

ESFR K14 and high clearance update

Presenters:

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October 2014 – ESFR K14 High Clearance Questioned

Underwriters Laboratory informed the Sprinkler Manufacturers that a Follow Up Service was being considered for 20 ft (6m) storage of Cartoned Group A Rack Storage with 20 ft (6m) clearance to ceiling with a Offset Ignition Between Two Sprinklers

October 2014 – ESFR K14 High Clearance Questioned

It was understood by assumption (and limited validation) that if testing of 30 ft (9m) with 10 ft (3m) clearance was successful, the same ceiling height with lower storage would generate a smaller fire and therefore be acceptable.

“This will be a Piece of Cake” – James Golinveaux

BUILDING 11 LARGE SCALE TEST LOG

Test Number:	1
Test Description:	20' Commodity Storage w/40' ceiling
Ceiling Height (ft):	40
Model:	K14 ESFR
Temperature (°F)	165
RTI	Quick
k Factor	14
Style	Pendant
Element Type	Link
Pressure (PSI)	75 Regulated Pressure
Number Installed:	49
Spacing:	10 by 10
Density:	1.21
Wet / Dry:	Wet
Ceiling to Deflector (inch):	14
Igniter Description:	3 inch cellulose 4 oz. gas
Location:	Between 2
Number	2

“Bad Cake” – James Golinveaux

Test Results

Test Date	10/14/2008
First Sprinkler Operation (mm:ss)	01:28
Last Sprinkler Operation (mm:ss)	06:06
Number of Operated Sprinkles	16
Peak Gas Temp, °F (Amb06)	1364
Maximum 1 Minute Average Gas Temp, °F (Amb06)	880

“I can fix that!” – James Golinveaux

Pressure:

Since the laboratory testing regulates the operating pressure of all active sprinklers to their design minimum (75 psi (5.2 bar) in this case), the “REAL” world has higher pressure on the first operating sprinklers (deteriorating pressure) – Repeat the test with 100 psi (6.9 bar) for the first 4 sprinklers operating.

“I forgot” – James Golinveaux

Test Results

Test Date	12/30/2008
First Sprinkler Operation (mm:ss)	00:55
Last Sprinkler Operation (mm:ss)	07:36
Number of Operated Sprinkles	18
Peak Gas Temp, °F (Amb08)	1461
Maximum 1 Minute Average Gas Temp, °F (Amb08)	2883

Pressure:

Higher pressure discharges more water – but not more efficient water. We learned this with the K5.6 (K80) and K8 (K115) storage sprinklers in the early 1990's.

ESFR K14 High Clearance Update

rev 01 February 2016

The Zurich Services Corporation – Risk Engineering



Photo source: Rich Gallagher, The Zurich Services Corporation

- NFPA 13
 - Scope is limited to new installations
 - The ESFR K14 changes are not retroactive to existing buildings
- NFPA 25
 - Scope is limited to inspection, testing, and maintenance
 - Design of existing systems is assumed to be correct

Observation

There is no NFPA guidance:

- Requiring existing buildings to comply with the ESFR K14 changes
- Confirming existing buildings are adequately protected “as is”

- How widespread is the high clearance concern?
 - NFPA 13 protection option for ESFR K14 under 12.2 m (40 ft.) ceilings
 - Added in 1994
 - Removed in 2013
 - That allowed buildings during the 19 year period to use ESFR K14 sprinklers which would not be permitted today's standards

Observation

There is likely a significant inventory of existing buildings protected with ESFR K14 sprinklers under 12.2 m (40 ft.) ceilings

What are possible mitigation strategies

- Consider retroactive application of NFPA 13
 - Replace ESFR K14 with ESFR K17 sprinklers
 - Install a ceiling at 10.7 m (35 ft.) and extend sprinklers below
 - Provide inrack sprinklers
- Consider management practices
 - Keep storage 4.6 m (15 ft.) or less
 - Fire tests for storage at or below this height have been successful
 - Keep storage 9.1 m (30 ft.) or more
 - Fire tests for storage at or above this height have been successful
 - Avoid using the bottom rack storage tier
- Research
 - Pursue further full-scale fire tests to identify boundaries
 - Lower class commodities in racks
 - Rolled paper

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Large Scale Fire Testing – Protection of Pile Storage with K14 ESFR Sprinklers



PROTECTION OF PILE STORAGE WITH K14 SPRINKLERS

- Whirlpool has a warehouse distribution network with buildings ranging in size from 500,000 ft² (46,451 m²) to 1.8 million ft² (167,225 m²)
- Warehoused product is typically stored in piles on floor
- Commodity classification from II-IV
- Storage heights range from 20 ft to 30 ft (6.1 m - 9.1 m)
- Buildings with up to 40 ft (12.2 m) peak height, measured from floor to underside of roof deck
- Several of the buildings are protected with K14 ESFR sprinklers designed for 75 psi (5.17 bar) operating pressure



PROTECTION OF PILE STORAGE WITH K14 SPRINKLERS

- Zurich, Whirlpool's lead property insurance carrier, made scheduled visits to several of the distribution warehouses for loss prevention inspections
- The visits resulted in multiple recommendations to either replace K14 ESFR sprinklers with K17 ESFR sprinklers or regulate storage heights to no greater than 15 ft (4.5 m) (regulating storage heights is impractical due to loss of storage volume and resulting cost implications) due to the change in NFPA 13
- Engineering loss estimates included in the reports indicated an uncontrolled fire would occur with complete loss of the building and contents unless sprinklers were changed
- We had several issues of concern with the recommendations:
 1. Replacement of sprinklers would be costly and disruptive to operations
 2. Previous actual loss experience in a Whirlpool warehouse indicated the K14 could provide adequate protection for pile storage
 3. The NFPA 13 revision was based on 3 rack storage tests using cartoned plastic product and 4 ft wide aisles, which present a higher challenge fire than similar commodity in a pile configuration
 4. FM Data Sheet 8-9 still allows the use of K14 sprinklers as a protection scheme for solid pile storage of uncartoned unexpanded plastics (as well as cartoned unexpanded plastics in racks) to any height in buildings up to 40 ft (12 m)

PROTECTION OF PILE STORAGE WITH K14 SPRINKLERS

- Internal discussions within Whirlpool Risk Management led to the idea of Whirlpool conducting a large scale fire test at UL to confirm the K14 capability for our storage arrangements before completing any of the recommendations
- Zurich agreed to accept the results of the test and remove the recommendations as well as revise loss expectancies based on the following criteria being satisfied:
 1. Operation of 8 sprinklers or less
 2. No thermocouple reaching the sprinkler operating temperature in the outer-most two rings (thermocouples provided in these two rings rather than sprinklers)
 3. Ceiling temperature (peak one minute average) remaining below 1000⁰ F
 4. Fire contained to the test array ... and likely not exceeding a fuel consumption of 3 or 4 pallet loads.
- It was decided to conduct the test using the standard cartoned unexpanded plastic commodity as a conservative measure and to be consistent with the commodity used in the rack storage tests
- The pile configuration emulated the arrangement used for the HVLS fan tests.



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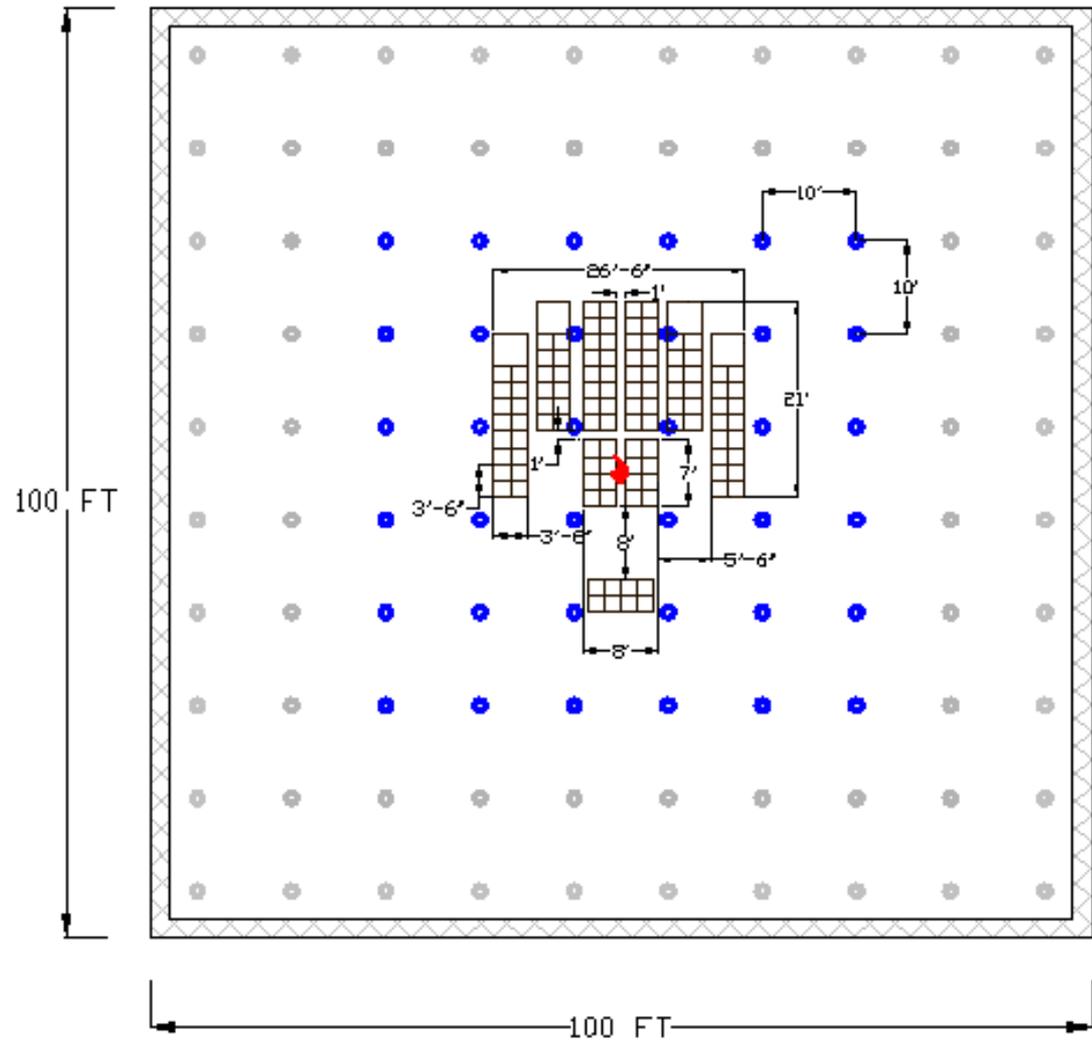
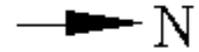
Test Specifics



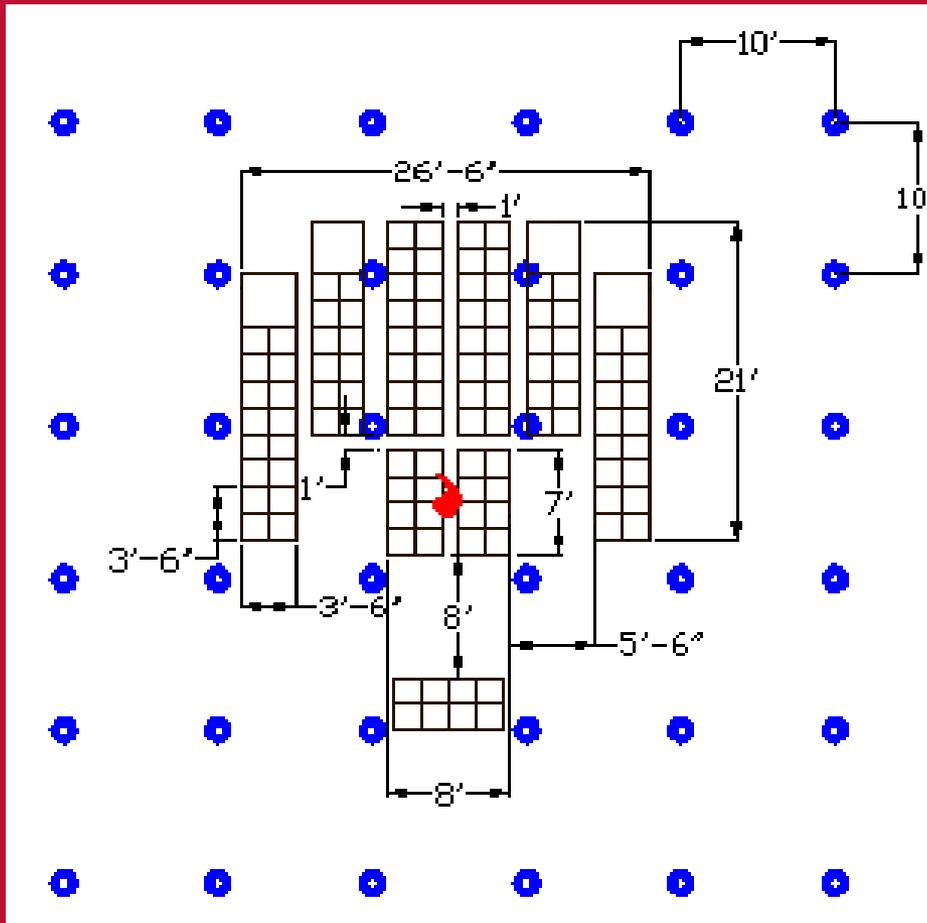
Test Date	8/17/2015
Storage Type	Palletized
Commodity Type	Cartoned Unexpanded Group A Plastic (Polystyrene Cups in Corrugated Containers)
Pallet Type	2 way entry, stringer, hardwood
Nominal Storage Height, ft.	20
Ceiling Height, ft.	40
Nominal Clearance, ft.	20
Ignition Location	Between 4 Sprinklers
Sprinkler Type	K = 14 ESFR
Deflector to Ceiling, in.	14
Ceiling Sprinkler Spacing, sprinkler by branchline ft. by ft.	10 by 10
Temperature Rating, F	155
Sprinkler SIN	TY6236
Sprinkler Response Type	QR
Nominal Sprinkler Discharge Coefficient K, gpm/psig ^{0.5}	14
Nominal Discharge Density, gpm/ft ²	1.21
Nominal Discharge Pressure, psig	75
	Test Results
Length of Test (min:s)	30:00
First Ceiling Sprinkler Operation (min:s)	1:22
Last Ceiling Sprinkler Operation (min:s)	1:23
Number of Operated Ceiling Sprinklers	4
Peak Gas Temperature at Ceiling Above Ignition °F	340
Maximum 1 Minute Average Gas Temperature at Ceiling Above Ignition °F	118
Peak Steel Temperature at Ceiling Above Ignition °F	99
Maximum 1 Minute Average Steel Temperature Above Ignition °F	95
Fire Spread Across Aisle	NO
Sustained Combustion at Outer Edges of Target Array	NO
Fire Spread to Array Extremities	NO



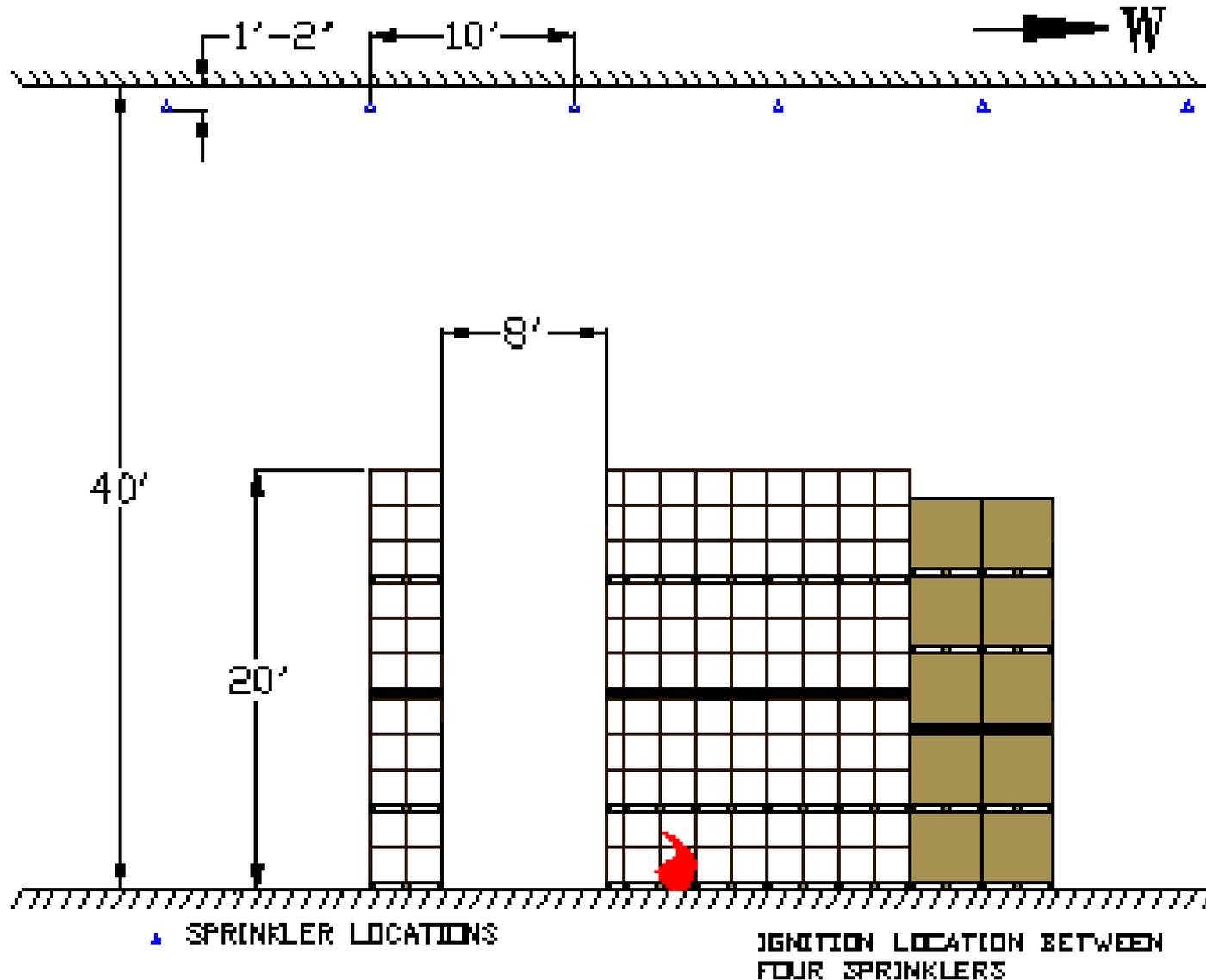
Test Setup



Test Setup



Test Setup



UL Test Video



Whirlpool K14 / Project 4787039146

Photos



Questions?

THANK YOU.

