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THE COLLECTION AND USES OF FIRE DATA[1]

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ABSTRACT

The main objective of the National Fire Incident Reporting system is collecting, analyzing, and disseminating comprehensive fire loss statistics reported by attending fire departments. Data are recorded in blocks on the NFIRS fire incident and fire casualty report forms, whose coding is based on a uniform classification scheme. NFIRS data can be used to investigate such relationships as those between construction type and actual fire loss experience. Fire Scenarios are another analytical tool used to rank fire hazards. With NFIRS report catalogs, feedback reports will be available to interested parties. Presently, the National Fire Data Center and NFIRS have joined in an effort to create a comprehensive National Fire Data System. The data presented in this study are not definitive and only illustrate potential utility of fire data.

Keywords: National Fire Incident Reporting System, National Fire Data System, fire analyses, ignition factors.

INTRODUCTION

The National Fire Data Center of the National Fire Prevention and Control Administration is directed by law to collect, analyze, and disseminate data on the occurrence, control, and results of all types of fires (Federal Fire Prevention and Control Act, 1974). One of the major efforts undertaken to carry out this mandate is the National Fire Incident Reporting System (NFIRS) (Tovey 1974, 1977; Buchbinder 1975). This paper describes the basic design of NFIRS. It also illustrates several ways in which it can be used to identify and evaluate the roles played by different fire factors and suggests possible intervention strategies.

THE NATIONAL FIRE INCIDENT REPORTING SYSTEM

The National Fire Incident Reporting System is a nationwide fire data network whose primary objective is the collection of comprehensive fire loss statistics on fires attended by the fire service. It is based on the cooperation of local fire departments, municipal and state fire jurisdictions, and the National Fire Prevention and Control Administration (NFPCA) (Fig. 1). NFIRS is meant to benefit all participants by providing them with valid data for decision-making.

Procedurally, NFIRS calls on local fire departments to collect data on each fire incident attended. Fire incident reports are sent to the appropriate state-level auhority, generally the office of the state fire marshall, where they are processed onto computer tape. Alternatively, the data can be processed at the local or regional level and then passed on to state jurisdictions in computerized form (Fig. 2). Collected fire data are tabulated and analyzed. The data are used by the municipality or the state for production of general annual and periodic reports, for developing feedback reports to participating fire departments, and for special problem analysis. Data collected and processed by a state are sent to the National Fire Data Center. In the Center, the data received from all participating NFIRS systems are tabulated and analyzed, and reports are prepared for feedback to participating state sources as well as for general dissemination (Fig. 3).

To ensure compatibility across the na-

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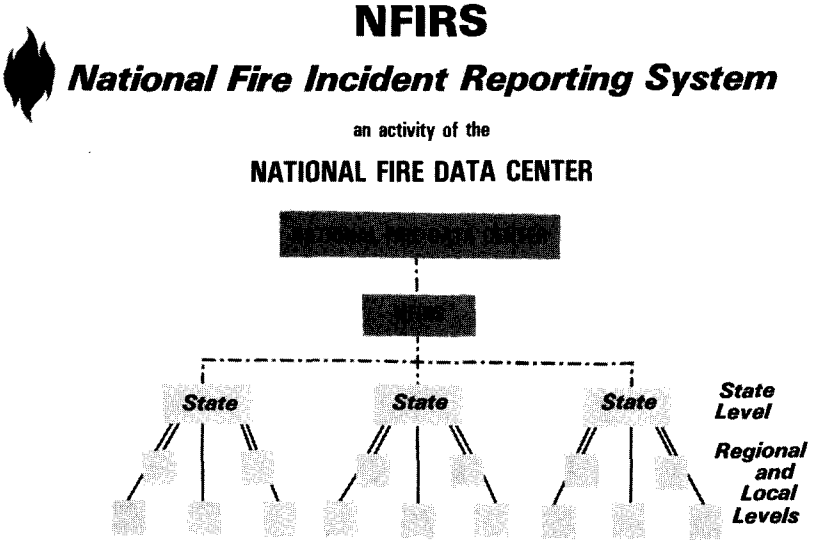

FIG. 1. Flow chart of NFIRS.

tion, NFIRS adopted an official set of data elements and fire incident and fire casualty reporting forms (Figs. 4 and 5). NFIRS also developed a training manual for instructors, a handbook for those who complete the forms, and a well-documented computer software package for processing the data. These materials are provided free of charge to participating state-level jurisdictions. In addition, a small grant of up to $20,000 can be obtained by a "new" state to partially offset the cost of gearing up for participating in the system. Currently, Maryland, Missouri, New York, Ohio, and Oregon participate in the system. Although not officially an NFIRS state, California has operated a very similar fire data system for a couple of years and provides data to the Center. It is expected that Delaware, Iowa, Michigan, Minnesota, Rhode Island, South Dakota, and West Virginia will join the network in fiscal year 1977. Alaska is planning to join on its own in 1977. The Center plans to expand NFIRS to between 17 and 19 states by 1979, at which time the system is expected to cover a large sample of the U.S. population. Since NFIRS is designed to benefit reporting jurisdictions, it is expected that eventually all states will participate.

THE NFIRS FORM

NFIRS fire incident and fire casualty reporting forms (Figs. 4 and 5) are based on a uniform classification scheme developed for fire data reporting by the nation's fire community through the voluntary consensus mechanism of the National Fire Protection Association's Committee 901 on Fire Reporting (Nat. Fire Prot. Assn. 1976). These forms include some data elements that are not utilized at the national level

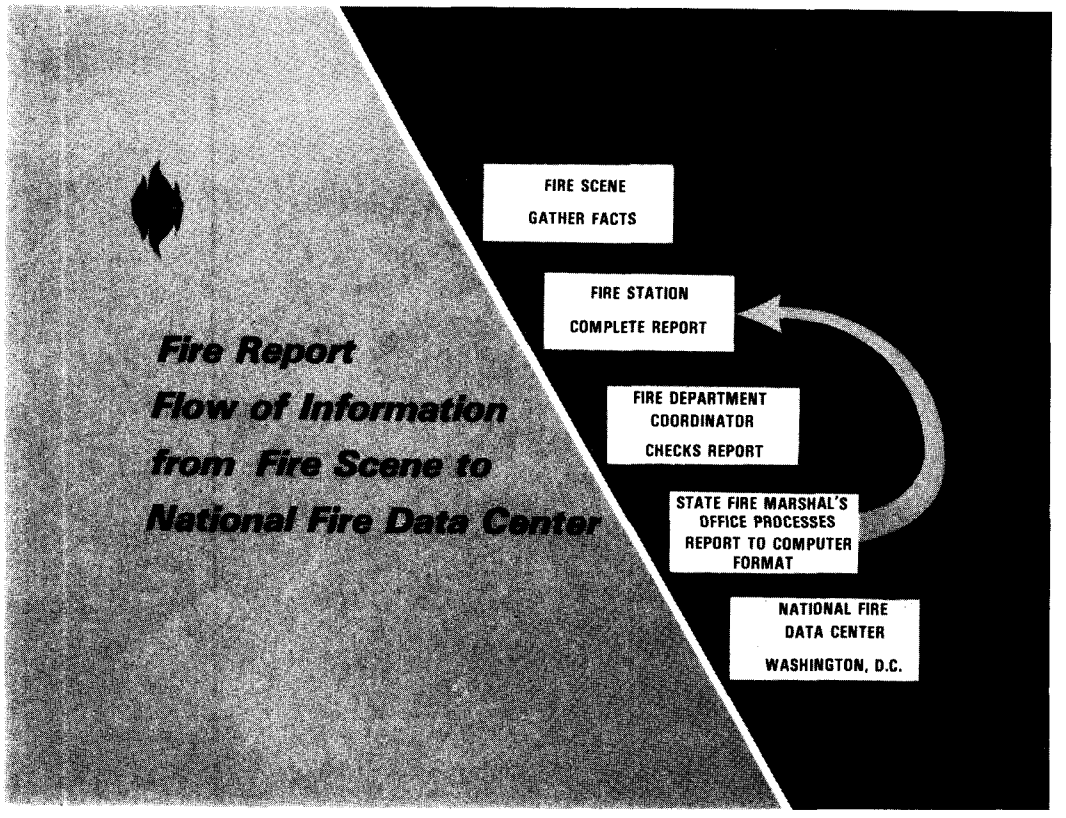

FIG. 2. Flow of information from fire scene to National Fire Data Center.

but can be valuable to local, municipal, regional, or even state jurisdictions. NFIRS adopted the NFPA Committee forms to maintain uniformity and allow participating fire jurisdictions to collect the needed data. However, NFIRS does not require use of these or any other specified forms. As long as NFIRS data elements are collected and coding is based on the uniform classification scheme, participating jurisdictions can add as many data elements as they wish, and even design their own forms. The standard NFIRS software must be modified to process special forms.

DATA COLLECTED AND ILLUSTRATIVE OUTPUTS

Validity

A brief discussion of the validity of the NFIRS data base is necessary before tables derived from these data are presented. A brief study conducted by Auerbach Assoc., Inc., for the Center, on data supplied by one of the early NFIRS states for the first three quarters of 1976, provides some insight into this problem (Auerbach 1977). The study estimated that only about half of the fire incidents occurring during the first nine-month period studied were actually reported. This was not unexpected, however, since the system had been going through a start-up phase. The extent of reporting improved during the last three months of the year. The study could not determine how well the reported incidents represented the total fire picture. However, it included a wide range of incident types and constituted a large sample of the total.

The "quality" of the data, the extent to which the reports covered all aspects of

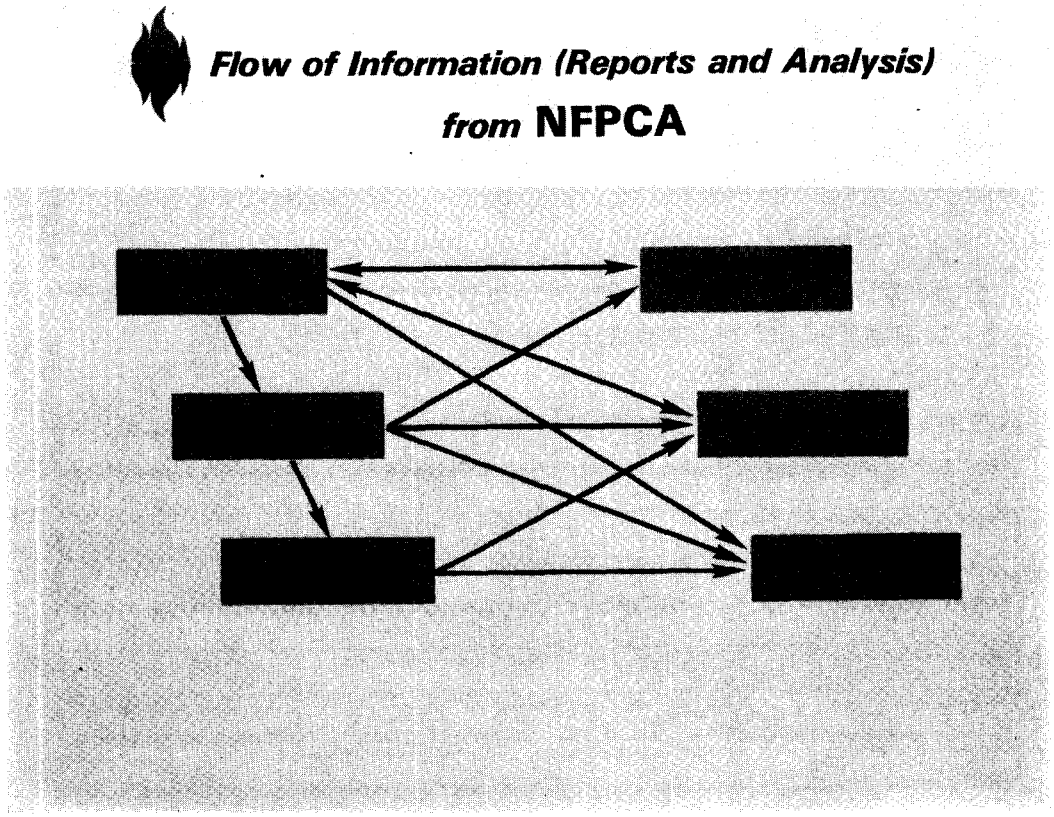

FIG. 3. Flow of information (reports and analyses) from NFPCA.

the incident, was found to be relatively high. Discounting reports on grass, rubbish, and some no-loss fires, for which only the first eight lines of the form were completed as a matter of policy, the blank spaces in the various data element fields averaged about 5% for most of the data elements. The percentage of "illegal" codes (codes not accepted by NFIRS computer program) for most data elements was approximately 0.5%.

The third aspect of NFIRS data validity examined by AAI was "accuracy," which can be defined as the proper use of the coding system to describe the circumstances of an incident. This was a difficult factor to evaluate, because it is usually not possible to say that a given code is incorrect without having been on the scene. However, by analyzing various combinations of codes, it is possible to observe some codes that are clearly inconsistent or incompatible. These analyses indicated considerable variability among the different data elements. The results for the worst data element group, ignition factors, show an apparent code misuse rate of approximately 10%. Code misuse rate was found to decrease as fire department personnel acquired experience with the system.

The set of data elements collected by NFIRS reflects a compromise between the

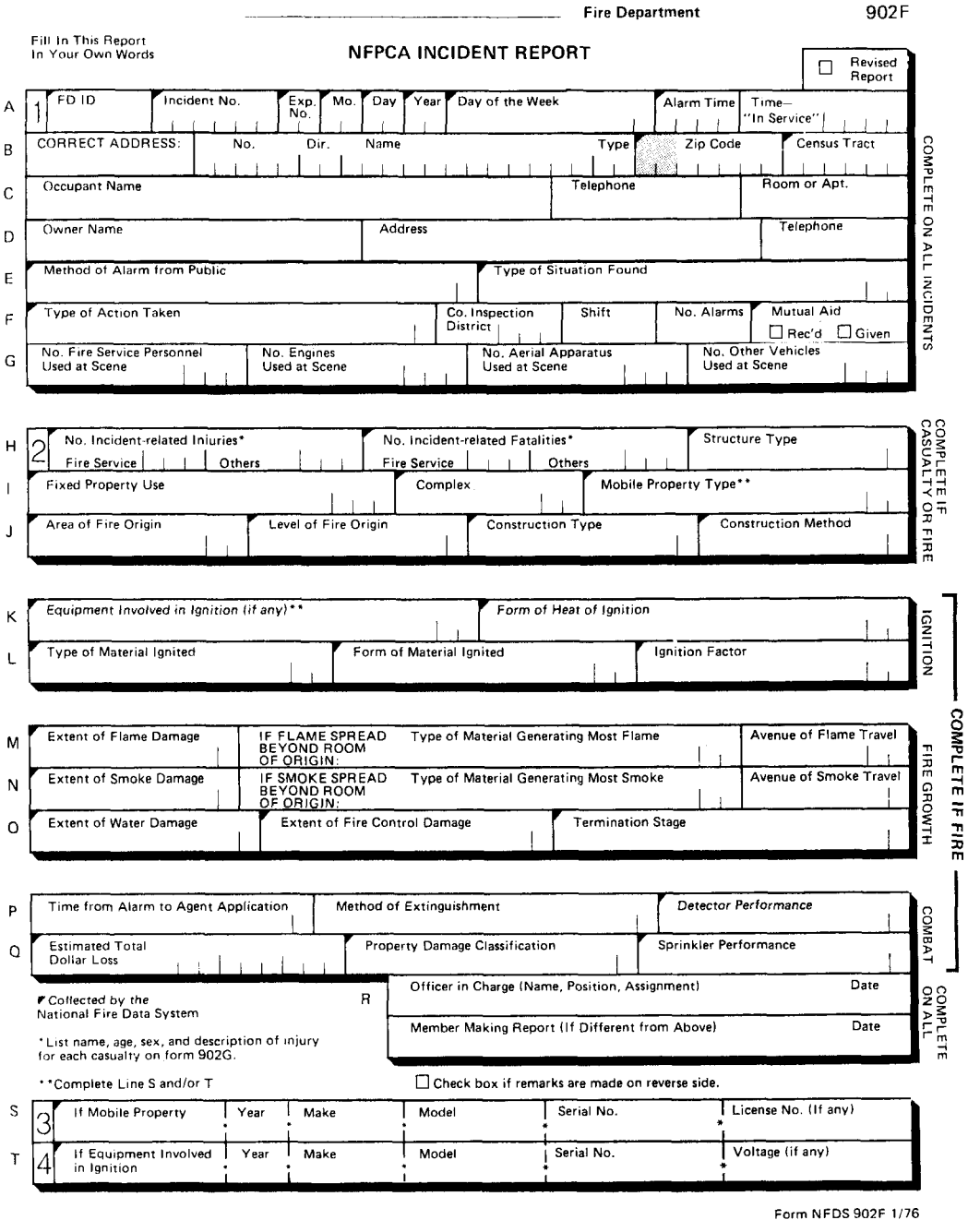

FIG. 4. NFPCA incident report.

need to keep the incident report simple and short, to minimize the effort needed to complete it, and the need to collect data on the many factors involved in fire, so as to help in the development of effective fire prevention and control programs. Only extensive experience with the system will demonstrate how close it is to optimum and

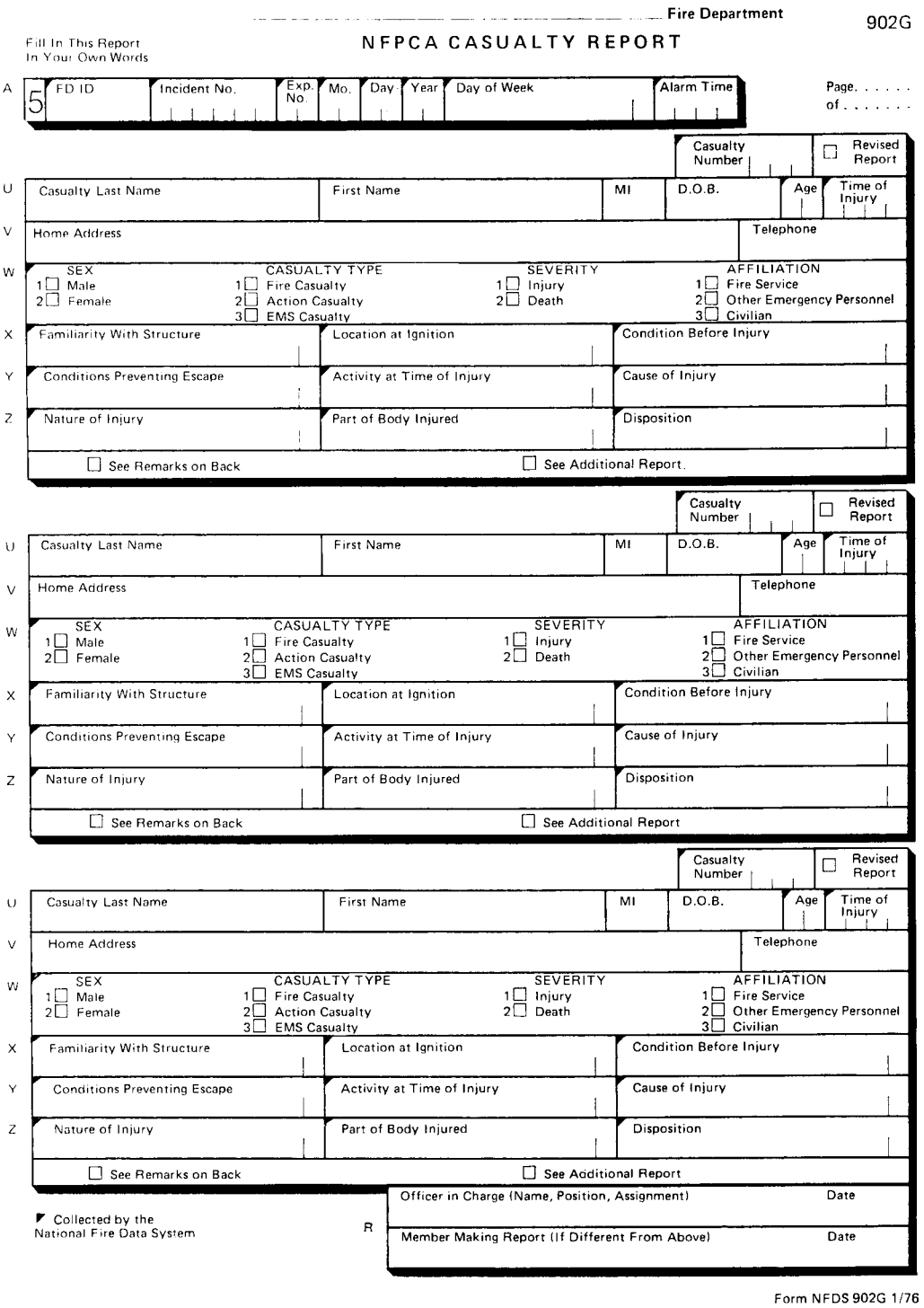

FIG. 5. NFPCA casualty report.

the degree of necessary modification. Results of the preliminary study indicate that most fire departments are making a conscientious effort to provide high-quality reports, and the coding error rate is relatively low. However, the data are quite incomplete and contain errors. For this reason, the tables presented below, which were prepared from preliminary, raw data in the NFIRS data bank early in 1977, must be considered only as illustrative of NFIRS' potential utility. The actual values given are subject to very substantial revisions and must not be presumed to be accurate.

Who, where, and when

The NFIRS fire incident reporting form is comprised of blocks of data elements (Fig. 4). The logic behind this arrangement is that particular incidents only require recording a certain set of facts. The first block on the form contains the minimal set of elements that is reported for even the simplest incident. They give the incident a unique ID, record the when, where, and who, and provide important information to fire department management, such as the number of fire service personnel, engines, aerial apparatus, and other vehicles used at the scene. However, NFIRS does not collect data on all these elements. Collecting names of occupants would be of little value for national-level analysis and could lead to problems under the Privacy Act (1974). NFIRS does, however, ask for zip codes and census tracts. Both of these constitute bridges that permit relating fire incident data to demographic and other data collected by the Bureau of the Census and other agencies and organized by census tract. This makes it possible to investigate the relationship between socioeconomic population factors and the fire problem. Such data are also helpful in estimating fire risk levels as distinguished from fire losses. Fire losses can be estimated from NFIRS data. However, to approximate fire risk levels, one must be familiar with the "population at risk" (e.g., number of fires in residential dwellings per thousand dwellings potentially subject to fire). Unfortunately, zip code and census tract are among the data elements that frequently are not recorded properly. This is partly because they are not known to individuals completing the forms, but also perhaps because their usefulness is not obvious. It is hoped that once meaningful analyses based on combining NFIRS and census tract data appear, this situation will change.

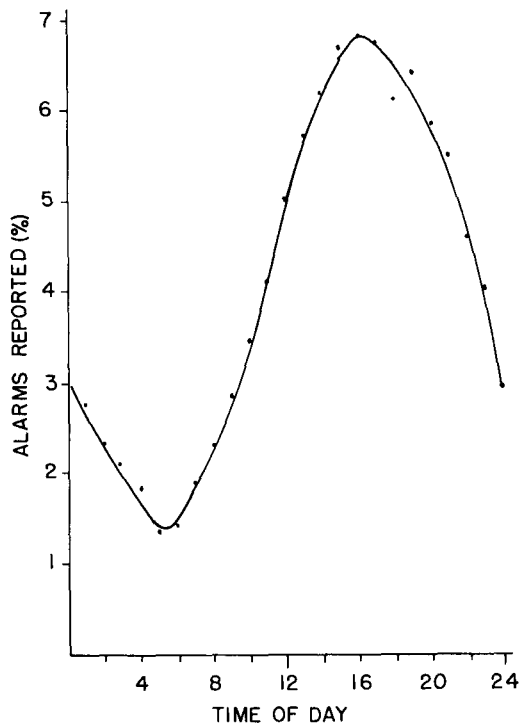

FIG. 6. Percentage of alarms reported by time of day.

The utility of other elements in the first block of the form is apparent. For example, plotting the number of incidents against the time of alarm or day of the week can indicate the existence of patterns that can be used to establish cost-effective staffing levels in fire stations. Data received from Ohio for 1976 show that the number of alarms is lowest at about 5:00 a.m., rises to a peak at the early afternoon, and then drops again (Fig. 6). The day of the week, on the other hand, seems to have no effect (Fig. 7).

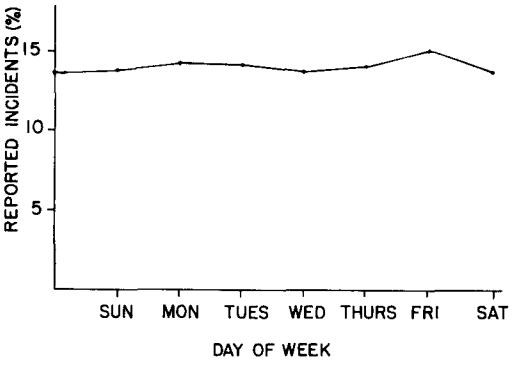

FIG. 7. Percentage of incidents by day of week.

Construction factors

The second block on the form deals largely with the place in which the fire occurred, such as structure type, fixed property use, construction type, and construction method. The following lists are from NFPA Standard 901 (NFPA 1976).

Ten different categories of structure type can be coded, and tabulating data by these categories makes it possible to identify their different characteristics:

Types of structure

1. Building with one fixed property use.
2. Building with two or more fixed property uses.
3. Open structure. Includes roofs with no wall, open steel framings, bridges, trestles, outdoor process equipment, and outdoor tanks.
4. Air-supported structure.
5. Tent.
6. Open platform. Includes piers, wharves, and loading docks.
7. Underground structure. Includes earth-covered structures, tunnels, and mines.
8. Not a structure.
9. Structure type not classified above.
0. Structure type undetermined or not reported.

For example, while fires in category 8 (not a structure) are generally more frequent, the dollar loss associated with category 1 (building with one fixed property use) is often higher. Such information makes it possible to focus prevention programs where they are most needed.

Fixed property use is the purpose for which the property is used or occupancy type:

Fixed property use

1. Public assembly property
2. Educational property
3. Institutional property
4. Residential property
5. Store, office property
6. Basic industry, utility, defense property
7. Manufacturing property
8. Storage property
9. Special property

Different occupancies are generally required to provide different levels of safety. For example, fire safety requirements for a nursing home may be much more severe that those for private residences. For this reason, fire data are frequently analyzed in terms of these categories. Comparisons of the fire experience of structures with different fixed property uses can be utilized in monitoring the effectiveness of codes and regulations and suggesting appropriate revisions.

Construction types are defined in terms of their combustibility, fire resistance, and stability under fire:

Types of construction

1. Fire resistive. Includes BBC Types 1A, 1B; SBC Type I; UBC Type I.
2. Heavy timber. Includes BBC Type 3A; SBC Type III; UBC Type III (HT).
3. Protected noncombustible or limited combustible. Includes BBC Type 2A, 2B; SBC Type II, IV (1 hr); UBC Type II, IV (1 hr).
4. Unprotected noncombustible or limited combustible not qualifying for 3. Includes BBC Type 2C; SBC Type IV; UBC Type IV (N).
5. Protected ordinary. Includes BBC

Type 3B; SBC Type V (1 hr); UBC Type III (1 hr).
6. Unprotected ordinary, not qualifying for 5. Includes BBC Type 3C: SBC Type V; UBC Type III (N).
7. Protected wood frame. Includes BBC Type 4A; SBC Type VI (1 hr); UBC Type V (1 hr).
8. Unprotected wood frame, not qualifying for 7. Includes BBC Type 4B; SBC Type VI; UBC Type V (N).
9. Type of construction not classified above.
0. Type of construction undetermined or not reported.

Each category is cross-referenced to several building codes used throughout the United States. For example, the NFIRS fire resistive category includes Basic Building Code (BBC) Type 1A and 1B; Standard Building Code (SBC) Type I; and Uniform Building Code (UBC) Type I. Thus, data collected by NFIRS can be used to investigate the relationship between construction type and actual fire loss experience, help identify improper or ineffective codes, and point out needed improvements. Using the 1976 Ohio data of 67,264 reported incidents and selecting only residential fires, it appears that unprotected wood frame construction by far had more fires than any other construction type (Table 1). These fires also show the highest cumulative dollar loss. This is not unexpected, since most single-family dwellings are wood construction. Of course, these data do not show fire rates. It is not known how many wooden buildings were in the reporting Ohio districts compared with the number of buildings of different construction types. Moreover, without data on rates, fire risks associated with different construction types cannot be established. However, it is not always necessary to deal with rates. A loss of over $20,000,000 may be considered sufficient to warrant special action even if the relative fire risk for these constructions was lower than that for another construction type.

There are four major categories of construction methods:

TABLE 1. *Number of residential fires and associated dollar losses by construction type*

Construction type	No. of Residential Fires	Dollar loss in thousands
Fire resistive	969	2,776
Heavy timber	194	1,439
Protected non-combustible	329	1,408
Unprotected non-combustible	329	955
Protected ordinary	2,669	8,337
Unprotected ordinary	1,997	8,432
Protected wood frame	3,468	12,163
Unprotected wood frame	5,749	20,300

Source: Ohio, 1/1/76 - 12/31/76. Based on preliminary data from a pilot test system and presented for illustrative purposes only; should not be presumed to be accurate.

Method of construction

1. Site-built structure
2. Factory-built, site-assembled
3. Factory-built, modular
4. Factory-built, mobile
9. Method of construction not classified above
0. Method of construction undetermined or not reported

NFIRS data on this element indicate that most losses are associated with site-built structures (Table 2). Again, this is not unexpected since such structures dominate the field. Without information on how many buildings constructed by different methods are "at risk," little can be said about the relative safety of these methods. Perhaps a special effort is indicated.

Ignition factors

The fourth block of data elements on the NFIRS form deals with causative factors of ignition. These factors are important be-

TABLE 2. *Number of residential fires and associated dollar losses by method of construction*

Method of Construction	No. of Fires	Dollar Loss in thousands
Site built structure	15,462	55,215
Factory built, site assembled	220	498
Factory built modular	77	490
Factory built mobile	601	4,097

Source: Ohio, 1/1/76 - 12/31/76. Based on preliminary data from a pilot test system and presented for illustrative purposes only; should not be presumed to be accurate.

cause it is more desirable to prevent fires than suppress them. Four major types of causal factors are listed because, from a technical viewpoint, fire does not have a single cause. The following information is required to know how the fire started: form of heat of ignition, type of material first ignited, form of material first ignited, and ignition factor.

The form of heat of ignition is the form of heat energy that ignited the fire (NFPA 1976):

Form of heat ignition

1. Heat from fuel-fired, fuel-powered object
2. Heat from electrical equipment arcing, overloaded
3. Heat from smoking material
4. Heat from open flame, spark
5. Heat from hot object
6. Heat from explosives, fireworks
7. Heat from natural source
8. Heat spreading from another hostile fire (exposure)
9. Other form of heat ignition

The type of material first ignited is classified like other data elements on the fire incident reporting form into categories selected by the NFPA 901 Committee:

Type of material first ignited

1. Gas
2. Flammable, combustible liquid
3. Volatile solid, chemical
4. Plastic
5. Natural product
6. Wood, paper
7. Fabric, textile, fur
8. Material compounded with oil
9. Other type of material ignited

However, these categories may not be optimal for a particular field of technology or particular industry, especially where a major category, such as "wood, paper," is further subdivided into "growing wood" or "felled but unsawed wood," etc.:

Wood, paper

61. Growing wood.
62. Felled but unsawed wood.
63. Sawn wood. Includes all finished lumber.
64. Wood shavings. Includes sawdust and excelsior.
65. Hardboard, plywood.
66. Fiberboard, wood pulp. Includes wood fiberboard products.
67. Paper, untreated, uncoated.
68. Cardboard.
69. Wood, paper not classified above.
60. Wood, paper; insufficient information to classify above.

These breakdowns may be unrealistic. For example, they may group together materials that do not have similar burning characteristics. If this is true for wood and lumber, the NFPA 901 Committee should be notified (NFPA, 470 Atlantic Ave., Boston, MA 02110). To be most effective, a well-documented recommendation for changes should be submitted. Since the NFPA is a consensus organization, proposed revisions are reviewed on several levels. However, well-justified changes can be adopted without excessive delay. The revision of the breakdown for plastics, for example, took only a couple of years, and is now quite rational and reasonably current:

Plastic

41. Polyurethane
42. Polystyrene
43. Polyvinyl
44. Polyacrylic
45. Polyester
46. Polyolefin
49. Plastic not classified above
40. Plastic; insufficient information to classify

NFIRS data reported for 1976 residential fires in Ohio indicate that the sawn wood category (which includes all finished lumber) is the single most frequently first-ignited type of material, with nearly 3,000 incidents (Table 3). Second are finished cellulosic textiles with over 2,500 incidents, followed by food fat and grease with about 1,700, and synthetic textile products with about 1,300 incidents. None of the other coded categories of materials first ignited had more than 1,000 incidents. This is not consistent with the findings of the National Household Survey, which placed fat and grease first (Nat. Fire Prev. Cont. Admin. 1975). However, the Household Survey included numerous minor incidents that were not attended by fire departments and would not be included in the NFIRS data. It should also be pointed out that the data element on the reporting form reads "type of material ignited," not "type of material first ignited." This may have led to miscoding. Dollar losses generally followed the same pattern, with those ascribed to fires in which sawn wood was first ignited leading with $18,000,000. Cellulosic fabrics placed second with $5,000,000; synthetic fabrics third with $4,000,000; gasoline fires fourth, and hardboard/plywood fifth.

The fourth NFIRS causal factor, form of material first ignited, defines shapes and uses of ignited materials:

Form of material first ignited

1. Structural component, finish
2. Furniture
3. Soft goods, wearing apparel
4. Adornment, recreational material

TABLE 3. *Number of residential fires and associated dollar losses by type of material first ignited*

Type of Material First Ignited	No. of Fires	Dollar Loss in thousands
Sawn wood	2,969	18,238
Cotton, rayon, cotton fabric finished goods	2,637	5,048
Fat, grease (Food)	1,723	2,107
Man-made fiber	1,276	4,196
Gasoline	445	2,389
Hardboard, plywood	308	2,364

Source: Ohio, 1/1/76 - 12/31/76. Based on preliminary data from a pilot test system and presented for illustrative purposes only; should not be presumed to be accurate.

5. Supplies, stock
6. Power transfer equipment, fuel
7. General form
8. Special form
9. Other form of material

Of the seven major categories in this class of special interest to wood technologists, those which deal with structural components, furniture, and general form are significant:

Structural component, finish

11. Exterior roof covering, surface, finish
12. Exterior sidewall covering, surface, finish
13. Exterior trim, appurtenances. Includes doors, porches, platforms
14. Floor covering, surface
15. Interior wall covering. Excludes curtains and draperies
16. Ceiling covering, surface
17. Structural member, framing
18. Thermal, acoustical insulation within wall, partition, or floor/ceiling space
19. Structural component, finish not classified above
20. Structural component, finish; insufficient information to classify further

TABLE 4. *Number of residential fires and associated dollar losses by form of material first ignited*

TABLE

NUMBER OF RESIDENTIAL FIRES AND ASSOCIATED DOLLAR LOSS BY FORM OF MATERIAL FIRST IGNITED

Form of Material First Ignited	No. of Fires	Dollar Loss in thousands
Cooking materials	1,898	1,912
Structural member	1,641	11,957
Mattress/pillow	1,553	2,187
Upholstered furniture	1,310	4,663
Rubbish	994	1,310
Electrical wire	964	1,439
Interior wall	950	6,400
Wearing apparel	691	1,925
Bedding/blanket	610	1,634
Floor covering	561	2,735

Source: Ohio, 1/1/76 - 12/31/76. Based on preliminary data from a pilot test system and presented for illustrative purposes only; should not be presumed to be accurate.

Furniture

(Includes built-in furniture)

21. Upholstered sofa, chair, vehicle seats
22. Nonupholstered chair, bench
23. Cabinetry
24. Ironing board
25. Appliance housing or casing
29. Furniture not classified above
30. Furniture; insufficient information to classify further

General

71. Agricultural product
72. Fence, pole
73. Fertilizer
74. Growing, living form
75. Rubbish, trash, waste
76. Cooking materials
77. Sign

Again, these categories have been developed by the NFPA Committee, and while they reflect its best judgment they may not be optimal. The wood industry's recommendations for changes are welcome and will receive full consideration.

Subjecting the 1976 Ohio data to the analytical procedure used previously shows that cooking materials rank first among the various categories of form of material first ignited, with some 1,900 fires (Table 4). Structural members rank second, with over 1,600; mattresses/pillow third, with less than 1,600; and upholstered furniture fourth with about 1,300 fires. No other category exceeds 1,000 fires.

While fires in which cooking materials were first ignited ranked first in frequency, they ranked ninth in dollar loss with about $2,000,000. Structural member fires, second in frequency, had the highest loss, about $12,000,000; mattresses/pillow fires, third in frequency, were fifth in dollar loss with about $2,000,000, and upholstered furniture, fourth in frequency, was third in dollar loss. The second highest fire loss, $6,400,000, was associated with fires where interior walls were first to ignite, and floor covering was fourth highest with $2,700,000. In terms of frequency, these fires rank seventh and tenth, respectively.

When defining a fire hazard, it is often desirable to consider at least two fire factors as a single unit (Auerbach Assoc. 1975). Various products made from the same material can differ widely in both fire characteristics and fire properties. For this reason, it makes more sense to think of the hazard presented by a wooden roof, rather than by wood or roofs in general. The simplest analytical tool used to carry out this idea is the crosstab, as illustrated in Table 5. There are only 9 combinations of "form of material first ignited/type of material first ignited" that are associated with more than 1% of all fires. The largest combination is "power transfer equipment/flammable liquid" with 8.7%, and "structural component/wood" is second with 7.9%. Breaking down the latter category into its components (Table 6) illustrates that the only two combinations exceeding

TABLE 5. *Form of material first ignited by type of material ignited*

Form of Material Ignited		Type of Material Ignited											
			Gas	Flamm Liquid	Volatile Solid	Plastic	Natural Product	Wood/ Paper	Fabric Textile	Oil Compounds	Other		
		0	10	20	30	40	50	60	70	80	90	Blank	TOTAL
Unknown	0	67	5	2	5	2	2	10	5	2	0	13	113
		0.10	0.01	0.00	0.01	0.00	0.00	0.02	0.01	0.00	0.00	0.02	0.17
Struct Comp/Finish	10	5	190	457	254	199	196	5315	408	149	54	162	7389
		0.01	0.28	0.68	0.38	0.30	0.29	7.90	0.61	0.22	0.08	0.24	10.99
Furniture	20	1	26	321	59	245	394	383	2833	6	19	101	4388
		0.00	0.04	0.48	0.09	0.36	0.59	0.57	4.21	0.01	0.03	0.15	6.52
Soft Goods/Wearing App	30	1	17	65	68	50	280	65	3516	21	18	53	4154
		0.00	0.03	0.10	0.10	0.07	0.42	0.10	5.23	0.03	0.03	0.08	6.18
Adorn/Rec Material	40	0	6	14	11	64	25	537	52	41	14	7	771
		0.00	0.01	0.02	0.02	0.10	0.04	0.80	0.08	0.06	0.02	0.01	1.15
Supplies/Stock	50	2	6	69	24	72	165	641	93	30	12	34	1148
		0.00	0.01	0.10	0.04	0.11	0.25	0.95	0.14	0.05	0.02	0.05	1.71
Power Tran Equipt/Fuel	60	1	157	5866	127	1112	2294	180	113	35	128	126	10139
		0.00	0.23	8.72	0.19	1.65	3.41	0.27	0.17	0.05	0.19	0.19	15.07
General Form	70	2	26	82	1704	74	2305	2417	135	41	641	257	7684
		0.00	0.04	0.12	2.53	0.11	3.43	3.59	0.20	0.06	0.95	0.38	11.42
Special Form	80	1	229	903	54	61	65	88	111	17	141	39	1709
		0.00	0.34	1.34	0.08	0.09	0.10	0.13	0.17	0.03	0.21	0.06	2.54
Other Form of Material	90	0	19	204	136	211	79	143	61	26	119	19	1017
		0.00	0.03	0.30	0.20	0.31	0.12	0.21	0.09	0.04	0.18	0.03	1.51
Blank		15	62	267	66	79	97	247	76	17	97	27729	28752
		0.02	0.09	0.40	0.10	0.12	0.14	0.37	0.11	0.03	0.14	41.22	42.75
TOTAL		95	743	8250	2508	2169	5902	10026	7403	385	1243	28540	67264
		0.14	1.11	12.27	3.73	3.23	8.77	14.91	11.01	0.57	1.85	42.43	100.00

Source: Ohio, 1/1/76-12/31/76. Based on preliminary data from a pilot test system and presented for illustrative purposes only; should not be presumed to be accurate.

1% of the total are "structural member/sawn wood," with 3.1% and "sidewall covering/sawn wood," with 1.1%. Wooden structural members and wooden sidewall coverings appear to be appropriate targets for improvement. Of course, factors other than frequency of occurrence, such as population at risk, must be considered before a remedial effort is undertaken. However, ranking by frequency based on NFIRS data can provide an initial target list.

The final causal factor, ignition, is the act or absence of an act which results in the heat of ignition igniting the first material:

Ignition factor

1. Incendiary
2. Suspicious
3. Misuse of heat of ignition
4. Misuse of material ignited
5. Mechanical failure, malfunction
6. Design, construction, installation deficiency
7. Operational deficiency
8. Natural condition
9. Other ignition factor

One example of an ignition factor is arson, which is a deliberate criminal act. While the incidence of arson is increasing rapidly, the most important ignition factor in terms of loss of life is not action but inaction; leaving smoking material unattended. The Ohio data indicate that the "misuse of heat of ignition" category, which includes discarded smoking materials, ranks first in frequency for fires in which wood/paper is the first-ignited material (Table 7).

Fire scenarios

Another analytical technique used in ranking fire hazards and in evaluating different intervention strategies is the "fire scenario" (Clark and Ottoson 1976). A fire

TABLE 6. *Form of material first ignited by type of material ignited*

Form of Material Ignited		60	Growing Wood 61	Unsawn Wood 62	Sawn Wood 63	Wood Shavings 64	Hardboard and Plywood 65	Fiber-board and Wood Pulp 66	Paper 67	Card-board 68	Other 69	Blank	Total
Struct Comp/Finish, Unc	10	21	1	2	93	0	4	2	2	0	2	21	148
		0.03	0.00	0.00	0.14	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.22
Roof Covering	11	5	3	2	222	3	3	3	2	4	8	10	265
		0.01	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.39
Sidewall Covering	12	12	5	1	744	1	23	16	6	6	15	10	839
		0.02	0.01	0.00	1.11	0.00	0.03	0.02	0.01	0.01	0.02	0.02	1.25
Exterior Trim	13	3	0	3	171	0	5	2	4	0	4	5	197
		0.00	0.00	0.00	0.25	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.29
Floor Covering	14	7	0	1	271	5	23	0	7	3	13	17	347
		0.01	0.00	0.00	0.40	0.01	0.03	0.00	0.01	0.00	0.02	0.03	0.52
Interior Wall Covering	15	25	5	5	516	3	158	52	25	8	34	39	870
		0.04	0.01	0.01	0.77	0.00	0.24	0.08	0.04	0.01	0.05	0.06	1.29
Ceiling Covering	16	1	1	3	54	2	21	47	3	5	3	7	147
		0.00	0.00	0.00	0.08	0.00	0.03	0.07	0.00	0.01	0.00	0.01	0.22
Structural Member	17	44	10	17	2094	3	81	17	19	6	41	36	2368
		0.07	0.02	0.03	3.11	0.00	0.12	0.03	0.03	0.01	0.06	0.05	3.52
Insulation	18	6	2	2	38	3	14	46	18	4	17	13	163
		0.01	0.00	0.00	0.06	0.00	0.02	0.07	0.03	0.01	0.03	0.02	0.24
Struct Comp/Finish, Other	19	3	0	2	96	2	13	3	2	1	7	4	133
		0.00	0.00	0.00	0.14	0.00	0.02	0.00	0.00	0.00	0.01	0.01	0.20
Blank		39	8	7	72	2	6	7	70	9	27	27729	27976
		0.06	0.01	0.01	0.11	0.00	0.01	0.01	0.10	0.01	0.04	41.22	41.59
TOTAL		166	35	45	4371	24	351	195	158	46	171	27891	33453
		0.25	0.05	0.07	6.50	0.04	0.52	0.29	0.24	0.07	0.25	41.47	49.73

Source: Ohio, 1/1/76-12/31/76. Based on preliminary data from a pilot test system and presented for illustrative purposes only; should not be presumed to be accurate.

scenario describes the chain of events leading up to the fire. In the scenarios prepared at the Data Center, the following attributes or characteristics of a fire are used:

1. Fixed property use
2. Time of day
3. Form of material of ignition
4. Type of material ignited
5. Form of material ignited
6. Ignition factor.

The Data Center has developed computer programs that query NFIRS data for combinations of these factors and print out those occurring most frequently. Such a printout, derived from the 1976 Ohio data in the data base, is shown in Table 8. It illustrates that the most frequent scenario for residential fires is a cigarette left burning on a sofa while the smoker falls asleep. This scenario, incidentally, is believed to be responsible for over 50% of all deaths resulting from residential fires. However, Table 8, like all tables in this paper, is based on preliminary data from a pilot test system and is presented for illustrative purposes only. It should not be assumed to be accurate.

Once the most frequent fire scenarios are identified, the next step is to develop the most cost-effective intervention strategies. This is a difficult process. Currently there is much controversy, for example, about one proposed strategy: a mandatory flammability standard for upholstered furniture (Prod. Safety Letter 1977). The major problem is the lack of accurate, valid data necessary to compare results of alternative strategies. In spite of these difficulties, however, the fire scenario technique is a promising tool for planning fire prevention and control programs. As NFIRS expands and the accuracy of its data improves, it will provide some of the necessary data.

TABLE 7. *First-ignited wood/paper materials by ignition factor*

TABLE

FIRST IGNITED WOOD/PAPER MATERIALS BY IGNITION FACTOR

Ignition factor	No. of Fires
Incendiary	1,665
Suspicious	1,706
Misuse of heat of ignition	2,866
Misuse of material ignited	696
Mechanical failure, malfunction	1,962
Deficient design, construction	1,062
Operational deficiency	499
Natural condition	292
Other ignition factor	171

Source: Ohio, 1/1/76 - 12/31/76. Based on preliminary data from a pilot test system and presented for illustrative purposes only; should not be presumed to be accurate.

The NFIRS Report Catalog

In principle, any and all data elements in NFIRS can be cross-tabulated with one another. Therefore, an almost infinite number of output reports is possible. For this reason, the National Fire Data Center has prepared a "catalog" of potential NFIRS output reports. The catalog consists of several hundred tables believed most likely to be useful for feedback reports to local fire departments, state fire jurisdictions, and nationally. Currently, this catalog is undergoing extensive reviews by working fire service officials as well as others and will soon be available for a limited field trial. When completed, it will be made available free to participating jurisdictions together with the software necessary to generate the reports by computer. Hopefully, the catalog will be accessible to others having an interest in the fire problem, including members of interested scientific and technical groups, such as the Society of Wood Science and Technology.

THE NATIONAL FIRE DATA SYSTEM

Although NFIRS is expected to provide data that are statistically representative of the national fire experience and to aid in the identification and ranking of major fire hazards, it was not designed to satisfy all fire data needs. The National Fire Data Center is developing several other data systems to supplement NFIRS and together constitute a comprehensive National Fire Data System. Thus, since NFIRS is limited by design to fire incidents attended by the fire service, household surveys will be conducted periodically. The National Fire Data System is expected to include or establish regular access to other relevant data

TABLE 8. *Scenario report on number of incidents for major fixed property use: residential*

Time	Form of Heat Ignition	Type of Material Ignited	Form of Material Ignited	Ignition Factor	Total Incidents	%
Night	Smoking Material	Fabric/Textile/Furniture	Soft Goods/Wearing Apparel	Misuse of Heat Ign	587	3.39
Day	Open Flame, Spark	Fabric/Textile/Furniture	Soft Goods/Wearing Apparel	Misuse of Heat Ign	396	2.28
Night	Smoking Material	Fabric/Textile/Furniture	Furniture	Misure of Heat Ign	393	2.26
Night	Electric Equipment Arcing	Wood,Paper	Structural Comp/Finish	Mech Failure/Malfunc	360	2.07
Night	Hot Object	Volatile Solid/Chemical	General Form	Operational Def	352	2.03
Day	Hot Object	Volatile Solid/Chemical	General Form	Operational Def	285	1.64
Night	Open Flame, Spark	Fabric/Textile/Furniture	Soft Goods/Wearing Apparel	Misuse of Heat Ign	279	1.61
Night	Unknown			Unknown	277	1.59
Day	Smoking Material	Fabric/Textile/Furniture	Soft Goods/Wearing Apparel	Misuse of Heat Ign	266	1.53
Day	Electric Equipment Arcing	Wood, Paper	Structural Comp/Finish	Mech Failure/Malfunc	239	1.38
				Scenario Total	3,434	19.83
				Overall Total	17,314	

Source: Ohio, 1/1/76-12/31/76. Based on preliminary data from a pilot test system and presented for illustrative purposes only; should not be presumed to be accurate.

bases, such as the insurance industry, the National Center for Health Statistics, the Consumer Product Safety Commission, and the Bureau of the Census. A modest effort to develop an international fire data system, which would permit comparisons of fire experience across national boundaries, is also underway (Tovey 1976). In addition, since NFIRS was not designed to provide detailed, exhaustive information necessary for suggesting possible solutions to fire hazard problems, the Data Center is implementing a network of in-depth investigations of specific classes of fires to be conducted on a contract basis by well-trained investigators all over the country. This effort is coordinated with a related program conducted at the Center for Fire Research of the National Bureau of Standards.

The NFPCA legislative mandate specifies that the Data Center provide an accurate analysis of the national fire problem, identify major problem areas, assist in setting priorities, determine possible solutions to problems, and monitor the progress of programs to reduce fire loss. This is a difficult task, but the Fire Administration and its Data Center are on their way to accomplishing it.

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