



Special Hazards (Ignitable Liquids)

Occupancy Hazards

- Are there ignitable liquids present?

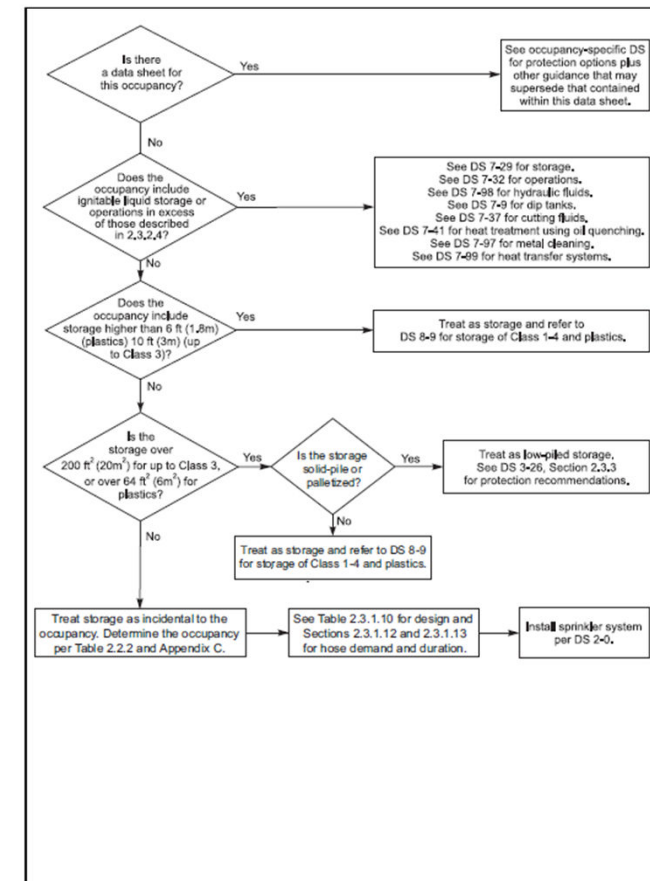


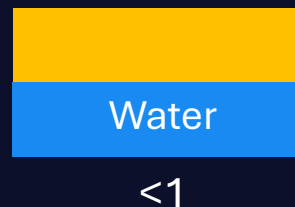
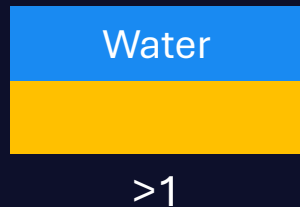
Fig. 2.2.1. Flowchart for determining appropriate use of Data Sheet 3-26

Definitions



← Ease of ignition

Specific gravity



Water miscibility

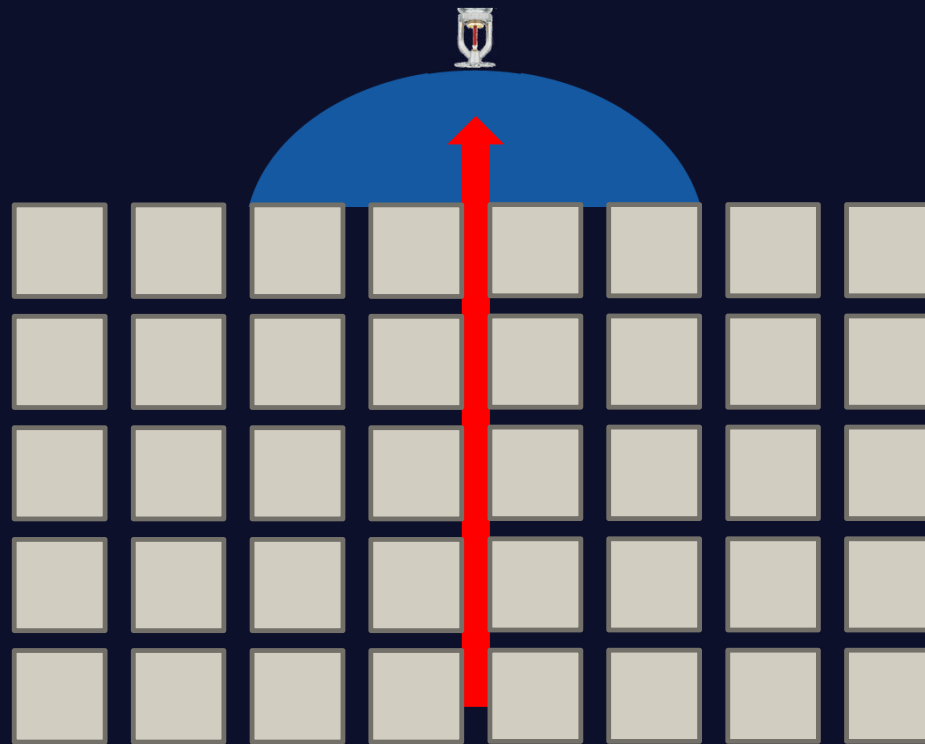


Heat release rate

- Proportional to pool fire area
- Similar for most hydrocarbon fuels
- Less for water miscible liquids

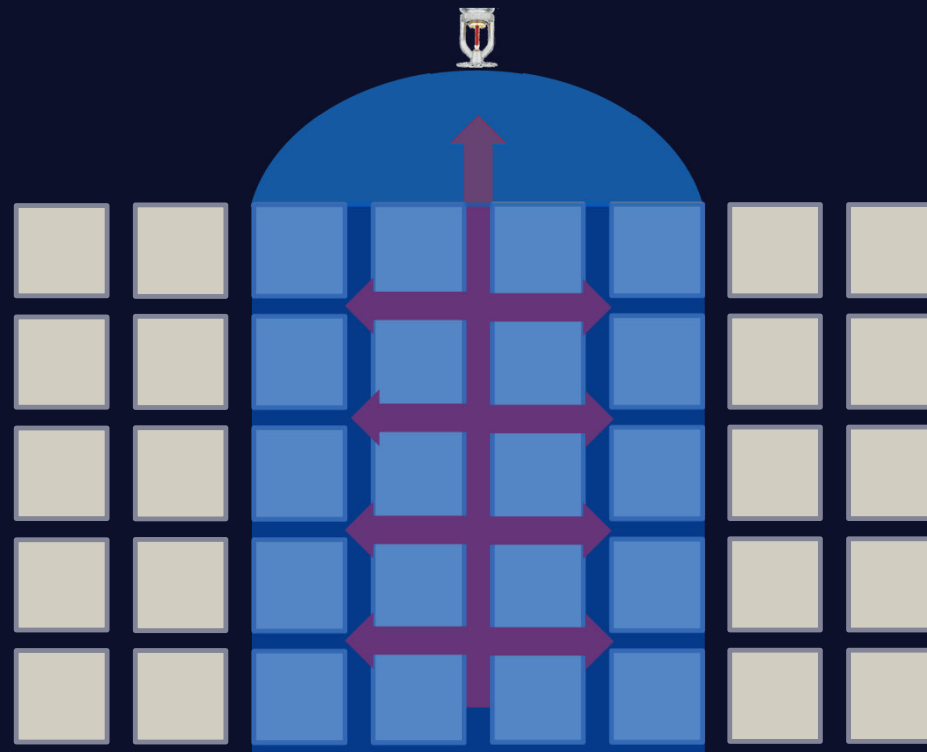
Standard (Solid) Commodities

Ceiling



Standard (Solid) Commodities

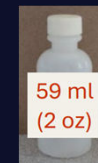
Ceiling



How to Ignitable Liquid Burn



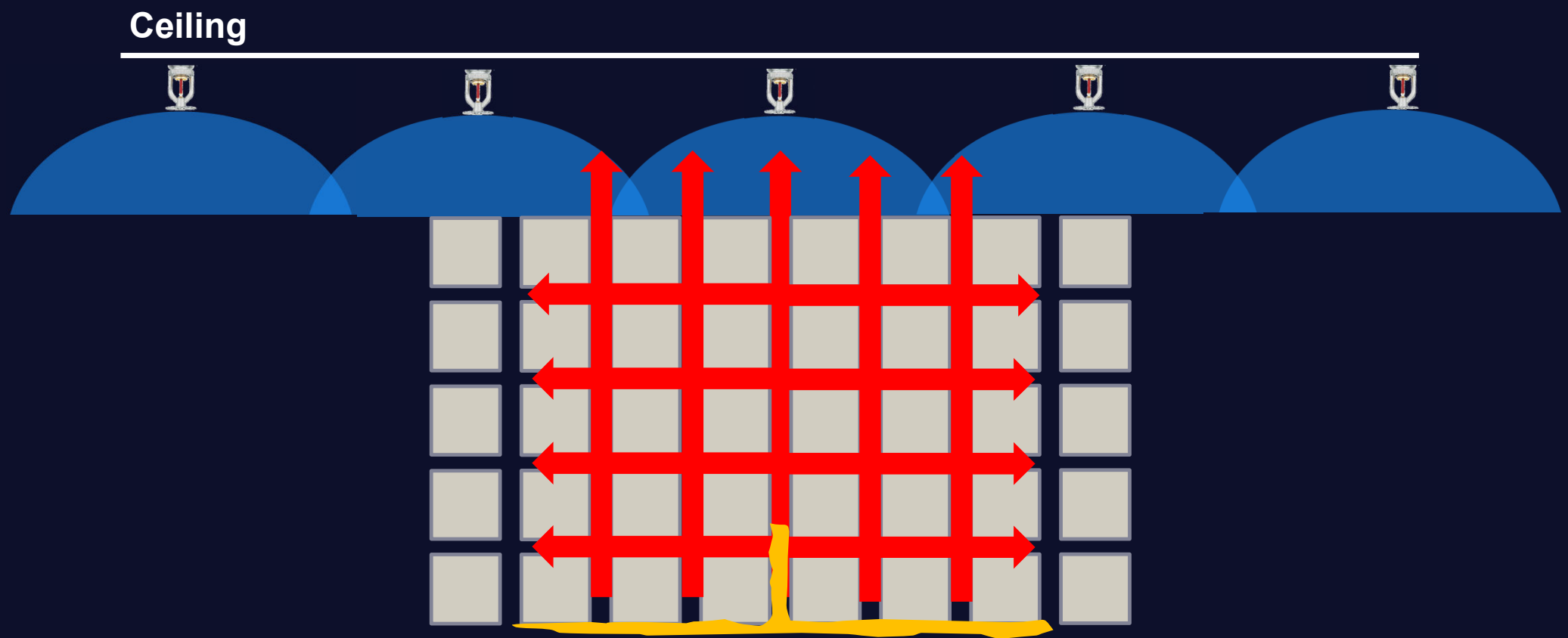
- Lubrication oil
- Sprinkler density 12 mm/min
- 3-D spill fire
- Fire cannot be extinguished by sprinklers alone



=



Ignitable Liquid Storage



What Liquid Burn

Mayonnaise

Flavorings

Alcohol

Lamp oil

Motor oil

Beverages

Varnish

Cooking oil

Nail polish

Paints

Cutting fluid

Heat transfer fluid

Cosmetics

European
ADR / UN
Transport



Class 1	Class 2	Class 3
FP -	FP < 23°C	FP ≤ 60°C
BP < 35°C	BP > 35°C	BP > 35°C

Flammable
Combustible
Inflammable

US
NFPA

Flammable

Combustible

Class I A,B, C
FP ≤ 38°C

Class II
FP ≤ 60°C

Class III A
FP ≤ 93°C

Class III B
FP > 93°C

FM

Ignitable Liquid
(any liquid can burn i.e., has a 'fire point')

Low-Flashpoint Ignitable Liquid
FP ≤ 93°C

High-Flashpoint Ignitable Liquid
FP > 93°C

VHFPL
FP ≥ 212°C

What Liquid Burn

Mayonnaise

Beverages

Paints

Cutting fluid

Flavorings

Varnish

Heat transfer fluid

Alcohol

Coatings

Cosmetics

New Sunshine, LLC

Expose Body Lotion

Revision 00 06/2011

SECTION 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION

Household Settings: This is a personal care / cosmetic product that is safe for consumers and other users under normal and reasonably foreseen use.

Non-Household Settings: Use safety glasses if splash hazards exist, use gloves and other protective clothing to prevent skin contact. Always follow good hygienic work practices. Avoid prolonged contact with skin and clothing.

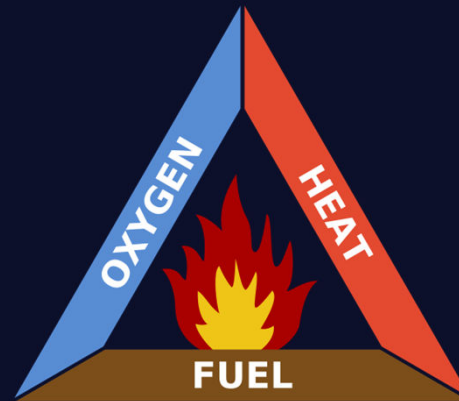
SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Viscous liquid body lotion.
Appearance	Various colored viscous liquid.
Odor	Fragrant.
Odor Threshold	Not available
pH	3.8 – 6.5
Melting Point/Freezing Point	Not Applicable
Boiling Point	>212 F / 100 C
Flash Point	>212 F / 100 C
Evaporation Rate	Not Applicable
Flammability	Not Applicable
Upper/Lower Flammability	Not Applicable
Vapor Pressure	Not Applicable
Vapor Density	Not Applicable
Relative Density	Not Available
Specific gravity at 25C	Not available.
Solubility in water at 20C	Slightly Insoluble
Partition coefficient	Not Applicable
Auto-ignition Temp	Not Applicable
Decomposition Temp	Not Available
Viscosity	10,000 – 14,000 cps.
Volatile %	Complies with Federal and State VOC regulations.



Sprinkler Performance Goals

- Building Codes
 - Protect occupants
 - Protect surrounding properties
- Property/business Protection
 - Limit release / contain release
 - Remove fuel (or remove oxygen)
 - Cooling
 - Control or extinguishment



FM Liquid Groupings

1	Flash point <200°F (93°C)	Cannot be extinguished by sprinkler discharge
2	Flash point ≥200°F (93°C)	Can be extinguished by sprinkler discharge
3	Flash point ≥414°F (212°C) [Very High Flash Point]	Will not propagate a pool fire
4	Water Miscible	Reduced heat release rate, can be extinguished by sprinkler discharge
5	Specific Gravity >1.0	Sinks below water and can be extinguished by sprinkler discharge
6	Atypical Liquids	Liquids with unique characteristics

Water Miscible Liquids

- Only the liquids listed can be treated as water miscible

Table 2.1.2.2. Water-Miscible Liquid Groupings (Note 3)

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

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

Note 2. See Section 2.1.2.2.3

Note 3. See Section D.1 for explanation of abbreviations.

Atypical Ignitable Liquids

- Very high flash point liquids
- Silicone fluids and emulsions
- Paste ink
- Isocyanate, MDI, PMDI, polyol
- Buttermilk or milk fat
- Propylene glycol, ethylene glycol, glycerin
- NMP and DMSO
- Semi-solids: Butter, margarine, salad dressing

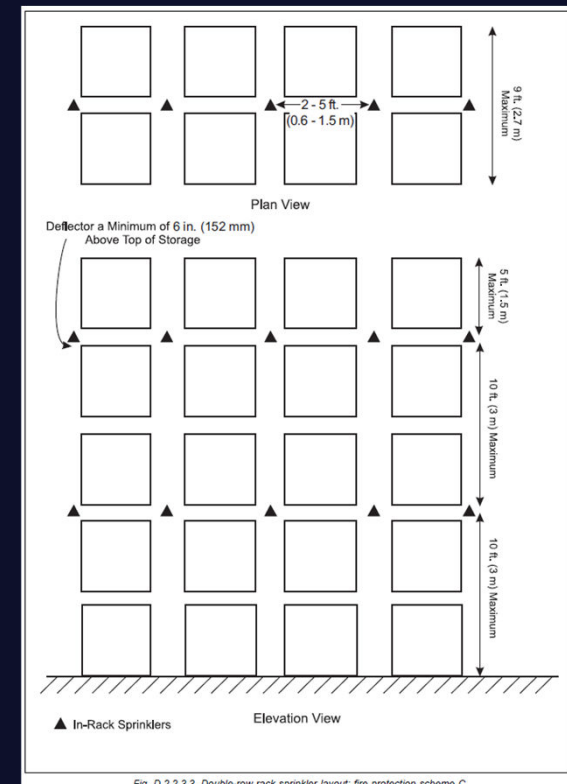
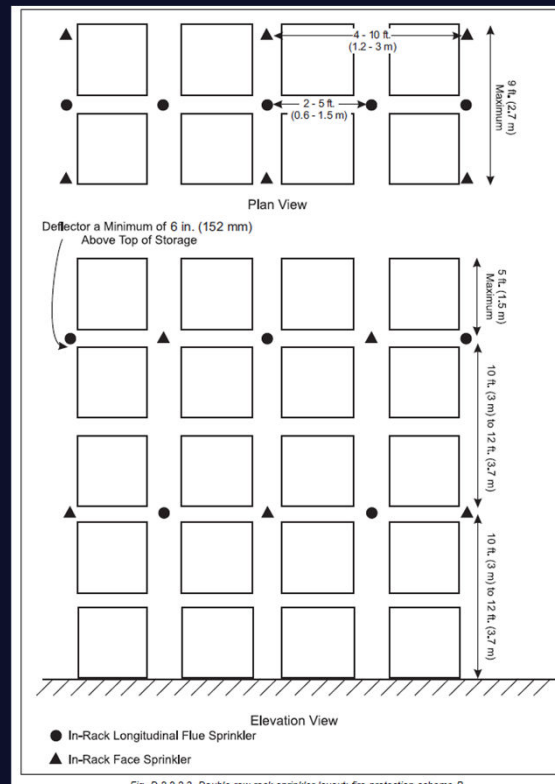
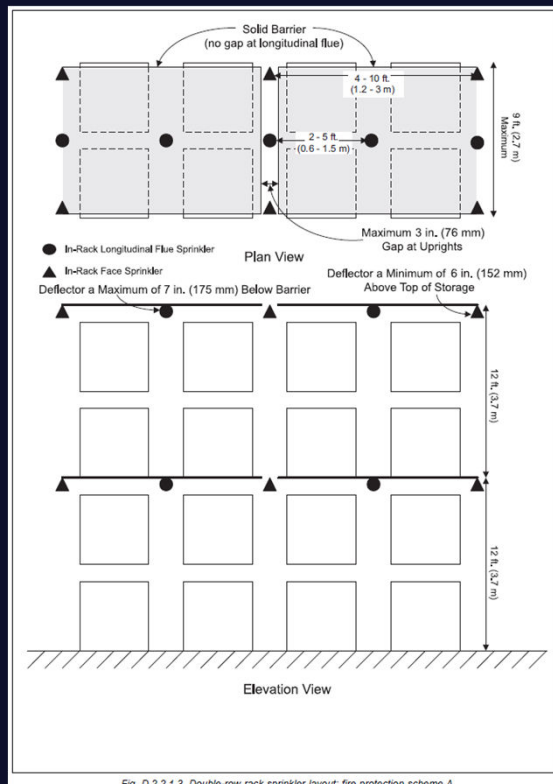
Ignitable Liquid Storage

- FM Data Sheet 7-29
- No one-size-fits-all solution
- Protection tied to test conditions:
 - Liquid properties (flash point etc.)
 - Container type and volume
 - Secondary packaging (cartoned vs uncartoned)
 - Storage arrangement
 - Storage height
 - Ceiling height



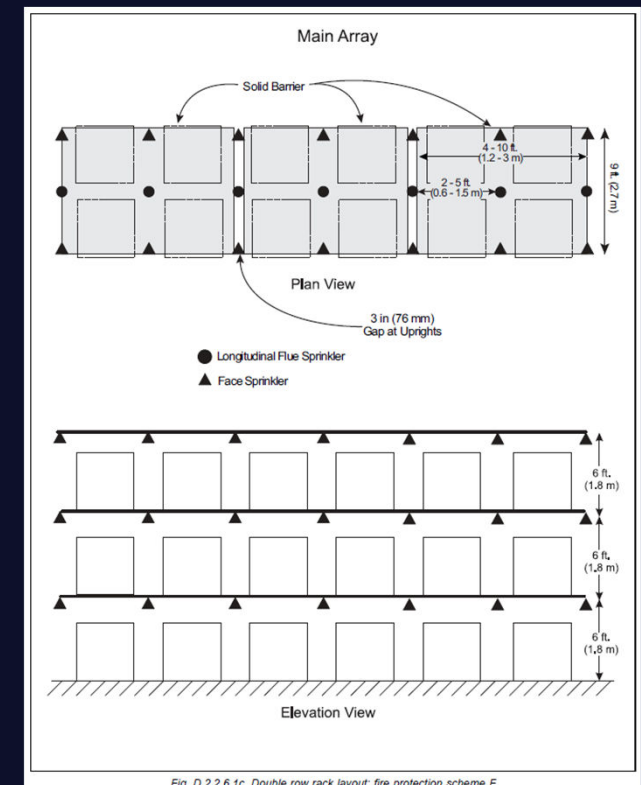
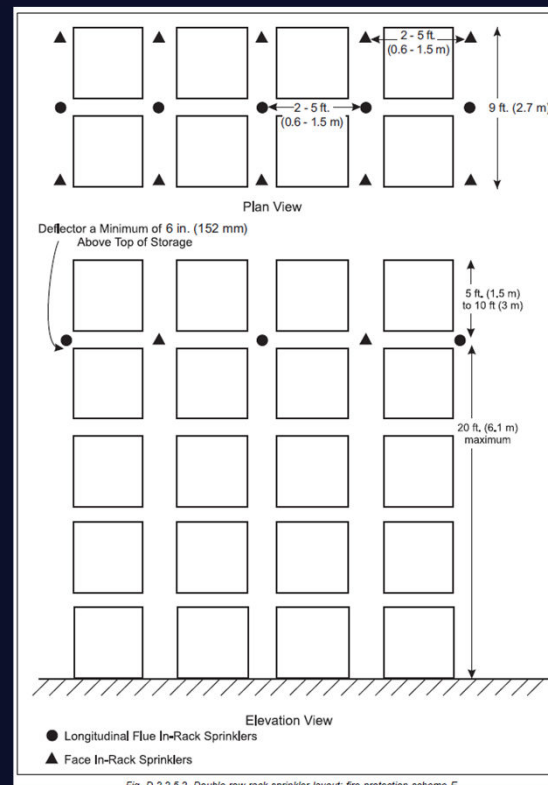
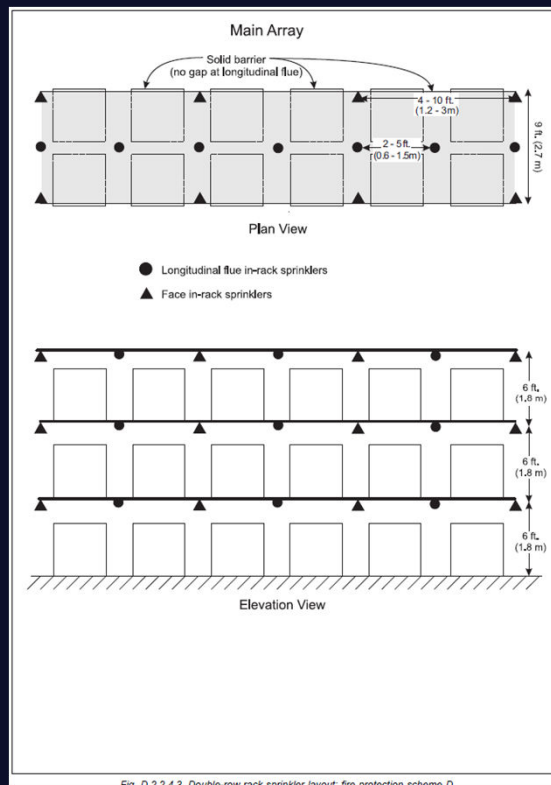
Ignitable Liquid Storage

- Protection schemes often involve in-rack sprinklers and sometimes horizontal barriers



Ignitable Liquid Storage

- Just because Scheme F has the most sprinklers and barriers it does not mean it can be used for stuff protectable by Scheme A or B for example



Case Study Example

- Heptane in 150 mL plastic bottles
- 6 bottle per carton, 500 L per pallet
- Test with modified Scheme A failed. Scheme F passed.



Ignitable Liquid Operations

- FM Data Sheet 7-32
- Must stop the flow of fuel (interlock to sprinkler flow switch, leak detection, etc)
- Sprinklers cannot extinguish a spray fire or 3-D fire
- Sprinklers provide cooling
- Containment and drainage needed to control/remove fuel



Ignitable Liquid Operations

Table 2.4.3. Sprinkler Protection for Occupancies Using Ignitable Liquids

Liquid Flash Point °F (°C)	Drainage Required	Protection Goal	Maximum Roof Height ft (m)	Ceiling Sprinkler		Density gpm/ft ² (mm/min)	Demand Area ft ² (m ²)	Hose Streams gpm (L/min)	Duration min
				Response, Nominal Temperature Rating, Orientation	K factor gpm/psi ^{0.5} (L/min/bar ^{0.5}) Note 2				
Any liquid with an associated room or equipment explosion hazard or nitrocellulose lacquer Note 1	Yes	Fire control only	40 (12)	SR/High/Any	≥8.0 (115)	0.30 (12)	6000 (560)	1000 (3800)	120
				SR/Ordinary/Any	≥8.0 (115)		8000 (740)		
FP <200°F (93°C)	Yes	Fire control only	40 (12)	SR/High/Any	≥8.0 (115)	0.30 (12)	4000 (370)	500 (1900)	60
				SR/Ordinary/Any	≥8.0 (115)		6000 (560)		
FP ≥200°F (93°C)	Yes	Fire control only	40 (12)	SR/High/Any	≥8.0 (115)	0.30 (12)	4000 (370)	500 (1900)	60
				SR/Ordinary/Any	≥8.0 (115)		6000 (560)		
	No	Fire extinguishment	15 (4.6)	SR/Ordinary/Any	≥11.2 (161)	0.30 (12)	For pool areas <200 ft ² (18 m ²), use design area of 2000 ft ² (186 m ²). For pool areas >200 (18) and < 625 ft ² (56) m ² , use design area of 8000 ft ² (743 m ²).		
			30 (9.1)	SR/Ordinary/Any	≥11.2 (161)	0.40 (15)			
			40 (12)	SR/Ordinary/Any	≥11.2 (161)	0.70 (29)			
			45 (14)	SR/Ordinary/Any	≥11.2 (161)	0.80 (33)			
Liquids with a SG > 1	No	Fire extinguishment	40 (12)	SR/High/Any	≥8.0 (115)	0.3 (12)	4000 (370)	500 (1900)	60
				SR/Ordinary/Any	≥8.0 (115)		6000 (560)		
Very High Flash Point Liquids	No	No pool fire	Unlimited	Design sprinkler protection for the surrounding occupancy					

Ignitable Liquid Operations

Table 2.4.3. Sprinkler Protection for Occupancies Using Ignitable Liquids

Liquid Flash Point °F (°C)	Drainage Required	Protection Goal	Maximum Roof Height ft (m)	Ceiling Sprinkler		Density gpm/ft ² (mm/min)	Demand Area ft ² (m ²)	Hose Streams gpm (L/min)	Duration min
				Response, Nominal Temperature Rating, Orientation	K factor gpm/psi ^{0.5} (L/min/bar ^{0.5}) Note 2				
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Ignitable Liquid Operations

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Very High Flash Point Liquids	No	No pool fire	Unlimited	Design sprinkler protection for the surrounding occupancy					

Ignitable Liquid Operations

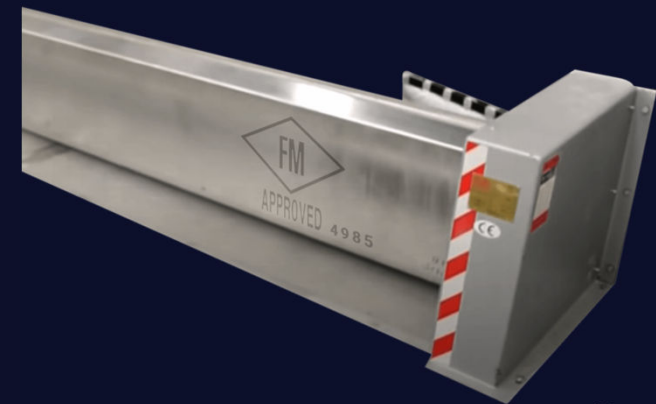
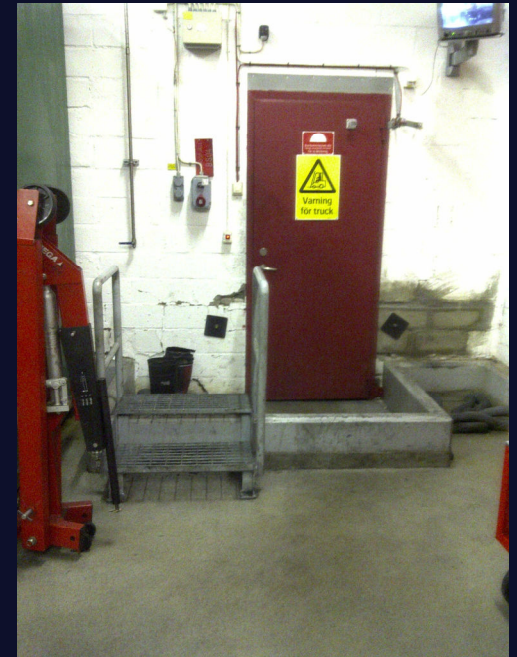
- Just a 55 L spill at an average depth of 3 mm will create an 18 m² pool area
- Flow flow rates in piping systems are often thousands of liters per minute...
- Sprinkler activation and automatic interlocks take some time to operate
- For systems where the release cannot be limited, see Data Sheet 7-14, *Chemical Plants*

Ignitable Liquid Operations

- May also need to consider:
 - Corrosive environments
 - Protection of steel columns
 - Testing of automatic interlocks during fire protection testing (typically annually)

Containment and Drainage

- Spill containment for the room is usually needed
- If fuel SG > 1, containment only is sufficient
- For ignitable liquid operations, the protection table indicates if drainage is needed
- For storage, in some cases drainage is also required
- A few storage protection schemes also require foam-water sprinklers



Containment and Drainage

- Adequate spill drainage can usually be found at chemical plants etc
- Requires floor slope, retention basins etc
- Drainage pipe sizes for the spill and sprinkler discharge are significant (larger than any drainage for cleaning/washing down)
- Potential to eliminate the need for drainage in ignitable liquid operations with interlocks, leak detection, and containment
- Special protection systems e.g., water mist or low-expansion foam can be an alternative to drainage

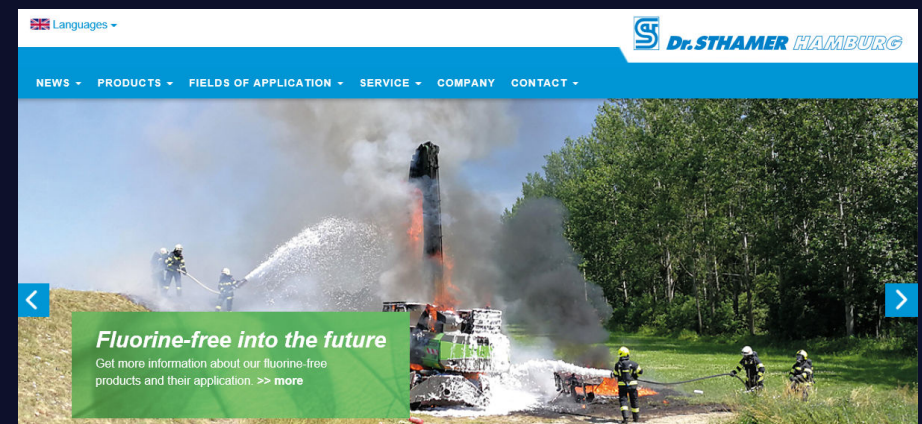
Foam-Water Sprinklers

- Fluorinated chemicals are extremely persistent in the environment and have serious negative effects on human health
- Restrictions and bans on fluorine-based foam concentrates
- PFAS, PFOS, PFOA, PFHxS
- Transition period
(from October 2025):
- Plan now!!
- FM advice is not to
impair foam systems (as a minimum keep sprinkler water on)

Seveso sites	10 years
Other industries	5 years
Military	5 years
Ready-to-use applications (Fire extinguishers)	5 years
Marine applications (ships, offshore):	3 years
Export	10 years

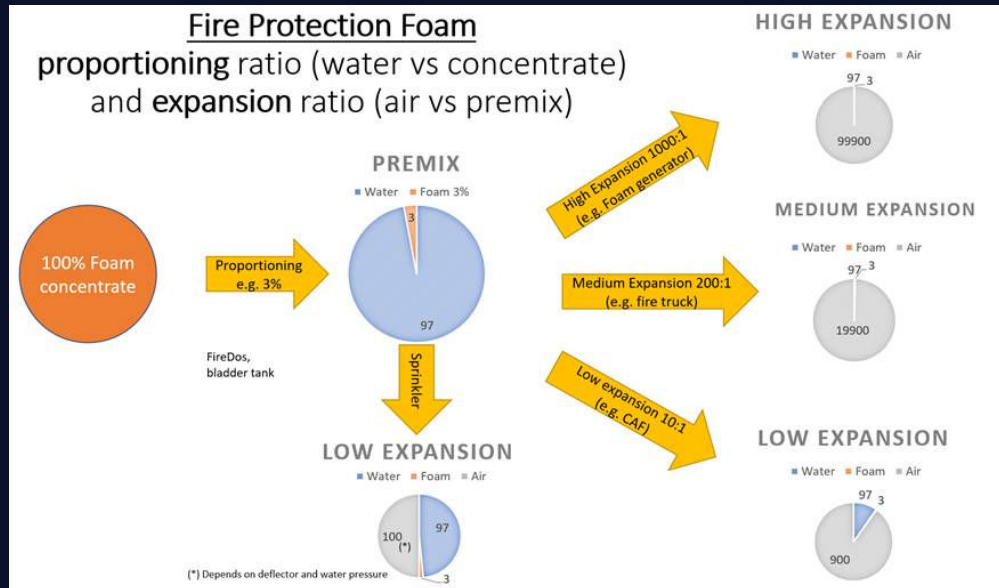
Foam-Water Sprinklers

- Foam transition to synthetic fluorine-free foams (SF3, SFFF, 3F, FFF)
- These can have various approvals including EN1568, UL162, ICAO etc.
- Important to understand limitations of some of these tests versus FM Approval Standard 5130.



Foam-Water Sprinklers

- AFFF was never originally intended to be used with sprinklers.
- Sprinkler heads are very poor aspirating devices.



AFFF vs SFFF

- It is not a drop-in replacement!



Synthetic Fluorine Free Foam (SFFF)



Synthetic Fluorine Free Foam (SFFF)

- Same test, but only change was a different model of K115 sprinkler



Foam-Water Sprinkler Design

- Follow FM Data Sheet 4-12, *Foam Extinguishing Systems*
- Start with foam concentrate and liquid/fuel to be protected
- Hydrocarbons – acceptable to use concentrate tested on heptane (flash point -3.9°C) if the flash point of the fuel is higher

Product	Concentrate Type	Concentrate % in Water	Configuration	Approved Fuel Hazards
Fomtec Enviro USP	SFFF	3%	For use with KC Antincendi Srl ratio controllers and bladder tanks specifically tested with this concentrate, pre-mixed solution, or other FM Approved proportioning methods within acceptable viscosity range only. For use with Viking Corp. and KC Antincendi Srl discharge devices evaluated with the specific concentrate only. Refer to applicable KC Antincendi Srl listings for further details.	Heptane, Jet A-1

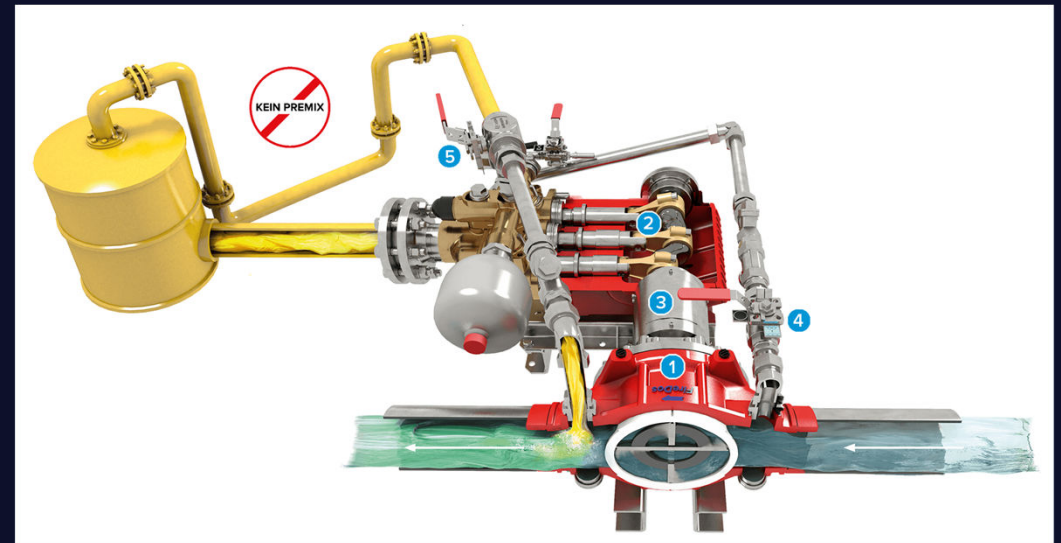
Foam-Water Sprinkler Design

- Polar liquids – use an alcohol-resistant SFFF and only on the specific fuels listed
- Anything else must undergo fire testing

Product	Concentrate Type	Concentrate % in Water	Configuration	Approved Fuel Hazards	Footnote
Fomtec Enviro ARK	SFFF	3%	For use with KC Antincendi Srl ratio controllers and bladder tanks specifically tested with this concentrate, pre-mixed solution, or other FM Approved proportioning methods within acceptable viscosity range only. For use with Viking Corp. and KC Antincendi Srl discharge devices evaluated with the specific concentrate only. Refer to applicable KC Antincendi Srl listings for further details.	Heptane, IPA, Acetone, Ethanol	1

Foam-Water Sprinkler Design

- Chose proportioning device that is either listed with the concentrate e.g., bladder tank and proportioner, or *other proportioning method with acceptable viscosity range*
- WB FirePacks, electric foam pump (EFP)
- FireDos, water-motor driven proportioner
- Saval Foamtronic
- FireMiks, water-motor driven proportioner



Foam-Water Sprinkler Design

- Check the viscosity limitations of the proportioner

FM Approvals | Approval Guide

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Fixed Extinguishing Systems | Foam | [Foam Extinguishing Systems, Variable Viscosity Proportioners](#)

FireDos GmbH Foam Concentrate Proportioners - Gen III

Viscosity Limitations

Suitable for use with Newtonian foam concentrates and for use with non-Newtonian foam concentrates having viscosity characteristics within (below) the maximum viscosity limitations provided in the viscosity vs. shear rate table shown below.

Shear Rate, (1/s)	Viscosity @ 68°F (20°C), (Cp)
5	7158
10	4031
20	2196
50	973
100	550
600	145

Foam-Water Sprinkler Design

- Check the viscosity of the concentrate

FM Approvals | Approval Guide

Fixed Extinguishing Systems | Foam | [Foam Extinguishing Systems, Low Expansion](#)

Low Expansion Foam Systems Using ANSUL NFF-332 3%x3% AR-SFFF Foam Concentrate

Foam Concentrate Viscosity

The viscosity of non-Newtonian foam concentrates will vary depending on the fluid's flow velocity and resultant shear rate. As such, it is important to define this relationship the viscosity changes with shear rate. The following table provides viscosity vs. shear rate data for the subject concentrate throughout a range of given shear rates.

Shear Rate, (1/s)	Viscosity @ 68°F (20°C), (Cp)
5	2693
10	1640
20	1014
50	558
100	365
600	151

Foam-Water Sprinkler Design

- Compare

FM Approvals | Approval Guide

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Fixed Extinguishing Systems | Foam | **Foam Extinguishing Systems, Variable Viscosity Proportioners**

FireDos GmbH Foam Concentrate Proportioners - Gen III

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600	145

**Ansul
NFF-332**

2693
1640
1014
558
365
151

**Solberg
RF3**

8670
4470
2347
1026
557
115

Foam-Water Sprinkler Design

- Installations tips for high viscosities
 - Design flow should be <70% of maximum flow of the proportioner
 - Large diameter and straight concentrate suction piping
 - Condition of concentrate, especially air entrapment <2% after filling
 - Setting of foam concentrate flow meter (dampened to increase average time i.e., 3s to 5 or 6s)
 - FireDos Gen3 has an Enhanced Viscosity (EV) upgrade

All installations must pass site acceptance testing

Foam-Water Sprinkler Design

- System approval. Use specific proportioner and discharge devices e.g., sprinklers that are listed with the concentrate.
- Pay attention to the fuel, maximum ceiling height, etc.
- Use the design density specified in the Data Sheet (=> min solution application rate)

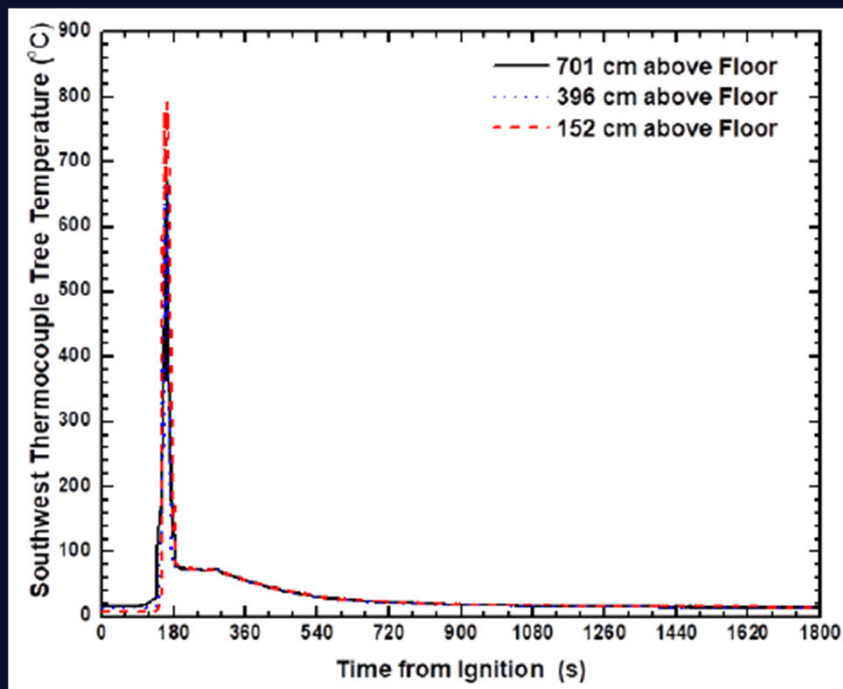
Product	Type of Equipment	Concentrate % in Water	Configuration	Approved Fuel Hazards	Min Solution Application Rate		Max Subsequent Water Application Rate		Min Installation Height		Max Installation Height		Connection	Orientation	K-Factor
					gpm/ft²	(mm/min)	gpm/ft²	(mm/min)	ft	(m)	ft	(m)			
VK1001, VK3001	Automatic Foam Water Sprinkler	3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	Heptane	.2	(8.0)	.3	(12.22)	6	(1.8)	24.8	(7.6)	1/2"	Upright	5.6
VK1021, VK3021	Automatic Foam Water Sprinkler	3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	Heptane	.2	(8.0)	.3	(12.22)	6	(1.8)	44	(13.4)	1/2"	Pendent	5.6
VK1021, VK3021	Automatic Foam Water Sprinkler	3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	Jet A-1	.2	(8.0)	.3	(12.2)	8.5	(2.6)	44	(13.4)	1/2"	Pendent	5.6
VK200, VK204, VK350, VK351	Automatic Foam Water Sprinkler	3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	Heptane	.3	(12.2)	.3	(12.2)	9	(2.7)	45	(13.7)	3/4"	Upright	8.0
VK2021, VK3521, VK2022, VK3522	Automatic Foam Water Sprinkler	3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	Heptane	.3	(12.2)	.3	(12.2)	8	(2.4)	44	(13.4)	3/4"	Pendent	8.0
VK377, VK536	Automatic Foam Water Sprinkler	3%	For use with proportioners specifically tested with this concentrate, pre-mixed solution or Water Motor-Powered Positive Displacement Pumps within acceptable viscosity range only.	Heptane	.3	(12.2)	.3	(12.2)	6	(1.8)	25.2	(7.7)	3/4"	Pendent	11.2

Water-Mist for Ignitable Liquids

- Historically water-mist has only been primary protection for specific ignitable applications
- Or as *supplemental* protection along with sprinklers
- FM Research completed in 2023/24 with a deluge high-pressure system
- Full-scale fire testing with rack storage of heptane in up to 19 L plastic containers, uncartoned
- No drainage!

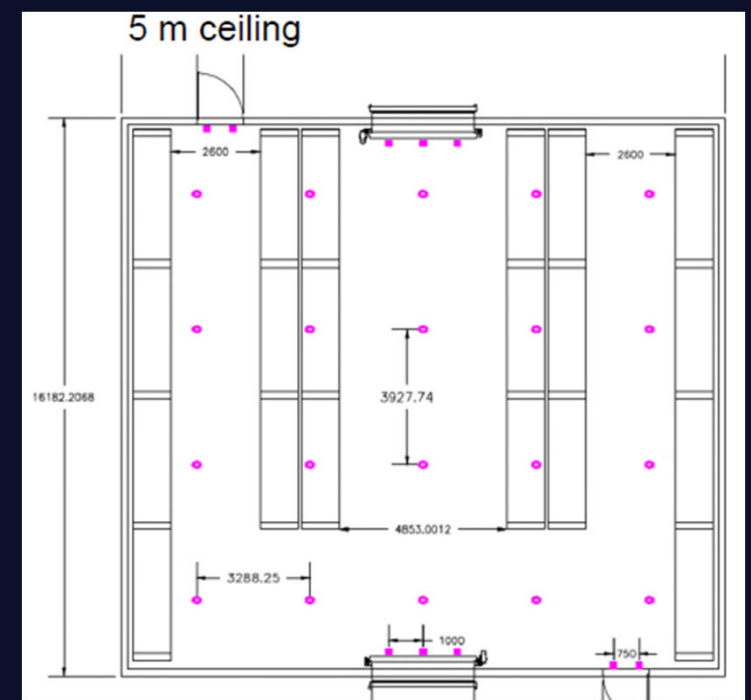
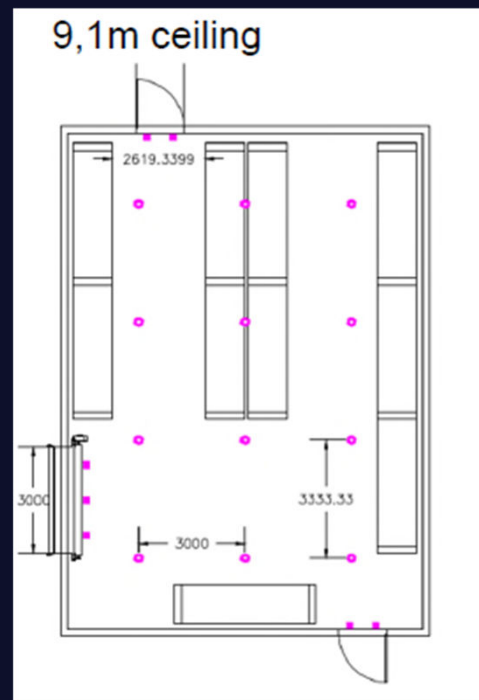
Water-Mist for Ignitable Liquids

- Fire tests of uncartoned storage of heptane in 19 L plastic containers.



Water-Mist for Ignitable Liquids

- FM Approval Standard 5560 in development
- Testing by manufacturers starting summer 2026
- Practical limits (initially):
 - Protected volume 1400 m³
 - Ceiling height 9.1 m
- Already included in Data Sheet 7-29
- Approval for ignitable liquid leads to Approval for ignitable liquid operations (Data Sheet 7-32)



Summary

- Classification/naming conventions are not aligned with the fire hazard
- Storage occupancies:
 - Impact of liquid/container/storage arrangement
 - Testing is needed to define the fire protection
- Process occupancies:
 - Critical to *automatically* shut down the flow of fuel
 - Testing interlocks during fire protection testing
- Difficulty with foam transition – engineer away the need for foam e.g., leak detection/interlocks, water-mist, etc.

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