

Storage of combustible liquids in nonmetallic intermediate bulk container

Risktopic 2-4.009

This document addresses combustible liquids stored in nonmetallic intermediate bulk containers. This specifically includes:

- Rigid plastic intermediate bulk containers
- Flexible plastic liner in a composite continuously wound corrugated paperboard intermediate bulk containers

Introduction

In accordance with NFPA 30, these containers are not to store Class I flammable liquids.

Zurich recommends storing these containers in dedicated liquid storage rooms, detached buildings, or in listed dispensing cabinets as described further below. There has not been sufficient research and testing to confirm that these containers are suitable for storage elsewhere such as in general purpose warehouses.

Discussion

Construction– Rigid nonmetallic intermediate bulk containers incorporate a rigid plastic receptacle to hold a liquid. This plastic receptacle is contained within a protective metal cage or other outer packaging system that is intended to carry stacking loads (where designed for stacking) as well as limited impact loads associated with normal use and handling.

Rigid nonmetallic intermediate bulk containers hold between 450 and 3000 liters (119 and 793 gallons) of liquids within the plastic receptacle. Under fire conditions, the plastic receptacle can weaken resulting in leaks. Leaks can develop into catastrophic failures of the receptacle which generates a pool fire. If other rigid nonmetallic intermediate bulk containers are present, they can be exposed to failure contributing to the pool fire.

Composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liners use the flexible plastic liner as the liquid receptacle. The flexible plastic liner is protected by the corrugated cardboard outer packaging.

The composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liner have been full-scale fire tested; however, per NFPA 30, testing was limited to just one test and the container size tested was 1,045 liters (275 gallons).

Shipping regulations – The regulations governing the transportation of rigid nonmetallic intermediate bulk containers are the U.S. Department of Transportation Hazardous Material Regulations and the UN Recommendations on the Transportation of Dangerous Goods. These regulations do not address the performance of the rigid nonmetallic intermediate bulk containers under fire conditions, and do not govern indoor storage of rigid nonmetallic intermediate bulk containers.

Testing standards – The majority of rigid nonmetallic intermediate bulk containers in use have not been evaluated for their performance under fire conditions. In response, Underwriters Laboratories has developed UL 2368 "Standards for Fire Exposure Testing of Intermediate Bulk Containers for Flammable or Combustible Liquids."

At present, UL lists only one rigid nonmetallic intermediate bulk container that meets the UL 2368 standard. Unlike most units, the listed model is completely encased in a stainless steel outer packaging system except for the exposed fill on top. The dispensing valve "dog house" is protected with a stainless steel flap. The plastic receptacle is separated from the outer steel packaging by a ceramic paper insulation.

Zurich does not presently recognize the UL listed rigid nonmetallic intermediate bulk container as offering any improvement beyond non-listed units.

Zurich is not aware of any test standard for the composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liner.

[NFPA guidance](#)– NFPA 30 does not permit the use of rigid nonmetallic intermediate bulk containers for the storage of flammable liquids. See Table 9.4.3.

Where rigid nonmetallic intermediate bulk containers are used to store combustible liquids, NFPA 30 only considers the storage to be "protected" if the containers are listed in accordance with UL 2368 "Standards for Fire Exposure Testing of Intermediate Bulk Containers for Flammable or Combustible Liquids" or equivalent testing standard. See paragraph 16.5.1.8.

NFPA 30 does not permit the use of composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liner for the storage of any flammable or combustible liquids unless a fire protection system is provided that is based upon a full-scale fire test conducted at an approved test facility or an engineered protection scheme is provided that is considered to be an acceptable alternative to a protection approach contained in Chapter 16 "Automatic Fire Protection for Inside Liquids Storage Areas". See Table 16.59.4.3.

Where composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liner are used to store combustible liquids, NFPA 30 only addresses containers less than or equal to 1,045 liters (275 gallons) stored in racks using fire protection Scheme "C". See Table 16.5.2.5.

[Failure modes of rigid nonmetallic intermediate bulk containers under fire conditions](#) – Full-scale fire tests of rigid nonmetallic intermediate bulk containers have demonstrated a number of manners in which the container are challenged by fire and may fail. These include:

- Holes formed in the plastic receptacle due to contact with hot metal components. This process is known as "branding" and can occur if the plastic receptacle expands
- Cracking of the plastic receptacles in the area of flues (the channels between adjacent containers) where fires are more persistent and difficult to control
- Softening and failures at the discharge valve located at the bottom of the container
- Loss of structural stability.

[Fire testing of rigid nonmetallic intermediate bulk containers](#) – Full-scale fire testing of Class IIIB combustible liquids in rigid nonmetallic intermediate bulk containers was conducted at UL in 2007 to compare the performance of listed and non-listed units. The executive summary notes:

- NFPA 30 contains protection guidance for listed rigid nonmetallic intermediate bulk containers; however, listed rigid nonmetallic intermediate bulk containers are generally not in use.
- Listed rigid nonmetallic intermediate bulk containers look similar to non-listed rigid nonmetallic intermediate bulk containers and there is concern they are perceived to be equal.
- Non-listed rigid nonmetallic intermediate bulk containers are routinely found in general storage.

This test series evaluated two fire scenarios. The first scenario was a pool fire under the containers. The second scenario involved a 7.6 lpm (2 gpm) simulated leak rate from a container. This second scenario was borrowed from test protocols adopted by the NFPA 30 committee for evaluating the performance of metal drums.

Testing based upon the first scenario showed no difference in performance between a listed and non-listed container. In each case the internal receptacle collapsed and released all liquid contents.

Testing based upon the second scenario was considered successful; however, the test did not pass the UL 2358 criteria for container leakage. Leaks did develop below the receptacle liquid level. It was noted that this may have been due to the containers provided for testing having different construction from those originally tested by UL.

Guidance

The following guidance uses "containers" to apply to both rigid nonmetallic intermediate bulk containers and composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liners unless otherwise noted.

Liquids that do not require action per this guide – For containers storing liquids that have a flash point but do not have a fire point, the containers are considered outside the scope of this document and can be handled as general storage.

For containers storing liquids that have a flash point and a volatile content less than 20% by volume, the containers are considered outside the scope of this document and can be handled as general storage.

Listed vs. non-listed rigid nonmetallic intermediate bulk containers – Few listed rigid nonmetallic intermediate bulk containers are in service today. Those that are available may not have been assembled in accordance with the original design tested and listed by UL. Ultimately, listed units should be managed in the same manner as non-listed units.

Protection approaches – Fixed fire protection systems are not expected to extinguish a fire involving flammable or combustible liquids in containers. It is expected that the fire will continue to burn until all liquids are consumed.

To afford the highest level of protection to the storage building and surrounding property, the following measures should be applied.

Storage location – Store containers in either a cutoff room, a detached building or shed, or a listed dispensing cabinet.

Do not store containers in general purpose storage or warehouse areas.

Locate flammable or combustible liquids containers in the following locations listed in order of preference

- Adequately detached storage building
- Attached storage building (three outside walls)
- Cutoff storage building with two outside walls
- Cutoff storage building with one outside wall

Consult with Zurich to determine if a building is adequately detached. Separation distance depends upon factors such as construction, occupancy, and slope of ground.

Storage configuration – Limit storage of containers to floor storage 1 unit high or where stacked more than 1 unit high, limit the stack to 3,013 liters (793 gallons).

Do not store container in racks except for composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liners that are protected in accordance with NFPA 30 Table 16.5.2.5.

Cutoff design–

- Provide interior walls with at least a 2 hour fire resistance for floor areas up to 46 m² (500 ft²). For larger rooms, provide 4 hour rated fire walls in accordance with NFPA 221. Where larger rooms store only Class IIIB liquids, 2 hour fire rated walls are acceptable in accordance with NFPA 30 Table 9.9.1.
- Protect interior wall openings with automatic closing fire doors. For 2 hour rated walls, use 1 1/2 hour rated doors. For 4 hour rated walls, use double 3 hour rated doors.

Dispensing–

- Dispense liquids from containers to listed safety containers in a cutoff room. Use the listed safety containers to transport liquids to the final point of use.

- Dispense liquids from containers in a cutoff room using a fixed pipe network designed in accordance with NFPA 30 to transfer liquids to the final point of use.
- Transport containers to a listed dispensing cabinet at the point of use where liquids will be dispensed to listed safety containers for transport to the final point of use.

Drainage and containment – It is recommended that the storage room have drainage capable of handling the sprinkler discharge, hose stream discharge, and contents of all container contents. If this cannot be provided, then containment with foam water protection is an acceptable option.

Where the option of containment and foam water protection is selected, provide containment facilities to hold the contents of all containers stored in the room along with one hour of sprinkler/foam plus hose stream discharge.

Automatic fire protection – Provide foam-water automatic sprinklers (k-factor of 161.4 lpm/bar^{1/2} (11.2 gpm/psi^{1/2}) or larger) designed to deliver a density of 24.4 mm/min (0.60 gpm/ft²) over the entire room.

Where water is used rather than foam-water, provide drainage to remove spilled liquids to a remote impounding location that does not expose the storage building, surrounding property, or responding fire service personnel.

For composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liners stored in racks, apply fire protection guidelines in accordance with NFPA 30 Table 16.5.2.5.

Manual fire protection – Provide manual fire protection in accordance with NFPA 30.

Additional protection considerations – Where flammable liquids are stored in the same room, consult Zurich for further guidance regarding separation of liquids, electrical equipment, mechanical exhaust ventilation, explosion relief features, and control of ignition sources.

Where flammable or combustible liquids are stored in containers that do have a documented fire protection approach for storage in NFPA 30, those liquids should be stored in a separate cutoff room equipped with appropriate fire protection. This guideline does not apply to adequately detached storage buildings.

Conclusion

Rigid nonmetallic intermediate bulk containers and composite continuously-wound corrugated paperboard intermediate bulk containers with flexible plastic liners provide a convenient and economical means to transport liquids between suppliers and users. This convenience should not be permitted to mask the significant fire hazard posed by these containers.

Zurich recognizes that further testing of these containers is needed to fully understand the degree of hazard presented by a number of combinations and configurations not yet studied. However, until further research is conducted, the guidelines of this Risktopic should be carefully applied. Please direct any questions to your Zurich account team.

References

1. Scheffey, Joseph L., and Martin J. Pabich. Composite Intermediate Bulk Containers (IBCs) Research Project Phase II. Tech. Quincy, MA: Fire Protection Research Foundation, 2007. Print.
2. NFPA 30 Flammable and Combustible Liquids Code. Quincy, MA: NFPA, 2008.
3. NFPA 221 Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls. Quincy, MA: NFPA, 2009.
4. UL 2368 Standards for Fire Exposure Testing of Intermediate Bulk Containers for Flammable or Combustible Liquids. Northbrook, IL: Underwriters Laboratories, 2001.
5. U.S. Department of Transportation Hazardous Material Regulations (Title 49, Code of Federal Register, Parts 100-199).
6. UN Recommendations on the Transportation of Dangerous Goods (Part 6).

Appendices

Annex A – Classification of liquids–

Classification of flammable and combustible liquids		
Liquid class	Flash point	Boiling point
Flammable liquids		
Class IA	<22.8°C (73°F)	<37.8°C (100°F)
Class IB	<22.8°C (73°F)	≥37.8°C (100°F)
Class IC	≥22.8°C (73°F) but <37.8°C (100°F)	
Combustible liquids		
Class II	≥37.8°C (100°F) but <60°C (140°F)	
Class IIIA	≥60°C (140°F) but < 93°C (200°F)	
Class IIIB	≥93°C (200°F)	

Annex B – Definitions – The following definitions are from NFPA 30.

Fire point - The lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame in accordance with ASTM D 92, Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester. (See NFPA 30 paragraph 3.3.18)

Flash point - The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in Section 4.4. (See NFPA 30 paragraph 3.3.19)

Note: NFPA 30 Section 4.4 addresses several test methods for determining the flash point of liquids. These include:

- ASTM D 56, Standard Test Method for Flash Point by Tag Closed Cup Tester
- ASTM D 93, Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- ASTM D 3278, Standard Test Method for Flash Point of Liquids by Small Scale Closed Cup Apparatus
- ASTM D 3828, Standard Test Methods for Flash Point by Small Scale Closed Cup Tester

It is necessary to select the appropriate test method for the liquid being tested.

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