INK, PAINT AND COATING FORMULATIONS

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1.0 SCOPE

This document provides loss prevention recommendations for facilities that manufacture inks, paints, and coatings. Reactive processes of typical coating/resin facilities (e.g., exothermic polymerization) and powder-coating manufacturing are not covered in this data sheet.

The recommendations in this data sheet mainly refer to the following FM Property Loss Prevention Data Sheets, unless otherwise indicated:

- For manufacturing process and indoor storage tanks: Data Sheet 7-32, *Ignitable Liquids Operations*
- For storage areas: Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*
- For outdoor storage of ignitable liquids: Data Sheet 7-88, *Outdoor Ignitable Liquid Storage Tanks*

For nitrocellulose storage, handling, and protection guidance, see Data Sheet 7-86, *Cellulose Nitrate*.

1.1 Hazards

The primary hazards at these facilities are associated with a substantial volume of ignitable liquids. Ignitable liquids can be found in tank farms, loading/unloading stations, mixing vessels, and onsite storage areas. Final products may be water-based; however, intermediate stages could present a fire hazard due to the use of ignitable solvents, paint thinners, combustible powders, etc. Storage in plastic drums and intermediate bulk containers (IBCs) increases the risk of a large fire due to container failure.

Ignition source control is critical to reducing fire risk. Static electricity is often a concern due to the use of low-flashpoint solvents. The integrity of tanks, piping, hoses, rotating equipment, and relief devices is needed to prevent ignitable liquid releases. The leading loss events are fires involving ignitable liquids.

1.2 Changes

January 2022. This is the first publication of this document.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Construction and Location

2.1.1 Construct and locate areas with ignitable liquid operations and storage in accordance with the relevant data sheets. Ensure all of the following are included:

A. Segregation of ignitable liquid operations and equipment from solid commodity storage and occupancies not designed for ignitable liquid hazards

B. Drainage and containment

C. Piping systems

D. Indoor/outdoor storage tanks

2.1.2 Provide ventilation systems to maintain the vapor concentration at or below 25% percent of the lower explosive limit (LEL) in areas where ignitable liquids are processed. Calculate ventilation rates using either of the following options:

A. Area sampling to determine vapor concentration under normal operating conditions or the highest concentration measured during the sampling procedure.

B. Ventilation rate of not less than 1 cfm/ft^2 (0.3 m^3/min/m^2) of solid floor area.

2.1.3 Locate solvent recovery systems (e.g., solvent recovery stills and carbon bed adsorbers) in accordance with Data Sheet 7-2, *Waste Solvent Recovery*.

2.2 Process Hazards/Safety

2.2.1 Develop a process safety program in accordance with Data Sheet 7-43, *Process Safety*. Ensure the following process safety elements are included in the program:

- Process Knowledge
- Compliance to Codes and Standards
- Management of Change
- Incident Investigation

2.3 Protection

2.3.1 Provide automatic sprinkler protection for areas where ignitable liquids and combustible materials are processed, handled, or stored.

2.3.2 Protect areas handling only water-based products or other non-ignitable liquids in combustible vessels with an automatic sprinkler system designed in accordance with Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*, using hazard category HC-3.

2.4 Equipment and Processes

2.4.1 Provide vessels and equipment that present a fire and explosion hazard with adequate protection to prevent or mitigate the effects of these events caused by combustible dust and/or flammable vapor. For equipment that presents an explosion hazard, typical examples of protection include explosion venting, equipment with adequate strength to contain an internal explosion, inerting systems, explosion suppression systems, etc. For combustible dust and hybrid mixtures guidance, see also Data Sheet 7-76, *Combustible Dusts*.

2.4.2 For dust collector guidance, see Data Sheet 7-76, *Combustible Dusts*.

2.4.3 Provide noncombustible covers for portable and fixed tanks during mixing, transportation, and idle periods.

2.4.4 Provide appropriate interlocks or liquid isolation valves for ignitable liquids used in manufacturing processes and automatic filling systems, interlocked with fire detection to close in the event of fire to isolate the liquid supply. Examples include fire-actuated safety shutoff valves, transfer pump interlocks, and liquid level limits.

2.4.5 Provide heating systems used for hot rooms, boxes, or drums with an indirect heating means that does not require an open flame (steam, hot water, electric, organic heat transfer fluid, etc.).

2.4.6 For guidance on thermal and regenerative catalytic oxidizers, refer to Data Sheet 6-11, *Thermal and Regenerative Catalytic Oxidizers*.

2.4.7 For guidance on waste solvent recovery systems, refer to Data Sheet 7-2, *Waste Solvent Recovery*.

2.5 Operation and Maintenance

2.5.1 Develop and implement operating procedures for ignitable liquid transfer operations that include all the different transfer systems, as well as flexible hoses, pumps, and connections.

2.5.2 Develop a manifold management program to ensure adequate cleanliness and a double-blocking policy are in place.

2.5.3 Establish a maintenance and asset integrity program per Data Sheet 9-0, *Asset Integrity*.

2.5.4 Inspect, test, and maintain safety controls, alarms, and interlocks in accordance with Data Sheet 7-45, *Safety Controls, Alarms and Interlocks*.

2.6 Ignition Source Control

2.6.1 Ensure static electricity management programs are in place for areas in which materials sensitive to electrostatic ignition are handled. At a minimum, consider including the following in the program:

A. Grounding and bonding of metal components. Include frequent visual inspections for evidence of corrosion or physical damage. Include clamps and cables in the inspection.

B. Use conductive floors, and shoes for grounding personnel.

C. Use non-static-producing clothing (e.g., cotton).

D. Adopt floor cleaning methods that do not create ignition hazards by releasing ignitable liquid vapors.

E. Adopt tank and vessel cleaning procedures that minimize ignition hazards.

See Data Sheet 5-8, *Static Electricity*, for additional information.

2.6.2 Provide electrical hazardous area classification where ignitable liquids are processed or stored.

2.6.2.1 Ensure lift trucks are properly rated for use in electrically classified areas. See also Data Sheet 7-39, *Material Handling Vehicles*, for guidance.

2.6.2.2 Ensure all electrical/electronic equipment or products that are used or introduced in areas where ignitable liquids are processed or stored, are adequately rated according to the electrical classification of the area.

2.7 Training

2.7.1 Train operators on the functions and required actions associated with paint manufacture in accordance with Data Sheet 10-8, *Operators.* At a minimum, include the following in the training:

- Specific hazards associated with manufacturing operations including ignitable liquids and combustible dusts
- Handling and storage procedures
- Safe work practices
- Cleanup and disposal procedures
- Forklift operation
- Housekeeping
- Alarm response

Ensure no restart attempts are made until the cause of the alarm or trip is fully understood and a detailed inspection has been conducted to verify the affected equipment is suitable for continued service.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Occupancy Overview

Paints and coatings are typically manufactured by blending various components into a final mixture. The main types can be broken down as either solvent-based or water-based. Water-based paints may have a flashpoint due to volatile components; however, the liquid may not have a demonstrable fire point. Intermediate stages may still present significant fire hazards.

There are four main components in paint: resin, additives, solvent, and pigment. Resin is the component that binds the pigments together and ensures the paint adheres to the surface it is applied to. In a water-based paint, the resin is typically a high flashpoint polymer.

The manufacturing process can be broken down into four typical steps. An individual facility may use the entire process or subsets of the process. The typical steps, shown in Figure 3.1-1, are mill base creation, letting down, combining, and mixing/filling.

Mill base creation refers to the creation of the pigment mixture. Raw pigments are crushed and dispersed using milling and dispersion equipment.

Letting down is the process of combining resins, solvents, and additives in a separate vessel. Measuring and portioning of liquid and dry ingredients is done by either weight or volume. The process can be automated or manual. Bulk liquid storage can be found in tank farms inside or outside the facility, which may present a significant ignitable liquid hazard. Hazards are typical of loading/unloading stations and tank farms in these areas. For the let-down vessels, vessel deflagration and ignitable liquid pool fires are the primary hazards.

Combining refers to the combination of the mill base and the let-down. Mixing and filling are the final step. Paints and coatings can be filled in bulk totes, 55 gal (200 L) drums, or paint cans. This is typically an automated process. Automated lines may have long replacement times and special servicing agreements with the OEM. The “fill” could be a combination of several mixtures, depending on the desired color, gloss, finish, and a variety of other properties. Typically, the final product is tested in a laboratory for quality purposes before it is cleared for shipment. Transfer systems are typically interlocked to shut down in the event of a fire.

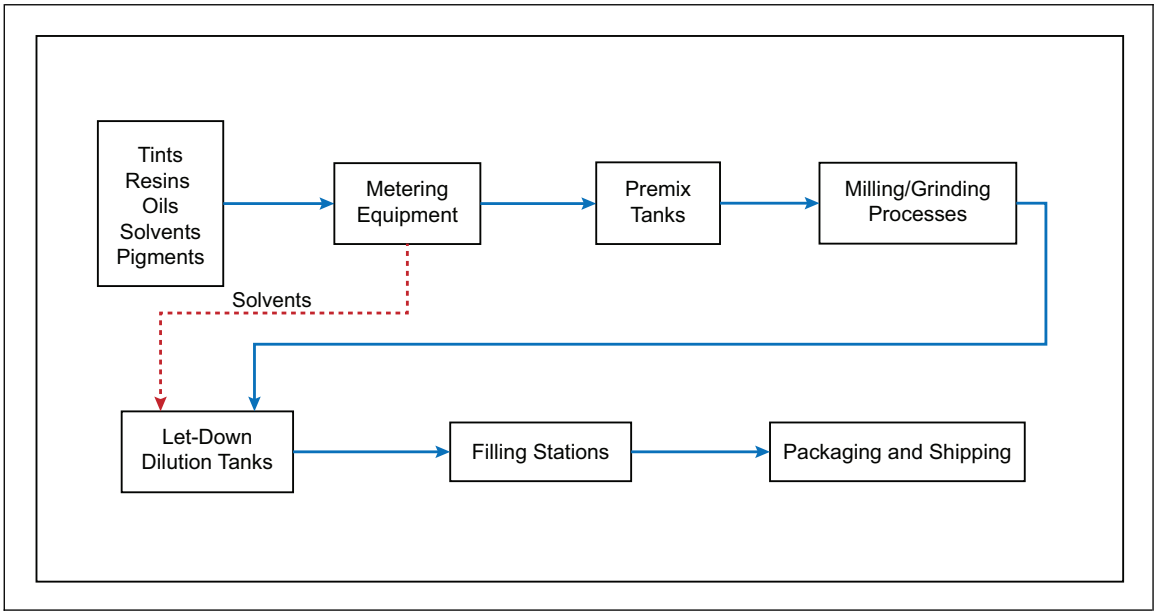

Fig. 3.1-1. Typical paint/coating blending system

To handle waste and other byproducts, paint and coating plants typically have a wastewater treatment facility, and possibly emissions control equipment such as thermal oxidizers.

3.2 Electrical Conductivity of Liquids

Electrical conductivity of liquid materials is used to determine if they are capable of conducting electricity or not. In the coatings and paint industry, this property plays an important role in assessing the potential of static accumulation and the generation of sparks during ignitable liquid handling and processing operations.

Based on the potential for charge accumulation or specific conductivity values, liquids can be classified as conductive, semiconductive (static dissipative), and nonconductive. Conductivity is measured in Siemen per meter (S/m) units. Conductive liquids have conductivities greater than 10^4 pS/m, and liquids having conductivities of 50 pS/m to 10^4 pS/m are considered semiconductive. A liquid is considered nonconductive (charge accumulating) if its conductivity is below 50 pS/m, assuming a dielectric constant of 2.

The conductivity of most ignitable liquids varies from about 10^{-2} pS/m to 10^{10} pS/m. Dielectric constants usually range from 2 to 40, the higher values generally being exhibited by polar liquids, which also exhibit higher conductivity.

3.3 Illustrative Losses

3.3.1 Fire at a Wooden and Ceramic Flooring Coatings Facility

A fire originated in the rack storage area on the second floor of the manufacturing area. The rack storage contained packaging and solid raw materials. The fire was not initially controlled and spread out quickly, completely engulfing the adjacent coating area. The entire facility was not provided with automatic sprinkler protection and initial attempts were made by employees to control the fire using fire extinguisher and hose reels. The fire brigade was notified and arrived within 15 to 20 minutes, controlling the fire within one hour. Walls, windows, flooring and the steel mezzanine floor in this area were severely damaged. Finished products, work in process, raw materials, packaging materials, production machines and testing equipment were destroyed or severely damaged beyond economic restoration. Minor damage was sustained to other manufacturing areas due to the presence of firewalls. The cause of the fire is unknown.

3.3.2 Fire Results in an Impaired Sprinkler Water Supply

A fire of unknown cause propagated through a yard storage area where ignitable liquids, IBCs containing other chemicals, idle pallets and empty IBCs were located. The fire also involved the pump house building, cooling tower and suction tanks, which were constructed with combustible materials, leading to an impairment of the water supply feeding the sprinkler systems. Lack of containment for ignitable liquid storage exacerbated fire propagation throughout the yard storage. All goods store in the yard were consumed by the fire. Production areas were not directly affected, but at the time of the loss visit, the authorities had not given permission to re-start operations.

Noncombustible construction helped to prevent fire spread into the main building. In addition, the slope of the yard caused ignitable liquids to flow away from the plant.

3.3.3 Batch Tank Fire

A batch tank caught fire during the addition of wax (mineral spirit-impregnated) from a 55-gal (200 L) steel drum that was supported by a drum runner, which was reportedly grounded. An adjacent batch tank was also involved in the fire. The foam-water sprinkler system operated properly, and 14 sprinklers controlled the fire. The most probable cause was static electricity either caused by material transfer or a spark created by one of the steel screws on the tool the employee was using to get wax out of the drum and into the batch tank.

3.3.4 Fire at a Finished Products Warehouse

During the transportation of finished products, two paint drums fell from a rack in the warehouse. One of the drums broke, releasing paint on the ground. When one employee tried to remove the broken drum by using a non-rated LPG forklift, the vapors from the paint ignited, and the fire quickly spread to the adjacent paint drums in the racks.

Smoke detectors actuated the fire alarm, which alerted an employee who manually triggered the remote-control button for the deluge sprinkler valve and the fire alarm on the control panel. He also manually opened the foam discharge valve, which was normally closed. However, none of the deluge valves actuated.

During the fire none of the fire doors were closed. Fire, smoke and water damage was limited to two of the three cells of the warehouse. The fire was eventually controlled by manual firefighting two hours after event initiation.

3.3.5 Fire in a Warehouse Where Paint Mixing Operations Were Conducted

The site was used for the storage of paint products and solvents, as well as paint mixing operations - where more than 15 mixing tanks of approximately 500-gal (1.9 m^3) capacity were located. The fire initiated at one of the steel mixing tanks, located inside the mixing room, while mixing nitrocellulose and a solvent. The fire propagated throughout the entire facility destroying the building, mixing equipment, inventory, and other contents.

During the investigation it was found that most of the electrical equipment in the area was not rated for use in hazardous locations, including the forklifts. There was no containment or drainage provided in the mixing areas or in the mixing room. Mechanical exhaust ventilation was provided at roof level in the mixing room and natural exhaust ventilation (roof vents) over the storage area. Ventilation was not provided at, or near, the floor level. Mixing tanks were found outside of the mixing room with no grounding. The building was not provided with sprinkler protection.

The fire was controlled after almost 10 hours and the cause of the fire was unknown at the time of the investigation.

4.0 REFERENCES

4.1 FM

Data Sheet 3-26, *Fire Protection for Nonstorage Occupancies*
Data Sheet 5-8, *Static Electricity*
Data Sheet 6-11, *Thermal and Regenerative Catalytic Oxidizers*
Data Sheet 7-2, *Waste Solvent Recovery*
Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*

Data Sheet 7-32, *Ignitable Liquids Operations*
Data Sheet 7-39, *Material Handling Vehicles*
Data Sheet 7-43, *Process Safety*
Data Sheet 7-45, *Safety Controls, Alarms and Interlocks*
Data Sheet 7-76, *Combustible Dusts*
Data Sheet 7-86, *Cellulose Nitrate*
Data Sheet 7-88, *Outdoor Ignitable Liquid Storage Tanks*
Data Sheet 9-0, *Asset Integrity*
Data Sheet 10-8, *Operators*
Data Sheet 7-59, *Inerting and Purging Vessels and Equipment*

APPENDIX A GLOSSARY OF TERMS

See Data Sheet 7-111.

APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

January 2022. This is the first publication of this document.