

COURSE OBJECTIVES

- Discuss history of high-volume low speed fans in buildings
- Review testing done by nationally recognized testing laboratories
- Address NFPA 13 and NFPA 72 requirements
- Conclusion/Questions



4

WHAT IS AN HVLS FAN?

- Fans typically have 4-12 blades
- Blades can be between 6 ft and 24 ft long
- Some take up to 10 minutes to shut down
- Run at speeds between 24 and 66 rpm



5

HISTORY OF HVLS FANS

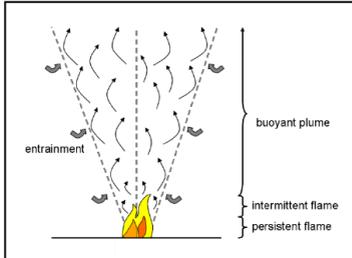
- Originally used in agricultural buildings to keep livestock cool in during hot summers
- Cows would produce less milk when hot
- Efficient and “green” way to circulate air
- Some run on a 1 HP motor
- Employees felt more comfortable
- Worker productivity improved



6

WHY ARE HVLS FANS A CONCERN?

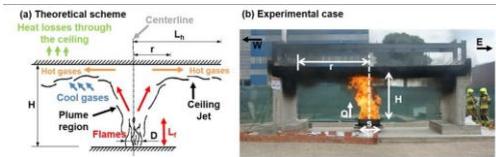
- Fire dynamics
- Fire plume



7

WHY ARE HVLS FANS A CONCERN?

- Fire dynamics
- Fire plume
- Ceiling jet



8

WHY ARE HVLS FANS A CONCERN?

- The following companies have sponsored tests regarding the impact of HVLS fans:
- Aon Risk Services (formerly Schirmer Engineering)
- Zurich Insurance
- CAN Insurance
- XL Insurance



9

WHY ARE HVLS FANS A CONCERN?

- Fire Test #1
- Cartoned expanded Group A plastic
- 15 ft. high storage on pallets
- K = 11.2 sprinklers
- Sprinkler system designed to NFPA 13
- Fire started on lowest carton
- 10 ft off center from HVLS fan



10

WHY ARE HVLS FANS A CONCERN?

- Fire Test #1
- Cartoned expanded Group A plastic
- 15 ft. high storage on pallets
- Ceiling height: 25 ft.
- K = 11.2 sprinklers
- Sprinkler system designed to NFPA 13
- Fire started on lowest carton
- 10 ft off center from HVLS fan
- 73 sprinklers opened**
- Time: Between 3:26 – 7:35**



11

WHY ARE HVLS FANS A CONCERN?

- Fire Test #2:
- Class II commodity
- Stored 12 ft. on pallets
- Ceiling height: 25 ft.
- K = 5.6
- Sprinkler system designed to NFPA 13
- Fire started on lowest carton
- 10 ft off center from HVLS fan



12

WHY ARE HVLS FANS A CONCERN?

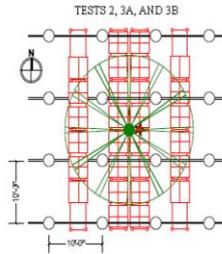
- Fire Test #2:
- Class II commodity
- Stored 12 ft. on pallets
- Ceiling height: 25 ft.
- K = 5.6
- Sprinkler system designed to NFPA 13
- Fire started on lowest carton
- 10 ft off center from HVLS fan
- 21 sprinklers opened**



13

WHY ARE HVLS FANS A CONCERN?

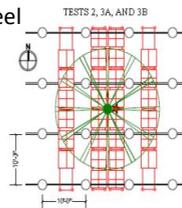
- Phase II Testing:
- FM Global (Rhode Island)
- Evaluated ESFR and CMDA sprinklers



14

WHY ARE HVLS FANS A CONCERN?

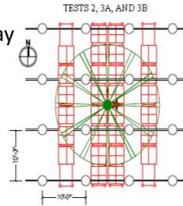
- Phase II Testing:
- Pass/Fail criteria:
- ESFR: A max of 8 sprinklers open
- Fire is contained to ignition/storage array
- Ceiling temperature to exposed steel was less than 3,000°F



15

WHY ARE HVLS FANS A CONCERN?

- Phase II Testing:
- Pass/Fail criteria:
- CMDA:
 - Max 20 sprinklers open
 - Ceiling temperatures do not exceed 1,000°F
 - Fire does not burn to end of test array or jump aisle to adjoining storage array



16

WHY ARE HVLS FANS A CONCERN?

- Phase II Testing Results:
- K14 ESFR sprinklers can protect cartoned unexpanded Group A plastics when:
 - Double-row racks
 - Storage height to 30 ft.
 - Max 40 ft. ceiling height
 - When HVLS fans shutdown a maximum of 90 seconds after waterflow



17

WHY ARE HVLS FANS A CONCERN?

- Phase II Testing Results:
- K14 ESFR sprinklers can adequately protect:
 - Cartoned unexpanded Group A plastics
 - Palletized storage
 - Storage height up to 15 ft.
 - Maximum 40 ft. ceiling
 - HVLS fans operating (not shutdown upon waterflow)



18

WHY ARE HVLS FANS A CONCERN?

- Phase II Testing Results:
 - K11.2 CMDA sprinklers can adequately protect:
 - Cartoned unexpanded Group A plastics
 - Pallet storage
 - Storage height: 15 ft.
 - Ceiling height: 25 ft.
 - HVLS fans shutdown upon waterflow (max 90 seconds)



19

FIRE TESTS	FPRF Test 1 (FM-1)	FPRF Test 2 (FM-2)	FPRF Test 3A (FM-3)	FPRF Test 3B (FM-4)
	8/20/2010	8/20/2010	8/22/2010	12/22/2010
PARAMETERS				
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Nominal Storage Height (ft)	40	40	40	15
Nominal Ceiling Height (ft)	40	40	40	25
Nominal Clearance (ft)	10	10	10	25
Aisle Width (in.)	48	48	48	48
Longitudinal Truss/Beam Flat (in.)	66	66	66	66
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters – 3" by 3" Each with 4 oz Glasolite	2 Half Igniters – 3" by 3" Each with 4 oz Glasolite	2 Half Igniters – 3" by 3" Each with 4 oz Glasolite	2 Half Igniters – 3" by 3" Each with 4 oz Glasolite
Sprinkler Type/Temperature Rating (T/F)	ESFR/165	ESFR/165	ESFR/165	ESFR/165
Sprinkler Orientation	Pendent	Pendent	Pendent	Pendent
Sprinkler Response	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1
Deflector to Ceiling (in.)	14	14	14	14
Nominal Sprinkler Discharge Coefficient (K (gpm/ft ²))	14	14	14	14
Density/Nominal Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	50	50	50	50
HVLS Fan Speed (rpm)	66	66	66	66
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	Off at Waterflow (90 sec delay)	Off at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MacroAir	MacroAir	MacroAir	MacroAir
HVLS Fan Model Name	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL
HVLS Fan Model Number	MA24XL2006	MA24XL2006	MA24XL2006	MA24XL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
RESULTS				
Length of Test (hr:min)	0:35:00	0:35:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:57	2:33	2:02
Number of Operated Ceiling Sprinklers	12	12	4	4
Peak Steel Temperature at Ceiling Above Ignition (T/F)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (T/F)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire spread to the Ends of the Array	NO	NO	NO	NO
Fuel Consumed (number of pallets)	12.5	5	5	0.5
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 3A with fan shutdown at waterflow	Repeat of Test 3B with 15 feet storage height

20

FIRE TESTS	FPRF Test 1 (FM-1)	FPRF Test 2 (FM-2)	FPRF Test 3A (FM-3)	FPRF Test 3B (FM-4)
	8/20/2010	8/20/2010	8/22/2010	12/22/2010
PARAMETERS				
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Nominal Storage Height (ft)	40	40	40	15
Nominal Ceiling Height (ft)	40	40	40	25
Nominal Clearance (ft)	10	10	10	25
Aisle Width (in.)	48	48	48	48
Longitudinal Truss/Beam Flat (in.)	66	66	66	66
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters – 3" by 3" Each with 4 oz Glasolite	2 Half Igniters – 3" by 3" Each with 4 oz Glasolite	2 Half Igniters – 3" by 3" Each with 4 oz Glasolite	2 Half Igniters – 3" by 3" Each with 4 oz Glasolite
Sprinkler Type/Temperature Rating (T/F)	ESFR/165	ESFR/165	ESFR/165	ESFR/165
Sprinkler Orientation	Pendent	Pendent	Pendent	Pendent
Sprinkler Response	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1
Deflector to Ceiling (in.)	14	14	14	14
Nominal Sprinkler Discharge Coefficient (K (gpm/ft ²))	14	14	14	14
Density/Nominal Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	50	50	50	50
HVLS Fan Speed (rpm)	66	66	66	66
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	Off at Waterflow (90 sec delay)	Off at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MacroAir	MacroAir	MacroAir	MacroAir
HVLS Fan Model Name	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL
HVLS Fan Model Number	MA24XL2006	MA24XL2006	MA24XL2006	MA24XL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
RESULTS				
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:42
Last Ceiling Sprinkler Operation (min:s)	7:53	3:57	2:33	2:02
Number of Operated Ceiling Sprinklers	12	12	4	4
Peak Steel Temperature at Ceiling Above Ignition (T/F)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (T/F)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire spread to the Ends of the Array	NO	NO	NO	NO
Fuel Consumed (number of pallets)	12.5	5	5	0.5
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 2 with fan shutdown at waterflow	Repeat of Test 3A with 15 feet storage height

21

FIRE TESTS	FFRF Test 1 (FM-1) 8/2/2019	FFRF Test 2 (FM-2) 8/2/2019	FFRF Test 3A (FM-3) 8/2/2019	FFRF Test 3B (FM-4) 12/2/2019
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Normal Storage Height (ft)	40	40	40	40
Normal Ceiling Height (ft)	10	10	10	25
Normal Clearance (ft)	48	48	48	48
Aisle Width (in.)	66	66	66	66
Longitudinal Transverse Flute (in.)	66	66	66	66
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite
Sprinkler Type/Temperature Rating (°F)	ESFR165	ESFR165	ESFR165	ESFR165
Sprinkler Orientation	Pendant	Pendant	Pendant	Pendant
Sprinkler Sensitivity	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1
Deflector to Ceiling (in.)	14	14	14	14
Normal Sprinkler Discharge Coefficient (K (gpm/ft ²))	14	14	14	14
Density/Normal Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	50	50	50	50
HVLS Fan Speed (rpm)	66	66	66	66
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	Off at Waterflow (90 sec delay)	Off at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MacroAir	MacroAir	MacroAir	MacroAir
HVLS Fan Model Name	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL
HVLS Fan Model Number	MA24XL2006	MA24XL2006	MA24XL2006	MA24XL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:97	2:03	1:42
Number of Operated Ceiling Sprinklers	12	4	4	4
Peak Steel Temperature at Ceiling Above Ignition (°F)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (°F)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire spread to the Ends of the Array	NO	NO	NO	NO
Fuel Consumed (number of pallets)	12.5	5	2.5	0.5
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 2 with fan shutdown at waterflow	Repeat of Test 3A with 15 test storage height

22

FIRE TESTS	FFRF Test 1 (FM-1) 8/2/2019	FFRF Test 2 (FM-2) 8/2/2019	FFRF Test 3A (FM-3) 8/2/2019	FFRF Test 3B (FM-4) 12/2/2019
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Normal Storage Height (ft)	40	40	40	40
Normal Ceiling Height (ft)	10	10	10	25
Normal Clearance (ft)	48	48	48	48
Aisle Width (in.)	66	66	66	66
Longitudinal Transverse Flute (in.)	66	66	66	66
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite
Sprinkler Type/Temperature Rating (°F)	ESFR165	ESFR165	ESFR165	ESFR165
Sprinkler Orientation	Pendant	Pendant	Pendant	Pendant
Sprinkler Sensitivity	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1
Deflector to Ceiling (in.)	14	14	14	14
Normal Sprinkler Discharge Coefficient (K (gpm/ft ²))	14	14	14	14
Density/Normal Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	50	50	50	50
HVLS Fan Speed (rpm)	66	66	66	66
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	Off at Waterflow (90 sec delay)	Off at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MacroAir	MacroAir	MacroAir	MacroAir
HVLS Fan Model Name	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL
HVLS Fan Model Number	MA24XL2006	MA24XL2006	MA24XL2006	MA24XL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:97	2:03	1:42
Number of Operated Ceiling Sprinklers	12	4	4	4
Peak Steel Temperature at Ceiling Above Ignition (°F)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (°F)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire spread to the Ends of the Array	NO	NO	NO	NO
Fuel Consumed (number of pallets)	12.5	5	2.5	0.5
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 3A with fan shutdown at waterflow	Repeat of Test 3B with 15 test storage height

23

FIRE TESTS	FFRF Test 1 (FM-1) 8/2/2019	FFRF Test 2 (FM-2) 8/2/2019	FFRF Test 3A (FM-3) 8/2/2019	FFRF Test 3B (FM-4) 12/2/2019
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Normal Storage Height (ft)	40	40	40	40
Normal Ceiling Height (ft)	10	10	10	25
Normal Clearance (ft)	48	48	48	48
Aisle Width (in.)	66	66	66	66
Longitudinal Transverse Flute (in.)	66	66	66	66
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite
Sprinkler Type/Temperature Rating (°F)	ESFR165	ESFR165	ESFR165	ESFR165
Sprinkler Orientation	Pendant	Pendant	Pendant	Pendant
Sprinkler Sensitivity	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1
Deflector to Ceiling (in.)	14	14	14	14
Normal Sprinkler Discharge Coefficient (K (gpm/ft ²))	14	14	14	14
Density/Normal Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	50	50	50	50
HVLS Fan Speed (rpm)	66	66	66	66
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	Off at Waterflow (90 sec delay)	Off at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MacroAir	MacroAir	MacroAir	MacroAir
HVLS Fan Model Name	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL	MacroAir Whisperfol XL
HVLS Fan Model Number	MA24XL2006	MA24XL2006	MA24XL2006	MA24XL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:97	2:03	1:42
Number of Operated Ceiling Sprinklers	12	4	4	4
Peak Steel Temperature at Ceiling Above Ignition (°F)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (°F)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire spread to the Ends of the Array	NO	NO	NO	NO
Fuel Consumed (number of pallets)	12.5	5	2.5	0.5
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 2 with fan shutdown at waterflow	Repeat of Test 3A with 15 test storage height

24

FIRE TESTS	FPFR Test 1 (FM-1)	FPFR Test 2 (FM-2)	FPFR Test 3A (FM-3)	FPFR Test 3B (FM-4)
	8/5/2019	8/29/2019	8/22/2019	12/2/2019
PARAMETERS				
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Nominal Storage Height (ft)	40	40	40	40
Nominal Ceiling Height (ft)	40	40	40	40
Nominal Clearance (ft)	10	10	10	25
Aisle Width (in.)	48	48	48	48
Longitudinal Transverse Flat (in.)	6/6	6/6	6/6	6/6
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene
Sprinkler Type/Temperature Rating (T/R)	ESFR165	ESFR165	ESFR165	ESFR165
Sprinkler Orientation	Pendent	Pendent	Pendent	Pendent
Sprinkler Sensitivity	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/SFR-1	Tyco/SFR-1	Tyco/SFR-1	Tyco/SFR-1
Deflector to Ceiling (in.)	14	14	14	14
Nominal Sprinkler Discharge Coefficient (K (gpm-ft ²))	14	14	14	14
Density/Nozzel Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	50	50	50	50
HVLS Fan Speed (rpm)	66	66	66	66
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	Off at Waterflow (90 sec delay)	Off at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MacroAir	MacroAir	MacroAir	MacroAir
HVLS Fan Model Name	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL
HVLS Fan Model Number	MAXXL2006	MAXXL2006	MAXXL2006	MAXXL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
RESULTS				
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:57	2:33	1:42
Number of Operated Ceiling Sprinklers	12	12	4	4
Peak Steel Temperature at Ceiling Above Ignition (T ₁)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (T ₂)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire Spread to Ends of the Array	NO	NO	NO	NO
Fuel Consumed (number of pallets)	12.5	5	5	0.5
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 2 with fan shutdown at waterflow	Repeat of Test 3A with 15 feet storage height

25

FIRE TESTS	FPFR Test 1 (FM-1)	FPFR Test 2 (FM-2)	FPFR Test 3A (FM-3)	FPFR Test 3B (FM-4)
	8/5/2019	8/29/2019	8/22/2019	12/2/2019
PARAMETERS				
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Nominal Storage Height (ft)	40	40	40	40
Nominal Ceiling Height (ft)	40	40	40	40
Nominal Clearance (ft)	10	10	10	25
Aisle Width (in.)	48	48	48	48
Longitudinal Transverse Flat (in.)	6/6	6/6	6/6	6/6
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene
Sprinkler Type/Temperature Rating (T/R)	ESFR165	ESFR165	ESFR165	ESFR165
Sprinkler Orientation	Pendent	Pendent	Pendent	Pendent
Sprinkler Sensitivity	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/SFR-1	Tyco/SFR-1	Tyco/SFR-1	Tyco/SFR-1
Deflector to Ceiling (in.)	14	14	14	14
Nominal Sprinkler Discharge Coefficient (K (gpm-ft ²))	14	14	14	14
Density/Nozzel Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	50	50	50	50
HVLS Fan Speed (rpm)	66	66	66	66
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	Off at Waterflow (90 sec delay)	Off at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MacroAir	MacroAir	MacroAir	MacroAir
HVLS Fan Model Name	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL
HVLS Fan Model Number	MAXXL2006	MAXXL2006	MAXXL2006	MAXXL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
RESULTS				
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:57	2:33	1:42
Number of Operated Ceiling Sprinklers	12	12	4	4
Peak Steel Temperature at Ceiling Above Ignition (T ₁)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (T ₂)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire Spread to Ends of the Array	NO	NO	NO	NO
Fuel Consumed (number of pallets)	12.5	5	5	0.5
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 3A with fan shutdown at waterflow	Repeat of Test 3A with 15 feet storage height

26

FIRE TESTS	FPFR Test 1 (FM-1)	FPFR Test 2 (FM-2)	FPFR Test 3A (FM-3)	FPFR Test 3B (FM-4)
	8/5/2019	8/29/2019	8/22/2019	12/2/2019
PARAMETERS				
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Nominal Storage Height (ft)	40	40	40	40
Nominal Ceiling Height (ft)	40	40	40	40
Nominal Clearance (ft)	10	10	10	25
Aisle Width (in.)	48	48	48	48
Longitudinal Transverse Flat (in.)	6/6	6/6	6/6	6/6
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene	2 Half Igniters – 3" by 3" Each with 4 oz Glasolene
Sprinkler Type/Temperature Rating (T/R)	ESFR165	ESFR165	ESFR165	ESFR165
Sprinkler Orientation	Pendent	Pendent	Pendent	Pendent
Sprinkler Sensitivity	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/SFR-1	Tyco/SFR-1	Tyco/SFR-1	Tyco/SFR-1
Deflector to Ceiling (in.)	14	14	14	14
Nominal Sprinkler Discharge Coefficient (K (gpm-ft ²))	14	14	14	14
Density/Nozzel Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	50	50	50	50
HVLS Fan Speed (rpm)	66	66	66	66
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	Off at Waterflow (90 sec delay)	Off at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MacroAir	MacroAir	MacroAir	MacroAir
HVLS Fan Model Name	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL
HVLS Fan Model Number	MAXXL2006	MAXXL2006	MAXXL2006	MAXXL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
RESULTS				
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:57	2:33	1:42
Number of Operated Ceiling Sprinklers	12	12	4	4
Peak Steel Temperature at Ceiling Above Ignition (T ₁)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (T ₂)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire Spread to Ends of the Array	NO	NO	NO	NO
Fuel Consumed (number of pallets)	12.5	5	5	0.5
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 2 with fan shutdown at waterflow	Repeat of Test 3A with 15 feet storage height

27

FIRE TESTS	FPRF Test 1 (FM-1)	FPRF Test 2 (FM-2)	FPRF Test 3A (FM-3)	FPRF Test 3B (FM-4)
	8/20/2010	8/20/2010	8/22/2010	12/2/2010
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Normal Storage Height (ft)	40	40	40	40
Normal Ceiling Height (ft)	10	10	10	10
Normal Clearance (ft)	48	48	48	48
Aisle Width (in.)	66	66	66	66
Longitudinal Transverse Flat (in.)	66	66	66	66
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite
Sprinkler Type/Temperature Rating (°F)	ESFR/165	ESFR/165	ESFR/165	ESFR/165
Sprinkler Orientation	Pendant	Pendant	Pendant	Pendant
Sprinkler Sensitivity	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1
Deflector to Ceiling (in.)	14	14	14	14
Normal Sprinkler Discharge Coefficient (K (gpm/ft²))	14	14	14	14
Density/Normal Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	66	66	66	66
HVLS Fan Speed (rpm)	On (no shutdown)	On (no shutdown)	On at Waterflow (90 sec delay)	On at Waterflow (90 sec delay)
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	On at Waterflow (90 sec delay)	On at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MaxAir	MaxAir	MaxAir	MaxAir
HVLS Fan Model Name	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL
HVLS Fan Model Number	MAXXL2006	MAXXL2006	MAXXL2006	MAXXL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
RESULTS				
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:57	2:03	1:42
Number of Operated Ceiling Sprinklers	12	4	4	4
Peak Steel Temperature at Ceiling Above Ignition (°F)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (°F)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire spread to the Ends of the Array	NO	NO	NO	NO
Fast Consumed (number of pallets)	2	5	2	0
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	Repeat of Test 2 with fan shutdown at waterflow	Repeat of Test 3A with 15 test storage height

28

FIRE TESTS	FPRF Test 1 (FM-1)	FPRF Test 2 (FM-2)	FPRF Test 3A (FM-3)	FPRF Test 3B (FM-4)
	8/20/2010	8/20/2010	8/22/2010	12/2/2010
Location of Test	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack	FM Global Double-Row Rack
Storage Type	Cartoned, Unexpanded Group A Plastic			
Commodity Type	Cartoned, Unexpanded Group A Plastic			
Normal Storage Height (ft)	40	40	40	40
Normal Ceiling Height (ft)	10	10	10	10
Normal Clearance (ft)	48	48	48	48
Aisle Width (in.)	66	66	66	66
Longitudinal Transverse Flat (in.)	66	66	66	66
Ignition Location	Under 1 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)	Between 4 Sprinklers (offset 2 ft)
Igniter Details	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite	2 Half Igniters - 3" by 3" Each with 4 oz Glasolite
Sprinkler Type/Temperature Rating (°F)	ESFR/165	ESFR/165	ESFR/165	ESFR/165
Sprinkler Orientation	Pendant	Pendant	Pendant	Pendant
Sprinkler Sensitivity	Fast Response	Fast Response	Fast Response	Fast Response
Sprinkler Make/Model Number	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1	Tyco/ESFR-1
Deflector to Ceiling (in.)	14	14	14	14
Normal Sprinkler Discharge Coefficient (K (gpm/ft²))	14	14	14	14
Density/Normal Sprinkler Discharge Pressure (psi)	75	75	75	75
Sprinkler Spacing (ft x ft)	10 x 10	10 x 10	10 x 10	10 x 10
Fan Size (ft)	24	24	24	24
Fan Location	Fan Tip 4.9 ft Beyond Ignition	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)	Hub Above Ignition (no offset)
Fan Distance Below Ceiling (in.)	66	66	66	66
HVLS Fan Speed (rpm)	On (no shutdown)	On (no shutdown)	On at Waterflow (90 sec delay)	On at Waterflow (90 sec delay)
HVLS Fan Operation	On (no shutdown)	On (no shutdown)	On at Waterflow (90 sec delay)	On at Waterflow (90 sec delay)
HVLS Fan Manufacturer	MaxAir	MaxAir	MaxAir	MaxAir
HVLS Fan Model Name	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL	MaxAir Whisperfol XL
HVLS Fan Model Number	MAXXL2006	MAXXL2006	MAXXL2006	MAXXL2006
HVLS Fan Blade Geometry	Whisperfol XL	Whisperfol XL	Whisperfol XL	Whisperfol XL
HVLS Fan Number of Blades	6	6	6	6
RESULTS				
Length of Test (hr:min)	0:35:00	0:25:00	0:30:00	0:30:00
First Ceiling Sprinkler Operation (min:s)	1:28	1:42	1:34	1:39
Last Ceiling Sprinkler Operation (min:s)	7:53	3:57	2:03	1:42
Number of Operated Ceiling Sprinklers	12	4	4	4
Peak Steel Temperature at Ceiling Above Ignition (°F)	169	117	113	113
Max. 1 Min. Average Steel Temperature Above Ignition (°F)	559	266	291	112
Fire Spread Across Aisle	YES	YES	NO	NO
Fire spread to the Ends of the Array	NO	NO	NO	NO
Fast Consumed (number of pallets)	2	5	2	0
Test Outcome (Pass/Fail)	FAIL	FAIL	PASS	PASS
Comments	Test failed due to 12 sprinklers activating	Test failed due to 12 sprinklers activating	shut down at waterflow	15 test storage height

29

NFPA 13 REQUIREMENTS

- Section 19.1.7
- HVLS fans in buildings equipped with sprinklers, including ESFR, shall comply with the following:
 - Maximum fan diameter shall be 24 ft.
 - HVLS fans shall be centered approximately between four adjacent sprinklers
 - Vertical clearance from HVLS fan to sprinkler deflectors shall be a minimum of 36 inches
 - HVLS fans shall be interlocked to shut down immediately upon waterflow



30

NFPA 13 REQUIREMENTS

- Section 19.1.7.2
- When a building is protected with a fire alarm system, the interlock required by 19.1.7.1(4) shall be in accordance with the requirements of NFPA 72 or other approved fire alarm code.



31

NFPA 72 REQUIREMENTS

- Section 21.8
- Where required by NFPA 13, HVLS fans shall be interlocked to shut down upon actuation of sprinkler waterflow.
- Added to NFPA 72 in 2019 Edition



32

NFPA 72 – DEDICATED FUNCTION FA SYSTEM

•Dedicated function fire alarm system – A protected premises fire alarm system installed specifically to perform emergency control function(s) where a building fire alarm system is not required.



33

NFPA 72 – DEDICATED FUNCTION FA SYSTEM

- Dedicated Function Fire Alarm Systems
 - Where codes or standards require monitoring of specific functions, but do not mandate a building fire alarm system, a dedicated function fire alarm system shall be provided.
 - Elevator recall
 - Sprinkler system
 - HVAC detectors
 - Other functions of the fire alarm system are not required.



34

NFPA 72 – DEDICATED FUNCTION FA SYSTEM

Clarification was made between the 2013 and 2016 editions to outline that a dedicated function system could be used for more than one purpose

2013 Edition

Dedicated Function Fire Alarm Control Unit. A protected premises fire alarm control unit which is intended to provide operation of a specifically identified emergency control function.

2016-2022 Editions

Dedicated Function Fire Alarm Control Unit. A protected premises fire alarm control unit that is intended to operate specifically identified emergency control function(s).



35

THANK YOU FOR YOUR TIME



Questions?



National Fire Sprinkler Association
www.nfsa.org

John Swanson
swanson@nfsa.org
 952-261-5854



36
