A Second Look at the Professional Opinions on Selected Fire Protection Engineering Topics

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In 1975, a very successful and informative survey entitled *A Survey of Professional Opinions on Selected Fire Protection Engineering Topics* was completed. It was compiled for the National Bureau of Standards (NBS) by Gregory A. Harrison, P.E., of NBS and James L. Houser, Research Associate, Gypsum Association. Resulting data were published by NBS as Technical Note 861, and were also presented in the March 1975 NFPA FIRE JOURNAL.

The survey covered topics such as the adequacy of the term "noncombustible" as contained in the 1961 edition of NFPA 220, *Standard on Types of Building Construction*,[1] hazards of fire loading concepts, code regulation and enforcement, furnishings, sprinkler systems, and smoke detectors.

With these advances in fire protection, many problems have been solved, but others have arisen.

The survey described in this article was prepared to follow-up on this vital topic. It is hoped that responses compiled here will provide some insight into the complexity of the problems that exist and the attitudes currently governing research, regulation, and standards. It is also hoped that data presented here will provide guidance for additional improvements in fire protection.

GENERAL DISCUSSION

This survey questionnaire was prepared and mailed to 314 fire protection professionals. The questionnaires were distributed throughout the United States and Canada. As the replies were received, they were categorized into fields of specialization, e.g., building official, insurance, fire service, etc., and the data were tabulated for analysis. Of the questionnaires sent out, 101 replies were received, of which 99 were statistically usable. This was an effective return of more than 33 percent, which is better than twice the rate for most mail surveys. The analysis of the results required the evaluation of more than 3,100 items of information. The following table illustrates the various groups surveyed and their responses.

Table 1. Group Surveyed

Group	*Total Mailed*	*Effective Mailing*	*Total Return*	*Effective Return*	*% Effective Return*
(A) Academic	14	14	6	6	42.9
(B) Building Official	51	50	21	21	42.0
(GI) General Interest	44	42	17	17	45.2
(FS) Fire Service	19	17	5	5	29.4
(GOV) Federal Government	10	10	4	4	40.0
(I) Insurance	31	28	7	6	25.0
(A/E) Architect/ Engineer	145	137	41	40	29.2
	314	298	101	99	33.2

The questions asked in the survey follow, along with the tabulated results and a brief evaluation of each topic. For maximum understanding of the responses, the results should be analyzed in light of the respondents' discipline or vocational bias.

SURVEY RESULTS

Question 1: In your opinion, is the Potential Heat and Noncombustibility of Elementary Materials Test Criteria of NFPA 220, *Standard on Types of Building*

Mr. Lawson conducted this survey and prepared the resulting report while serving as the Gypsum Association Research Associate at the National Bureau of Standards in 1976–77. He is currently an employee of the Center for Fire Research of the National Bureau of [illegible] as relate to the 1975 edition of NFPA 220, *Standard on Types of Building Construction.*

[1] The authors worked with the 1961 edition, as published in the 1972–73 NFPA *National Fire Codes.* ® Reg. TM National Fire Protection Association, Inc.

Construction, adequate to meet the needs of defining the fire hazards in building construction?

Data:	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
Yes	0	4	1	1	1	2	13	22
No	6	16	16	4	3	4	23	72

Evaluation: About 77 percent of those responding indicate they do not feel that the definition is adequate; but it should be noted that half of the respondents in the insurance and architect/engineer categories indicated that the definition is adequate.

Question 1a. Would you prefer to have additional criteria available to further assess the fire hazard of building materials, such as:

1) Ease of ignition of the material

Data:	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
Yes	6	12	14	3	3	5	25	68
No	0	5	1	0	0	1	15	22

2) Rate that heat is released by the burning material

Data:	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
Yes	5	12	15	2	4	4	23	65
No	0	6	0	1	0	1	8	16

3) Flame spread rating

Data:	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
Yes	5	14	14	4	4	4	25	70
No	0	4	1	0	0	1	4	10

4) Smoke production

Data:	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
Yes	6	17	14	5	4	5	33	84
No	0	3	3	0	0	1	2	9

5) Toxic gas production

Data:	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
Yes	6	17	11	3	3	5	34	79
No	0	3	5	0	0	1	2	11

Evaluation: It appears that the majority of respondents feel that additional criteria should be made available for the determination of fire hazards in building construction. A ratio of 9:1 indicated that smoke production data should be made available. Flame spread rating and toxic gas production had a ratio of 7:1. Heat-release rate followed with a ratio of 4:1, and ease of ignition criteria was last with a 3:1 ratio.

Question 1b: Are you using the new NFPA 220 definition of noncombustibility or the old one?

Data:	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
New	3	1	1	3	2	4	18	32
Old	0	5	5	0	0	0	11	21
Other	3	15	3	2	1	1	5	30

1 respondent uses all

1 respondent uses old and new

Evaluation: About 38 percent of the respondents indicate that they are using the new NFPA 220 definition. However, out of 21 responses from building officials, it is interesting to note only one stated that the new definition was being used. It is presumed that the 15 in the "other" category would be using the a and b parts of the old three-part definition as currently prescribed in the three model codes or a locally developed definition.

Question 2: Does the NFPA 220 definition properly characterize the fire hazard of "limited combustibility" in building construction?

Data:	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
Yes	1	7	5	2	1	3	15	34
No	5	12	11	3	2	2	21	56

Evaluation: 62 percent stated they believed the NFPA 220 definition does not properly characterize the fire hazard of "limited combustibility" in building construction. The only group that indicated the definition was adequate was the insurance group, and this with a response of 3 to 2. The latter group may be reflecting the use of the American Insurance Association's *National Building Code*, 1976 Edition.

Question 3: Is it necessary that all components in a fire-rated assembly of one or more hours be noncombustible or limited combustible when used in other than framed construction?

Data	*A*	*B*	*GI*	*FS*	*GOV*	*I*	*A/E*	*Total*
Yes	2	10	6	4	2	2	19	45
No	4	9	11	1	1	3	16	45

Evaluation: The 1:1 ratio of the total results indicated that there are two basic schools of thought. This is reflected within three of the professional groups — building officials, insurance, and architect/engineer.

Question 4: The following list reflects areas that are currently being studied in an attempt to help reduce the loss of life and property in fires. Of this group, please select and specify by marking on the scale below the square that indicates the importance of each item.

(**Note:** Each item could be rated from 1 to 5, with 1 indicating least important and 5 most important. A value of one was given to a rating as least important, and a value of 5 to a rating as most important, with intervening ratings weighted correspondingly. Each item was then given a weighted average total determined by dividing the weighted total by the total number of votes.)

4a. Importance to life safety:

Smoke density or obscurity

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0*	0	0	0	0	0	0	0	0
2–	0	0	1	2	1	1	1	6	12
3–	0	3	1	0	1	2	2	9	27
4–	4	3	5	1	1	0	11	25	100
5–	2†	16	10	3	1	3	25	60	300
								Average	4.39

* Least Important
† Most Important

Flame spread of a material

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0	0	0	0	0	0	0	0	0
2–	0	0	0	0	0	0	4	4	8
3–	3	6	9	1	0	0	8	27	81
4–	1	12	4	3	2	3	17	42	168
5–	2	4	4	1	2	3	10	26	130
								Average	3.91

Fire endurance of an assembly

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	3	3	0	1	0	2	5	14	14
2–	0	3	2	1	1	0	3	10	20
3–	1	5	5	3	3	1	11	27	81
4–	1	3	2	0	2	3	8	19	76
5–	1	8	8	0	0	0	11	28	140
								Average	3.37

The rate that heat is released by a burning material

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0	1	0	1	0	0	2	4	4
2–	1	3	3	1	0	0	6	14	28
3–	1	8	4	1	2	2	8	26	78
4–	3	7	5	1	1	2	15	34	136
5–	1	3	5	1	1	2	6	19	95
								Average	3.52

The ease with which a material will ignite

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0	3	0	0	0	0	2	5	5
2–	1	1	0	1	2	3	3	11	22
3–	2	8	4	3	1	1	10	29	87
4–	2	9	6	0	1	1	9	28	112
5–	1	1	7	1	0	1	14	25	125
								Average	3.54

4b. Importance to property loss:

Smoke density or obscurity

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	1	6	8	3	1	1	8	28	28
2–	4	8	5	1	2	3	14	37	74
3–	0	7	4	1	0	2	8	22	66
4–	1	0	0	0	1	0	5	7	28
5–	0	1	0	0	0	0	4	5	25
								Average	2.23

Toxic gas production

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0	0	0	0	0	0	1	1	1
2–	0	0	3	0	1	1	0	5	10
3–	1	2	3	0	0	0	3	9	27
4–	2	1	2	1	2	3	9	20	80
5–	3	19	9	4	1	2	26	64	320
								Average	4.42

Fire endurance of an assembly

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0	0	0	0	0	0	0	0	0
2–	0	0	0	1	1	0	1	3	6
3–	2	1	1	0	0	0	4	8	24
4–	2	7	3	1	0	2	11	26	104
5–	2	14	13	3	3	4	23	62	310
								Average	4.48

The ease with which a material will ignite

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0	0	0	0	0	0	1	1	1
2–	0	1	1	0	0	0	3	5	10
3–	3	4	6	1	1	2	4	21	63
4–	3	8	5	2	2	4	13	37	148
5–	0	9	5	2	1	0	18	35	175
								Average	4.01

Toxic gas production

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	4	11	13	2	2	2	15	49	49
2–	2	7	2	3	1	1	9	25	50
3–	0	3	0	0	0	2	7	12	36
4–	0	0	1	0	1	1	1	4	16
5–	0	1	1	0	0	0	4	6	30
								Average	1.89

Flame spread of a building material

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0	0	1	0	0	0	0	1	1
2–	0	0	1	1	0	2	1	5	10
3–	1	3	5	1	0	2	9	21	63
4–	4	15	5	0	1	2	16	43	172
5–	1	4	5	3	3	0	13	29	145
								Average	3.95

The rate that heat is released by a burning material

Data:

	A	B	GI	FS	GOV	I	A/E	Total	Weighted Total
1–	0	0	0	0	0	0	1	1	1
2–	0	0	4	1	0	0	4	9	18
3–	2	8	5	0	0	1	7	23	69
4–	2	11	5	3	1	4	19	45	180
5–	2	3	3	1	3	1	7	20	100
								Average	3.76

Evaluation: After determining a weighted total average of the response to each category, the importance value of each category was classified. The following lists the value of importance as assigned by the respondents:

a) Importance to life safety:

Least Important: 1 — Fire endurance of an assembly
2 — Rate that heat is released
3 — Ease of ignition
4 — Flame spread
5 — Smoke density or obscurity
Most Important: 6 — Toxic gas production

b) Importance to property loss:

Least Important: 1 — Toxic gas
2 — Smoke density or obscurity
3 — Rate that heat is released
4 — Flame spread
5 — Ease of ignition
Most Important: 6 — Fire endurance of an assembly

It should be noted that the importance to life safety is basically a reversal of the order indicated in importance to property loss.

Question 5. "Fire load/fuel load" of building construction and contents is defined as the quantity of combustible materials in a building expressed in its equivalent weight in wood, in BTUs per pound per square foot of gross space. How should the amount of "fire load/fuel load" in furnishings be controlled in buildings?

Using the following list of suggested means for controlling "fuel load" of furnishings in a building and the list of building types, match the corresponding letter of your choice to the building type.

Means for Control:

A) Control fire hazard characteristics of furnishings at the manufacturing level.

B) Establish building codes which will specify the maximum fuel load for a building or each room of a building.

C) Alert and educate consumers to select furnishings with low fire hazard characteristics.

D) Ignore furnishings but improve building design, fire resistance of structural components, sprinklers, detection systems, and exits.

E) Other.

Building Types

Office, high-rise more than 75 feet high

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	0	6	2	0	0	0	9	23	40
B.	1	2	5	1	2	1	6	12	30
C.	0	0	0	0	1	0	2	9	12
D.	1	10	6	1	0	2	12	19	51
E.	4	4	4	3	1	3	11		

E — Combinations Suggested

3-A,D	1-A,B 1-A,C 1-C,D	2-A,D 1-C,D	2-A,D 1-A,B	1-Mix of all	2-Mix of all 1-A,B,D	1-All 1-A,B 2-A,B,C 1-A,B,D 1-A,C,D 3-A,D

Evaluation: The primary control method suggested was the balanced protection provided by means D, and the control of furnishings at the manufacturing level is second. The establishment of building codes to control fuel load was third, with consumer education a weak fourth.

Office: low-rise less than 75 feet high

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	0	7	2	0	0	0	9	22	40
B.	0	2	4	1	2	1	3	10	23
C.	0	0	2	0	1	0	3	8	14
D.	2	9	6	1	0	2	13	17	50
E.	4	4	3	3	1	3	11		

E — Combinations Suggested

3-A,D	1-A,B 1-A,C 1-C,D	2-A,D	2-A,D 1-A,B	1-Mix of all	2-Mix of all 1-A,B,D	1-A,B 2-A,B,C 1-A,B,D 1-A,C,D 3-A,D

Evaluation: Balanced protection D received the greatest response. The control of furnishings at the manufacturing level exhibits a strong second, with building codes control ranking third, and consumer education last.

Residential: high-rise more than 75 feet high

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	0	5	2	1	1	1	13	23	46
B.	1	2	3	1	0	0	5	7	19
C.	0	1	1	0	2	0	5	14	23
D.	1	12	7	1	1	2	5	17	46
E.	4	2	4	2	0	3	12		

E — Combinations Suggested

3-A,D	1-A,B 1-A,C	2-A,D 1-A,C 1-C,D	1-A,D 1-A,C,D	2-Mix of all 1-A,B,D	1-A,B,C 2-A,B,D 2-A,C,D 4-A,C 1-A,D 1-C,D	

Evaluation: In this category, balanced protection D and control of furnishings at the manufacturing level were of equal importance. The education of consumers took on greater importance and ranked third, with building codes control becoming less important.

Residential: low-rise less than 75 feet high

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	0	6	3	1	1	1	13	20	45
B.	0	1	2	1	0	0	2	7	13
C.	0	2	3	0	2	1	8	13	29
D.	2	11	6	2	1	1	6	14	43
E.	4	2	3	1	0	3	11		

E — Combinations Suggested

3-A,D	1-A,B 1-A,C	1-A,C 1-A,D 1-C,D	1-A,D	2-Mix of all 1-A,B,D	1-A,B,C 2-A,B,D 2-A,C,D 4-A,C 1-C,D

Evaluation: The control of fuel loads of furnishings at the manufacturing level had the greatest response, with balanced protection following as a close second. Consumer education took on more importance and is classified in the third position, with building codes control a low fourth.

Garden-type apartments, 50 feet or less

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	0	5	4	2	1	0	13	15	40
B.	1	1	2	1	0	0	1	6	12
C.	0	5	3	0	2	3	10	11	34
D.	1	9	5	2	1	0	7	11	36
E.	4	2	2	0	0	3	9		

E — Combinations Suggested

3-A,D	1-A,B 1-A,C	1-A,C 1-A,D 1-C,D	2-Mix of all	1-A,B,C 1-A,B,D 2-A,C,D 1-B,C,D 2-A,C

Evaluation: Fuel load control of furnishings at the manufacturing level again received the greatest response, with balanced protection following a close second. Consumer education became increasingly important and ranked slightly behind balanced protection. Building codes control was fourth, with a low total response.

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Townhow house: connected single-family dwelling units

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	0	6	5	2	1	0	11	16	41
B.	0	0	1	0	0	0	1	7	9
C.	1	4	5	2	2	2	13	13	42
D.	1	9	4	1	1	1	6	12	35
E.	4	2	2	0	0	3	9		

E — Combinations Suggested

2-A,D 2-A,C	1-A,B 1-A,C	1-A,D 1-C,D	2-Mix of all 1-A,B,D	1-A,B,C 1-A,B,D 2-A,C,D 1-B,C,D 2-A,C 1-C,D

Evaluation: Consumer education placed first, and the fuel load controlled at the manufacturing level placed a very close second. Balanced protection was a strong third, while building codes control dropped to a low fourth position.

Detached single-family dwellings

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	0	5	7	2	1	0	9	16	40
B.	0	0	1	0	0	0	0	6	7
C.	1	7	5	3	2	3	20	12	53
D.	0	8	2	0	1	0	3	11	25
E.	5	1	2	0	0	3	8		

E — Combinations Suggested

2-A,D 3-A,C	1-A,C	1-A,D 1-C,D	2-Mix of all 1-A,B,D	1-A,B,C 1-A,B,D 2-A,C,D 2-A,C 1-B,D

Evaluation: As the family environment becomes more important, consumer education does, too. It maintained a strong first, with manufacturing-level control of fuel loads placing second. Balanced protection in the home also dropped slightly, but maintained its third position. Building codes control maintained its position as fourth.

Mobile homes/manufactured housing

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	1	10	9	4	1	2	19	17	63
B.	0	3	1	0	0	0	0	8	12
C.	0	2	3	0	0	1	8	10	24
D.	1	5	2	0	2	0	5	14	29
E.	4	2	2	1	1	3	7		

E — Combinations Suggested

2-A,D 3-A,C	1-A,B 1-A,C	1-A,D 1-C,D	1-Mix of all	2-Mix of all 1-A,B,D	1-A,B,C 1-A,B,D 1-A,C,D 1-A,D 2-B,D

Evaluation: The control of fuel loads at the manufacturing level is of major importance, carrying almost 50 percent of the total response, with balanced protection in the second position. Consumer education was third, showing a moderate response, and the importance of building codes control increased slightly, but remained in fourth place.

Public places of assembly: theaters, nightclubs, auditoriums, etc.

Data:

	A	B	GI	FS	GOV	I	A/E	Additions From E	Total
A.	0	6	3	0	0	0	9	20	38
B.	0	4	5	2	3	2	11	15	42
C.	0	0	0	0	0	0	1	8	9
D.	2	8	3	0	0	1	11	21	46
E.	4	3	6	3	1	3	8		

E — Combinations Suggested

3-A,D 1-B,C D,E	2-A,B 1-A,C	3-A,D 1-B,D 1-C,D	1-A,B 1-A,B,D 1-A,D	1-Mix of all	2-Mix of all 1-A,B,D	1-A,B,C 2-A,B,D 1-A,C,D 2-B,D 1-D*

* Plus data on ignition, heat, release rate, and smoke release rate of finishes and furnishings.

Evaluation: Balanced protection was considered of primary importance, with building codes control placing a close second. The control of furnishings at the manufacturing level exhibited a strong third position, and consumer education was a weak fourth.

Question 6: Does ASTM Standard E 136, *Test for Noncombustibility of Elementary Materials*, meet the needs for specifying the noncombustibility of materials?

Data:	A	B	GI	FS	GOV	I	A/E	Total
Yes	3	13	4	3	3	5	17	48
No	3	6	13	2	1	0	17	42

Evaluation: The responses to this question were almost evenly divided. A total of 53 percent of the respondents stated that they felt ASTM E 136 does meet the needs for specifying noncombustibility. Notice that the insurance group presented the only unanimous response.

Question 7: Should ASTM E 136 be used for testing the noncombustibility of other than elementary materials?

Data:	A	B	GI	FS	GOV	I	A/E	Total
Yes	2	9	5	0	2	1	15	34
No	4	10	12	4	1	5	17	53

Evaluation: Although 61 percent of the respondents indicated that the test method should not be used for the testing of other than elementary materials, the opinions of the building officials and architect/engineer groups were split.

Question 8: In order to further define fire hazard characteristics of building materials and furnishings, should NFPA 220 include additional categories for identifying low-, medium-, and high-hazard combustible materials?

Data:	A	B	GI	FS	GOV	I	A/E	Total
Yes	4	13	11	3	2	2	30	65
No	2	7	6	2	2	4	8	31

Evaluation: On the basis of total response, 68 percent indicated that there should be additional categories for the identification of low-, medium-, and high-hazard combustible materials. The insurance group showed a 2:1 response opposing inclusion of additional combustibility categories.

SUMMARY

The survey attempted to poll 314 professionals associated with the fire protection field in order to obtain a better understanding of the current fire protection philosophy. There were 99 effective returns, which placed the average response rate at more than twice the rate for most mail surveys.

Several interesting trends were apparent in the responses. A majority indicated that NFPA 220, *Standard on Types of Building Construction,* was not adequate, and stated that additional data should be made available for the determination of fire hazards in building construction. At this time, only one building official out of 21 indicated he was using the new NFPA 220 definitions.

In Question 4, the importance of the various fire characteristics to life safety is basically a reversal in order of the responses, indicating the importance of these characteristics to property loss.

Apparently many professionals believe that balanced protection (improved building design, fire resistance of structural components, detection systems, sprinklers, and exits) is the best approach to solving the fuel-load problem in high-rise office and apartment buildings, as well as in low-rise office buildings. It was also stressed that control of furnishings should take place at the manufacturing level.

Balanced protection was also given high priority in public places of assembly, with building codes' control of fuel loads receiving an almost equal response. Fuel-load control by the building codes received a low rating in the other categories.

In residential low-rise buildings, garden apartments, and mobile homes/manufactured housing groups, the control of fuel load of furnishings at the manufacturing level was indicated as the most desirable approach, with balanced protection receiving a large response. Consumer education became more important in this form of construction. Consumer education was indicated as most important when attached and detached single-family dwellings were concerned, and the control of furnishing fuel load at the manufacturing level received a high response. Generally, it appears that as the family dwelling unit becomes more personal, consumer education is more important.

With regard to the need for additional categories for identifying low-, medium-, and high-hazard combustible materials in NFPA 220, the majority of the respondents indicated that additional groupings should be provided.

It is hoped that the results obtained from this survey will be useful in providing a better understanding as to where we currently stand on the various fire protection topics surveyed. △