American Fire Sprinkler Association

The Impact of 18" Draft Stops on Sprinkler Activation for Vertical Opening Protection

Using the NIST Fire Dynamics Simulator

The Impact of 18” Draft Stops on Sprinkler Activation for Vertical Opening Protection

Introduction

NFPA 13:8.14.4 requires closely spaced sprinklers to be installed around certain unenclosed vertical floor openings. Along with the closely spaced sprinklers, the criteria call for 18-inch deep draft stops to be installed immediately adjacent to the opening. This draft stop is causing problems with building code required head clearance. In many instances, the draft stop encroaches below the plane 7 feet above finished floor which is the minimum clearance.

To the impact the 18” draft curtain has on sprinkler activation times for vertical opening scenarios, a fire model representing this situation was evaluated. In order to solve this problem, the latest simulator in fire modeling was chosen. The Fire Dynamics Simulator (FDS) and Smokeview version #3 is developed by the National Institute of Standards and Technology, a division of the US Department of Commerce. Smokeview allows the user to see a graphical representation of fire conditions with respect to all 3 axis and through time. FDS is a compiled program with no interface of its own, unlike other fire models such as FPETOOL. Instead, the user must write a data file in source code. This file contains all physical parameters for the room including obstructions and dimensions, fire source data, data capture guidelines, and other miscellaneous parameters. [On PC’s, this is accomplished through MS-DOS and writing a file with a “.data” extension.] Once the source code is written, it is fed into the FDS executable program which renders the data for viewing in Smokeview. Additionally, some data such as sprinkler heat temperatures at different time steps are rendered for using in spreadsheets.

Objective

To determine the applicability of requiring an 18” draft curtain in compliance with NFPA 13 for vertical openings with closely spaced sprinklers considering the advent and availability of quick response sprinklers.

Method

1. Establish a time to activation using standard response sprinklers in a conservative scenario with an 18” draft curtain adjacent to a vertical opening.
2. Evaluate the same scenario, removing the lintel and changing to a quick response sprinkler.
3. Compare the time to activation using a standard response sprinkler with the 18” draft curtain to the time to activation using quick response sprinklers without the draft curtain.

Description of Room (see Figure 1)

The room used in all simulations measured 10’-4” wide by 12’ long by 19’ tall. All surfaces were given surface characteristics of gypsum board except the vertical plane in the simulated vertical opening, which was given an “open” surface characteristic. An “open” surface allows the heat to escape and simulates a large open area in that direction. An obstruction was created measuring 7’-4” wide by 12’ long by 9’-6” tall. This obstruction was positioned in the space such that there is a vertical clearance of 9’-6” from the floor to the bottom of the obstruction and a 3’-0” gap between the obstruction and the “open” plane of the room (see **Figure 2**). This obstruction simulates the ceiling of the first level. Both the obstruction and the draft stop were created with gypsum board surface characteristics.

Figure 1 (plan view)

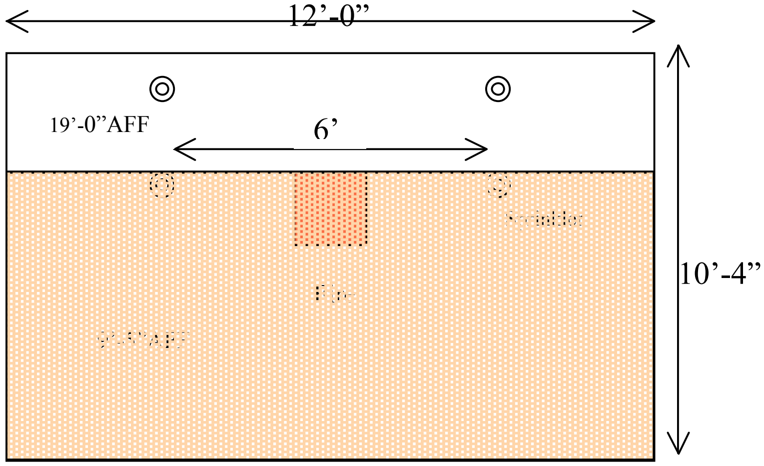
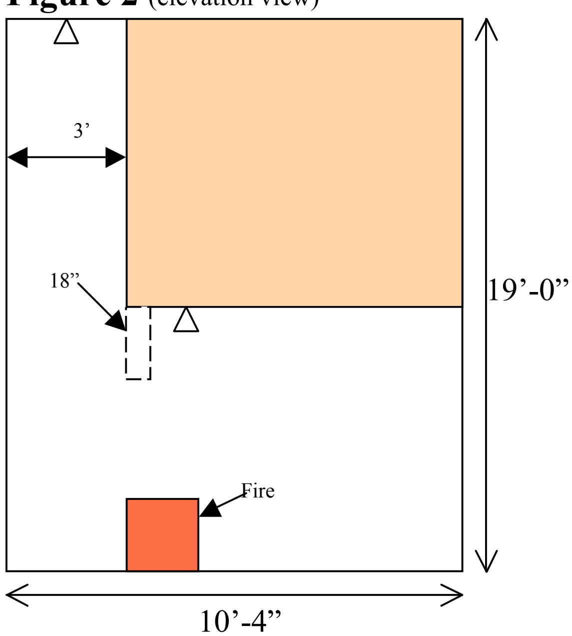


Figure 2 (elevation view)



Description of Fires

First, establishment of fire location is discussed. The most conservative location for a fire in this scenario is where the plume escaping to the upper area is maximized with the fire entirely under the lower ceiling. This location is centered between sprinklers and adjacent to the edge of the vertical opening.

Fires following three growth curves were used. One, considered a medium growth fire, starts at 0 MW at t=0 and ramps up following the standard HRR=αt^2 to a peak HRR of 4000-kw/sq.m. at 600 sec. The second, considered a fast fire, starts at 0 MW at t=0 and ramps up following the standard HRR=αt^2 to a peak HRR of 4000-kws/sq.m. at 300 sec. The third, considered an ultra-fast fire, starts at 0 MW at t=0 and ramps up following the standard HRR=αt^2 to a peak HRR of 3500-kws/sq.m. at 100 sec. All other fire parameter was left at default values.

Description of Sprinklers

Sprinklers were spaced 6' apart and 3' from their adjacent wall. In the other directions, they are located approximately 8" from the edge of the vertical opening (3'-8" from the open plane) and 6'-8" from the back walls. An additional pair of sprinklers were placed at the high ceiling elevation, but did not have an impact on the evaluation. Actually the sprinklers were input as heat detectors since heat detector and sprinklers behave exactly the same as far as response/activation time to fires and since activation time was the only parameter sought for analysis. Sprinklers were set for an activation temperature of 73.9C (165F). Some were given an response time index (RTI) of 177 simulating a standard response sprinkler and others were assigned an RTI of 50 simulating a quick response sprinkler.

FDS Grid Resolution

FDS breaks the room up into small cells the size of which can be prescribed by the user. Sizing these cells is also known as setting the grid resolution. In this model the grid cell dimensions were .098x.102x.097m or 3.875x4x3.8 inches, resulting in 69,120 cells. This resolution is a balance between accuracy and computation time.

Findings

The method of achieving the objective was carried out in the described room with the described fire and the described sprinkler layout. The time to activation with a ultra fast growth fire, without a draft stop, and with a standard response sprinkler was 51.8 sec. With a draft stop and with quick response sprinklers it was 48.6 sec. In the fast growth fire scenario with a draft stop and with standard response sprinklers the time to activation was 104 sec. Without the draft stop and with a quick response sprinkler it was 96 sec. In the medium growth fire scenario with a draft stop and with standard response sprinklers the time to activation was 168 sec. Without the draft stop and with quick response sprinklers it was 165 sec. See **Table 1**. In both scenarios, the results clearly show that when quick response sprinklers are installed, the 8" lintel is not necessary to maintain an acceptable time to activation.

Table 1

Name	Draft Stop	*Fire Growth	Sprinkler activation	#Sprinkler RTI
2QRnodraftultrafast	none	UF	48.6	50
2stand18ultrafast	18	UF	51.8	177
2QRnodraftfast	none	F	96	50
SRWC18F	18	F	104	177
QRnodraftM	none	M	165	50
SRWC18M	18	M	168	177

*UF =1 sq.meter @ 3500-kws/sq.m. ramped at T-square to 100 second peak.
*F =1 sq.meter @ 4000-kws/sq.m. ramped at T-square to 300 second peak
*M =1 sq.meter @ 4000-kws/sq.m. ramped at T-square to 600 second peak
#177 = Standard Response, 50 = Quick Response.

Conclusion

Even when the draft stop is absent, the quick response sprinkler still operates considerably faster than the standard response sprinkler when the draft stop present.