



High-Pile Storage

Commodity Classification

James Golinveaux

Objectives / Training Outline

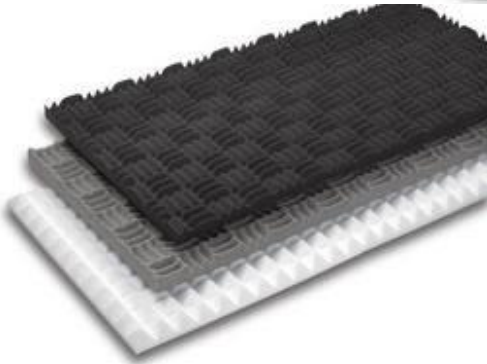
Determine commodity classifications

Identify storage arrangements

Class III - Freeburn

Freeburn Video
40 ft (12.2) Rack Storage of Class III under a
45 ft (13.7) Ceiling
Water Supply Turned Off
Testing Sprinkler Activation Sequence in Dry Systems

What was the Problem?



the ware

es Niel

Objectives / Training Outline

Determine commodity classifications

Identify storage arrangements

Storage Facilities Represent Challenging Fire Scenarios

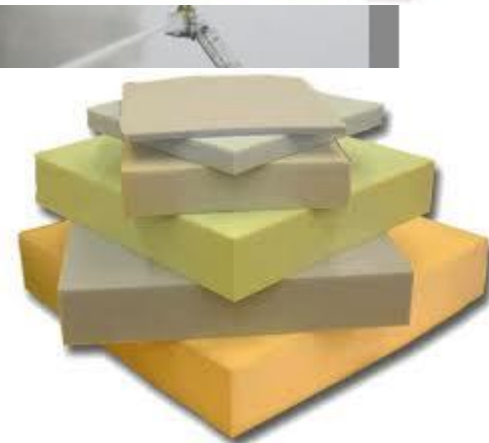
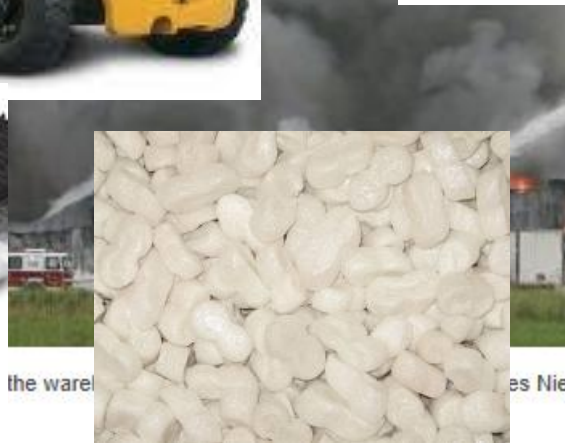
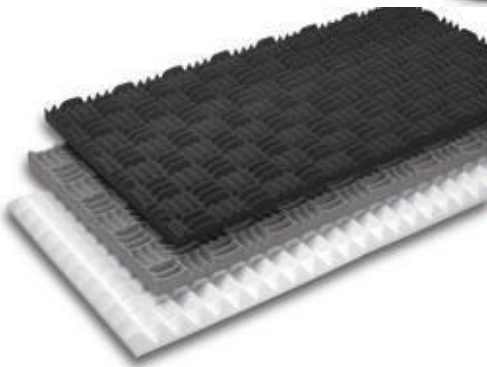
- Three dimensional fire with a vertical fuel load
- Fire can be over the heads of fire fighters
- Challenging to get water from ceiling sprinklers down to the fire
- Many storage configurations and type of fuel



Significant Content providers:



// What was the Problem?



the ware

es Niel

// Components of a Commodity



← Commodity includes:

← Material and internal packaging

← External packaging

← Pallet

// Commodity Hazards

- Noncombustible
- Class 1
- Class 2
- Class 3
- Class 4/Cartoned Unexpanded Plastic (CUP)
- Cartoned Expanded Plastic (CEP)
- Uncartoned Unexpanded Plastic (UUP)
- Uncartoned Expanded Plastic (UEP)



// How to Evaluate a Commodity?



Commodity includes:

Step 1: Material and Internal Packaging

Step 2: External packaging

Step 3: Pallet

Step 1: Material and Internal Packaging

- What's in the box?
- Use of packaging material?
- Are there plastics?
- What kind of plastics?
- If mixed, calculate %
- Use Flowchart for this step!



//Material

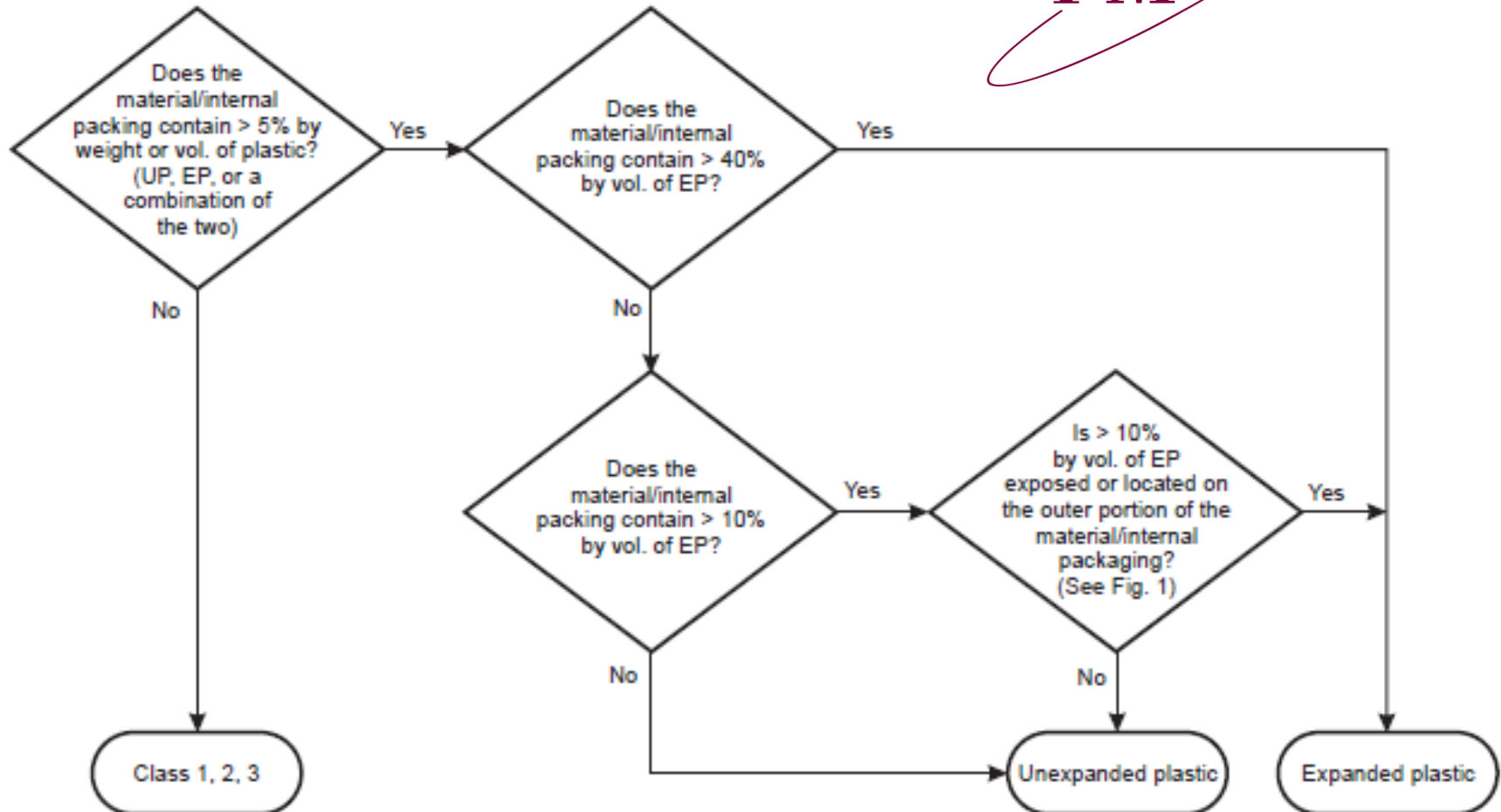


// ... and Internal Packaging



// Material and Internal Packaging

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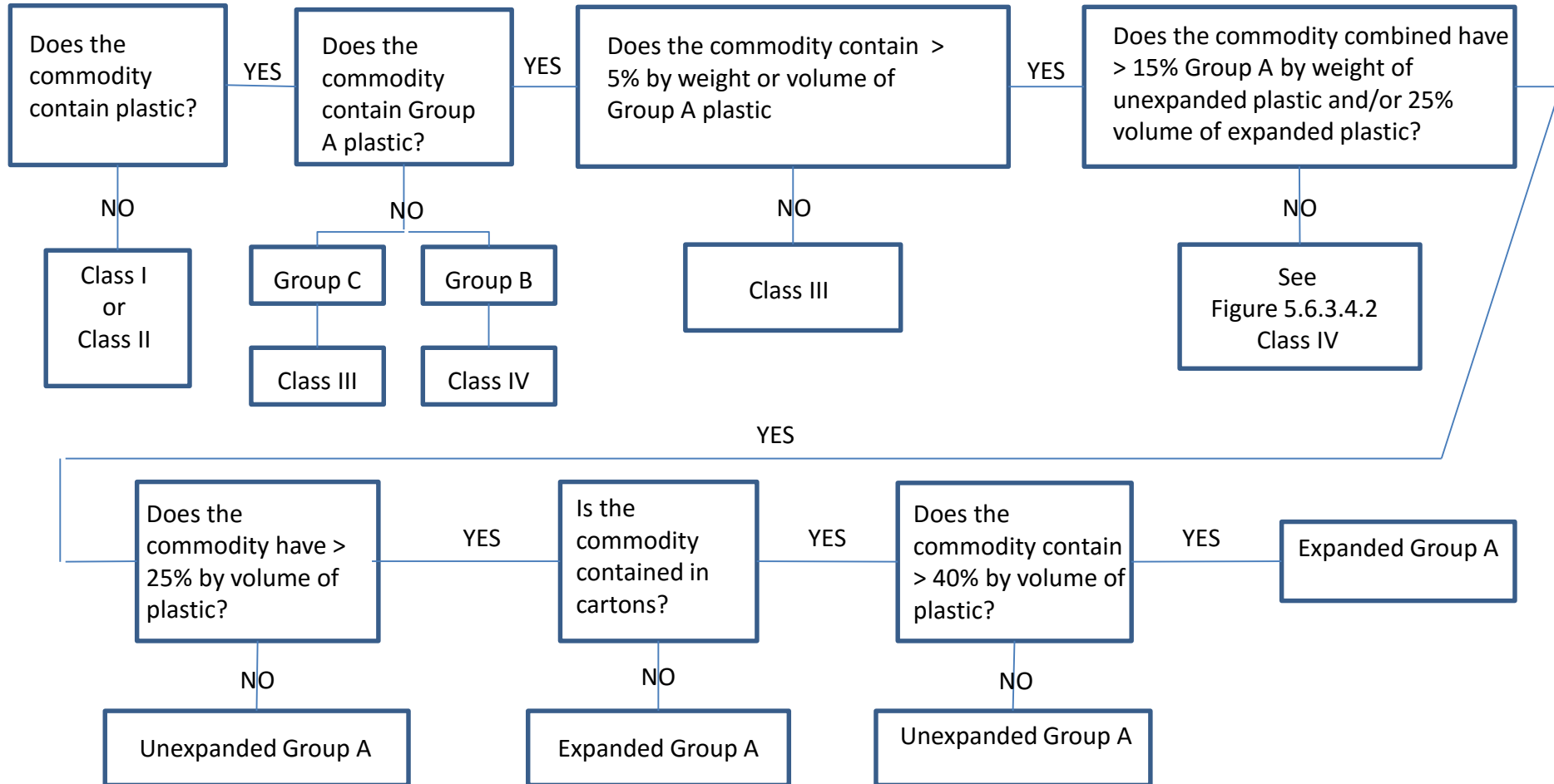
// Commodity Hazards

- Class 1
- Class 2
- Class 3
- Class 4
- Cartoned Unexpanded Plastic
- Cartoned Expanded Plastic
- Exposed Unexpanded Plastic
- Exposed Expanded Plastic

NFPA

// Material and Internal Packaging

NFPA 13 – 2016 Edition



// Step 2: External Packaging

- How is the material stored?
- Corrugated cardboard box?
- Metal container?
- Plastic container?
- Thickness of the plastic container?



// Step 2: Cardboard Cartons

- Benefits: Absorb sprinkler water
 - Pre-wet commodity and reduce fire spread



- Downfall: Burn easily and quickly
-

// Step 2: Metal Containers

- Benefit: Decrease the hazard
- Plastics can be treated as:
 - Class 3 (open top)
 - Class 1 (closed top)



// Step 2: Plastic Containers

FM Global®

- Non-ignitable liquids:
 - Class 1 (< 5 gal [19 L]) or in gridded containers
 - Class 2 (> 5 gal [19 L] and < ¼ in. [6 mm] thick wall)
 - UUP (> 5 gal [19 L] and > ¼ in. [6 mm] thick wall)
- Noncombustible solids
 - CUP
 - UUP (> 1 gal [3.8 L])
- Combustible
 - UUP
 - UEP
- Empty: UEP



// Step 3: Material Handling



- How is the material being transported?
 - Wood pallet?
 - FM Approved or Listed pallet?
 - Plastic pallet?
-

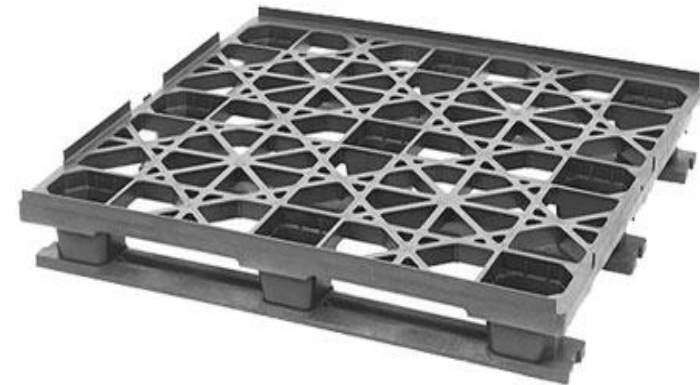
// Pallets

FM Global®

- Wood or FM Approved:
 - None, unless noncombustible materials, Class 1.



- Unexpanded plastic pallets (not FM Approved):
 - None, if material considered a plastic
 - Otherwise, increase by one level



// Storing Materials on Plastic Pallets

NFPA

One class upgrade for un-reinforced plastic pallets

- Class II → Class III
- Class IV → Group

Two class upgrade for reinforced plastic pallets

- Class II → Class IV
- Class IV → Group A Plastics



// Plastic Pallet Types

Un-reinforced plastic pallets **NFPA**

- Melt fairly easily in a fire and are less of a fire challenge
- Material
 - Polypropylene
 - High-density polyethylene

Reinforced plastic pallets

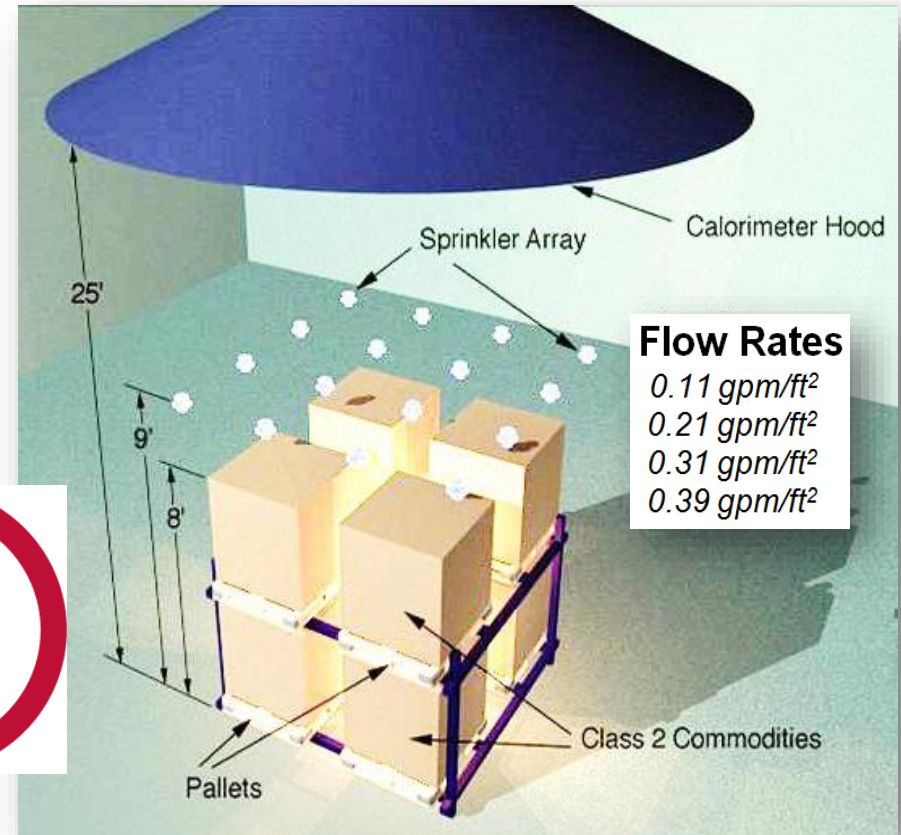
- Hold their structure and integrity longer allowing air gaps to remain longer within the pallet, which fuels the flames and creates a more intense fire
- Material
 - Polypropylene
 - High-density polyethylene

Classification by Listing



// Test Configuration – Commodity Classification

- Burn commodity with standardized water applications
- Determine the resulting Heat Release rate (HRR)
- Rank the hazard for the appropriate suppression design



Note: Valid Commodity Classification tests require palletized commodities.

// Test Results / Definitions



The four parameters for the tests are defined as follows

- V1 - Maximum one minute average of the total heat release rate.
 - V2 - Maximum one minute average of the convective heat release rate.
 - V3 - Effective convective heat release rate, defined as the average convective heat release rate measured over the five minutes of the most intense fire.
 - V4 - Convective energy, the total convective energy measured over the ten minutes of most severe burning.
-

// V1 – V4 Correlation to Rank

Each parameter correlates to a rank from 0.5 to 7.0 for each density

Delivered density: 0.11 gpm/ft ² (4.5 mm/min)				
Rank	V1	V2	V3	V4
	Maximum total heat release rate,	Maximum convective heat release rate,	Effective convective heat release rate,	Total convective energy,
	kW	kW	kW	MJ
0.50	0 – 3830	0 – 1970	0 – 620	
0.75	3840 – 4150	1980 – 2180	630 – 1040	199
1.00	4160 – 4520	2190 – 2410	1050 – 1460	200 – 589
1.25	4530 – 4910	2420 – 2660	1480 – 1880	590 – 940
1.50	4920 – 5310	2670 – 2940	1890 – 2300	941 – 1232
1.75	5320 – 5770	2950 – 3240	2310 – 2730	1233 – 1481
2.00	5780 – 6260	3250 – 3590	2740 – 3170	1482 – 1773
2.25	6270 – 6800	3600 – 3960	3180 – 3590	1774 – 1894
2.50	6810 – 7380	3970 – 4360	3600 – 4010	1895 – 2068
2.75	7390 – 7930	4370 – 4820	4020 – 4430	2069 – 2121
3.00	7940 – 8700	4830 – 5330	4440 – 4850	2122 – 2371
3.25	8710 – 9460	5340 – 5870	4860 – 5280	2372 – 2504
3.50	9470 – 10270	5880 – 6490	5290 – 5700	2505 – 2628
3.75	10280 – 11140	6500 – 7170	5710 – 6120	2629 – 2744
4.00	11150 – 12090	7180 – 7910	6130 – 6560	2745 – 2853
4.25	12100 – 13110	7920 – 8740	6570 – 6980	2854 – 2954
4.50	13120 – 14240	8750 – 9650	6990 – 7400	2955 – 3051
4.75	14250 – 15470	9660 – 10650	7410 – 7820	3052 – 3142
5.00	15480 – 16780	10660 – 11760	7830 – 8250	3143 – 3228



//Commodity Classification

Commodity Class Designations for Mean Total Rank Values		Rank
Mean Total Rank	Commodity Class	
Less than 1.5	I	1
Equal to or greater than 1.5 but less than 2.5	II	2
Equal to or greater than 2.5 but less than 3.5	III	3
Equal to or greater than 3.5 but less than 4.5	IV	4
Equal to or greater than 4.5 but less than 5.5	Cartoned Group B Unexpanded Plastic	5
Equal to or greater than 5.5 but less than 6.5	Cartoned Group A Unexpanded Plastic	6
Equal to or greater than 6.5 but less than 7.0	Cartoned Group A Expanded Plastic	7



// Commodity Classification Video – Exposed, Expanded Group A Plastic



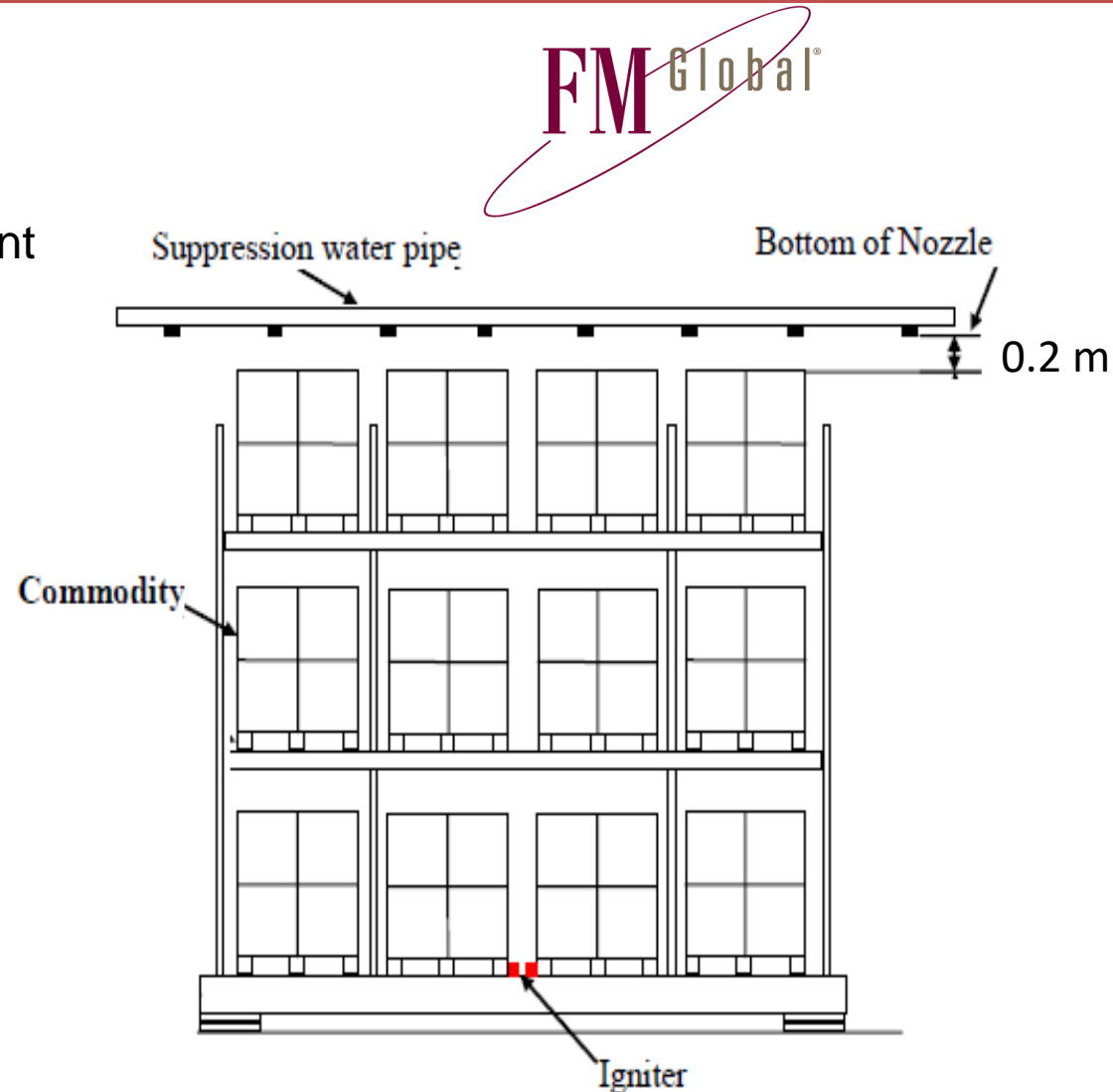
// Intermediate-Scale Testing



- More reliable than bench-scale
- Reduced array size
- Water Application Apparatus (WAA)
- Less cost prohibitive than large-scale
- Fire characteristics are compared to FM Standard Commodities:
 - Fire growth rate (HRR)
 - Critical density flux (CDF)

// Intermediate-Scale Testing - CDF

- Defined as: Min water density applied to array that will prevent fire growth
- Constant HRR



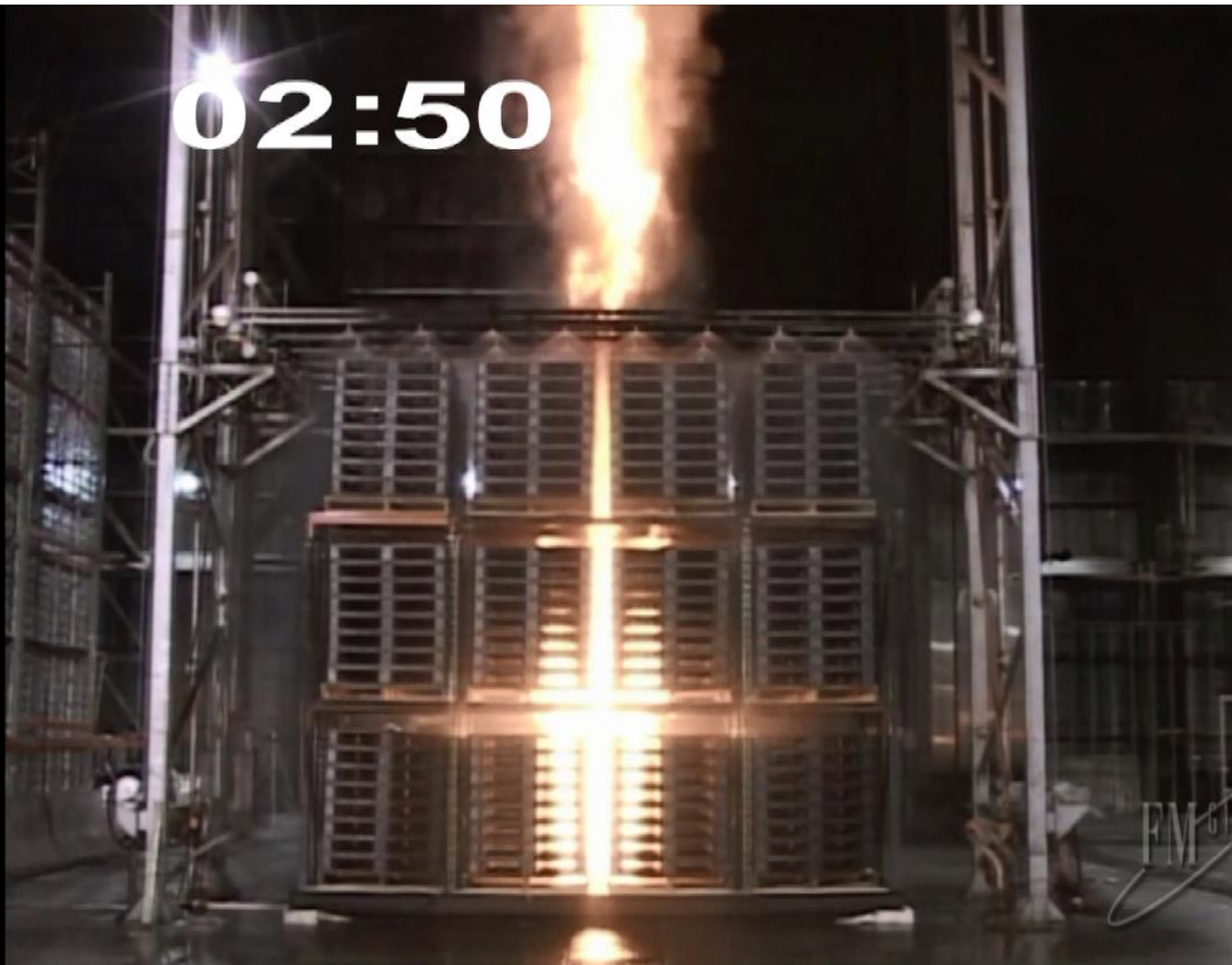
// Intermediate-Scale Testing



SR
sprinkler
286°F
WAA
activation:
2:17 min

Delivered
Flux
0.35
gpm/ft²

Intermediate-Scale Testing



SR
sprinkler
286°F
WAA
activation:
2:17 min

Delivered
Flux
0.35
gpm/ft²

// NFPA 13 Commodity Classification



Class or Group	Class or Group Material
Class I	Essentially non-combustible products in corrugated cartons on combustible pallets
Class II	Class I products in slatted wooden crates, solid wooden boxes or multiple thickness paperboard cartons with or without pallets
Class III	Wood, paper, natural fiber cloth or Group C plastics with or without pallets. May contain a limited amount (5% by weight or volume or less) of Group A or Group B plastics
Class IV	Class I, II or III commodities in corrugated cartons with appreciable amounts (5-15% by weight, or 5-25% by volume) of Group A plastics
Plastics	Cartoned Unexpanded Group A Plastic
	Cartoned Expanded Group A Plastic
	Exposed Unexpanded Group A Plastic
	Exposed Expanded Group A Plastic

Class 1

- Noncombustible on wood pallets
- Noncombustible in **single-layer** corrugated cardboard cartons on wood pallets.
- Material may contain negligible amount of plastic trim (e.g. knobs, handles)



Commodity Classes – Class II

Noncombustible product that is in slatted wooden crates, solid wood boxes, multiple-layered corrugated cartons, or equivalent combustible packaging material, with or without pallets.



Commodity Classes – Class III

A product fashioned from wood, paper, natural fibers, or Group C plastics with or without cartons, boxes, or crates and with or without pallets.

Group C plastics - (NFPA 13, 5.6.4.3)

1. Fluoroplastics (PCTFE — polychlorotrifluoroethylene; PTFE — polytetrafluoroethylene)
2. Melamine (melamine formaldehyde)
3. Phenolic
4. PVC (polyvinyl chloride — flexible — PVCs with plasticizer content up to 20 percent)
5. PVDC (polyvinylidene chloride)
6. PVDF (polyvinylidene fluoride)
7. PVF (polyvinyl fluoride)
8. Urea (urea formaldehyde)

A limited amount (5% by weight or volume or less) of Group A or Group B plastics.



Commodity Classes – Class IV

A product, with or without pallets, that meets one of the following criteria:

- Constructed partially or totally of Group B plastics
 1. Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
 2. Chloroprene rubber
 3. Fluoroplastics (ECTFE — ethylene-chlorotrifluoro-ethylene copolymer; ETFE — ethylene tetrafluoroethylene-copolymer; FEP— fluorinated ethylene-propylene copolymer)
 4. Nylon (nylon 6, nylon 6/6)
 5. Silicone rubber
- Consists of free-flowing Group A plastic materials
- Contains within itself or its packaging an appreciable amount (5 % to 15 % by weight or 5 % to 25 % by volume) of Group A plastics



A mixture of paper and plastic cups (15 % plastic by weight) on wood pallets.



Commodity Classes – Group A Plastic

Plastic materials

- Cartoned vs. Uncartoned (Exposed)
- Expanded vs. Unexpanded



NFPA 13- Table A.5.6.3



16-oz (450 g) Polystyrene
Plastic Jars in Compartmented
Cardboard Cartons



Expanded Polystyrene
Trays Cartoned



Expanded Polystyrene
Trays Exposed

Unexpanded Plastic (UP)

Cartoned or Uncartoned dictates Commodity Class

Cartoned



Exposed



Expanded Plastic (EP)

Cartoned or Uncartoned dictates Commodity Class

Cartoned

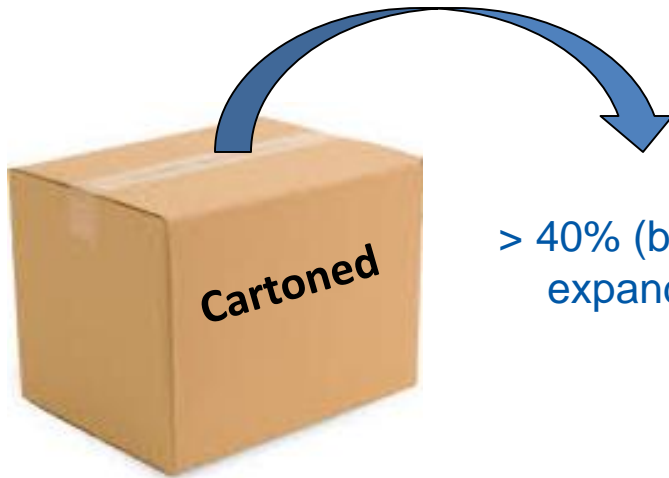


Exposed



Commodity Classes – Group A

NFPA



> 40% (by volume) of expanded plastic

= Cartoned expanded plastic

13: 5.6.4.4.1



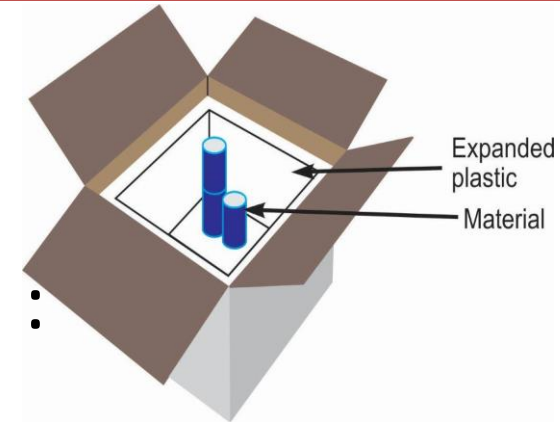
> 25% (by volume) of expanded plastic

= Exposed expanded plastic

13: 5.6.4.4.2

Unexpanded Plastic (UP)

- Weight of UP
 - > 5%

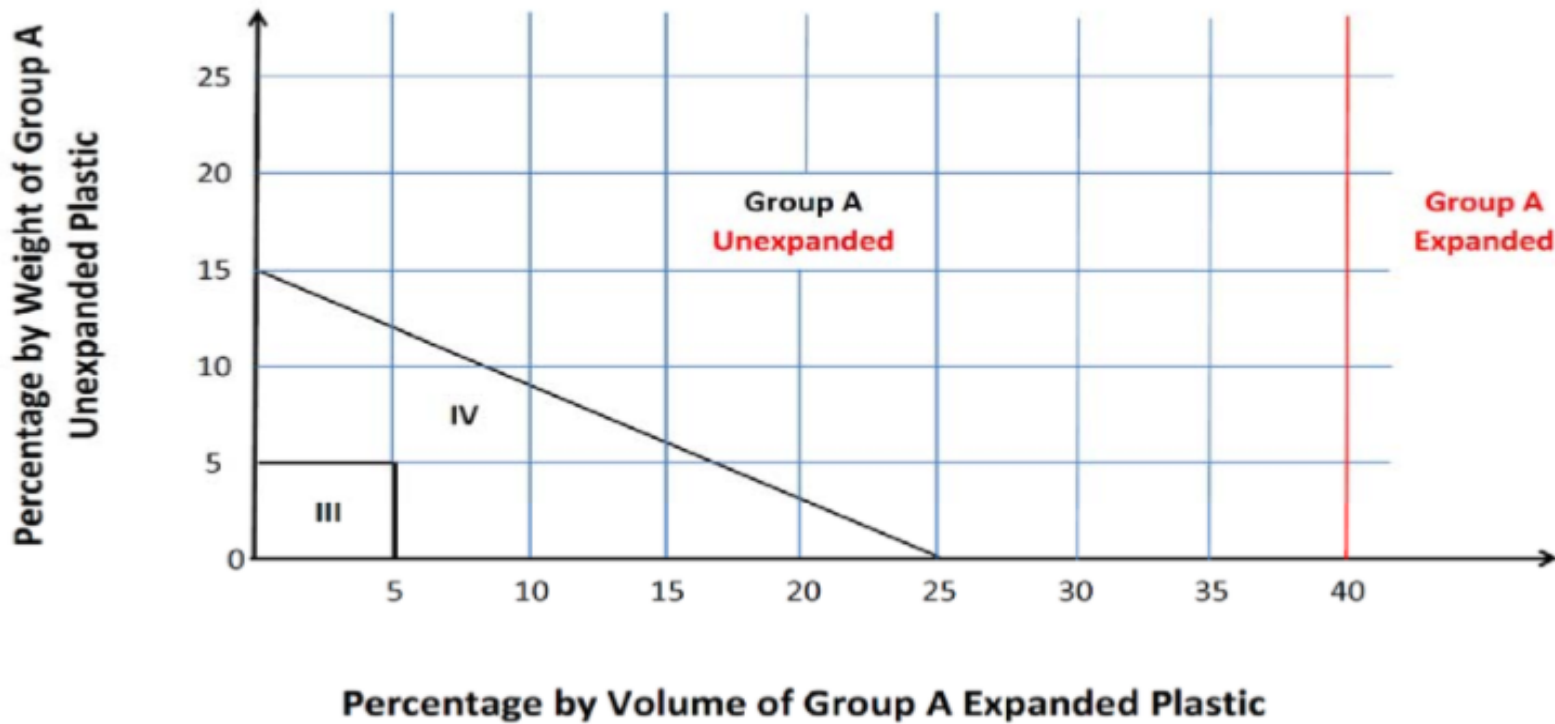


- Volume of expanded plastic (foam) :
 - >5%-40%
 - >5%-10% exposed/outer portion of material



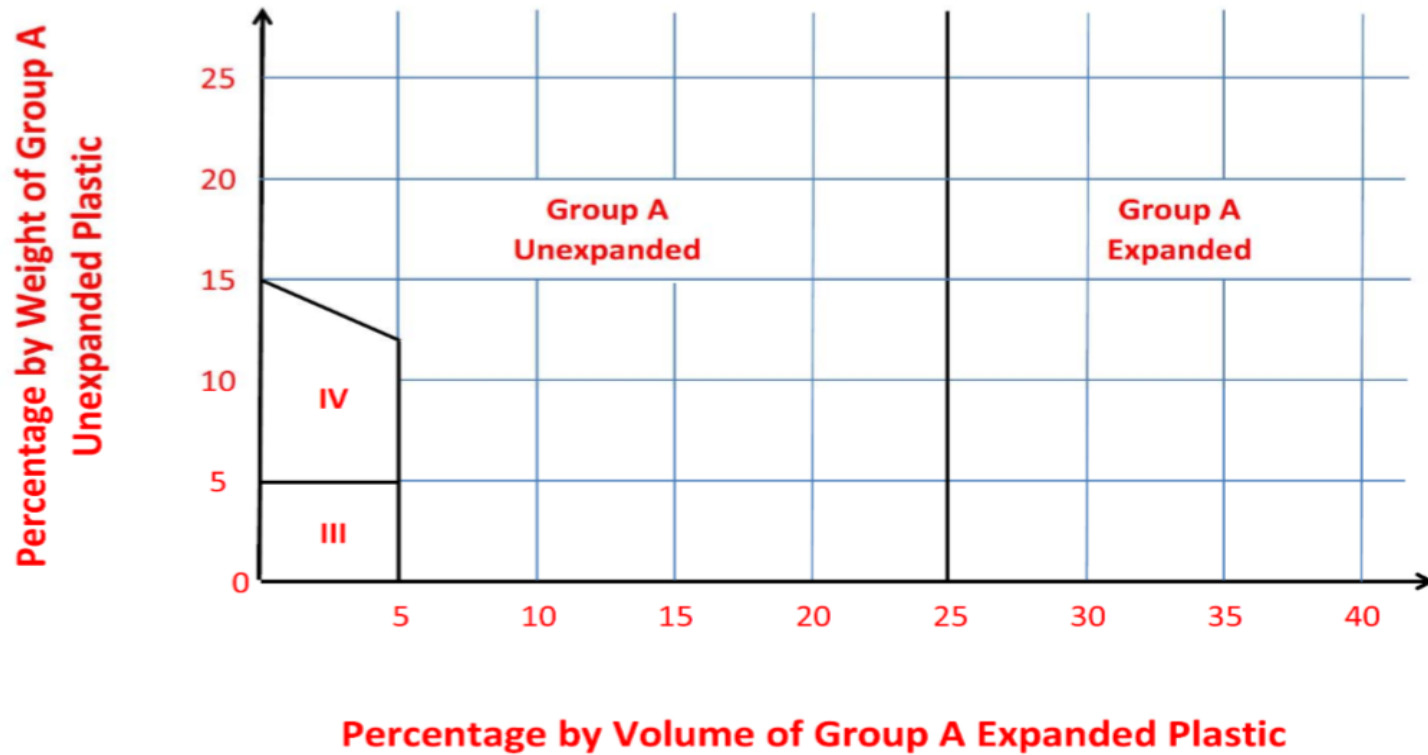
Mixed Commodities - Cartoned

Figure 5.6.3.4.2.3.3.1 Commodities, **Cartoned or Within a Wooden Container**, Containing a Mixture of Expanded and Unexpanded Group A Plastics



Mixed Commodities - Exposed

Figure 5.6.3.3.2 Exposed Commodities Containing a Mixture of Expanded and Unexpanded Group A Plastics



III - Class III Commodity. Refer to 5.6.2 if a plastic pallet is used.

IV - Class IV Commodity. Refer to 5.6.2 if a plastic pallet is used.

// Encapsulation

NFPA

- // Plastic sheet completely enclosing the sides **and top** of a pallet load containing a combustible commodity
- // Combustible commodities individually wrapped in plastic sheeting and stored exposed in a pallet load
- // Where there are holes or voids in the plastic on the top of the carton that exceed more than half of the area of the cover, the term *encapsulated* does not apply



Mixed Commodities

Protection requirements shall not be based on the overall commodity mix in a fire area.

In general, mixed commodity storage shall be protected by the requirements for the highest classified commodity and storage arrangement.

The protection requirements for the lower commodity class shall be permitted to be utilized where all of the following are met:

- Up to 10 pallet loads of a higher hazard commodity shall be permitted to be present in an area not exceeding 40,000 ft² (3716 m²).

- The higher hazard commodity shall be randomly dispersed with no adjacent loads in any direction (including diagonally).

- Where the ceiling protection is based on Class I or Class II commodities, the allowable number of pallet loads for Class IV or Group A plastics shall be reduced to five.

The protection requirements for the lower commodity class shall be permitted to be utilized in the area of lower commodity class, where the higher hazard material is confined to a designated area and the area is protected to the higher hazard in accordance with the requirements of this standard.



Other types of commodities



Idle Pallet



Baled Cotton



Rolled Paper



Rubber Tire

Impact on Design – Density

Significant increases based on each Class increase
 30 ft (9.1m) Ceiling, 25 ft (7.6m) Storage – Double Row Rack

Class or Group	Class or Group Material	
Class I	.51 gpm/sq ft (20.8 mm/min)	
Class II	.57 gpm/sq ft (23.2 mm/min)	
Class III	.65 gpm/sq ft (26.5 mm/min)	
Class IV	.37 gpm/sq ft (13 mm/min) w/in-rack	
Plastics	Cartoned Unexpanded Group A	.8 gpm/sq ft (32.6 mm/min)
	Cartoned Expanded Group A	.8 gpm/sq ft (32.6 mm/min)
	Exposed Unexpanded Group A	.8 gpm/sq ft (32.6 mm/min) w/in-rack
	Exposed Expanded Group A	Not Allowed

Impact on Design – CMSA

Less Significant increases based on each Class increase
30 ft (9.1m) Ceiling, 25 ft (7.6m) Storage – Double Row Rack

Class or Group	Class or Group Material
Class I	K16.8 – 15 @ 10psi (.7bar)
Class II	K16.8 – 15 @ 10psi (.7 bar)
Class III	K16.8 – 15 @ 22psi (1.52 bar)
Class IV	K16.8 – 15 @ 22psi (1.5 2bar)
Plastics	Cartoned Unexpanded Group A K16.8 – 15 @ 22psi (1.52 bar)
	Cartoned Expanded Group A Not Allowed
	Exposed Unexpanded Group A K16.8 – 15 @ 22psi (1.52 bar)
	Exposed Expanded Group A Not Allowed

Impact on Design – ESFR

Little increases based on each Class increase

30 ft (9.1m) Ceiling, 25 ft (7.6m) Storage – Double Row Rack

Class or Group	Class or Group Material	
Class I	K16.8 – 12 @ 35psi (2.4 bar)	
Class II	K16.8 – 12 @ 35psi (2.4 bar)	
Class III	K16.8 – 12 @ 35psi (2.4 bar)	
Class IV	K16.8 – 12 @ 35psi (2.4 bar)	
Plastics	Cartoned Unexpanded Group A	K16.8 – 12 @ 35psi (2.4 bar)
	Cartoned Expanded Group A	K16.8 – 12 @ 35psi (2.4 bar)
	Exposed Unexpanded Group A	K16.8 – 12 @ 35psi (2.4 bar)
	Exposed Expanded Group A	Not Allowed*

* 2016 Edition allows K25 ESFR

Inadequate Classification of Commodity

Bulk Retail Store Fire

Tempe, Arizona
March 19, 1998



NFPA investigated a fire that occurred in an occupied bulk retail store.

This incendiary fire involved Group A plastics and resulted in 67 sprinkler heads activating before it was brought under control by the fire department. There were several significant factors involved in this incident including draft curtains, ceiling vents and sprinkler density.



National Fire Protection Association
Fire Investigations Department

Designed for Class IV but.....

The building was equipped with three ceiling level, wet sprinkler systems. The systems were designed to provide water at a density of 0.495 gpm/ft² over 2,000 ft² (20.2 (L/min)/m² over 185.8 m²) and were designed to protect a **Class IV** commodity for a maximum storage height of 20 ft (6 m).

...It is actually Group A Plastic

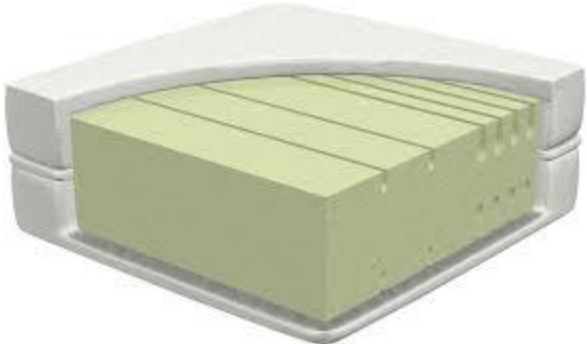
The area where the fire occurred contained merchandise such as seat cushions, patio umbrellas, and plastic lawn chairs. Merchandise at the lower levels was either loosely packed or within cartons that had been opened to allow customer access to the product. Merchandise on the upper levels was on pallets that had been shrink-wrapped around four sides. The product on the adjacent rack was comprised of grass trimmers, plastic gasoline cans and other outdoor-related products. Much of the material would be classified as a Group A plastic, both expanded and unexpanded, as defined by NFPA

Not good for the Sprinkler Industry

This is the third fire that NFPA has investigated in a bulk retail building in three years. The other two, one in Quincy, Massachusetts, and the other in Albany, Georgia, involved pool chemicals, which greatly accelerated the fire. In this case, however, the fire was fueled by conventional fuel loads, and overwhelmed the inadequately designed sprinkler system, destroying 96 linear ft (29 m) of racks and product, and **causing six million dollars in damage.**

Classify the Following Commodities

Mattresses:





DEC 13 2007 11:53

Case Study – Dishwashers

Situation

The customer wanted to investigate the fire challenge created by packaged dishwashers stored in a warehouse facility. The dishwasher was constructed of plastic and metal components and partially wrapped with foil faced, fiberglass insulation. The dishwashers were packaged in a cardboard carton.



Testing

Packaged dishwashers as intended to be stored in the warehouse.

Results

Stored dishwashers created a fire challenge similar to cartoned, unexpanded Group A plastic commodity.



Case Study – Beverage Company

Situation

To save money and present a greener footprint, the client wanted to shift from traditional wood pallets to lighter and more durable plastic pallets. However, the proposed shift posed multiple questions from a risk perspective, including whether the plastic pallets would create more of a fire hazard and if enhancements would be required to existing suppression systems to adequately protect warehouse facilities.

Testing

Materials tested included palletized *glass bottled and canned beer* in paperboard containers on two different plastic pallet designs

Results

Short and long term impact/value derived from testing

- Burning characteristics of the loaded plastic pallets were determined to be consistent with the performance of loaded wood pallets
- Knowing the performance of the palletized commodity in an actual fire allowed the customer to avoid unnecessary and expensive upgrades to warehouse fire protection systems



Case Study – Plastic / Wood Pallet Combination

Situation

The customer's warehouse sprinkler system was designed to protect Class IV commodity. An Automated Storage and Retrieval System (ASRS) potentially required the use of a plastic pallet in addition to the traditional wood pallet. The purpose of the investigation was to determine the increase in commodity hazard attributable to the inclusion of a plastic pallet on top of the wood pallet. With no specific information about the actual risk posed by adding the HDPE pallets, a 2-class penalty to the commodity class would be required per NFPA 13, requiring expensive upgrades to existing fire protection systems.

Testing

- Class IV commodity placed on customer-supplied wood pallets
- Class IV commodity placed on customer-supplied plastic pallets placed on top of customer-supplied wood pallets

Case Study – Plastic / Wood Pallet Combination



Case Study – Plastic / Wood Pallet Combination

Results

The results of the investigation demonstrated that the commodity tested with the wood and plastic pallet combination had a commodity class increase of not less than 2 units greater than the same commodity tested with the wood pallets only.

Case Study – Electric Shavers

Situation

The client unsure of the true hazard of the commodity, refused to risk the value of their high bay warehouse and was renting offsite storage space. The individual shaver kits consisted of a rechargeable electric shaver, a charging base and a 5.7 oz. plastic “Clean & Renew” SD Alcohol 40-B cartridge. The shaver kits retail packaging consisted of the components in Styrofoam and printed paperboard boxes, covered by a clear flexible plastic shell. The retail packages (2 each) were further contained with Styrofoam separators in single thickness corrugated cartons.

Plastics were beyond the NFPA 13 Class IV allowance of 15% by weight and 25% by volume. The product contains a flammable liquid in a plastic container.

Testing

- Materials tested included both retail-packaged shaver kits and retail-packaged alcohol refill cartridges
 - Data was collected under UL’s large calorimeter
-

Classify the Following Commodities



Electric Shaver Kits

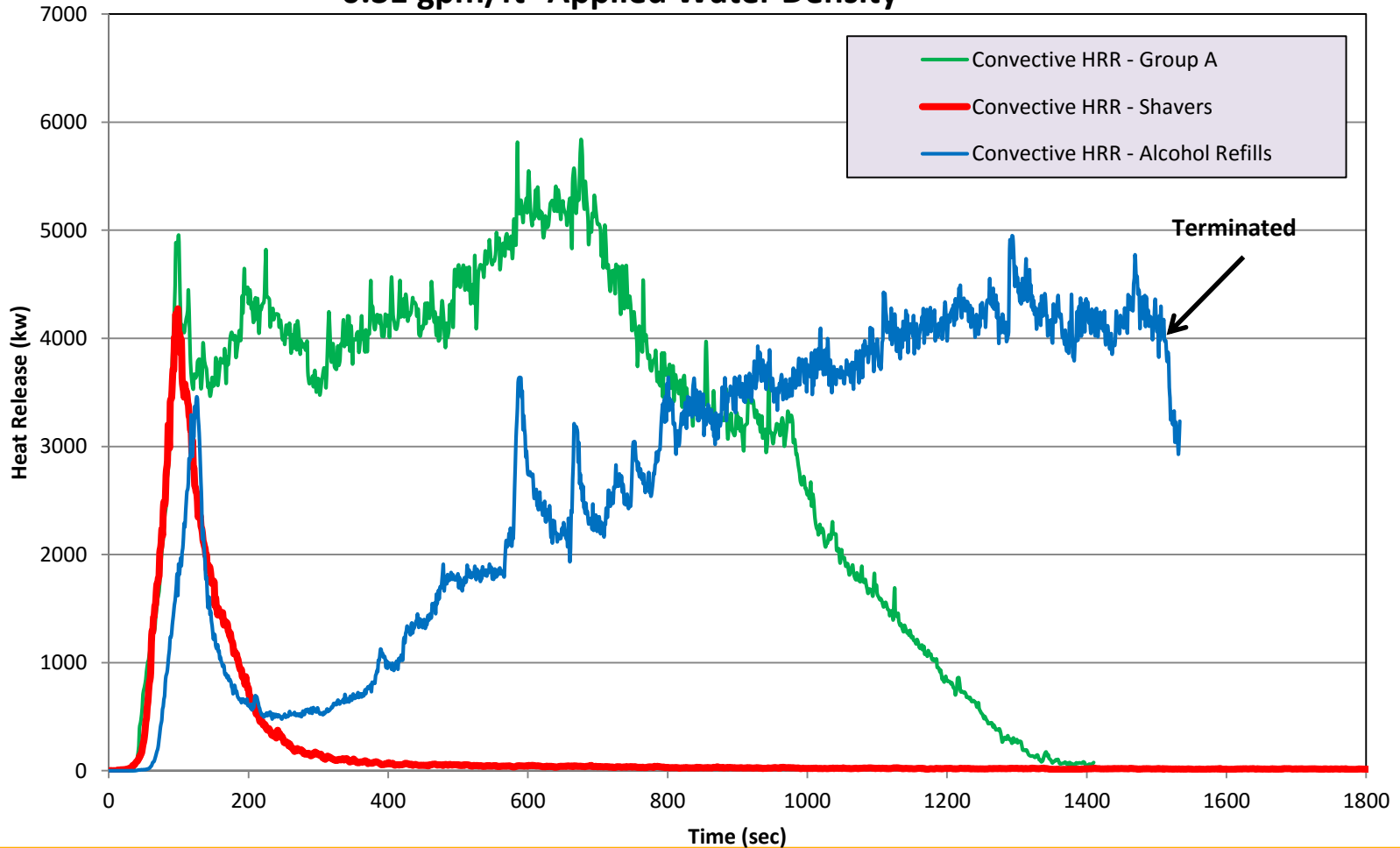


Electric Shaver Kits

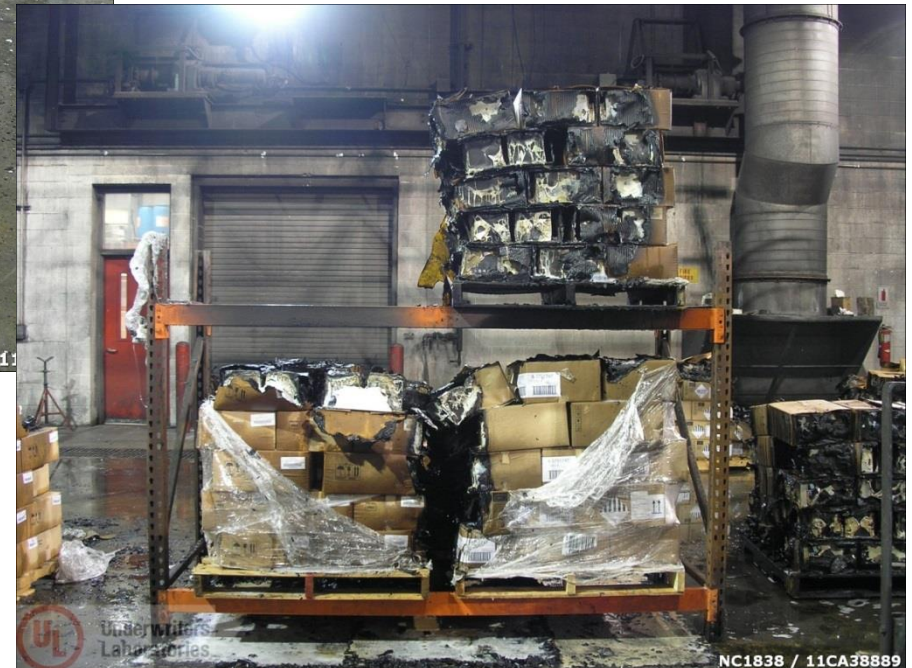


Shaver Kit Test Data – Energy Release

**Electric Shaver Kits
Hazard Index Test
0.31 gpm/ft² Applied Water Density**



Electric Shaver Kits - Damage Photos



Case Study – Electric Shavers

Results

- Electric shaver kits created a fire challenge that was less than cartoned, unexpanded Group A plastic
 - Client realized a substantial cost savings by eliminating off-site storage of the shaver kits
 - Alcohol refills are stored at an offsite facility
-

My Challenge to You

Start every commodity exercise with:

- This is Exposed Expanded Group A Plastic
 - If there are cartons – then it is Cartoned Expanded
 - If its not expanded then it is Cartoned Unexpanded
 - » If the % of plastic is.....
 - If there is no plastic.....

Prove yourself down to the actual class

Palletized Storage

3.9.2.3 Palletized Storage. Storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage.



Solid Piled Storage

3.9.2.7 Solid-Piled Storage. Storage of commodities stacked on each other.



Bin Box Storage

3.9.2.2 Bin Box Storage. Storage in five-sided wood, metal, or cardboard boxes with open face on the aisles in which boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes.



Shelf Storage

3.9.2.6* *Shelf Storage.* Storage on structures up to and including 30 in. (0.76 m) deep and separated by aisles at least 30 in. (0.76 m) wide.



Back to Back Shelf Storage

3.9.2.6.1* Back-to-Back Shelf Storage. Two solid or perforated shelves up to 30 in. (0.76 m) in depth each, not exceeding a total depth of 60 in. (1.52 m), separated by a longitudinal vertical barrier such as plywood, particleboard, sheet metal, or equivalent, with a maximum 0.25 in. (6.4 mm) diameter penetrations and no longitudinal flue space and a maximum storage height of 15 ft (4.57 m).

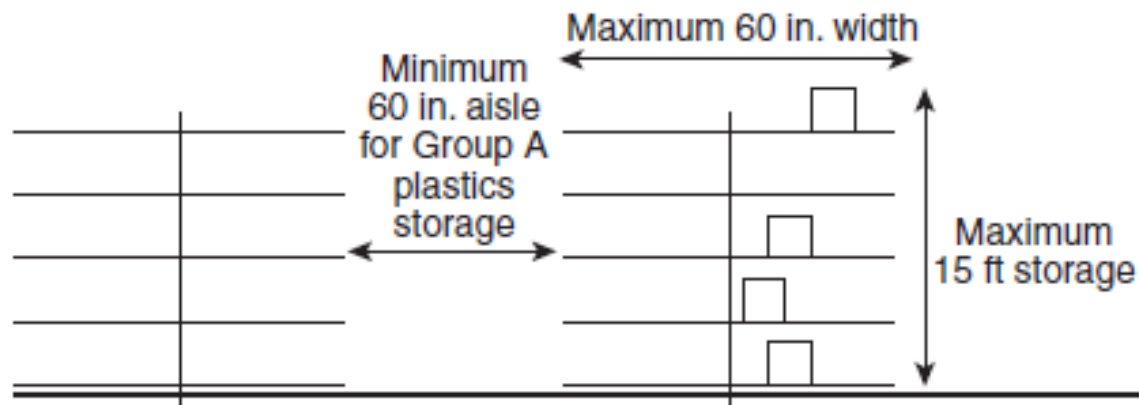


FIGURE A.3.9.2.6.1 Back-to-Back Shelf Storage.

Open Rack Storage

3.9.3.7.7 Open Rack. Racks without shelving or with shelving in racks that are fixed in place with shelves having a solid surface and a shelf area equal to or less than 20 ft² (1.9m²) or with shelves having a wire mesh, slatted surface, or other material with openings representing at least 50 percent of the shelf area including the horizontal area of rack members and where the flue spaces are maintained.



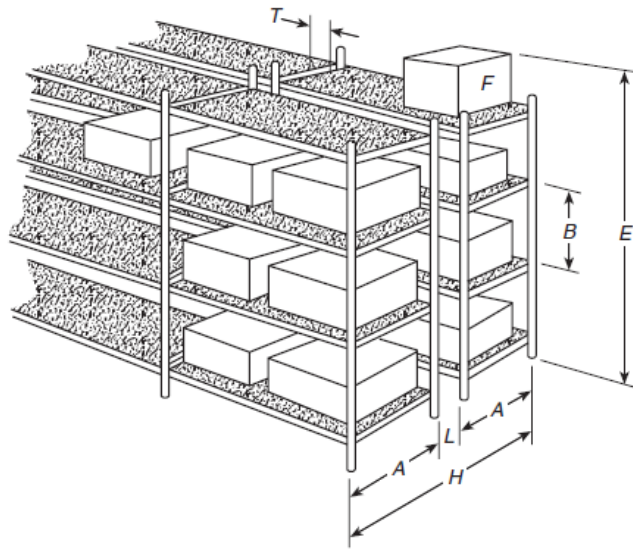
Slatted Shelf Storage

3.9.3.7.8 Slatted Shelf Rack. A rack where shelves are fixed in place with a series of narrow individual solid supports used as the shelf material and spaced apart with regular openings.



Solid Shelf Rack

3.9.3.7.9 Solid Shelf Rack. A rack where shelves are fixed in place with a solid, slatted, or wire mesh barrier used as the shelf material and having limited openings in the shelf area.



- | | |
|------------------|---------------------------|
| A Shelf depth | H Rack depth |
| B Shelf height | L Longitudinal flue space |
| E Storage height | T Transverse flue space |
| F Commodity | |

FIGURE A.3.9.3.7(c) Double-Row Racks with Solid Shelves.



Single Row Rack

3.9.3.7.5 *Single-Row Racks.* Racks that have no longitudinal flue space and that have a depth up to 6 ft (1.8 m) with aisles having a width of at least 3.5 ft (1.1 m) between loads on racks.



Double Row Rack

3.9.3.7.1 Double-Row Racks. Racks less than or equal to 12 ft (3.7 m) in depth or single-row racks placed back to back having an aggregate depth up to 12 ft (3.7 m), with aisles having an aisle width of at least 3.5 ft (1.1 m) between loads on racks.

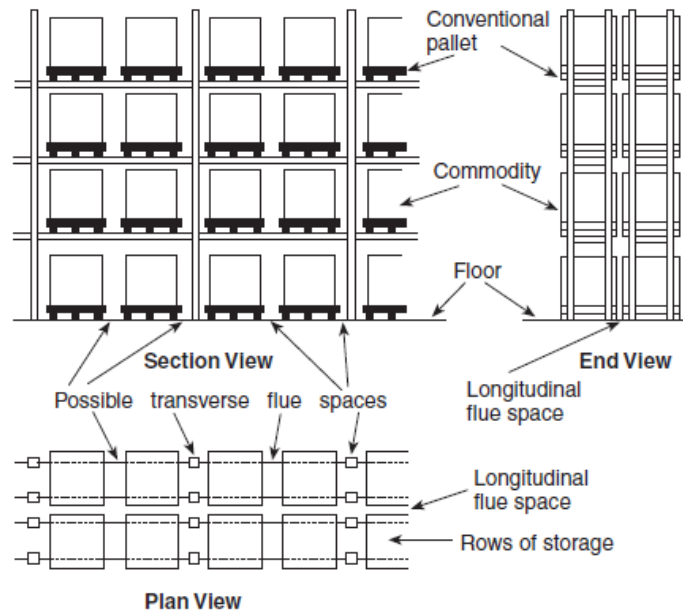


FIGURE A.3.9.3.6 Typical Double-Row (Back-to-Back) Rack Arrangement.



Multiple Row Rack

3.9.3.7.3 Multiple-Row Racks. Racks greater than 12 ft (3.7 m) in depth or single- or double-row racks separated by aisles less than 3.5 ft (1.1 m) wide having an overall width greater than 12 ft (3.7 m).



Portable Rack

3.9.3.7.4 Portable Racks. Racks that are not fixed in place and can be arranged in any number of configurations.

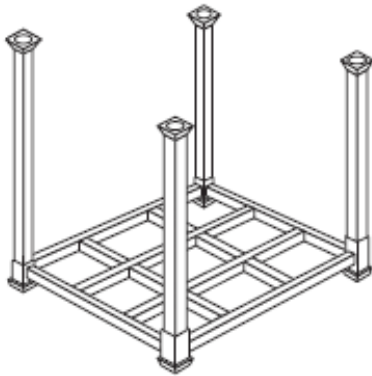


FIGURE A.3.9.3.7(i) Flow-Through Racks (Top) and Portable Racks (Bottom).

THANK YOU!

Commodity class is the most important first step in proper Storage protection design, the best technologies can be overwhelmed by inadequate classifications. Determining the appropriate storage arrangement is second.

Questions?
