

## Update on Flammable and Combustible Liquids

### Introduction

The Society of Fire Protection Engineers (SFPE) sponsored a two-day symposium on flammable and combustible liquids in Baltimore, MD on October 4-5, 2000. The focal point of this symposium was the newly-released 2000 edition of the National Fire Protection Association's NFPA 30 - Flammable and Combustible Liquids Code.

This bulletin is a brief overview of most of the subjects discussed, particularly with respect to new research, latest developments and important changes to NFPA 30.

Flammable liquids have a flash point below 100°F (37.8°C) while combustible liquids have a flash point of 100°F or greater. The flash point is the lowest temperature at which a liquid gives off enough combustible vapours to form an ignitable mixture in air. Flammable liquids (Class I liquids) are more hazardous than combustible liquids (Class II and III liquids).

### NFPA 30 - 2000 Edition

The 2000 edition of NFPA 30 continues the tradition of evolutionary change from the previous edition in 1996, incorporating new fire protection criteria based on the latest full-scale fire testing. Chapter 4 (Container and Portable Tank Storage) has new design criteria for palletized storage in metal drums up to three and four tiers high, water-miscible liquids in plastic containers, liquids in intermediate bulk containers ("totes"), and the use of ESFR sprinklers for liquids in relieving-style metal containers (all discussed further).



Fire testing of intermediate bulk containers

Other changes include the rewrite of Chapters 2 and 3 (Tank Storage and Piping Systems respectively), new guidelines for heat transfer fluid systems and solvent distillation units in Chapter 5 (Operations), and the consolidation of all

requirements for electrical area classification in hazardous locations in Chapter 6 (Electrical Equipment and Installations).

### Relieving-Style Drums

Metal drums containing flammable & combustible liquids traditionally come equipped with metal drum hole plugs. Metal drums with special plastic drum hole plugs are called relieving-style drums. In a fire situation, the plastic plugs will fail much earlier than metal plugs, allowing the drum to vent. This relieves the pressure build-up in the drum while still containing the contents, preventing a dangerous explosion that could occur from the violent failure of an unvented drum.

Fire testing has proven that relieving-style drums reduce the fire protection requirements for drum storage of flammable liquids. The tables in section 4.8 of NFPA 30 now offer different design criteria for the protection of relieving and non-relieving-style metal drums in rack and palletized storage arrangements.

A "relieving-style container" is now defined in NFPA 30. It requires that the plugs be listed and labelled for the drums to be considered relieving-style.



## Palletized Drum Storage

Eight large-scale fire tests were done using 3-high and 4-high palletized storage of a Class IB flammable liquid in 55 US gallon (205 l) relieving-style metal drums. Testing was done using water and foam-water ceiling sprinkler systems.



Rack storage fire test of cartoned commodities

It was found that relieving-style drums palletized three levels high can be protected by a closed head, AFFF foam-water sprinkler system designed to provide a density of 0.45 gpm/sq. ft. over 3,000 sq. ft. (18.3 mm/min. over 279 sq. m). These same drums palletized four levels high can be protected by a foam-water sprinkler system designed to provide 0.60 gpm/sq. ft. over 3,000 sq. ft. (24.5 mm/min over 279 sq. m).

## Plastic Containers

Plastic containers increase the fire hazard when used to store flammable and combustible

liquids. Their tendency to melt causes them to fail more quickly than metal containers, spilling their contents and adding to the fuel load.

A series of decision trees have been added to section 4.8 of NFPA 30-2000 for easier use of the standard. One of the more important considerations is whether or not the flammable or combustible liquid is water miscible i.e. soluble in water. Water-miscible liquids are less hazardous because they are often diluted with water and can be extinguished with water only. Isopropyl alcohol and acetone are examples of water-miscible liquids. Unfortunately, most flammable and combustible liquids are not water miscible.

There are very few acceptable fire protection arrangements for non-water-miscible liquids in plastic containers (excluding intermediate bulk containers). Basically, only high flash point (over 200°F/93°C) Class IIIB combustible liquids in small plastic containers up to 5 gallons (19 l) in size can be accommodated in specially protected racks. Refer to Table 4.8.2(e).

There are more protection options available for water-miscible liquids in plastic containers. High concentration water-miscible liquids (flammable liquid concentration greater than 50%) in plastic containers up to 60 US gallons (227 l) in size can be protected in specially protected racks [see Table 4.8.2(g)]. Lower concentration

water-miscible liquids (less than 50%) in plastic containers can be protected as more ordinary commodities using the requirements of NFPA 13 - Standard for the Installation of Sprinkler Systems [refer to decision tree Figure 4.8.2(c)].

## Intermediate Bulk Containers

Intermediate bulk containers (IBCs) - commonly referred to as "totes" - are large, cube-shaped containers that typically hold 250 US gallons (946 l) or more, although NFPA 30 allows IBCs up to 793 US gallons (3,000 l). They can be of metal, plastic or composite construction (composite is plastic container with metal or other support framing). The plastic and composite IBCs are of greatest concern in terms of fire exposure.



Various types of IBC's

Large scale fire testing done in the late 1990s to evaluate the use of IBCs for the storage of flammable and combustible liquids led to the development of Underwriters Laboratories test standard UL 2368 for the approval/listing of IBCs. NFPA 30 requires that non-metallic IBCs (i.e. plastic and composite) be listed and labelled for use in a protected

building. There were no listed IBCs as of October 2000 but two companies are reportedly working towards approval.

NFPA 30 now has a protection standard for Class II and III combustible liquids in listed non-metallic IBCs stored one and two high [see Table 4.8.2(i)]. NFPA does not permit Class I flammable liquids in plastic or composite IBCs.

## ESFR Sprinklers

Five large-scale fire tests were done to see if Early Suppression Fast Response (ESFR) sprinklers could be used to protect flammable and combustible liquids in 5 gallon (19 l) or smaller relieving-style steel containers in 14 ft. (4.3 m) high display racking. This arrangement was chosen to replicate conditions typically found in the paint section of "big box" retail stores. Tests were done using both slatted wood and steel wire mesh shelving. Test results with the slatted wood shelves were not considered successful.

It was found that this storage array with open wire mesh shelving could be protected using K-14 ESFR sprinklers operating at 50 psi (3.4 bar) with 165°F (74°C) rated, 5/8 inch (16 mm) orifice in-rack sprinklers flowing 35 gpm (132 lpm). The K-14 ESFR sprinklers could not protect the array without the use of in-rack sprinklers. Larger orifice K-25 ESFR sprinklers were found capable of protecting this storage arrangement when operating



ESFR sprinklers in operation

at both 35 psi (2.4 bar) and 25 psi (1.7 bar), but not as low as 15 psi (1.0 bar).

These test results have been incorporated into Table 4.8.2(h) for Class IB & IC flammable liquids and Class II and III combustible liquids in small, relieving-style metal containers using ESFR ceiling sprinklers.

## Aerosols

Research into new protection alternatives for aerosols will need to cover several issues. Recent fire tests investigated the use of tray and shrink wrap packaging as an alternative to cardboard cartons. It looks like this alternate packaging arrangement increases the fire hazard when compared to cardboard cartons.

The complex issue of aerosol can venting versus rupturing needs to be investigated. Aerosol cans can vent through failure of the plastic nozzle but venting cans usually cannot be extinguished. Proper cooling may be able to contain the fire

but what constitutes proper cooling

remains to be determined. Rupturing leads to rocketing of aerosol cans and potential fire spread. Successful fire tests must be able to account for both venting and rupturing.

Another issue is the space separation between aerosols and flammable liquids. This is being driven by storage arrangements found in "big box" retail stores. New sprinkler technology such as K-25 ESFR sprinklers look promising for aerosol protection. The use of extra large orifice K-11 sprinklers as in-rack sprinklers may also be evaluated.

Large-scale fire tests are needed to evaluate the above issues. Aerosols are addressed by NFPA 30B - Code for the Manufacture and Storage of Aerosol Products.

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## Drainage & Containment

The three areas of concern are limiting fire spread from one fire area to another (spill containment), limiting the size of a spill to limit the number of operating sprinklers (liquid spread control) and environmental issues.

The 2000 edition of NFPA 30 contains new criteria for drainage, containment and spill size control but does not provide guidance for addressing environmental concerns. Figure 4.8.5 in NFPA 30 provides a decision tree for spill containment and liquid spread control of protected storage.

Spill containment can be achieved by curbs, sills and ramps while liquid spread control requires floors sloped to drains or open grate trenches.

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