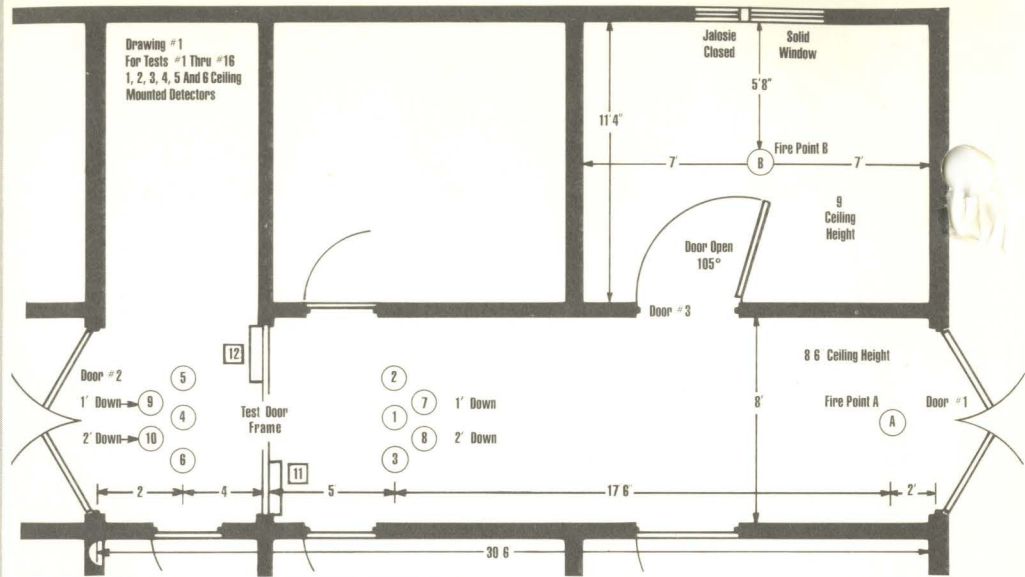


Fire/Life Safety Research

Report of Test Data

Smoke Detector Location for
Automatic Closing Fire/Smoke Doors

Fire test conducted at "Project Corridor" facility
with the consent of the California State Fire Marshal



Test Data

PROJECT CORRIDOR is a significant fire and life safety research program conducted by the California State Fire Marshal. The basic purpose of the Project is to determine the effect on egress corridors of various designs, when subjected to the exposure of a fire in an adjacent room. Various construction and occupancy features, perpetuated by building and fire codes, are examined and measured under full scale fire exposures in a setting as nearly representative of actual conditions as is practically possible.

Test Facility And Procedure

The fire test facility duplicated typical hospital corridor/patient room construction. The patient room was approximately 11' wide by 14' long, with a 9' ceiling. The corridor was 8' wide and 8½' high. Separate fires were located at two points (A and B), and all tests were duplicated for correlation of results.

Tests were made with a minimum fire size to which both photoelectric and ionization fire detectors would respond. All detectors were set at minimum sensitivity (2-4% obscurity).

Shredded newsprint, used in UL test fires, was also used as the main fire fuel. (Optimum test results are obtained when the fire will smolder for the longest period before breaking into flame.)

Tests conducted at Point A provide data on cross corridor openings, with increasing depth of the wall section above the door.

Tests at Point B provided data for cross corridor openings, with a fire in an adjoining room.

Test Criteria

Smoke detection and automatic door control is an established life safety concept. Cross corridor smoke barrier doors are required for certain occupancies by NFPA 101, the Hill-Burton Act and the Basic and Southern Standard building codes. The 1970 Basic Building Code requires any door which opens onto an exitway to be either self-closing and be so maintained or automatic closing by the detection of products of combustion other than heat. Identical requirements were written into the Uniform Building Code in 1971.

While the first code requirements were established as early as 1964, there have been no specific guidelines which define the proper location of smoke detectors for "door control" purposes. The only published recommendation, covered in NFPA 101, Section 5-2134C, simply states that detectors are to be located on either side of a horizontal exit. The question "where" is left unanswered – the meaning of the word "either" is confusing.

The California fire tests were therefore conducted to:

1. *Gain an understanding of how smoke flows through door openings under actual fire conditions.*
2. *Determine the most effective detector positioning, for optimum response, with various door-ceiling conditions.*
3. *Establish conditions when one or two detectors are required per opening.*
4. *Determine if a single detector, of proper design and location, can provide protection comparable to two ceiling-mounted devices, one on each side of the door opening.*
5. *Gather preliminary data on other closely related applications; specifically, the concept of smoke detection in all patient occupied areas, as compared to 100% sprinkler protection.*

Summaries of actual fire tests follow.

TESTS NO. 1 and NO. 2

Date 2-25-72 Time 11:50-12:45 PM

Fuel—2 oz. shredded paper tightly packed. Located at Fire Point "A". Top of door header with detectors No. 11 and No. 12 flush with ceiling.

TEST NO. 1

Detector*	Time		Test Start
	Min.	Sec.	
	0	0	Test Start
	0	25	Active Flame
1		27	
7		28	
8		29	
<u>11</u>		31	
4		33	
9		33	
10		34	
<u>12</u>		39	
	3	0	End Test

TEST NO. 2

Detector*	Time		Test Start
	Min.	Sec.	
	0	0	Test Start
	0	22	Active Flame
1		25	
7		26	
8		27	
<u>11</u>		28	
4		31	
9		32	
10		33	
<u>12</u>		38	
	3	0	End Test

TESTS NO. 3 and NO. 4

Date 2-25-72 Time 4:00—6:00 PM

Fuel—2 oz. shredded paper. Located at Fire Point "A". Door header with detectors No. 11 and No. 12 located 12" below ceiling.

TEST NO. 3

Detector*	Time		Test Start
	Min.	Sec.	
	0	0	Test Start
		22	Active Flame
1		28	
7		29	
<u>11</u>		31	
8		31	
<u>12</u>		34	
2		34	
4		35	
9		36	
10		41	
3	1	5	
6	1	13	
	3	0	End Test

TEST NO. 4

Detector*	Time		Test Start
	Min.	Sec.	
	0	0	Test Start
		27	Active Flame
1		37	
7		38	
<u>11</u>		39	
8		39	
2		43	
4		43	
<u>12</u>		45	
9		45	
10		45	
3	1	11	
6	1	34	
	3	0	End Test

*See explanation following Tests No. 17 and 18.

TESTS NO. 5 and NO. 6

Date 2-25-72 Time 9:30—10:45 PM

Fuel—2 oz. shredded paper. Located at Fire Point "A". Door header with detectors No. 11 and No. 12 located 24" below ceiling.

TEST NO. 5

Detector*	Time		Test Start
	Min.	Sec.	
	0	0	Test Start
		18	Active Flame
		33	
		38	
		44	
1	3	0	End Test

1
11
12

TEST NO. 6

Detector*	Time		Test Start
	Min.	Sec.	
	0	0	Test Start
		22	Active Flame
		49	
		54	
		55	
1	1	1	
11	1	1	
7	3	0	End Test

1
11
7
12
8

TESTS NO. 7 and NO. 8

Date 2-26-72 Time 10:30—11:30 AM

Fuel—2 oz. shredded paper. Located at Fire Point "A". Door header with detectors No. 11 and No. 12 located 36" below ceiling.

TEST NO. 7

Detector*	Time		Test Start
	Min.	Sec.	
	0	0	Test Start
		22	Active Flame
		38	
		42	
		50	
1	3	0	End Test

1
11
12

TEST NO. 8

Detector*	Time		Test Start
	Min.	Sec.	
	0	0	Test Start
		23	Active Flame
		39	
		41	
		42	
		43	
		48	
1	1	7	
7	3	0	End Test

1
7
8
11
12
2

Note—Very slight natural draft present during this test. Flowing in direction from detectors toward fire.

TESTS NO. 9 and NO. 10

Date 2-25-72 Time 2:20—3:00 PM

Fuel—4 oz. shredded paper. Located at Fire Point "B". Top of door header with detectors No. 11 and No. 12 flush with ceiling.

*See explanation following Tests No. 17 and 18.

TEST NO. 9		
Detector*	Time	
	Min.	Sec.
	0	0
	0	37
1	1	17
12	1	28
4	1	30
11	1	35
7	1	52
2	2	20
6	3	42
3	3	54
	5	0

Test Start
Active Flame

End Test

TEST NO. 10		
Detector*	Time	
	Min.	Sec.
	0	0
	0	34
12	1	32
11	1	36
1	1	38
2	2	28
6	3	57
	5	0

Test Start
Active Flame

End Test

TESTS NO. 11 and NO. 12

Date 2-25-72 Time 8:00—8:45 PM

Fuel—4 oz. shredded paper. Located at Fire Point "B". Door header with detectors No. 11 and No. 12 located 12" below ceiling.

TEST NO. 11		
Detector*	Time	
	Min.	Sec.
	0	0
		30
1	1	12
11	1	17
12	1	30
4	1	45
3	2	26
6	3	43
	5	0

Test Start
Active Flame

End Test

TEST NO. 12		
Detector*	Time	
	Min.	Sec.
	0	0
		36
1	1	13
11	1	24
12	1	26
6	3	50
2	3	53
3	3	58
	5	0

Test Start
Active Flame

End Test

TESTS NO. 13 and NO. 14

Date 2-26-72 Time 8:45—9:30 AM

Fuel—4 oz. shredded paper. Located at Fire Point "B". Door header with detectors No. 11 and No. 12 located 24" below ceiling.

TEST NO. 13		
Detector*	Time	
	Min.	Sec.
	0	0
		16
		47
1	1	33
11	1	33
12	1	51
	5	0

Test Start
Active Flame

End Test

TEST NO. 14		
Detector*	Time	
	Min.	Sec.
	0	0
		30
		39
1	1	39
11	1	40
12	1	54
	4	20
	5	0

Test Start
Active Flame

End Test

TESTS NO. 15 and NO. 16

Date 2-26-72 Time 11:45 – 12:30 PM

Fuel—4 oz. shredded paper. Located at Fire Point "B". Door header with detectors No. 11 and No. 12 located 36" below ceiling.

TEST NO. 15

Detector*	Time		
	Min.	Sec.	
	0	0	Test Start
		48	Active Flame
1	2	21	
11	2	37	
12	3	19	
	5	0	End Test

TEST NO. 16

Detector*	Time		
	Min.	Sec.	
	0	0	Test Start
		32	Active Flame
1	1	6	
11	2	26	
12	2	49	
	5	0	End Test

Note—Test No. 15 paper either damp or too tightly packed. Very slow to start with long period of smoldering.

TESTS NO. 17 and NO. 18

Test within patient room comparing response of ceiling mounted, and door frame mounted smoke detectors.

Date 2-26-72 Time 1:15—2:00 PM

Detectors No. 4, 5, 6, 9, 10, 11 relocated in "Patient Room" as shown in Drawing No. 2. Detector No. 12 not used. Fire located as shown in Drawing No. 2. Fuel—2 oz. shredded paper. Ceiling height 9 ft. Ceiling to door header 28". Door 6'8" H x 48" W open 105°.

TEST NO. 17

Detector*	Time		
	Min.	Sec.	
	0	0	Test Start
		21	Active Flame
6		26	
4		28	
11		42	
10		54	
1	2	39	
2	2	39	
	5	0	End Test

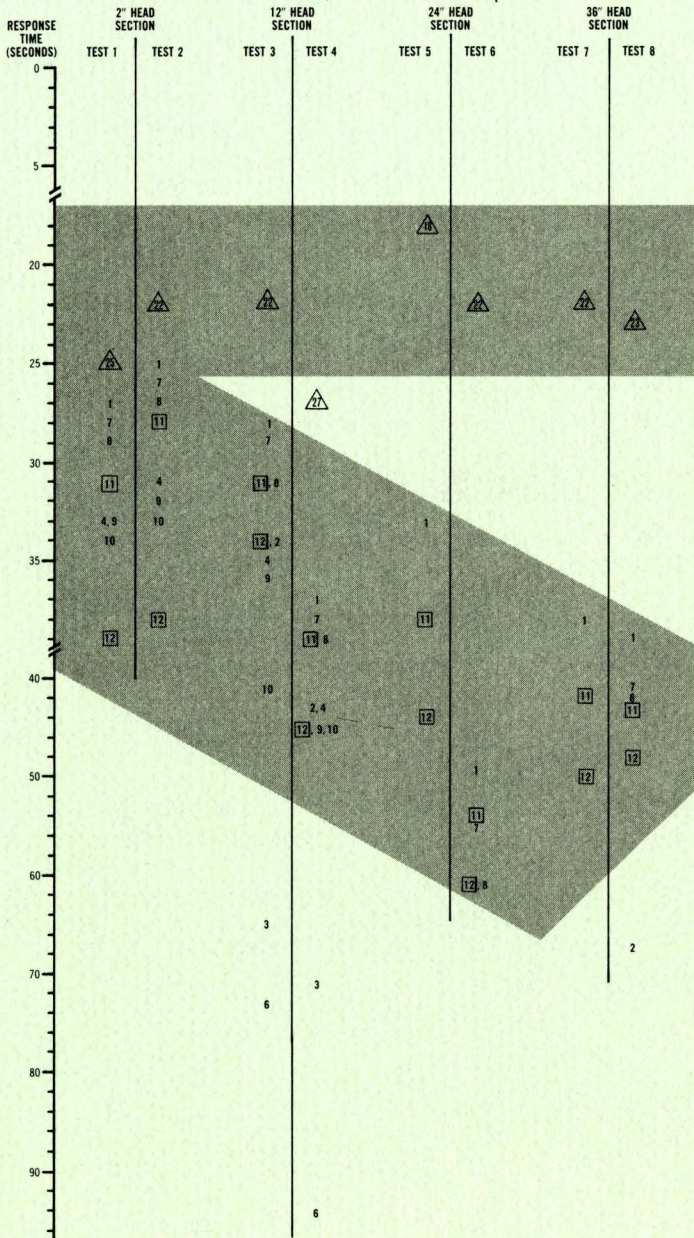
TEST NO. 18

Detector*	Time		
	Min.	Sec.	
	0	0	Test Start
		14	Active Flame
4		19	
6		21	
11		33	
10		46	
	4	0	End Test

*Detectors No. 1, 4, 7, 8, 9, 10 and frame mounted units 11 and 12 were ionization detectors. Detectors 2, 3, 5 and 6 were photoelectric.

GRAPHICAL TABULATION OF TEST RESULTS (SHOWING EFFECT OF WALL DEPTH ABOVE DOOR OPENING)

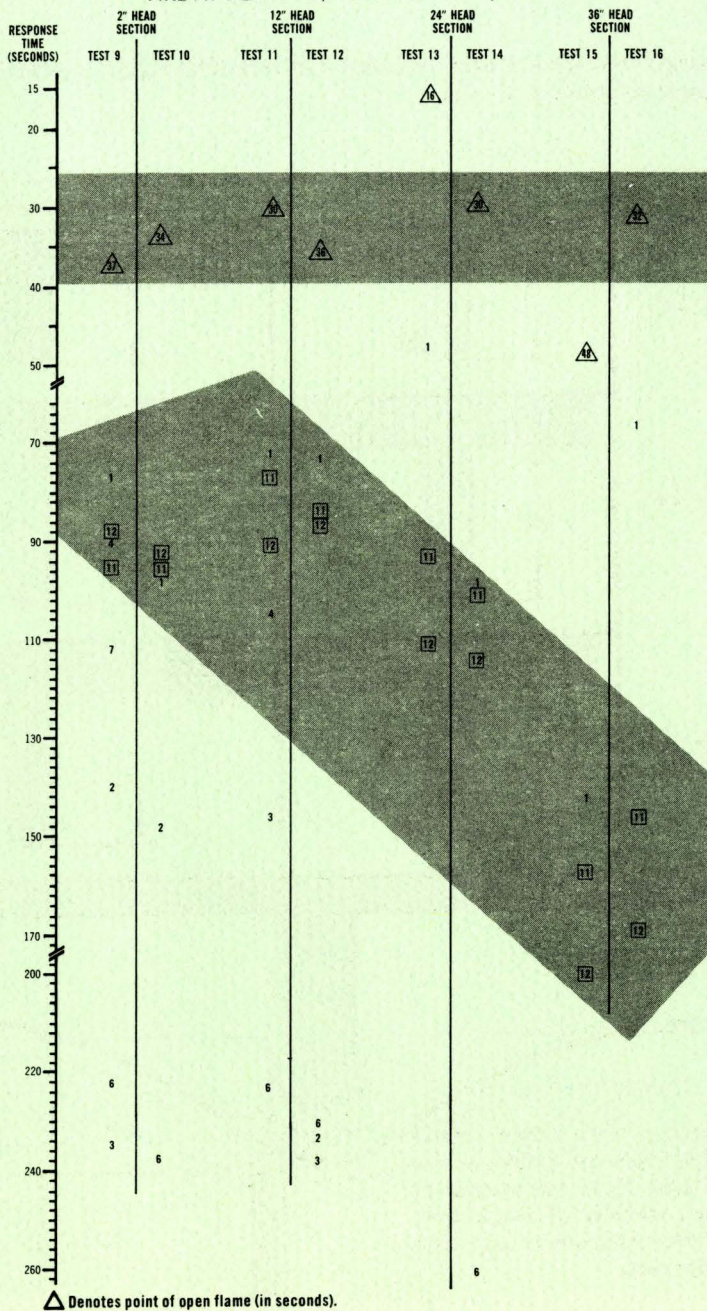
FIRE AT POINT "A," 2 Ounces of Paper



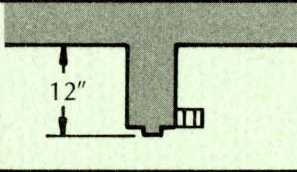
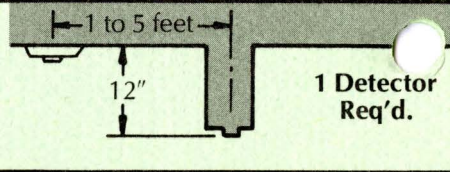
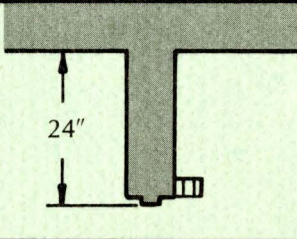
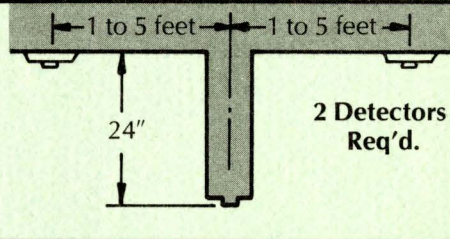
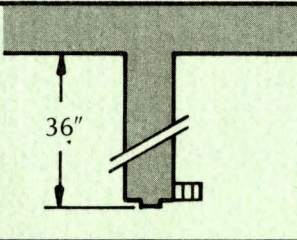
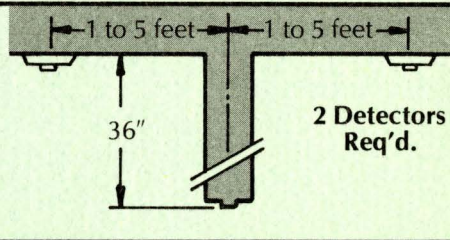
△ Denotes point of open flame (in seconds).

GRAPHICAL TABULATION OF TEST RESULTS (SHOWING EFFECT OF WALL DEPTH ABOVE DOOR OPENING)

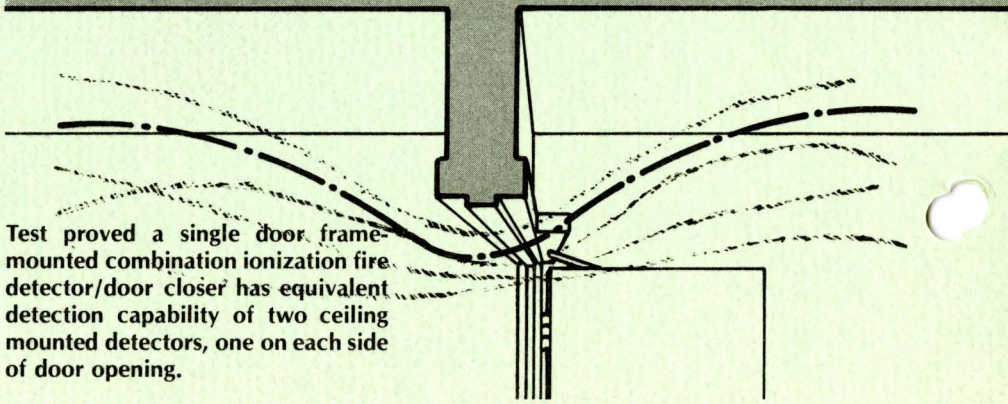
FIRE AT POINT "B," 4 Ounces of Paper

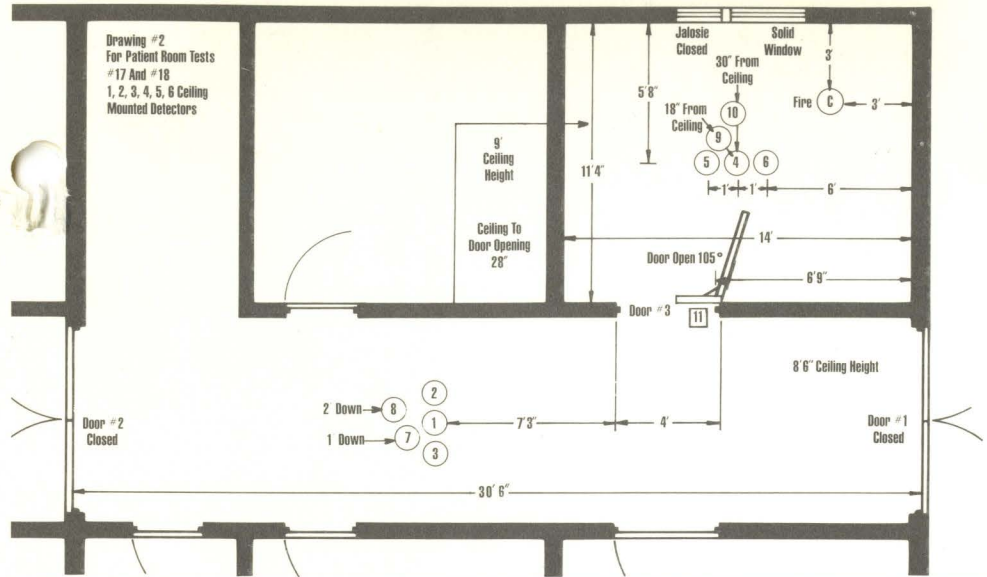


Smoke Detector Installation Guide For Door Opening Protection
 (Based on actual fire tests)

Depth of Wall Section Above Door	Smok-Chek III	Conventional Detectors
0 to 12"		 <p>1 Detector Req'd.</p>
12" to 24"		 <p>2 Detectors Req'd.</p>
24" to 36"		 <p>2 Detectors Req'd.</p>

Test proved a single door frame-mounted combination ionization fire detector/door closer has equivalent detection capability of two ceiling mounted detectors, one on each side of door opening.





Summary And Conclusions

1. A single smoke or ionization fire detector, placed on the ceiling within 1 to 5 feet of the opening, will provide good protection if the wall section above the door does not exceed 12" on either side. (Note: As a corollary to these conditions, only a slight difference in response time was noted between the detector mounted on the *fire* side and the one mounted on the *opposite* side of the door opening.)
2. Two ceiling mounted detectors, one on each side of the opening *must be used* if the wall section above the door exceeds 12" in depth.
3. A specially designed door closer, with a built-in single ionization fire detector, was mounted on the door frame. This combination unit provided comparable response *time*, plus a safety advantage, to conventional two detector installations. The frame mounted device was satisfactorily tested to a depth of 3 feet. The unit also consistently responded when placed on a closed 4' door of a pair of doors with the fire on the opposite side of the opening.
4. The combination unit, when used for early warning detection in hospital patient rooms, has the same fire detection capability as a ceiling mounted smoke detector in the patient room and it provides automatic door control function.
5. Fire and smoke barrier doors can now be held open to assist building egress, until the first trace of smoke passes thru the open doors. Under the present rules of the life safety code, all cross corridor doors are generally released simultaneously when the fire alarm or sprinkler system is actuated. Any such procedure can impede safe egress, by closing the door in the exit paths in unaffected areas of the building.



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