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The Impact of 8" Lintels on Sprinkler Activation within Small Rooms

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NFPA 13:8.6.2.1.2 and 13:8.6.3.2.4 give special allowances for spacing of sprinklers in small rooms. To qualify for these allowances the room must meet the definition of a small room given in 13:3.3.20. The room must have, among other things, an 8" lintel at the ceiling above all openings to adjoining spaces. This has resulted in problems where ceilings are too low or where the doors are too tall, either of which can result in a lintel that is less than 8" in depth.

To evaluate the question of what impact 8" lintels have on sprinkler activation times for the small room rule, the latest simulator in fire modeling was selected. 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 three axes 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, dimensions, fire source data, data capture guidelines, and other miscellaneous parameters. Once the source code is written, it is fed into the FDS executable program which performs the computations and renders the output data for viewing in Smokeview. Additionally, some data such as sprinkler heat temperatures at different time steps are rendered for use in spreadsheets.

The objective of this evaluation was to determine the applicability of requiring an 8" lintel when using the "small room rule" from NFPA 13. According to the Automatic Sprinkler Systems Handbook, a lintel with a depth of at least 8" ensures adequate collection of heat from a fire at the ceiling of the room of fire origin and promotes faster operation of the sprinklers nearest to the fire. Considering the fact that quick response sprinklers are mandatory throughout all light hazard occupancies, we asked, "Are lintels still necessary?"

In carrying out the evaluation we took the following steps. (1) We established a conservative time to activation using a standard response sprinkler in a scenario with an 8" lintel over the door opening. (2) We evaluated the same scenario, removing the lintel and changing to a quick response sprinkler. (3) We compared the time to activation using a standard response sprinkler with the 8" lintel to the time to activation using a quick response sprinkler without the lintel.

The room used in all simulations measured approximately 13.5' wide by 16.5' long by 8' tall (see Figure 1). All surfaces except the ceiling were given surface characteristics of gypsum board. The ceiling was given ceiling tile surface characteristics. Since walls were created, heat was forced to accumulate and build an upper gas layer. Keeping all

parameters the same (except for the sprinkler response time index and the presence of the lintel) for all simulation runs results in consistency and accurate portrayal of activation time differences.
A door opening was located in one of the long walls and nearest the fire. The opening measured 36" wide by 8' tall. Some simulations were run with an 8" lintel at the top of this opening and some without.

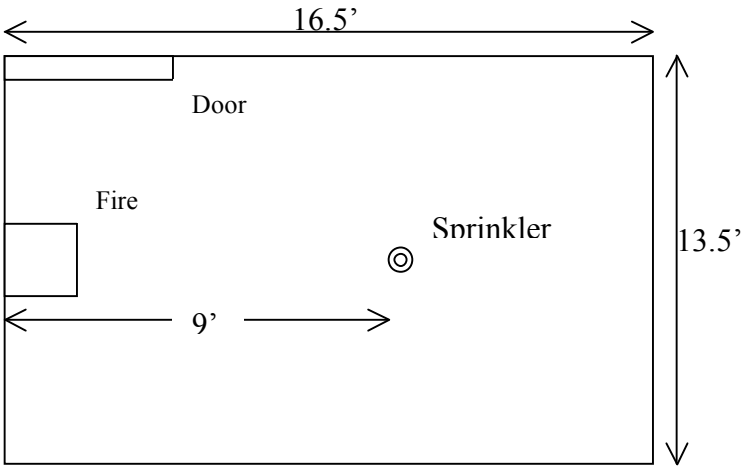

Figure 1

In order to determine the most conservative location for the fire, we ran six test simulations. We were looking for the location that would be most affected by the absence of a lintel resulting in the greatest difference in time to activation between a scenario with a lintel to one without. As shown in **Table 1**, the most conservative location for a fire would have been adjacent to the doorway. However, this location was not included since the path of ingress and egress is not likely to contain a fuel package. The next nearest location was selected.

Table 1

Name	Lintel Depth (in)	*Fire Growth	Sprinkler activation time (sec)	#Sprinkler RTI	Fire location
Test 1	0	UF	51.2	50	Far corner
Test 2	0	UF	57.9	50	Mid wall
Test 3	0	UF	60.1	50	Next to door
Test 4	0	M	160	50	Far corner
Test 5	0	M	170.8	50	Mid wall
Test 6	0	M	178.6	50	Next to door

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

Fires following two growth curves were used. One, considered a medium growth fire, starts at 0 megawatts (MW) at time zero (t=0) and ramps up following the standard heat release rate (HRR) curve given by the formula $HRR=\alpha t^2$ to a peak HRR of 4000-kw/sq.m. at 600 sec. The other, considered an ultra-fast fire, starts at 0 MW at t=0 and ramps up following the standard $HRR=\alpha t^2$ to a peak HRR of 3500-kws/sq.m. at 100 sec. All other fire parameters were left at default values. The fires were centered on the short wall nearest the door opening.

A sprinkler was centered in the 13.5' room dimension, 9' from the wall adjacent to the fire. Actually the sprinkler was input as a heat detector since a heat detector and a sprinkler behave exactly the same with respect to response/activation time to fires and since activation time was the only parameter sought for analysis. The sprinkler was set for an activation temperature of 73.9C (165F). In some simulations the sprinkler was assigned a response time index (RTI) of 177, simulating a standard response sprinkler, and it others it was assigned an RTI of 50, simulating a quick response sprinkler.

The Fire Dynamics Simulator 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 .101x.101x.087m or 4x4x3.4 inches, resulting in 57,600 cells. This resolution balances accuracy and computation time.

The evaluation was carried out in the described room with the described fire and the described sprinkler. The time to activation with a medium growth fire with a lintel and standard response sprinkler was 230.5 sec. Without a lintel and with quick response sprinkler it was 176 sec. In the ultra fast fire scenario with a lintel and standard response sprinkler the time to activation was 83.8 sec. Without the lintel and with a quick response sprinkler it was 57.9 sec. See **Table 2**. 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 2

Name	Lintel Depth (in)	*Fire Growth	Sprinkler activation time (sec)	#Sprinkler RTI	Fire location
UFSRWL	8	UF	83.8	177	Mid wall
UFQRWOL	0	UF	57.9	50	Mid wall
MSRWL	8	M	230.5	177	Mid wall
MQRWOL	0	M	176.5	50	Mid wall

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

Even when the lintel is not present, the quick response sprinkler operates considerably faster than the standard response sprinkler when the lintel is present.