise hot work on or in the vicinity of shot-blasting enclosures to avoid igniting the combustible lining. Establish a hot work permit and supervision program in accordance with the recommendations in Data Sheet 10-3, *Hot Work Management.*

2.7.2.3 Avoid excessive accumulations of combustible materials such as ignitable solvents or sawdust.

2.7.2.4 Maintain the temperature of the parts being cleaned at least 25°F (14°C) below the flash point of any ignitable solvent used.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Solvent Cleaning

3.1.1 Nonignitable Solvents

Processes using solvents that are nonignitable have essentially no fire hazard, and special provision for protection against fire is unnecessary. Oily deposits from which a nonignitable solvent have evaporated are combustible and should not be permitted to accumulate.

3.1.2 Emulsifiable Cleaners

The hazard of emulsifiable cleaners is essentially that of the solvent. These types of cleaners are emulsifying and blending agents dissolved in kerosene or a similar solvent. Water is added to the bath for some cleaning purposes. The emulsions may be heated to temperatures from 80°F to 150°F (27°C to 66°C). The work is

sprayed with or immersed in the cleaner and rinsed with water. The surface obtained requires only light treatment with an alkaline cleaner to make it suitable for electroplating.

3.1.3 Ignitable Solvents

Solvents having a flash point above 100°F (38°C), such as Stoddard solvent, are sold under various trade names. These solvents are used for wiping, dipping, spraying, and for washing in conveyor cleaning units. The work can be dried with compressed air or by gentle heating. A light film usually remains to give some protection against corrosion. This film may in some cases be objectionable.

Solvents with flash points below 100°F (38°C) are easier to ignite, and sustain combustion more easily than those with higher flash points. By limiting the level of heating of an ignitable liquid to 25°F (14°C) below its flash point, an additional safety margin is achieved in case the mechanism governing the temperature either malfunctions or is out of adjustment.

Volatile liquids such as gasoline, low-flash-point petroleum naphthas, benzene, toluene, xylene, or lacquer thinners are sometimes used for metal cleaning. Except in very small quantities, their use is likely to create a serious fire and explosion hazard. The application of one of these materials to a large surface area from which it can evaporate, such as a floor in an enclosed area, may create a particularly hazardous condition.

Attempts are sometimes made to reduce the volatility of these materials by mixing them with nonignitable or high-flash-point solvents. Untested mixtures must be used with caution because the flash point of the mixture may not be significantly raised or the nonignitable solvent may vaporize faster, leaving the ignitable portion.

For operations where an ignitable solvent is sprayed in the open, a sprinklered, ventilated booth will limit flammable vapor from spreading beyond the work area and prevent an explosive mixture forming within the booth.

Where ignitable liquids are sprayed under pressure in enclosed equipment, an explosive condition may exist if the spray forms a mist, regardless of the flash point of the liquid. For example, No. 6 fuel oil, which has a flash point of 150°F-270°F (66°C-132°C), is commonly used for heating boilers, ovens, and furnaces. The fuel is first atomized to maximize combustion. Several explosion losses have occurred where a piece of equipment was filled with fuel oil mist in the explosive range and then ignited.

Another example is to compare high-flash-point liquids to dusts. A beaker containing coal dust requires a relatively strong ignition source to ignite, and will burn as a smoldering surface fire, but, when suspended in the air, a small spark can ignite the same dust with explosive force. A beaker full of fuel oil requires a similarly strong ignition source to ignite and will burn as a surface fire, but, when atomized, a small spark will also ignite the mist with explosive force.

3.1.4 Automatic Conveyor Washing Units Using Ignitable Liquid

Safety ventilation is needed for conveyor washing units because flammable or explosive concentrations of vapor may form as a result of spraying operations. Interlocking the ignitable liquid spray pump with the ventilation fan will prevent the formation of flammable or explosive concentrations of vapor. Even with ventilation across the unit, it is possible that a pocket of flammable vapor will form in an area of the equipment due to a process upset. Explosion protection measures, such as explosion vents, inerting, or explosion resistant construction (as specified in Data Sheet 7-32, *Ignitable Liquid Operations),* will decrease the amount of damage in the event of an explosion.

Immersion tanks in automatic conveyor washing units use large quantities of solvents that are heated up to or above their flash points. The presence of low flash point or overheated ignitable liquids will most likely result in a prolonged discharge of the sprinklers in the washing unit, without control of the fire. A prolonged sprinkler discharge may overwhelm overflow tanks and cause burning ignitable liquid to spill outside the washing unit and spread to other areas.

These tanks can be designed to contain the liquid within the system, however. Tanks may be provided with adequate overflow pipes, emergency bottom drains, or special protection systems designed to supplement automatic sprinkler protection. Tanks that are provided with one or more of these design features or safeguards are not expected to create a pool outside the equipment footprint, provided no other sources of ignitable liquid release exist in the area. Additional information on these safeguards is provided in Data Sheet 7-9, *Dip Tanks, Flow Coaters, and Roll Coaters.*

3.2 Chemical Cleaning

3.2.1 Acid Cleaning

Scale and rust are often removed from metal parts by dipping in a solution of mineral acid, organic acid, or acid salt and water. In addition, wetting agents, detergents, and inhibitors may be added. Application may be by hand wiping, immersion, spraying, or dipping in rotating barrels. A hot, diluted solution of sulfuric, nitric, or hydrochloric acid is commonly used, followed by successive hot alkaline and water rinses. Phosphoric acid cleaners are sometimes used to give a milder treatment. A fume-removal system consisting of combustible plastic exhaust ducts and scrubbers may be employed. Certain metals react with concentrated acids to produce hydrogen gas. Examples are aluminum, tantalum, and zinc. The ventilation provided to remove acidic fumes is typically sufficient to prevent explosive or flammable concentrations of hydrogen gas.

3.2.2 Alkaline Cleaners

Alkaline cleaners are widely used because of their low cost and ability to produce a surface suitable for electroplating. Caustic soda, sodium metasilicate, or sodium sesquisilicate may be used. Alkaline cleaners are used for removing materials such as drawing compounds, oils, rust preventives, or buffing or polishing materials. This process may be carried on in tanks or automatic washing machines, or the cleaning solutions may be applied to portable equipment. Operating temperatures usually are from 180°F to 200°F (82°C to 93°C).

3.2.3 Electrocleaning

Electrocleaning produces a surface suitable for electroplating. Cleaning is accomplished by passing a low voltage current (6 to 12 volts) through an alkaline solution in which the work is immersed. The work serves as one electrode. The tank is sometimes used as the other electrode, but separate electrodes are preferable to reduce the short-circuiting hazard. Solutions are commonly heated to 150°F (66°C) to increase the speed of the process and reduce the resistance to current flow.

3.3 Mechanical Cleaning

Widely used mechanical cleaning processes include blast cleaning, tumbling, and wire brushing. Ultrasonic waves are sometimes used to remove particles from inaccessible surfaces. In blast cleaning, the work is usually placed in a metal enclosure lined with rubber or wood. A jet of abrasive grit or shot is impinged on the surface to be cleaned, producing a scouring action that removes scale, rust, and molding sand. The abrasive may be impelled by air or water, or thrown from a revolving wheel. Batch equipment or automatic machines with conveyors are available. A dust collector is usually provided. For operations that create combustible dust the potential for a dust explosion needs to be evaluated.

Solid carbon dioxide pellets may also be used as the abrasive medium in blast cleaning. The method of cleaning is very similar to blast cleaning using grit except there is no residue left behind, other than the soil removed. Because the carbon dioxide is nonconducting, it can be used to remove flux from electronic circuit boards without damaging the board.

4.0 REFERENCES

4.1 FM

Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*
Data Sheet 4-5, *Portable Extinguishers*
Data Sheet 6-0, *Elements of Industrial Heating Equipment*
Data Sheet 7-2, *Waste Solvent Recovery*
Data Sheet 7-6, *Plastic and Plastic-Lined Tanks with Electric Immersion Heaters*
Data Sheet 7-9, *Dip Tanks, Flow and Roll Coaters, and Oil Cookers*
Data Sheet 7-27, *Spray Application of Flammable and Combustible Materials*
Data Sheet 7-32, *Ignitable Liquid Operations*
Data Sheet 7-41, *Heat Treating of Materials Using Oil Quenching and Molten Salt Baths*
Data Sheet 7-78, *Industrial Exhaust Systems*
Data Sheet 7-83, *Drainage and Containment Systems for Ignitable Liquids*

Data Sheet 7-88, *Ignitable Liquid Storage Tanks*
Data Sheet 7-99, *Heat Transfer Fluid Systems*
Data Sheet 10-3, *Hot Work Management*

APPENDIX A GLOSSARY OF TERMS

FM Approved: Products and services that have satisfied the criteria for FM Approval. Refer to the *Approval Guide*, an online resource of FM Approvals, for a complete listing of products and services that are FM Approved.

Ignitable liquid: Any liquid or liquid mixture that has a measurable flash point. The hazard of a liquid depends on its ability to sustain combustion or create a flammable vapor-air mixture above its surface. Flash point is one way of understanding if a liquid can create that flammable vapor-air mixture. For a liquid to burn in a pool, it must have a fire point as well as a flash point. Ignitable liquids include flammable liquids, combustible liquids, inflammable liquids, or any other term for a liquid that will burn.

Very high flash point liquid: Very high flash point liquids are liquids that meet the definition specified in Data Sheet 7-32, Section 2.1.3.1.1.

APPENDIX B DOCUMENT REVISION HISTORY

January 2022. Interim Revision. Lowered the flashpoint threshold of very high flashpoint liquids to be consistent with other ignitable liquid data sheets.

July 2013. The following major changes were made:

A. Revised terminology and guidance related to ignitable liquids to provide increased clarity and consistency. This includes the replacement of references to “flammable” and “combustible” liquids with “ignitable” liquids throughout the document.

B. Reorganized the document to provide a format that is consistent with other data sheets.

C. Added information to assist in evaluating the fire hazard scenario associated with metal cleaning using sprays or immersion in solvents, vapor degreasing, mechanical cleaning, and cleaning using corrosive solutions. This includes an evaluation of the specific solvent used for cleaning operations.

D. Added background information on various metal-cleaning operations to Section 3.0, Support for Recommendations.

E. Added reference to Data Sheet 7-27, *Spray Application of Flammable and Combustible Materials,* and Data Sheet 7-9, *Dip Tanks, Flow Coaters, and Roll Coaters,* for recommendations on the appropriate construction, location, and protection of solvent spraying and dipping operations, respectively.

F. Added information on the impact of using an FM Approved dip tank for small manual parts cleaning operations.

G. Added reference to Data Sheet 7-32, *Ignitable Liquid Operations,* for the appropriate design of piping systems.

H. Deleted information on the use of carbon dioxide and dry chemical special protection systems for automatic conveyor washing units.

I. Updated the methods for automatically shutting down pumping systems to reflect current technologies and practices.

J. Added information related to ignition source control and housekeeping.