

**ASSESSMENT OF HAZARDS OF FLAMMABLE AND
COMBUSTIBLE LIQUIDS IN COMPOSITE IBCs IN
OPERATIONS SCENARIOS**

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Fire Protection Research Foundation Project

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Introduction

- Common usage scenario involves unlisted IBCs in ‘operations scenarios’
- Storage configurations addressed by NFPA 30 for Listed IBCs
- Minimal guidance provided for ‘operations scenarios’
- Historically protection strategies developed via full-scale testing (i.e., Annex E of NFPA 30)



Operations Scenario



Objectives

- Identify fire hazards associated with the storage/use of unlisted IBCs in operations scenarios

- Develop protection options which will:
 - ◆ Confine fire to reasonable area
 - ◆ Limit thermal exposure to structural steel overhead
 - ◆ Prevent ignition of adjacent combustibles
 - ◆ Limit thermal hazard to personnel



Assumptions/Limitations

- Unlisted, non-hardened, 1041 L (275 Gal.) IBCs only
- Open-air scenarios with ceiling heights of 3.1 – 9.1 m (10 – 30ft)
- Leak, ignition, and involvement of adjacent IBCs assumed
- Bulk storage of IBCs is adequately protected
- Containment area designed to capture all IBC contents (based on analysis)
- Gaseous systems not considered

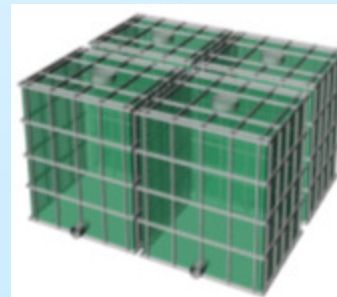
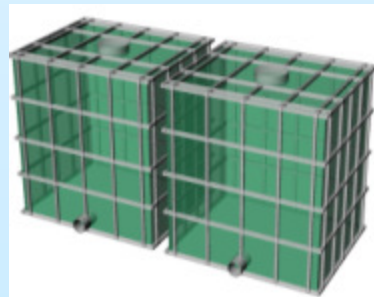
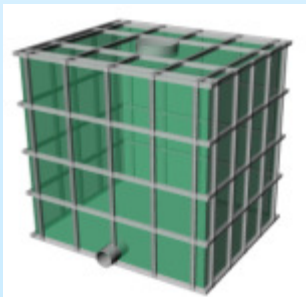


Fire Scenario Development

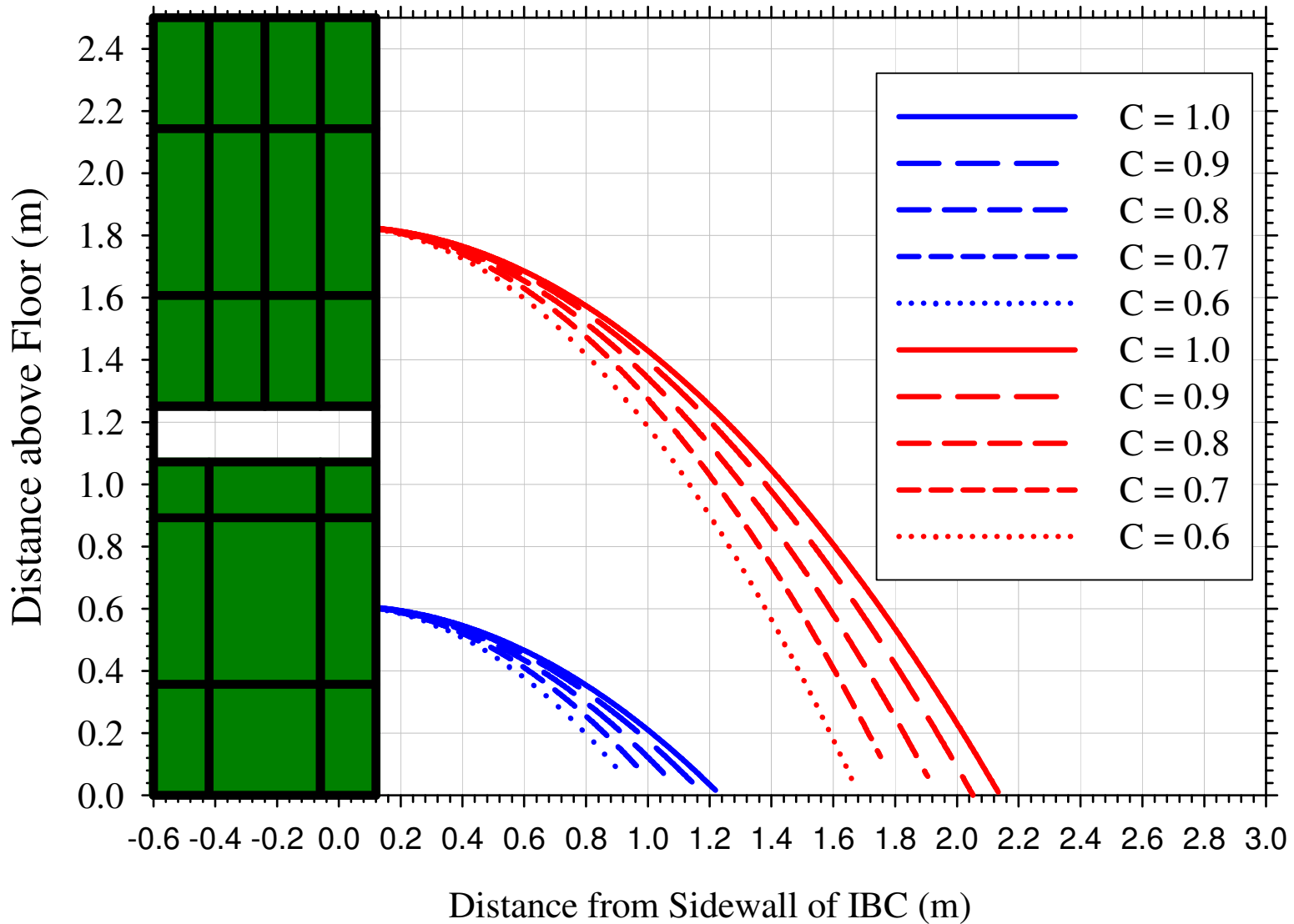
■ Operations Environment

- ◆ Foot Print: 46 m (150 ft) square
- ◆ Ceiling Height(s): 6.1 – 9.1 m (20 – 30 ft)
- ◆ Exposed steel joist overhead
- ◆ Neighboring material composition: Plastic / Cellulose

■ IBC Configurations

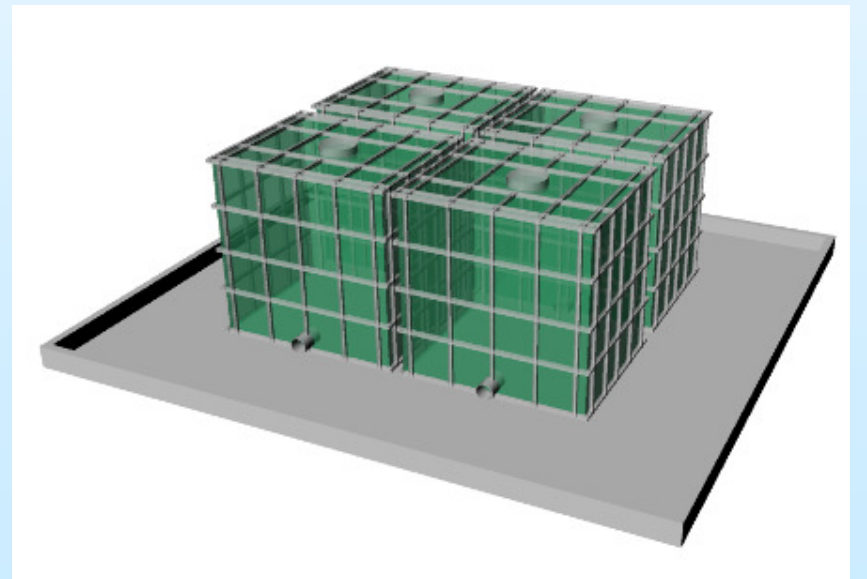
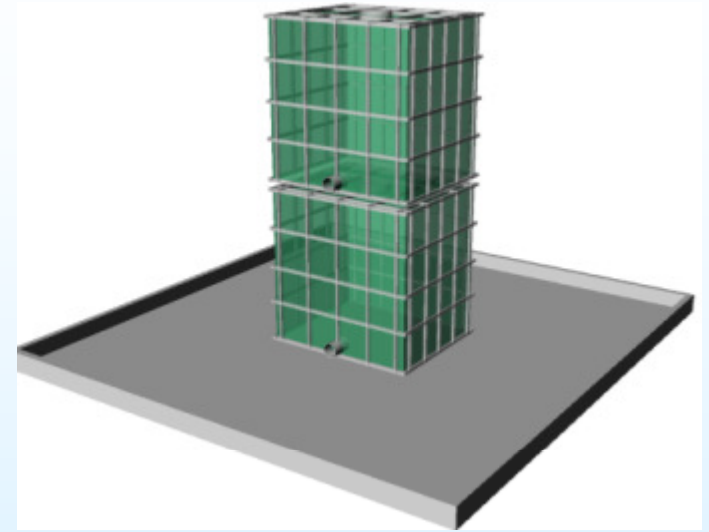


Liquid Discharge Scenarios

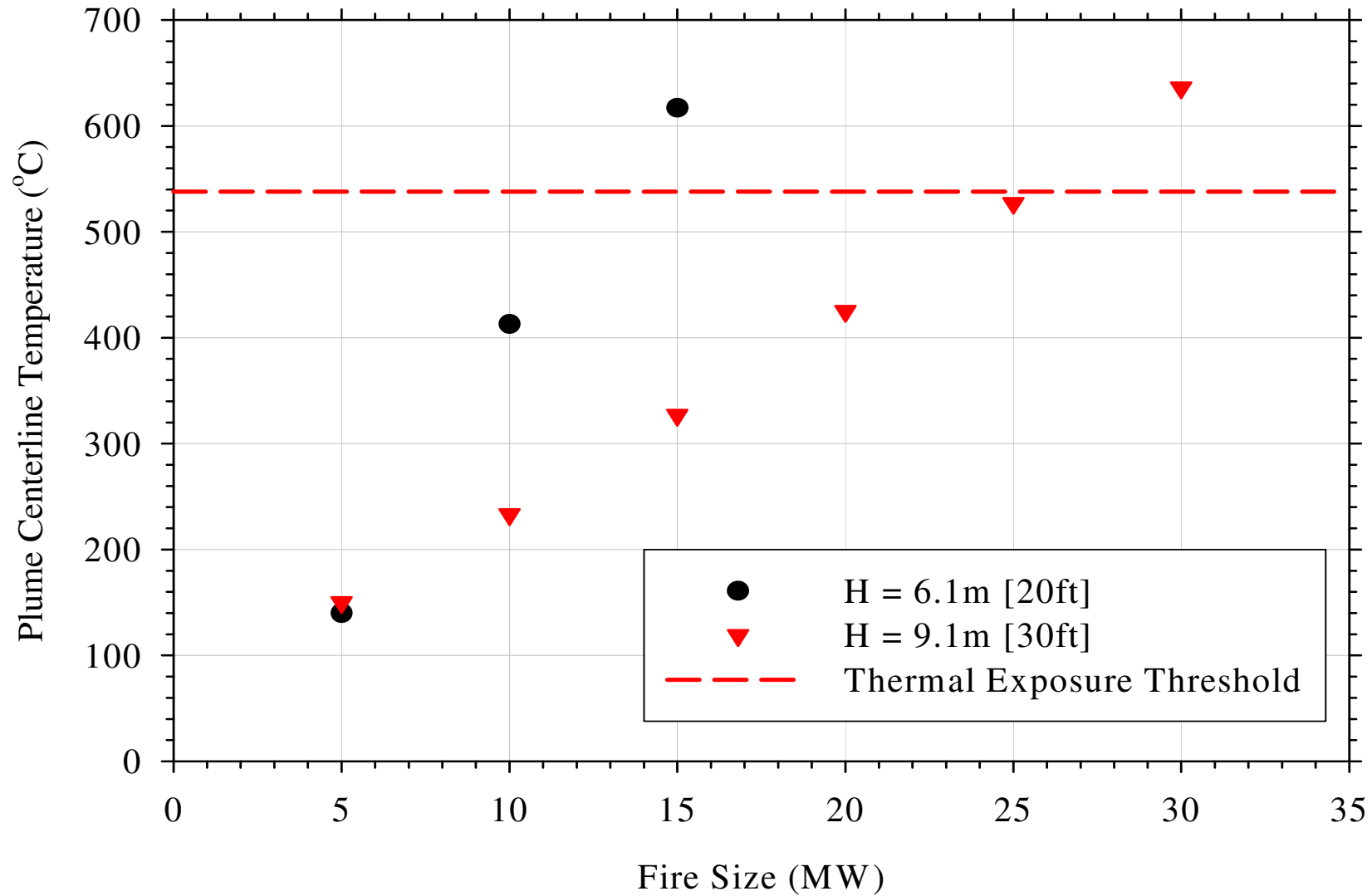


Design Fires 3 - 7

- Larger containment areas required
- Larger fires expected
- Areas between 13 – 42 m² (136 – 452 ft²)
- Estimated fire sizes between 5.0 – 160 MW depending on fuel



Localized Heating Approach



Summary of Fire Hazards

- Protection optional for certain scenarios
 - ◆ Relatively 'small'-area
 - ◆ Alcohols
- 'Large'-area, hydrocarbon scenarios require additional protection
- Containment systems required for all scenarios
- Uncontained scenarios present significant hazard to neighboring combustibles and structure



Options for Protection

- Containment
 - ◆ Passive fire suppressant
- Fire Suppression
 - ◆ Local
 - ◆ Overhead
- Fire Detection



Containment System Options

- Raised sumps
- Fixed Berm / Raised Sill
- HazMat Storage Locker



Passive Vapor/Fire Suppression

- Cellular glass material (FOAMGLAS PFS)
- Developed for the LNG industry
- Limits vapor emission and burning area of fuel spills
- Lightweight, re-usable, relatively maintenance-free solution
- Up to 95 percent reduction in radiant energy release ?
- Must be coupled with fire-resistive containment



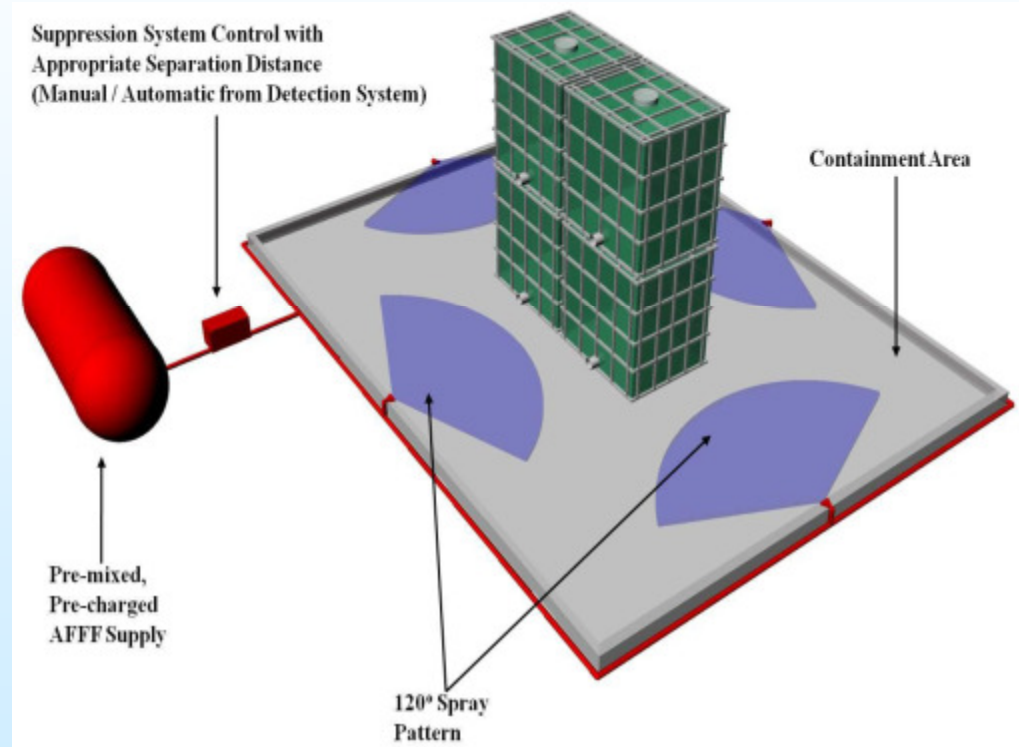
Overhead Systems

- Traditional approach to protecting scenarios involving IBCs
- Large application rates required
 - ◆ Water Sprinkler - 0.45 – 0.60 gpm/ft²
 - ◆ Foam-Water Sprinkler - 0.10 – 0.30 gpm/ft²
- Systems require appropriately sized containment to avoid overflow



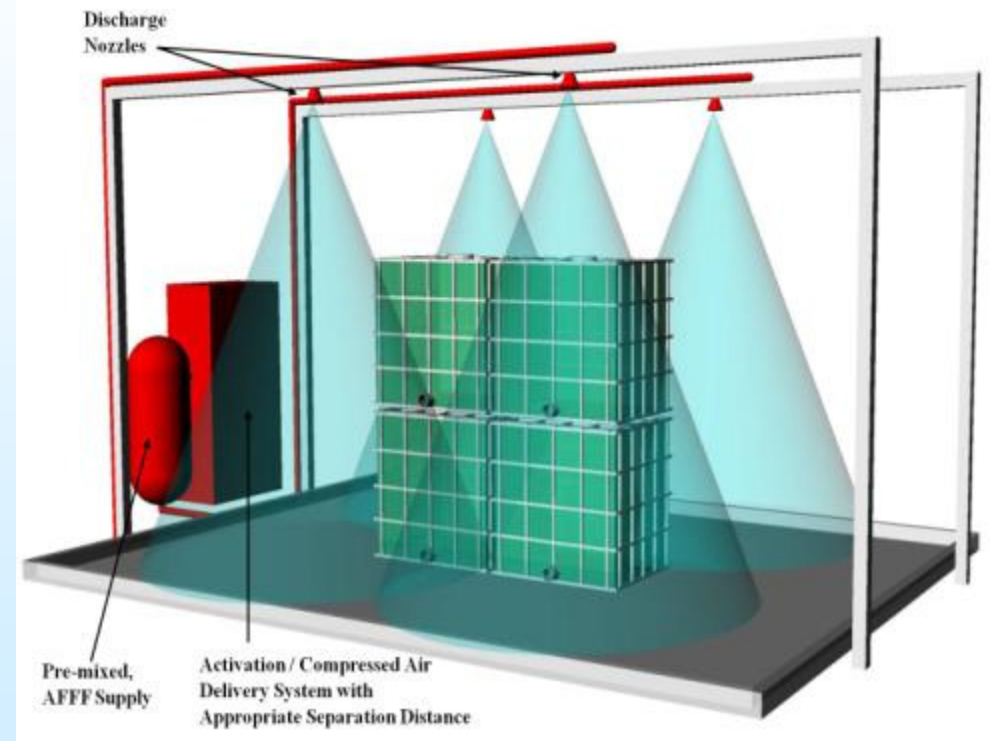
Low-Level AFFF Foam

- Existing approach to extinguish fuel fires
- Lower application rates permitted due to proximity to fuel surface
- Currently, no Listed/Approved systems for this application
- Unable to extinguish 3D fire scenarios



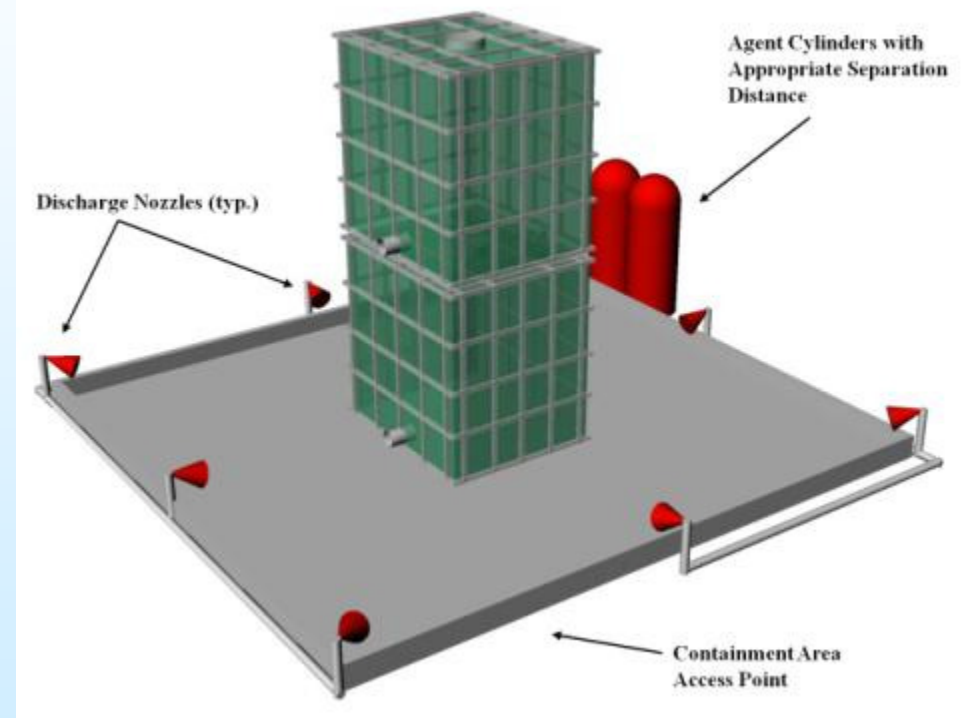
Compressed Air Foam System (CAFS)

- Optimized foam
 - ◆ Reduced water/foam demand
 - ◆ Enhanced plume penetration
 - ◆ Improved re-flash resistance
- Pre-engineered systems
- Listed systems available
- Complex systems
- Inspection, Testing, and Maintenance must be considered



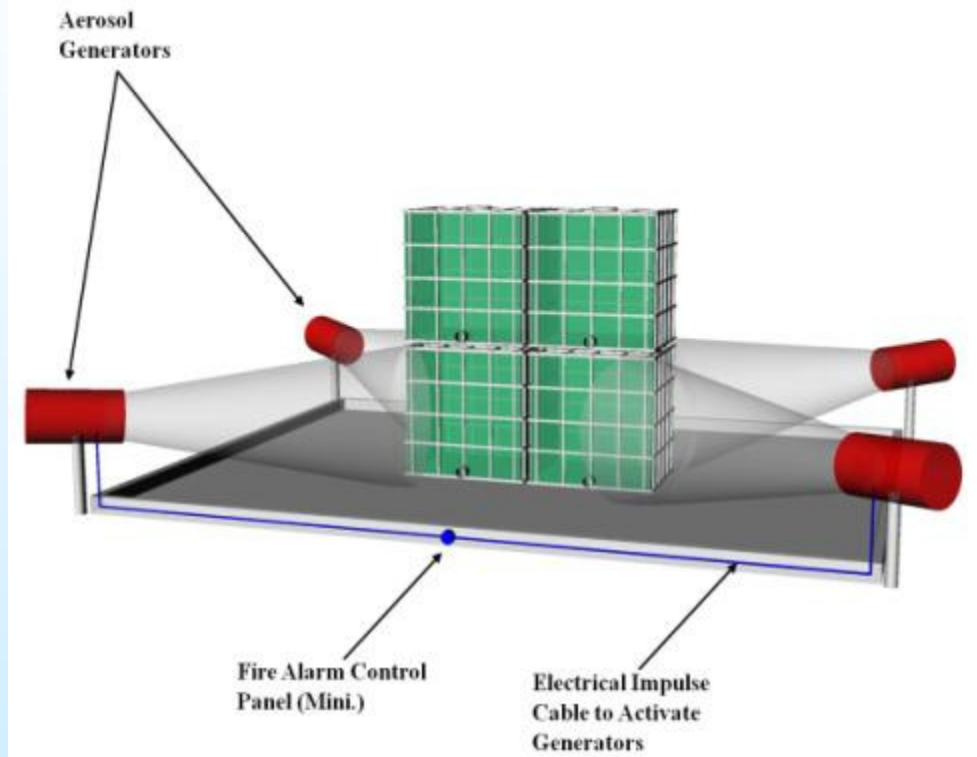
Dry Chemical System

- Commonly used petrochem industry
- Listed systems available
- Susceptible to re-flash
- Collateral damage due to migration of discharged agent must be considered
- Inspection, Testing, and Maintenance must be considered



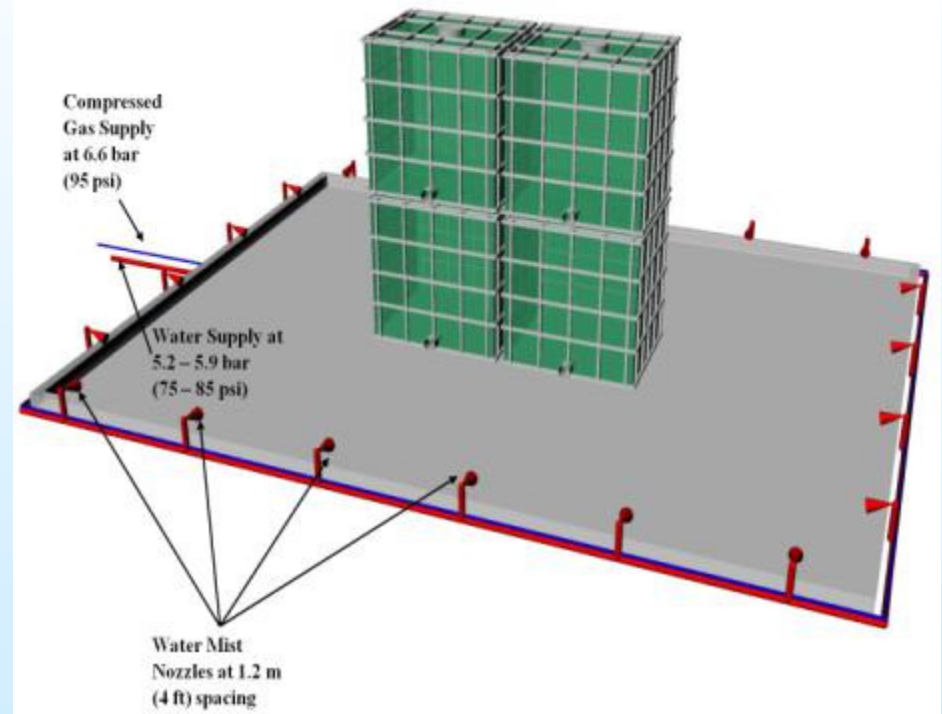
Aerosol

- Produce ultra-fine potassium based aerosol which displaces oxygen
- Stand-alone, 'maintenance-free' systems
- Currently, no Listed/Approved systems for this application
- Collateral damage due to migration of discharged agent must be considered



Water Mist

- Low/High pressure systems available
- Relatively limited water usage required
- Pre-engineered system
- Approved systems available



Suppression System Summary

	Water Usage Efficiency ¹	Suppression of 3D Fire	Inherent Protection of Neighboring Combustibles	Protection against Re-ignition / Burn-back	Obstructs Movement in Containment Area	Low-Level Piping Req.	Insp., Testing, and Maint.	Requires Local Detection System	UL Listed or FM Approved System	Requires Dev. or Veri. Testing
Overhead Sprinkler	1.00	No	Yes	No	No	No	Minimal	No	Yes	Veri.
Overhead AFFF	0.75 or less	No	Yes	Yes	No	No	Moderate	No	Yes	Veri.
Low-level Application of AFFF	0.17	No	No	Yes	Yes, Minimal	Yes	Moderate	Yes	No	Dev.
Compressed Air Foam	0.11	No	Yes/No	Yes	No	Yes, Minimal	Moderate	Yes	Yes	Veri.
Pre-Engineered Dry Chemical	N/A	Potentially yes, Re-flash possible	No	No	Yes, Minimal	Yes	Moderate	Yes	Yes	Veri.
Aerosol Generators		Potentially yes, Re-flash possible	No	Unlikely	No	No	Very Low	Yes	No	Dev.
Local Application Water Mist	0.06 ²	Yes, potentially	No	Yes, for duration of discharge	Yes, Minimal	Yes	Moderate	Yes	Yes	Veri.
Passive Pool Fire Suppression	N/A	No	Yes	N/A	Yes	N/A	Essentially None	N/A	N/A	Veri.



Summary of Findings

- Unlisted IBCs containing combustible/flammable liquids can result in fires capable of;
 - ◆ Overwhelming 'typical' industrial fire protection systems
 - ◆ Involving neighboring combustibles
 - ◆ Compromising the structural integrity of the facility

- Commercial methods of protection are available to mitigate this hazard
 - ◆ Containment
 - ◆ Suppression

- Properly designed protection scheme can address all of the hazards identified above



Protection Scheme Overview

■ Containment System

- ◆ Fire Resistive
- ◆ Adequate area to capture 'worst-case' discharge scenarios
- ◆ Adequate depth to contain IBC content and suppression agent
- ◆ In certain scenarios, containment may be sufficient

■ Suppression System

- ◆ Passive system represents potential solution that does not require installation of active suppression
- ◆ Listed/Approved system preferred to reduce developmental costs

■ Detection System

- ◆ Type of system dependent upon desired/available stand-off distances

■ Systems require verification testing



Path Forward

- Intermediate scale testing in progress
- Quantification of leakage characteristics
- Background burns of representative fuels
- Passive suppression system capability
 - Explore different fuels and installation configurations
- If successful, scale up tests to include overhead, automatic sprinklers



Questions / Comments?



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