IGNITABLE LIQUID EVALUATION AND CLASSIFICATION

Table of Contents

Page

List of Figures

List of Tables

1.0 SCOPE

This data sheet provides guidance on defining and grouping ignitable liquids. The term "ignitable liquid" is defined as any liquid that has a measurable closed-cup flash point.

Some liquids identified as ignitable liquids in this data sheet may be treated as non-ignitable liquids in specific uses and applications. Refer to the applicable occupancy-specific data sheets for loss prevention recommendations related to the following subjects, which are not covered in this data sheet:

- *Waste Solvent Recovery* (FM Property Loss Prevention Data Sheet 7-2)
- *Dip Tanks, Flow Coaters and Roll Coaters* (Data Sheet 7-9)
- *Fire Protection for Chemical Plants* (Data Sheet 7-14)
- *Oil Cookers* (Data Sheet 7-20)
- *Spray Application of Ignitable and Combustible Materials* (Data Sheet 7-27)
- *Ignitable Liquid Storage in Portable Containers* (Data Sheet 7-29)
- *Ignitable Liquid Operations* (Data Sheet 7-32)
- *Cutting Fluids* (Data Sheet 7-37)
- *Heat Treating of Materials Using Oil Quenching and Molten Salt Baths* (Data Sheet 7-41)
- *Distilleries* (Data Sheet 7-74)
- *Drainage and Containment Systems for Ignitable Liquids* (Data Sheet 7-83)
- *Aircraft Hangars, Aircraft Manufacturing and Assembly Facilities, and Protection of Aircraft Interiors During Assembly* (Data Sheet 7-93)
- *Metal Cleaning* (Data Sheet 7-97)
- *Hydraulic Fluids* (Data Sheet 7-98)
- *Heat Transfer Fluid Systems* (Data Sheet 7-99)

1.1 Hazards

Ignitable liquids burn as vapor. Low flash and fire point liquids can easily ignite at ambient temperatures, while higher flash point liquids require heating, a higher ignition energy or a physical change (i.e., spraying) to burn.

The ability for liquids to flow or spread, regardless of flash point, creates a significant challenge for ceiling level sprinkler protection in controlling the fire hazard. The fire will spread wherever the liquid flows. The fire's heat release rate increases with the surface area of a liquid pool.

Ignitable liquids can be subdivided into three groups:

A. Liquids for which a fire cannot be extinguished by ceiling sprinklers

   1. Low flash point liquids (<200°F [93°C])

B. Liquids for which a fire can be extinguished by ceiling sprinklers

   1. High flash point liquids (≥200°F [93°C] and <414°F [212°C])

   2. Liquids with a specific gravity >1.0

   3. Water-miscible liquids

C. Liquids that resist fire spread when unheated and pooled

   1. Very high flash point liquids (≥414°F [212°C])

Liquids with a flash point and no fire point do not present a pool fire hazard but could create a spray fire hazard or an explosion hazard within an enclosed piece of equipment.

1.2 Changes

April 2026. This is the first publication of this data sheet.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

Use FM Approved equipment, materials and services whenever 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 General

2.1.1.1 Identify applicable properties for all liquids, such as:

- Closed-cup flash point
- Open-cup fire point
- Boiling point
- Water miscibility
- Specific gravity
- Chemical composition

2.1.1.2 Treat materials that are liquid at 68°F (20°C) and have a measurable closed-cup flash point as ignitable liquids unless otherwise defined in Section 2.1.2.

2.1.1.2.1 Determine the closed-cup flash point of the liquid using one of the following test methods:

- ASTM D56, *Standard Test Method for Flash Point by Tag Closed Tester*
- ASTM D93, *Standard Test Methods for Flash Point by Pensky-Martens Closed-cup Tester*
- ISO 2719, *Determination of Flash Point - Pensky-Martens Closed-cup Method*

2.1.1.2.2 If elevation is above 5,000 ft (1,500 m), adjust ignitable liquid flash points for altitude per Section 3.1.1.2 before determining fire protection requirements.

2.1.2 Ignitable Liquid Evaluation

2.1.2.1 Very High Flash Point Liquids

2.1.2.1.1 Treat liquids that meet one of the following conditions as very high flash point liquids:

A. Unheated liquids with a flash point at or above 414°F (212°C), including liquids, previously tested, listed in Table 2.1.2.1.1

B. Heated liquids with a flash point at or above 414°F (212°C), having an operating temperature that meets the following equations:

1. Closed-cup flash point (°F) - operating temperature (°F) > 324°F (Imperial)
2. Closed-cup flash point (°C) - operating temperature (°C) > 180°C (Metric)

Utilize the imperial or metric equations above to calculate if the liquid is a very high flash point liquid. Conversion of the threshold value between imperial and metric is not appropriate, since the equations represent a temperature difference.

C. Vegetable oils and fish oils with a closed-cup flash point of 450°F (232°C) and greater that are heated to ≤150°F (65°C).

Table 2.1.2.1.1. Very High Flash Point Liquids

Liquid	*CAS Number*
Canola	120962-03-0
Corn	8001-30-7
Palm	8002-75-3
Rapeseed	8002-13-9
Soybean/Soya	8001-22-7
Sunflower	8001-21-6
Butter Fat	N/A
Milk Fat (Milkfat)	N/A
Lecithins	N/A

A liquid with a flash point at or above 414°F (212°C) will not propagate in a pool fire, unless a large ignition source is present. However, it might still burn in the form of a spray; if the pressure is greater than or equal to 50 psi (3.4 bar).

2.1.2.1.1.1 Treat silicone fluids in accordance with Section 2.1.2.5.

2.1.2.1.2 Confirm the measured closed-cup flash point through testing, using one of the test methods listed in Section 2.1.1.2.1.

2.1.2.1.2.1 Repeat the test three times. Use the average value from the three tests as the closed-cup flash point.

2.1.2.2 Aqueous Mixtures or Emulsions

2.1.2.2.1 Treat aqueous mixtures or emulsions, each having more than 20% ignitable liquid, in accordance with their flash point.

2.1.2.2.2 Treat aqueous mixtures or emulsions, each having less ≤20% ignitable liquid, as mixtures that will not create a pool fire regardless of flash or fire point.

2.1.2.3 Water-Miscible Liquids

2.1.2.3.1 Treat liquids that mix with water at all proportions as water-miscible.

2.1.2.3.2 Group water-miscible, ignitable liquids in accordance with Table 2.1.2.3.2.

2.1.2.3.2.1 If not listed in Table 2.1.2.3.2, treat water-miscible liquids as Group 1.

Table 2.1.2.3.2. Water-Miscible Liquid Groupings

	Volume Percent Range (%)				
Liquid	Group 1	Group 2	Group 3	Group 4	Group 5
Alcohol (Note 1)	100 – 71	70 – 51	50 – 31	30 – 21	20 – 0
Acetone	80 – 16	NA	NA	NA	15 – 0
Acetic Acid	NA	NA	100 - 90	NA	89 – 0
N-Methylpyrrolidone (NMP)	NA	NA	100 - 86	NA	85 – 0
Ethylene Glycol	NA	NA	100 - 81	NA	80 – 0
Propylene Glycol	NA	NA	100 - 81	NA	80 – 0
Glycerin	NA	NA	100 - 81	NA	80 – 0
Dimethyl Sulfoxide (DMSO)	NA	NA	100 - 81	NA	80 – 0

Note 1. Methyl alcohol, ethyl alcohol, n-propyl alcohol, isopropyl alcohol, tert-butyl alcohol, allyl alcohol.

2.1.2.3.3. Treat a mixture of alcohol and another water-miscible liquid by adding the percentages and basing the group on total percentage of water-miscible liquid content. Refer to Table 2.1.2.3.2, as specified, for alcohol. For example, treat a mixture comprised of 40% alcohol, 30% propylene glycol and water for the remainder as 70% alcohol (Group 2).

2.1.2.3.4 Treat acetone-water mixtures containing more than 80% acetone as non-miscible, ignitable liquids in accordance with their flash point.

2.1.2.4 Viscous Liquids and Viscous Mixtures

2.1.2.4.1 Viscous Liquids

2.1.2.4.1.1 Treat liquids with a dynamic viscosity ≥10,000 cP as viscous liquids.

2.1.2.4.1.2 Treat viscous liquids as ignitable liquids in accordance with their closed-cup flash point.

2.1.2.4.2 Viscous Mixtures

2.1.2.4.2.1 Treat mixtures consisting of ignitable liquids and solids with a dynamic viscosity ≥10,000 cP as viscous mixtures.

2.1.2.4.2.2 Treat viscous mixtures as viscous liquids in accordance with their flash point and dynamic viscosity as shown in Figure 2.1.2.4.2.2.

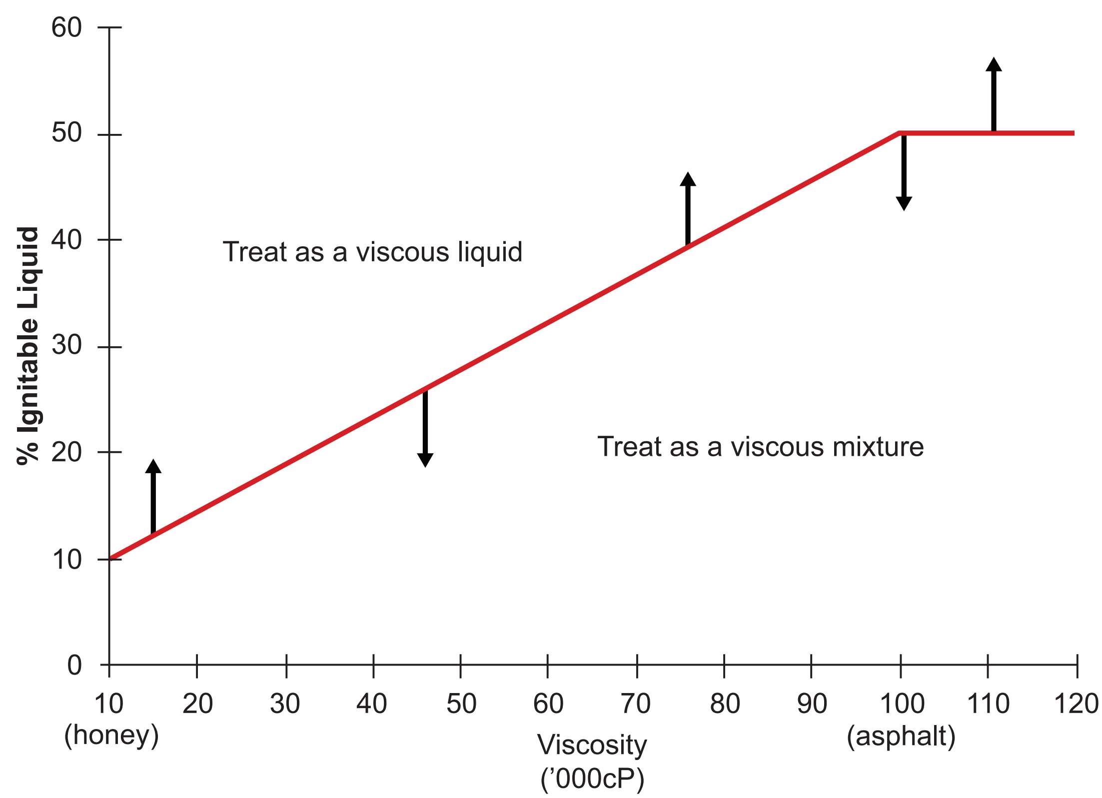

Fig. 2.1.2.4.2.2. Viscous mixture classification

2.1.2.5 Silicone Fluids and Silicone Emulsions

2.1.2.5.1 Silicone Fluids

2.1.2.5.1.1 Treat pure silicone fluids per Table 2.1.2.5.1.1

Table 2.1.2.5.1.1 Treatment of Pure Silicone Fluids

Closed Cup Flash Poinr	*Treat As*
<200°F (93°C)	<200°F (93°C)
200°F (93°C)≤CCFP< 500°F (260°C)	>200°F (93°C)
≥500°F (260°C)	Very High Flash Point

2.1.2.5.2 Silicone-Water Emulsions

2.1.2.5.2.1 Treat silicone emulsions consisting of ≥50% silicone fluid in water as ignitable liquids in accordance with their flash point.

2.1.2.5.2.2 Treat silicone emulsions consisting of <50% silicone fluid as non-ignitable liquids.

2.1.2.6 Paste Ink

2.1.2.6.1 Treat inks that meet the following conditions as paste inks:

A. A closed-cup flash point ≥200°F (93°C)

B. Vegetable oil based

C. Do not pour or readily flow at 68°F (20°C) without the application of pressure

2.1.2.7 Polyurethane Foam Components

2.1.2.7.1 Treat polymethylene polyphenyl isocyanate, diphenylmethane diisocyanate, or polymeric MDI or PMDI as ignitable liquids in accordance with their flash point.

2.1.2.7.2 Treat pure polyether or polyester polyols as non-ignitable liquids.

2.1.2.7.3 Treat polyether or polyester polyols blended with oil or any other ignitable liquid, such as glycols or glycerines, as ignitable liquids in accordance with their flash point.

2.1.2.8 Unsaturated Polyester Resin (UPR)

2.1.2.8.1 Treat unsaturated polyester resin (UPR) as an ignitable liquid in accordance with its flash point.

2.1.2.8.1.1 For storage applications, determine the percentage of styrene in the UPR.

2.1.2.9 Semi-Solid Liquids

2.1.2.9.1 Treat liquid salad dressings as follows:

A. Dressings with <50% oil content as a Class 3 commodity in accordance with FM Data Sheet 8-1, *Commodity Classification*.

B. Dressings with ≥50% oil content as an ignitable liquid in accordance with its flash point.

2.1.2.9.2 Treat lubricating grease, shortening and deep-frying fat as ignitable liquids in accordance with their flash point.

2.1.2.10 Phase Change Materials (PCMs)

2.1.2.10.1 Treat phase change materials (PCMs) as ignitable liquids based on the lowest closed-cup flash point for any component.

2.1.2.11 FM Approved Fluids

2.1.2.11.1 Treat storage of FM Approved Fluids as ignitable liquids in accordance with their flash point.

2.1.2.11.2 Treat use of FM Approved Fluids in accordance with the appropriate data sheets.

2.2 Training

2.2.1 Develop a system to identify ignitable liquids that are in use or storage. Include the following characteristics, as applicable:

- Pure material or a mixture
- Chemical composition
- Closed-cup flash point
- Fire point
- Water miscibility

- Specific gravity
- Viscosity
- If liquid is a mixture, identify those that are:
  - ≤20% by volume alcohol-water
  - ≤20% by volume ignitable liquid-water emulsion
  - ≤20% by volume sum of multiple water-miscible liquids in water

2.2.2 Classify the identified ignitable liquids per this data sheet.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Introduction

Ignitable liquids do not burn; the flammable vapors produced by the ignitable liquids burn. Combustion is an exothermic, chemical reaction between a fuel and an oxidizer (usually oxygen). Combustion will occur only when an adequate concentration of flammable vapor and an oxidizer are present. Combustion in air (approximately 21% oxygen) can take place over a range of vapor concentrations (expressed in terms of percentage by volume of vapor in air). The minimum vapor concentration in air that, when ignited, will propagate a flame is the lower flammable limit (LFL) or lower explosive limit (LEL). The maximum vapor concentration in air that, when ignited, will propagate a flame is the upper flammable limit (UFL) or upper explosive limit (UEL). The range of vapor concentrations between the lower and upper flammable limits is the flammable range.

The flammable range for a vapor can be altered by changes in oxygen concentration, system pressure or temperature. An increase in oxygen concentration or system pressure will increase the upper flammable limit and have a minimal effect on the lower limit. An increase in temperature will increase the upper limit and reduce the lower limit. In general, an increase in oxygen concentration, system pressure or temperature will increase the hazard created by an ignitable liquid by increasing its vapor’s flammable range.

One of the protection challenges involving ignitable liquids is that they can spread, making it possible for a fire to travel beyond the point of ignition. Ignitable liquid fires increase in severity with expanded pool size. Fire severity will be minimized if the ignitable liquid can be contained within the equipment (equipment fire exposure) or contained to a small footprint on the floor. If the ignitable liquid is released from the equipment and forms a large pool, the potential exists for a large fire that can operate all exposed sprinklers. Passive and active fire protection features will vary, depending on the severity of the potential fire hazard.

The consequences of an upset condition in an ignitable liquid process are dependent on several factors. The overall severity of the hazard depends on the amount of liquid and the surrounding occupancy. A highly sensitive occupancy (e.g., a clean room) may be unable to tolerate even a few gallons (liters) of burning liquid. Conversely, a generally noncombustible occupancy with robust construction features (e.g., a steel mill) may be able to tolerate a significantly larger liquid fire without severe damage.

Regardless of the quantity of ignitable liquid, the best practice is to control an ignitable liquid release, limit the possible pool area and prevent ignition.

Liquid Burning Propensity

The first step in evaluating a liquid fire or explosion hazard is to determine if the liquid burns. If the liquid cannot support combustion, it does not represent a fire or explosion hazard. The ability of a liquid to burn is generally tied to its closed-cup flash point. However, a flash point alone does not always indicate whether a liquid can sustain combustion. Some liquid solutions have a closed-cup flash point but no fire point. That is, the liquid solution cannot produce enough flammable vapor to permit sustained combustion; or the vapor mixture produced has a very low heat of combustion and slow heat release rate. This type of mixture does not present a fire hazard but could create an explosion hazard within an enclosed piece of equipment.

Determining if a liquid will burn can be challenging. Current labeling practices required by transportation codes and other regulations are inconsistent and can be misleading. Naming conventions (i.e., ″flammable″ versus ″combustible″) can also imply that liquids create different relative fire hazards. In fact, they can all create an exposure to a building when they burn.

Fire severity is driven by heat release rate. For liquid fires, the heat release rate is controlled by the surface area of the liquid, the liquid's heat of combustion and the mass loss rate of the liquid. The flame height is tied to the fire's heat release rate. The heat of combustion and mass loss rate are physical properties of the liquid. The surface area available to burn is dependent on numerous external factors, including:

A. The amount of liquid released

B. Liquid release method (spray release, liquid stream, catastrophic mass release)

C. Floor surface and pitch (rough surface and/or floor pitch will limit liquid spread)

D. Construction of equipment or piping (Noncombustible equipment will tend to retain liquid in a fire if properly protected; combustible or brittle equipment will release liquid in a fire, regardless of protection.)

Pool fires located inside a building will produce a similar overall exposure to the building, independent of the ignitable liquid's heat release rate. For example, pool fires that produce theoretical flame heights of 38 ft (11.6 m) or 30 ft (9 m) will both quickly heat structural steel elements if the building height is only 30 ft (9 m).

Low flash point, ignitable liquids are easily ignited (vapor can be present at room temperature [68°F (20°C)]). High flash point ignitable liquids require heating for ignition to occur, and the fire will initially progress slowly across the liquid's surface. However, both types of liquid have a high heat of combustion. Once ignited, they will produce a high heat release rate fire (i.e., the fires will produce high temperatures in a short period of time). Since the heat release rate provides a measure of the fire severity, subdividing hydrocarbon liquids by their flash point alone does not capture their real fire hazard.

Flash point does have an impact on the ceiling sprinklers' ability to extinguish a pool fire. FM tests have shown ceiling sprinklers were successful in extinguishing pool fires involving liquids with a closed-cup flash point at or above 200°F (93°C). The testing evaluated mineral seal oil with a closed-cup flash point of 285°F (141°C). This testing demonstrated that liquids with flash points above 200°F (93°C) could be ignited with a small local ignition source, and the fire would spread across the pool's surface even with unheated oil and sprinklers operating. The tests also provided the water discharge rate needed to extinguish the pool fire.

Even though automatic fire sprinklers have been shown to be effective against high flash point liquid fires, they will not extinguish or control a liquid spray or 3-dimensional (3-D) spill fire, regardless of the liquid's flash point. Even special protection systems such as foam-water sprinkler systems and compressed air foam systems are not effective against a flowing liquid fire. Providing the ability to shut down the flow of an ignitable liquid during a fire is critical when designing fire protection.

Other characteristics that may impact the fire hazard include whether the ignitable liquid is a mixture or emulsion, and material/liquid properties such as water miscibility, chemical composition, viscosity, boiling point and specific gravity.

Finally, vapor from ignitable liquids can form explosive mixtures with air. Some liquids are unstable or very reactive (e.g., burn when exposed to air without an ignition source, susceptible to spontaneous heating, react violently with other materials including water). These characteristics combine to create a significant fire and/or explosion hazard.

Liquids with Boiling Point Below 100°F (38°C)

No large-scale fire testing has been conducted on ignitable liquids with a boiling point below 100°F (38°C). Their low boiling point results in rapid vaporization when released. This characteristic creates the potential for the formation of an explosive cloud if the liquid is spilled, or the quick buildup of pressure in a sealed container exposed to fire. The impact on the overall fire hazard may be limited. Quick vaporization produces a high mass loss rate that will quickly reduce the pool area. These two factors may negate each other's impact on the overall heat release rate. The key concern with these liquids is the prevention of a large liquid release that could result in an explosion, and the prevention of container over-pressurization during a fire.

Liquids with a Specific Gravity Greater than 1.0

The specific gravity permits a determination of what effect water will have on an ignitable liquid fire.

Liquids lighter than water will float, indicating the fire would not be extinguished but could be spread by water.

Liquids heavier than water will sink, eliminating the availability of oxygen and extinguishing the fire.

3.1.1 Resources to Obtain Ignitable Liquid Physical Properties

Ignitable liquid properties can be obtained from the following sources:

- Safety Data Sheets
- Liquid manufacturer
- Online resources

A **Safety Data Sheet (SDS)** is a standardized document that provides detailed information about a chemical substance or mixture.

The primary purpose of an SDS is to inform workers and emergency personnel about the hazards associated with a chemical; guide safe practices in handling, using and storing chemicals; and to support compliance with occupational safety regulations (e.g., OSHA in the U.S.).

An SDS typically includes 16 sections, including:

1. **Identification** – Product name, manufacturer, recommended uses
2. **Hazard(s) Identification** – Physical and health hazards
3. **Composition/Information on Ingredients** – Chemical ingredients and concentrations
4. **First-Aid Measures** – Emergency procedures for exposure
5. **Fire-Fighting Measures** – Suitable extinguishing methods
6. **Accidental Release Measures** – Spill response and cleanup
7. **Handling and Storage** – Safe practices and conditions
8. **Exposure Controls/Personal Protection** – PPE and exposure limits
9. **Physical and Chemical Properties** – Appearance, odor, boiling point, etc.
10. **Stability and Reactivity** – Reactivity and stability data
11. **Toxicological Information** – Health effects and symptoms
12. **Ecological**
13. **Disposal**
14. **Transport**
15. **Regulatory Information**
16. **Other Information** – Revision dates and additional notes

For an ignitable liquid, the SDS focuses on properties that relate to flammability, volatility and safe handling. These are especially important for fire prevention and emergency response.

Key Liquid Properties in an SDS for an Ignitable Liquid (Section 9):

1. **Appearance** – Description of the liquid (e.g., clear, amber, viscous)
2. **Odor** – Often strong or characteristic (e.g., solvent-like, gasoline-like)
3. **Flash Point** – Critical for ignitable liquids; the lowest temperature at which vapors can ignite in air.
4. **Boiling Point** – Helps determine volatility and evaporation rate.
5. **Evaporation Rate** – Indicates how quickly the liquid turns to vapor; faster rates mean higher fire risk.
6. **Flammability (solid, gas)** – Confirms the liquid is flammable and under what conditions.
7. **Upper/Lower Flammability or Explosive Limits** – Vapor concentration range in air in which ignition can occur.
8. **Vapor Pressure** – Higher values mean more vapor in the air, increasing fire risk.
9. **Vapor Density** – Vapors heavier than air can accumulate in low areas, creating ignition hazards.

10. **Auto-Ignition Temperature** – Temperature at which the liquid ignites without a spark or flame.

11. **Solubility** – May affect how the liquid spreads or mixes with water during spills.

12. **Partition Coefficient (n-octanol/water)** – Indicates the potential for bioaccumulation or environmental spread.

13. **Viscosity – Affects how the liquid flows and spreads if a leak or spill occurs.**

Safety Data Sheets (SDS), while essential for hazard communication and workplace safety, may provide insufficient information on how a liquid should be treated or protected, because:

- Manufacturers may list certain ingredients as “trade secrets”, omitting specific chemical identities or concentrations.
- The completeness and clarity of SDSs can vary.
- The provided flash points may not have been tested and simply represent the lowest flash point of the mixture or a value available in literature.
- If a flash point is provided, the value is not always specified as Open-Cup or Closed-Cup.
- The Fire Point is seldom provided.
- Information about miscibility and solubility uses a wide variety of terms.

3.1.1.2 Modifying Closed-Cup Flash Points for Elevation Differences

Flash points are listed relative to mean sea level (MSL). However, altitude can reduce the flash point as the elevation increases. This scenario may result in the need for ventilation and ignition source controls when located well above sea level.

Adjust the flash points for altitude by using the following equation:

EQ 3.1.1.2: $F_c\ (°F) = F_{sl}\ (°F) – 0.06\ (760 – P)$ (Derived from ASTM D56)
$F_c\ (°C) = F_{sl}\ (°C) – 0.033\ (760 – P)$

where:

F_c = the flash point corrected to desired altitude;
F_{sl} = flash point at sea level;
760 mm Hg = the average barometric pressure at sea level;
P = average barometric pressure at the given altitude, expressed in mm Hg

Note: This approach was developed from the methodology provided in ASTM D56, *Standard Test Method of Flash Point by Tag Closed Cup Tester*.

3.1.2 Ignitable Liquid Evaluation

3.1.2.1 Very High Flash Point Liquids

Based on the results of several research test programs, FM has defined a closed-cup flash point threshold at which liquids will not support fire spread across an unheated liquid pool. These results do not mean these liquids will not burn. In fact, they still represent a severe fire hazard when stored in small plastic containers with cardboard packaging and (in some instances) when heated.

3.1.2.1.1 Butterfat or Milkfat

Butter is a soft yellow or white emulsion made from butterfat, water, air and sometimes salt. It is churned from milk or cream for use in cooking and as a food.

Butterfat is the natural fat of milk from which butter is made. It can also be called milkfat.

Fire testing on butterfat demonstrated that it will not support fire spread across the surface of a liquid pool.

3.1.2.1.2 Lecithins

Lecithins are emulsifying agents separated from vegetable oils (most commonly from soybean oil). They are difficult to ignite, but they do burn. After ignition, the fire will have difficulty spreading over the surface, which is similar to the behavior of very high flash point liquids.

Pure lecithin is a phosphatidyl choline. Lecithins may also be known as phosphoglycerides, phosphatides or phospholipids.

3.1.2.2 Aqueous Mixtures of Emulsions

Some products consist of a water base, mixed with various percentages of immiscible ignitable liquids and solids. Many of these products are emulsions, where the immiscible, ignitable liquid does not separate from the mixture because of an emulsifying agent. A common example of this type of product is a waterborne paint or coating. Latex paints generally have little or no ignitable liquid content. Some newer paints have various percentages of ignitable liquid in a water base. The ignitable liquids can be water-miscible or immiscible. Bench-scale testing on paint products with up to 20% immiscible, ignitable liquid has shown these materials present no measurable fire hazard. Many of these materials cannot be easily tested using standard flash or fire point test methods. However, efforts to ignite larger quantities of liquid than required by these tests also failed to produce any sustained combustion. All unconfirmed emulsion products with ignitable liquid content require testing to confirm whether the product has a fire point.

3.1.2.3 Water-Miscible Liquids

Historically, water-miscible, ignitable liquids were thought to require significantly less protection than other hydrocarbon liquids. They generally have lower heat release rates, low flame radiation (due to limited soot production) and can be diluted with water to a point where they cease to burn. Some protection criteria for water-miscible liquids, as a general group, can be reduced due to these factors.

Water-miscible liquids do mix with water. As the water percentage of the mixture rises, the flash point and fire point of the mixture increase, while the heat of combustion and heat release rate decrease. Most of the mixing in a sprinklered pool fire scenario is due to sprinkler discharge impacting the liquid pool surface. Full-scale tests by FM have shown that although mixing does occur, if the water-miscible liquid is lighter than water, the process is very slow.

At some point, the mixture will cease to have a fire point but may still have a flash point. A water-miscible, ignitable liquid typically has a lower boiling point than water. The ignitable liquid is the first to vaporize if the solution is heated. Therefore, the solution will still produce a closed-cup flash point. However, mixtures that do not have a fire point will not burn.

Conversely, if the mixture has a fire point, it will burn and can create a pool fire. Therefore, liquid mixtures with limited amounts of a water-miscible liquid and a fire point have the potential for creating a pool fire if the liquid release is not controlled or contained during a fire. This scenario could allow fire spread well beyond the area of fire origin, even if the overall fire severity is limited (i.e., a dilute alcohol pool fire will not damage the building). Mixtures that have fire points should always be considered ignitable liquids.

3.1.2.3.1 Propylene and Ethylene Glycol Mixtures

Propylene glycol and ethylene glycol are water-miscible, high flash point (FP above 200°F [93°C]) ignitable liquids. One advantage of these liquids over other high flash point or water-miscible liquids (from a protection standpoint) is that they quickly cease to produce a fire point when diluted. Bench-scale testing of both propylene glycol and ethylene glycol has shown they no longer produce a fire point once they have been mixed with 20% by volume water. Glycol-water mixtures containing 80% by volume or less glycol do not need to be treated as ignitable liquids, because the liquids will not burn when in a pool on the floor. However, these liquid mixtures can still impact a fire while they are on the surface of burning cellulosic materials. Intermediate-scale testing of glycol-water mixtures discharged onto burning wooden pallets has shown that mixtures with more than 35% by volume glycol will increase the burning rate of the pallets.

3.1.2.3.2 N-Methylpyrrolidone (NMP)

NMP is used in the manufacture of lithium-ion batteries, and the CAS number is 872-50-4. NMP is a water-miscible liquid that no longer produced a fire point in an 85% NMP/15% water mixture.

3.1.2.3.3 Dimethyl Sulfoxide (DMSO)

DMSO is a water-miscible, chemical solvent; and the CAS number is 67-68-5. DMSO no longer produced a fire point in an 80% DMSO/20% water mixture.

3.1.2.4 Viscous Liquids and Viscous Mixtures

3.1.2.4.1 Viscous Liquids

An important benefit of viscous liquids is their reduced flow capacity. Highly viscous liquids will resist free flow, resulting in reduced surface area, which has a direct impact on fire severity.

Viscosity is measured by many different types of tests. Many of the measurements were developed for a particular type of liquid at a fixed temperature. Conversion between most of the viscosity measurements is not possible. One unit of dynamic (absolute) viscosity is a centipoise (cP). One cP is equivalent to 6.72×10^{-4} lb/ft-s or 0.01 g/cm-s. The viscosity of several liquids (at 70°F [21°C]) is:

- Water: 1.0 cP
- Gasoline: 0.65 cP
- Acetone: 0.35 cP
- Lubricating oil (SAE 10): 60 cP
- Glycerin: 1000 cP
- Honey: 10,000 cP
- Asphalt: >100,000 cP

A common unit of measure for kinematic viscosity (ratio of dynamic viscosity and density) is centistokes (cSt). At 68°F (20°C), water has a kinematic viscosity of about 1 cSt.

The viscosity of many materials decreases with elevated temperatures. Since current viscosity measurement techniques do not provide viscosities at fire temperatures, a reduction in fire hazard for viscous homogenous materials cannot be determined.

3.1.2.4.2 Viscous Mixtures

Viscous mixtures consist of a mixture of solids and an ignitable liquid. In cases where the solid content is elevated, a reduction in fire hazard is expected. One example is automobile repair putty, which consists of a viscous base material combined with a small quantity of low flash point solvent.

3.1.2.5 Silicone Fluids and Silicone Emulsions

3.1.2.5.1 Silicone Fluids

Historically, silicone fluids were thought to present a minimal fire hazard; because the silicone dioxide ash produced by burning silicone fluids was believed to coat the liquid surface and extinguish the fire. However, large pool fires create significant upward momentum that lift even silicone dioxide ash away from the liquid surface. Both small-scale and full-scale fire testing of higher viscosity silicone fluids has shown that they do burn and can create very challenging fires. Testing has also shown that relatively low sprinkler discharge rates can quickly extinguish some pool fires.

3.1.2.6 Paste Ink

Paste inks are used in the printing industry. They consist of a vegetable oil base mixed with solids. Paste ink will not flow at 68°F (20°C) without the application of pressure. Fires involving paste ink are usually localized, because the ink tends to accumulate on the floor and not spread freely.

3.1.2.7 Polyurethane Foam Components

The chemicals used to produce polyurethane are:

- Polymethylene polyphenyl isocyanate, diphenylmethane diisocyanate, or polymeric MDI or PMDI, often designated as “Part A”

- Polyester or polyether Polyol, often designated as “Part B” for packaging systems

Polyurethane packaging systems are used at manufacturing facilities to package products with a secure foam cushion around them. These polyurethane systems are water-based and consist of two liquid components that, when mixed, react to form polyurethane foam. One component is either a polyester or polyether polyol. This material is commonly listed with a flash point on its SDS. However, numerous tests failed to result in a pool fire. When polyurethane is used to manufacture padding for seats or other final products, a polyether polyol is used. Many times, an oil is added to improve the flexible foam properties. This variation of the polyol does burn.

The second component of the foam packaging is polymethylene polyphenyl isocyanate (PMDI). This liquid is ignitable; however, the fire hazard it creates is limited. If spilled, it will support fire spread across the liquid surface and can release enough energy to activate sprinklers. Sprinkler discharge will quickly extinguish the pool fire. However, release of this liquid in a general-purpose warehouse will result in a very large ignition source. Composite IBC storage of PMDI will quickly fail when exposed to a PMDI pool fire.

3.1.2.8 Unsaturated Polyester Resin (UPR)

UPR is a polyester resin mixture with various amounts of styrene added. It is a liquid with most of the material being a higher flash point resin, combined with various amounts of styrene, which drives the lower flash point. If the mixture has less than 50% styrene, protection recommendations will vary.

Spilled UPR will burn as a pool on the floor. It tends to spread less and have a slower flame spread than common low flash point liquids. Heating UPR in a metal container will cause polymerization without significantly over-pressurizing the container. The container may partially vent without creating overpressure damage in the building.

3.1.2.9 Semi-Solid Liquids

(Reserved)

3.1.2.10 Phase Change Materials (PCMs)

The use of a standard flash point testing apparatus is not appropriate for these gelled materials. The gels have a very low ability to conduct heat, creating large temperature differentials within the test cup. This behavior means open- or closed-cup flash points cannot be accurately measured.

Since a meaningful flash point cannot be measured, the base components need to be examined. The PCM can be classified based on the closed-cup flash point of the individual component(s). Recognize that these products do burn, either as a pure liquid or as a gel. If not properly protected, they could represent a significant fire hazard to a facility.

3.1.2.11 FM Approved Fluids

(Reserved)

4.0 REFERENCES

4.1 FM

Data Sheet 7-2, *Waste Solvent Recovery*
Data Sheet 7-9, *Dip Tanks, Flow Coaters and Roll Coaters*
Data Sheet 7-14, *Fire Protection for Chemical Plants*
Data Sheet 7-20, *Oil Cookers*
Data Sheet 7-27, *Spray Application of Ignitable and Combustible Materials*
Data Sheet 7-29, *Ignitable Liquid Storage in Portable Containers*
Data Sheet 7-32, *Ignitable Liquid Operations*
Data Sheet 7-37, *Cutting Fluids*
Data Sheet 7-41, *Heat Treating of Materials Using Oil Quenching and Molten Salt Baths*
Data Sheet 7-74, *Distilleries*
Data Sheet 7-83, *Drainage and Containment Systems for Ignitable Liquids*
Data Sheet 7-93, *Aircraft Hangars, Aircraft Manufacturing and Assembly Facilities, and Protection of Aircraft Interiors During Assembly*

Data Sheet 7-97, *Metal Cleaning*
Data Sheet 7-98, *Hydraulic Fluids*
Data Sheet 7-99, *Heat Transfer Fluid Systems*

4.2 Other

American Society of Mechanical Engineers (ASME). *Standard Test Method for Flash Point by Tag Closed Tester*. ASTM D56.

American Society of Mechanical Engineers (ASME). *Standard Test Methods for Flash Point by Pensky-Martens Closed-cup Tester*. ASTM D93.

International Organization for Standardization (ISO). *Determination of Flash Point - Pensky-Martens Closed-cup Method*. ISO 2719.

United States Government, Department of Transportation (USDOT). *Transportation*. Code of Federal Regulations (CFR) Title 49.

APPENDIX A GLOSSARY OF TERMS

Boiling Point: The temperature at which a liquid's vapor pressure is equal to the atmospheric pressure on the liquid. The boiling point is measured at an atmospheric pressure of 14.7 psia [1 bar(a)]. The boiling point of an ignitable liquid permits the comparison of liquid volatility without knowing the vapor pressures. Liquids with low boiling points are very volatile.

Emulsion: A stable mixture of two or more immiscible liquids held in suspension by small percentages of substances called emulsifiers.

Fire Point: The lowest temperature at which a liquid in an open container will give off enough vapor to ignite and continue to burn. Fire points are usually slightly higher than the open-cup flash point for a given liquid. Liquids can have flash points without having fire points. A liquid without a fire point will not burn (e.g., 15% ethanol-water solution: closed-cup flash point 107°F (42°C), no fire point; 15% acetone-water solution: closed-cup flash point 49°F (9°C), no fire point).

Flash Point: The minimum temperature at which sufficient vapor is liberated to form a vapor-air mixture that will ignite and propagate a flame away from the ignition source (flash fire, not continuous combustion). Evaporation will take place below the flash point, but the quantity of vapor released is not sufficient to produce an ignitable vapor-air mixture. A flash point can be determined by using either a closed- or open-cup test apparatus. The closed-cup test will produce a lower flash point than the open-cup test, because it provides greater vapor containment (i.e., increases vapor accumulation). The closed-cup flash point is used to classify a liquid, because it is conservative (i.e., produces the lowest flash point for the liquid). It also represents the condition in which most liquids are handled (i.e., most liquids are kept in closed containers or equipment).

Flammable (Explosive) Limit/Flammable (Explosive) Range: The terms ″flammable″ and ″explosive″ are used interchangeably; because unconfined vapor mixed in air will burn, while confined vapor will produce an explosion.

FM Approved: References to ″FM Approved″ in this data sheet mean a product or service has 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.

Heat of Combustion: The amount of heat released when a unit quantity of fuel is oxidized completely to yield stable end products. The measurement is generally made in an oxygen bomb calorimeter. A similar term is the chemical heat of combustion, which represents the amount of heat released when a unit quantity of fuel is combusted in air. The chemical heat of combustion is less than the heat of combustion due to the inefficiency of the combustion process in air.

Heat Release Rate: The rate at which energy is released in a fire. The heat release rate is a function of the fuel's heat of combustion, mass loss rate and the exposed surface area.

Ignitable Liquid: Any liquid or liquid mixture that has a measurable closed-cup 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.

Lecithins: Emulsifying agents separated from vegetable oils (most commonly from soybean oil). Pure lecithin is a phosphatidyl choline. Lecithins may also be known as phosphoglycerides, phosphatides, or phospholipids.

Liquid: A material that does not have a defined shape at 68°F (20°C), unless it is stored in a container. These materials flow freely when released (e.g., water, honey, heptane).

Non-Ignitable Liquid: A liquid that does not burn.

Paste Inks: High-viscosity fluids commonly used in the printing industry. They generally consist of a vegetable oil base mixed with solids. Paste inks will flow under pressure or shear.

Phase change materials (PCMs): Materials used in packaging to maintain temperature of shipments during transit. They are typically gel when at or below 68°F (20°C) but can quickly change to a liquid when heated. PCMs can be stored in individual packaging containers or can be stored in bulk.

Semi-Solid: A material that has a defined shape at 68°F (20°C) without containment, but can be forced to flow with pressure (e.g., butter, paste ink, gels).

Solid: A material that has a defined shape at 68°F (20°C) and cannot be forced to flow with pressure (e.g., wood, plastic, glass, wax). Materials with a melting point greater than 150°F (66°C) can be treated as a solid.

Specific Gravity: The ratio of the weight of a substance to the weight of the same volume of another substance. The specific gravity for ignitable liquids is provided using water as a basis. Specific gravities less than one indicate the liquid will float on water, while specific gravities greater than one indicate the liquid will sink in water.

Stable Liquid: A liquid that does not self-react or polymerize.

Unstable Liquid: A liquid that, in its pure state or as commercially produced or transported, will vigorously polymerize, decompose, undergo condensation reaction, or become self-reactive under conditions of shock, pressure or temperature.

Vapor Density: The weight of a volume of pure vapor or gas (with no air present) compared to the weight of an equal volume of dry air at the same temperature and pressure. Vapor density is calculated as the ratio of the molecular weight of the gas to the average molecular weight of air (29 g/mol). A vapor density figure less than one indicates the vapor is lighter than air. A figure greater than one indicates the vapor is heavier than air.

Vapor Pressure: A measure of the pressure created by a liquid's vapor at a specific temperature. The vapor pressures for ignitable liquids provide a basis for comparing the volatility of the liquids at various temperatures (i.e., provide a measure of the tendency of the liquids to vaporize). Ignitable liquids with a high vapor pressure at room temperature (68°F [20°C]) are more hazardous than liquids with lower vapor pressures, because they will produce more flammable vapor without heating. Vapor pressure data is often not available.

Viscosity: A measure of a fluid's resistance to flow. It describes the internal friction of a moving fluid. A fluid with high viscosity resists motion, because its molecular makeup creates a lot of internal friction. A fluid with low viscosity flows easily, because its molecular makeup results in very little internal friction. Two related measures of fluid viscosity are dynamic (or absolute) and kinematic viscosity (dynamic viscosity divided by the density). A unit of measure for dynamic viscosity is the Poise (P). A unit of measure for kinematic viscosity is Stokes (St).

Viscous Liquid: A fluid characterized by a high resistance to shear or flow, quantified by its dynamic viscosity (μ), typically measured in Pascal-seconds (Pa·s) or centipoise (cP).

Viscous Mixture: A mixture that exhibits significant resistance to flow due to its internal friction and cohesive interactions among its components. The effective viscosity is elevated compared to its individual components, resulting in a thick, slow-moving consistency.

Water-Miscible Liquids: Liquids that mix with water in all proportions. When water-miscible, ignitable liquids are mixed with water, a homogeneous solution is formed. The flash point, fire point, heat of combustion and heat release rate of the solution will be different from the pure ignitable liquid. The flash point and fire point of the solution will increase as the water concentration increases. At a certain concentration (which varies for different ignitable liquids), the fire point will no longer exist; and the solution will no longer present a fire hazard (e.g., 15% ethyl alcohol in water, 15% acetone in water).

Water-Soluble: The ability of a substance to dissolve in water, forming a homogeneous solution at the molecular or ionic level. A compound is considered water-soluble if it can dissociate or disperse uniformly in water, typically due to its polar nature or ionic interactions with water molecules. All water miscible liquids are water-soluble liquids, but not all water-soluble liquids are water-miscible liquids. Solubility is quantified by the solubility limit, usually expressed in grams per liter (g/L) or molarity (mol/L), and is influenced by factors such as temperature, pressure and the chemical nature of both solute and solvent.

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).

April 2026. This is the first publication of this data sheet.

APPENDIX C CLASSIFICATION OF LIQUIDS THAT BURN

C.1 Ignitable Liquid Classification Schemes

Existing classification schemes for liquids that burn are based on their closed-cup flash points. Some assign numerical values, while others group liquids by name (e.g., flammable, combustible) according to flash point ranges. Some classifications have many subdivisions and others only define a few. None of them, however, define the fire hazard created by the liquid; and, in many cases, confusion exists regarding the severity of the hazard.

Classifying liquids based on flash point started when liquids were commonly mixed in open vessels or tanks, and a measure of the potential for ignition was needed. The flash point served this purpose well, but it does not provide any measure of the fire or explosion hazard created by a given liquid. The fire and explosion hazards of liquids that burn are determined by the inherent physical properties of the liquid and external factors such as the amount of liquid, process temperatures, process flow rates and building construction.