



Distilled Spirits Cased Goods Storage

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Global Research Update: High Challenge Storage Protection
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Project Goals and Accomplishments

- Establish protection options for diluted water miscible ignitable liquids in glass bottles
 - Palletized storage
 - Rack storage
- Conducted tests to define
 - Ceiling-only protection for palletized storage
 - 9.1 m (30 ft) and 12.2 m (40 ft) ceiling
 - Ceiling and in-rack protection for rack storage

What Is a Water Miscible Liquid?

- A liquid can be mixed in all proportions with water
 - As water concentration increases
 - Flash point and fire point will increase
 - Heat of combustion will decrease
- Limited number of liquids
 - 3-carbon or less alcohol (IPA, EtOH, MeOH)
 - Acetone, propylene glycol

Protection-Water Miscible Liquids

Group	Volume Percent Range
	Alcohol (short chain)
1	71 – 100
2	51 – 70
3	31 – 50
4	21 – 30
5	0 - 20

Full Scale Fire Testing: 1997 - 2003

- 20 full scale fire tests
 - 14 rack storage tests (99% - 20% IPA in plastic)
 - 3 palletize storage tests (99% IPA in plastic)
 - 2 rack storage tests (50% EtOH in glass)
 - 1 palletized storage test (50% EtOH in glass)
- Goals
 - Define new protection criteria

Protection Options – Rack Storage

Container Size Container Type Packaging	Storage / Roof Height Limit	Protection Options
≤ 4 L (1 gal) Plastic/Glass	7.6 m (25 ft) / 9 m (30 ft)	K200-QR, K160-SR + In-racks
Cartoned	7.6 m (25 ft) / > 9 m (30 ft)	Protection Scheme A
≤ 25 L (6.5 gal) Plastic/Glass Any	Unlimited	Protection Scheme A

Protection Options – Palletize Storage

Container Size Container Type Packaging	Storage / Roof Height Limit	Protection Options
≤ 1.75 L (59 oz) Plastic Cartoned	6.1 m (20 ft) / 9 m (30 ft)	K200-QR, K160
≤ 750 ml (25 oz) Glass Cartoned	4.9 m (16 ft) / 9 m (30 ft)	K200-QR

Recent Testing

Alcohol in Glass Bottles

- Clients bottled, stored, and shipped distilled spirits
- Classified as group 3, water miscible ignitable liquid
 - 50% (v/v) denatured alcohol, 100-proof
 - Filled in 1.75 L (59 fl. oz.) glass bottles



Test Commodity

- 1.75 L Glass Bottles in Cartons
 - Industry standard cartons from supplier
 - 6 bottles per carton
- Pallet-load
 - 36 Cartons per pallet
 - 141 cm (55.5 in.) high
 - Stretch-wrapped in place



Test Commodity

- Class 2 Commodity
 - Corrugated paper carton outside
 - Non-combustible sheet metal liner
- Used at periphery of array
- Assess fire propagation but not representative of hazard



Palletized Testing

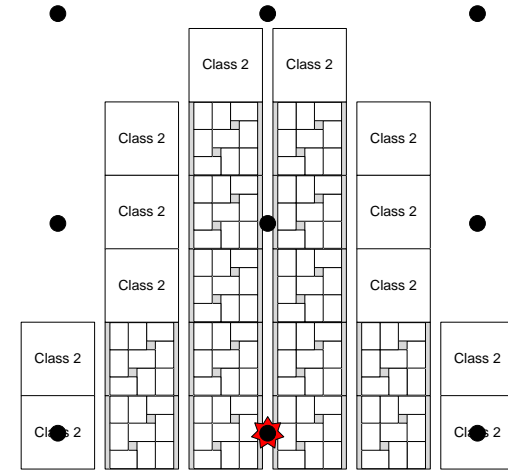
Palletized Test Arrangement

- 6 parallel rows of stacked commodity
 - Cartoned alcohol to 5.0 m (16.5 ft)
 - Class 2 commodity to 4.8 m (15.7 ft)
- 30 cm (12 in.) longitudinal flues
 - No transverse flues
 - Pallets overhung by ~8 cm (3 in.)



Palletized Test Plan

- K200 (K14) QR Upright 74 °C (165 °F)
 - Ceiling-only protection
 - Vary design pressure
- 9.1 m (30 ft) and 12.2 m (40 ft) ceiling heights



Evaluation Criteria

- Extent of fire damage
 - Contained within alcohol commodity
 - Array collapse was considered
- Number of sprinkler operations
- Steel temperatures

9.1 m Ceiling Test 1

- 5.0 m (16.5 ft) storage / 9.1 m (30 ft) ceiling
- K200 (K14) QR Upright 74 °C (165°F) @ 1.2 bar (18 psi)
 - 24 mm/min (0.6 gpm/ft²) design density
- Test Video

9.1 m Ceiling Test 1 Results

- Initial collapse @ 5 min
 - 8 operating sprinklers
- Fire propagated to extent of array
 - 12 stacks collapsed during test
- 13 total sprinkler operations
- Fire was extinguished at test termination



9.1 m Ceiling Test 2

- 5.0 m (16.5 ft) storage / 9.1 m (30 ft) ceiling
- K200 (K14) QR Upright 74 °C (165°F) @ 3.4 bar (50 psi)
 - 41 mm/min (1.0 gpm/ft²) design density
- Results
 - 1 sprinkler operation
 - No collapse during test



12.2 m Ceiling Test

- 5.0 m (16.5 ft) storage / 12.2 m (40 ft) ceiling
- K200 (K14) QR Upright 74 °C (165°F) @ 5.2 bar (75 psi)
 - 49 mm/min (1.2 gpm/ft²) design density
- Test Video

12.2 m Ceiling Test Results

- Initial collapse @ 20 min
 - 1 operating sprinklers
- 3 total sprinkler operations
- Fire was extinguished at test termination



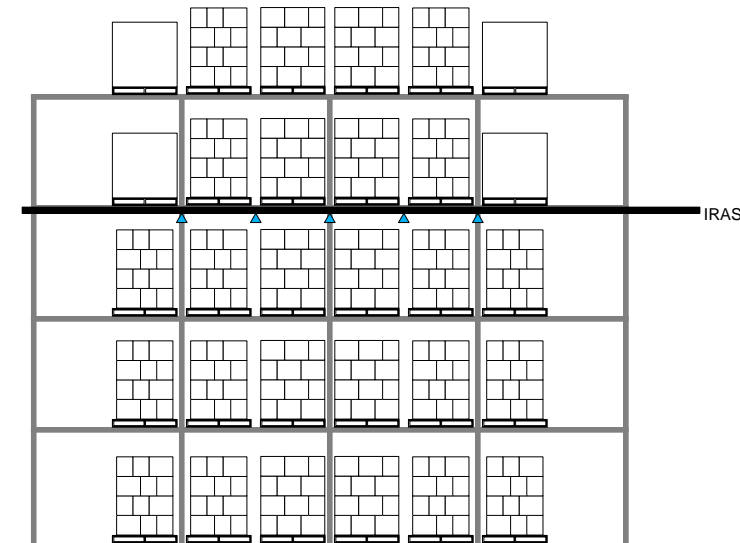
Rack Storage Testing

Rack Storage Strategy

- Client interested in rack storage up to 12.8 m (42 ft)
- Strategy to install IRAS up to 5.5 m (18 ft) vertical increments
 - 3.7 m (12 ft) storage below 1st level IRAS
 - 5.5 m (18 ft) storage below 2nd level IRAS
 - 3.7 m (12 ft) storage above with ceiling sprinklers
- Test subset of the arrangement

Rack Storage Test Arrangement

- 9.1 m (30 ft) storage / 10.7 m (35 ft) ceiling
- IRAS installed at 5.5 m (18 ft)
 - Face and flues, 1.2 m (4 ft) spacing
 - K115 (K8.0) @ 114 lpm (30 gpm)
- Ceiling protection for top 3.7 m (12 ft) storage
 - K160 (K11.2) @ 2 bar (28 psi)
- Test Video



Rack Storage Test Results

- 2 IRAS operated (52 s, 3 min 8 s)
- No propagation above IRAS
- No ceiling sprinklers operated
- Fire contained to ignition area

Conclusions From Testing

- Cartoned alcohol in 1.75 L (59 fl. oz.) glass bottles
- Palletized storage to 5.0 m (16.5 ft) can be protected
 - 9.1 m (30 ft) and 12.2 m (40 ft) ceiling
 - Collapse of stacks likely for all protection options
 - Floor level pool fire protected at lower pressure
- IRAS protection for 5.5 m (18 ft) vertical section
 - Ceiling level sprinklers not evaluated

Future Work

- Data Sheet 7-29, Table 16
 - Rack storage below 9.1 m (30 ft) ceiling
 - Ceiling-only protection, \geq K200 (K14)
 - 12 sprinklers @ 5.2 bar (75 psi)
 - K200 (K14) = 49 mm/min (1.2 gpm/ft²)
 - K360 (K25) = 90 mm/min (2.2 gpm/ft²)
- Conduct test with K360 (K25) at equivalent density
 - 1.6 bar (23 psi)
 - 49 mm/min (1.2 gpm/ft²)



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QUESTIONS?