IIT RESEARCH INSTITUTE
Technology Center
Chicago, Illinois 60616

FIRE DEPARTMENT OPERATIONS ANALYSIS

FINAL REPORT

by

Willis G. Labes

January, 1968

Prepared for
Office of Civil Defense
Office of the Secretary of the Army
Washington, D. C. 20310
under
Work Unit 2522F
through the
U. S. Naval Radiological Defense Laboratory
San Francisco, California 94135
Contract No. N0022867C0701

OCD REVIEW NOTICE

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NRDL-TRC-68-26
IITRI Project J6105

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FOREWORD

This is a final report on Contract No. N00228-67-C-0701, Task Order Number 64-200(40), OCD Work Unit 2522F, (IITRI Project No. J6105), "Fire Department Operations Analysis". The program is sponsored by the Department of the Army, Office of the Secretary of the Army, Office of Civil Defense through the U. S. Naval Radiological Defense Laboratory.

The contribution of the following consultants, who compiled the reports on all of the fires, is gratefully acknowledged: Division Marshall Joseph T. Deichman, Chicago Fire Department; Chief Frederick Richter, Batavia, Illinois Fire Department; and Mr. Lawrence Smith, Fire Protection Engineer. Also, the assistance of Thomas E. Waterman and Frederick Salzberg in the planning and execution of the data analysis is acknowledged.

This report covers the period from October 27, 1966, to January 30, 1968.

Respectfully submitted,

IIT RESEARCH INSTITUTE

Willis C. Labes
Research Engineer

APPROVED:

W. J. Christian, Manager
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ABSTRACT

This is a final report of a study designed to evaluate public fire fighting operations. Information is developed on how fire fighting operations are performed under a variety of field conditions. The primary body of data consists of information extracted from reports on one hundred thirty-four (134) fires. Useful correlations between the following parameters are presented:

1. Water Application Rate Density for Control vs Fire Area
2. Water Application Rate for Control vs Fire Area
3. Quantity of Water Used for Control vs Fire Area
4. Fire Control Time vs Fire Area
5. Man-Hours Expended for the Complete Fire Fighting Operation:
   a. Rescue Through Extinguishment
   b. Salvage and Overhaul vs Fire Area

In this case, the fire area represents the maximum floor area of the space involved in the fire.

An application of these correlations to the fire suppression effort at the time of a nuclear emergency is presented.

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I. INTRODUCTION

A. Background

Studies of fire department operations were conducted as part of OCD-OS-62-210, "An Approach to Trans-Attack Fire Suppression in Urban Areas".[1] Twenty-seven (27) fires were investigated.

Fire department operational research studies were conducted, and an interim technical report was issued on Contract No. N228(62479) 69031, Task Order Number 64-200(40), OCD Work Unit 2522F, "Fire Department Operations Analysis".[2] The interim report covered the first year of a two-year study; analysis of the results and conclusions were drawn from data on 73 fires.

B. Scope

This present work is an extension of the previously conducted fire department operational studies. Sixty-one (61) fire reports have been compiled and analyzed during the present study, including the collection of more complete information on the use of manpower during fire fighting operations. This report includes the data on 61 fires from this work, as well as the data on 73 fires from the previous studies; analysis of the results and conclusions are drawn from the entire body of data on 134 fires.

C. Objectives

Data taken from the fire reports permits an evaluation of fire fighting operations as carried on in the field; these data provide information on fire fighting operations performed under a variety of field conditions. This body of data, together with its various trends and correlations, has been studied with a view toward developing greater efficiency in the use of water for fire control and extinguishment, and in the use of manpower and equipment at the time of a nuclear emergency.

D. The Type of Fire Report

The report submitted on each fire included in this analysis provides a relatively complete time history of the fire from ignition (where possible to estimate) to the beginning of fire fighting operations, through control to final extinguishment and overhaul. Individual fire reports were prepared by two professional fire department chief officers, and one fire protection engineer who gathered information through actual observations at the fire scene, and subsequent interviews with the fire department officers involved in suppressing the fires. An attempt was made to obtain a good cross-section of fire operations by choosing various types of occupancy, sizes of city, types of construction and magnitude of the fires

II. DISCUSSION

A. Building Fires

Within a building, a fire which is small compared to the size of its immediate enclosure behaves very much like an unconfined fire, in that is has ample air supply and space above to dissipate heat and fire gases; the burning rate is fuel surface controlled, and the fire spreads to involve fuel nearby as a result of heat transfer by thermal radiation and convection. As the fire increases in size, the fire behavior tends to shift toward that of a confined fire.

In a compartmented enclosure, flashover eventually occurs in the compartment of origin; fire spread to adjoining spaces occurs by barrier penetration and by flow of fire gases through openings in walls and floors. From experimental full-scale building burns (3) it has been found that the spread of fire through a building divided into various interconnecting spaces can be described as a succession of predictable flashovers according to an equation of the form

$$V_T/V_o = \exp(T/m) \qquad (1)$$

where T is the time after the first flashover, V_T is the flashover building volume at time T, V_o is the initial flashover building volume at time T = 0, and m is a time constant. For building areas of the same story height, Eq. 1 can be rewritten using floor areas, as follows:

$$A_T/A_o = \exp(T/m) \qquad (2)$$

where A_T is the flashover building floor area at time T, and A_o is the initial flashover building floor area.

The fire time history curves shown in Fig. 1 are presented as an aid to the qualitative description of data

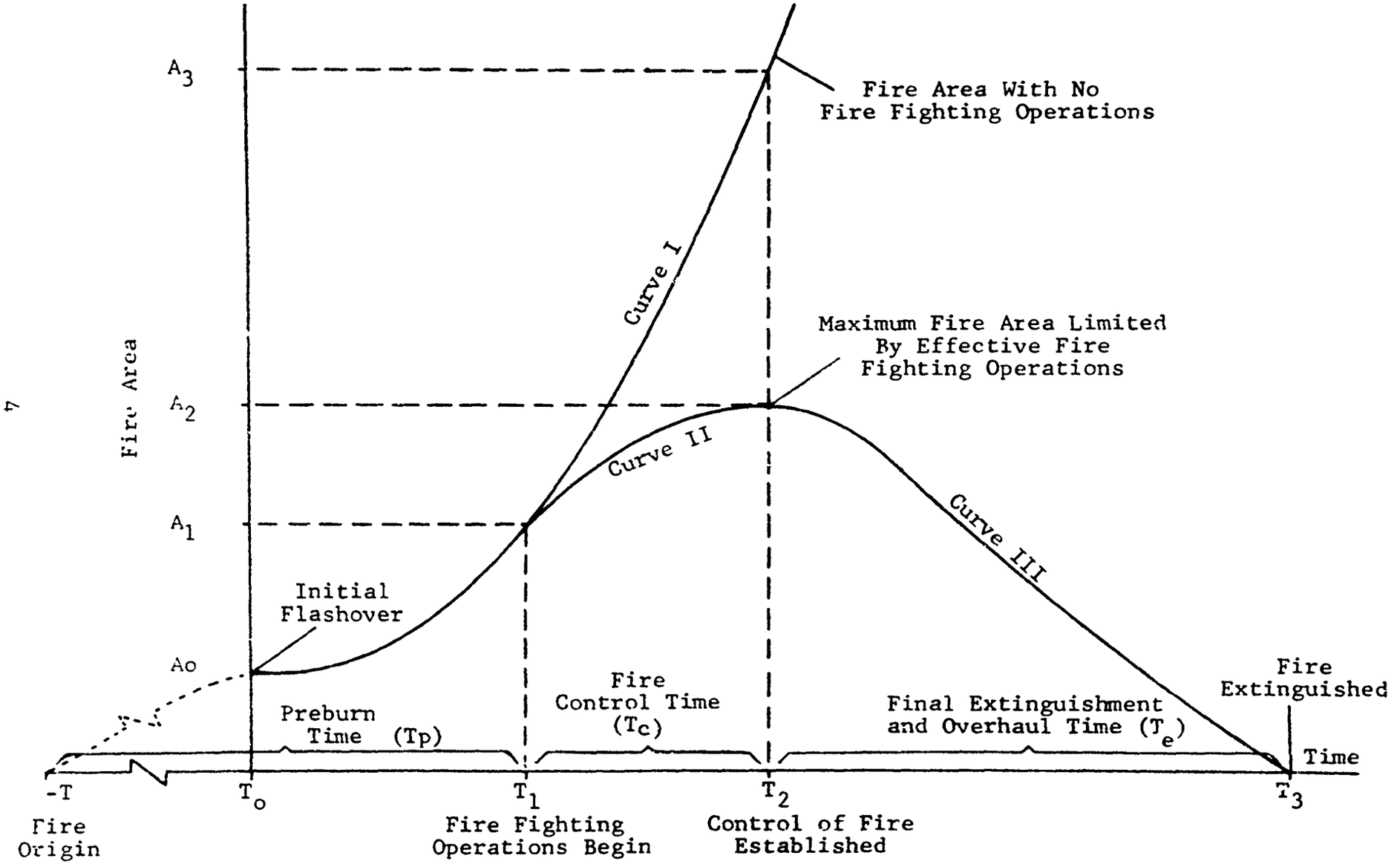

FIG. 1 FIRE TIME-HISTORY CURVES

extracted from the fire reports. Curve I is a fire growth curve according to which the fire area increases with time after the initial flashover in a building. At some time (T_1) after the initial flashover (T_o) the first fire fighting unit arrives and begins to work. During this time the fire area has increased according to Curve I from an initial flashover area (A_o) to an area (A_1). The origin of the fire occurred at some time prior to the flashover at time (T_o). The fire preburn time (T_p) is the time from the origin of the fire until the time (T_1) when fire fighting operations begin.

Curve II represents the fire growth curve after fire fighting operations have begun. While the form of the equation for this curve has not been determined, Fig. 1 indicates that the fire area increases to a value (A_2) at time (T_2) when control of the fire has been established. While no data is presented herein to clarify this point, for most fires it is believed the fire size changes relatively little after fire fighting operations begin; that is, the value of (A_2) is not much larger than (A_1). "Control" describes the state where the major flames have been subdued, and the fire no longer is increasing in size. Therefore, the fire area (A_2) represents the maximum area attained by the fire and the time interval ($T_2 - T_1$) represents the fire control time (T_c). It is of interest to note that the fire area (A_3) on Curve I at time (T_2) represents the projected fire size which would have occurred with no fire fighting operations.

Curve III represents the fire degradation curve, with the extinction time (T_3) representing the time at which the complete suppression of all residual flames occurs. The time interval ($T_3 - T_2$), therefore, represents the final extinguishment and overhaul time (T_e).

B. Fire Reports

The outline of desired information used in preparation of the fire reports is reproduced in Appendix A. Also

shown there is a sample report submitted for one of the fires.

Each fire report accurately indicated the time (T_1) at which fire fighting operations began, but in most cases the fire area (A_1) was not known. In some cases, the time and location of the origin of the fire was known and reported; most often an estimate was made of the burning time prior to arrival of the first fire fighting unit. This estimate is used as a basis for stating either a preburn time or a minimum time that the fire was thought to be burning. The maximum fire area (A_2) and the extent of damage was usually carefully outlined in the fire report; the report included sketches of the building to scale, with the damaged area clearly marked. The officer-in-charge of the fire fighting operations noted the time (T_2) at which control was established (according to his judgment) and the time (T_3) when final extinguishment was completed; from this information the fire control time (T_c) and the final extinguishment and overhaul time (T_e) were determined and recorded. Sufficient information on hose streams was included in each fire report for calculation of the water used for control, and the water used for final extinguishment and overhaul. The total fire department response to the initial alarm and subsequent alarms, plus mutual aid, together with the use of manpower during the operations, was provided in the report and tabulated in the results.

The apparatus and manpower responding to any given alarm depends upon the type of fire department organization serving the area, upon the type of alarm (a still alarm or municipal fire alarm box), and upon the area from which the alarm originates. A typical large city running card for responses to structural fires is shown in Table I. The fire alarm response in a city of 8,000 population and the rural area in its fire district is given in Table II. The contrast between these two responses to fire alarms is quite apparent. The use of manpower on the fire ground is another important difference between the large city fully-paid department and

TABLE I

FIRE ALARM RESPONSE IN A LARGE CITY

Type of Apparatus	Manpower Per Unit	Telephone (Still) Alarm				Box Alarm											
		High Value Districts		Other Districts (Includes) (Residential)		All Districts										Special Alarms	
						Initial Alarm		2nd Alarm		3rd Alarm		4th Alarm		5th Alarm			
		No. of App.	No. of Men	No. of App.	No. of Men	No. of App.	No. of Men	No. of App.	No. of Men	No. of App.	No. of Men	No. of App.	No. of Men	No. of App.	No. of Men	No. of App.	No. of Men
Engine Company (E)	5	3	15	2	10	4	20	4	20	4	20	4	20	4	20	As Requested By Officer-in-Charge	Varies According To Apparatus Request
Ladder Company (L)	5	2	10	1	5	2	10	2	10	1	5						
Squad Company (S)	5	1	5	1	5	1	5	1	5	1	5						
				OR	OR												
Snorkel Squad Company (Sn Sq)	9	1	9	1	9	1	9	2	18								
Snorkel Company Sn	3					1	3										
Battalion Chief	2	1	2	1	2	2	4	2	4								
Division Marshal	2					1	2										
Deputy Fire Marshal	2							1	2								
Chief Fire Marshal	2									1	2						
Apparatus and Manpower Response		8	41	5	22 or 26	12	53	12	59	7	32	4	20	4	20		
Cumulative Apparatus & Manpower Response						12	53	24	112	31	144	35	164	39	184		

TABLE II

FIRE ALARM RESPONSE IN A SMALL CITY AND ITS RURAL AREA

FIRE DISTRICT INFORMATION

Land Area In Fire District - 36 square miles

Population - Within City - 8,000 people
- Within Entire Fire District - 12,000 people

Fire Department Manpower - Four paid men
- Twenty-one volunteers on call

Alarms received by telephone

STRUCTURAL FIRE IN A HIGH VALUE DISTRICT

Order Of Response	Apparatus	Manpower
Initial alarm	3 Engines 1 Ladder Truck 1 Emergency Truck	Entire department of 25 men responds
First call for help from nearby town	1 Engine 1 Ladder Truck	10 men respond
Additional calls for help from each of 3 nearby towns	1 Engine	5 men respond

STRUCTURAL FIRE IN A RURAL AREA OF THE DISTRICT

Initial alarm	2 Engines 1 Emergency Truck	One-half of department (12-men) responds

the volunteer department. In the former, companies are given assignments as units, while in the latter individual or small group assignments are usually made without regard to companies.

III. RESULTS

A. Primary Body of Data

The body of data extracted from reports on one hundred thirty-four (134) fires is assembled in Table B-I of Appendix B. Data on 61 of these fires were obtained from fire reports submitted during this project; data on the remaining seventy-three (73) fires were given in a report on previous work[1,2]. Information on the use of manpower during fire fighting operations was not obtained in one of the previous studies[1]. All data in Table B-I have been arranged in order of ascending building area involved by fire, (referred to as the "fire area"). Consecutive fire numbers have been assigned according to this listing. A brief remark about each fire is given in a list following Table B-I in Appendix B. Also included in Appendix B is a list of notes on the preparation of the data for Table B-I. These notes describe the meaning of the values listed in the respective columns of the table. A list of the symbols used in Table B-I is also given in Appendix B.

The one hundred thirty-four (134) fires listed in Table B-I are distributed in the following occupancy classes:

Residential	63
Hotel	5
Mercantile	14
Mercantile and Residential	14
Business, Mercantile and Business, or Business and Residential	8
Industrial	18
Storage	5
Lumberyard	2
Assembly or Assembly and Residential	3
Farm Buildings	2

B. Data Analysis

For the purpose of analysis and correlation, the data have been divided into two groups. One group consists of 64 fires which occurred in buildings with residential occupancies, including four of the five hotels. The other group consists of 63 fires which occurred in buildings housing other than residential occupancies, and is referred to as non-residential. Fires No. 110, 119, 120, 123, 126, 133 and 134 were excluded because their fire areas were too large to be classified within their respective groups; No. 126 provided insufficient data to be useful.

The group of 64 residential fires was divided into ten classes of fire area, as shown in Table III, this table also includes other data, such as the class mark, average fire area within each class, frequencies of fire areas, application rate density for control, application rate for control, quantity of water used for control and the control time. Similarly, the data for the 63 non-residential fires, divided into fifteen classes of fire area, are shown in Table IV.

The frequency distributions of fire area for the 64 residential fires and for the 63 non-residential fires are shown in Figs. 2 and 3 respectively. The cumulative frequency of fire area, expressed as a percentage of the total in each group (column 7 in Tables III and IV), is plotted against the class mark of the fire area (column 2 in Tables III and IV).

The body of data assembled in Table B-1 of Appendix B may be divided broadly into two kinds of data

1. Data gathered to describe the overall fireground conditions.
2. Data gathered to describe the water, equipment and manpower used to overcome the fire.

The gathering of data pertaining to the overall fireground conditions in general is a comparatively simple task. With the exception of preburn time (T_p) information is readily available and reliable. Building data, fire location, ultimate floor area involved by fire, and weather

TABLE III

GENERAL DATA ON 64 RESIDENTIAL FIRES

1	2	3	4	5	6	7	8	9	10	11
Classes of Maximum Fire Area A_2 Ft^2	Class Mark of Fire Area Classes	Average Fire Area Within Each Class A_2 Ft^2	Frequency of Fire Areas $F(A_2)$	100 X $\frac{F(A_2)}{N}$ N = 64 %	Cumulative Frequency of Fire Areas $\Sigma F(A_2)$	100 $\frac{\Sigma F(A_2)}{N}$ N = 64 %	Average Application Rate Density Within Each Class (For Control) (P) $GPM/100Ft^2$	Average Application Rate Within Each Class (For Control) (Q) GPM	Average Quantity of Water Used For Control (W) Gallons	Average Control Time Within Each Class (T_c) Minutes
0-500	250	304	28	43.7	28	43.7	55.4	155	740	14
501-1000	750	730	14	21.9	42	65.6	41.5	302	1570	17
1001-1500	1250	1290	5	7.8	47	73.4	40	508	3200	35
1501-2000	1750	1760	6	9.4	53	82.8	24	420	8000	21
2001-2500	2250	2180	3	4.7	56	87.5	31	673	9400	29
2501-3000	2750	2820	1	1.6	57	89.1	29	810	5210	13
3001-3500	3250	3200	2	3.1	59	92.2	15.5	485	5125	32
3501-4000	3750	3560	2	3.1	61	95.3	46.5	1650	16300	58
4001-4500	4250	-	0	0	-	-	-	-	-	-
4501-5000	4750	4700	3	4.7	64	100.0	14.1	668	14720	46

TABLE IV

GENERAL DATA ON 63 NON-RESIDENTIAL FIRES

1	2	3	4	5	6	7	8	9	10	11
Classes of Maximum Fire Area A_2 Ft^2	Class Mark of Fire Area Classes	Average Fire Area Within Each Class A_2 Ft^2	Frequency of Fire Areas $F(A_2)$	$\frac{100 \times F(A_2)}{N}$ N = 63 %	Cumulative Frequency of Fire Areas $\Sigma F(A_2)$	$\frac{100 \times \Sigma F(A_2)}{N}$ N = 63 %	Average Application Rate Density Within Each Class (For Control) P GPM/100 Ft^2	Average Application Rate Within Each Class (For Control) Q GPM	Average Quantity of Water Used For Control (W) Gallons	Average Control Time Within Each Class (T_c) Minutes
0-2000	1000	665	22	34.9	22	34.9	60	500	4240	19
2001-4000	3000	2830	9	14.3	31	49.2	42	1240	30000	72
4001-6000	5000	4510	5	7.9	36	57.1	26	1160	24000	55
6001-8000	7000	7500	1	1.6	37	58.7	21	1580	165000	103
8001-10000	9000	9480	7	11.1	44	69.8	39	3600	231000	100
10001-12000	11000	11250	3	4.7	47	74.6	5	540	7500	49
12001 14000	13000	12510	6	9.5	53	84.1	23	2820	240000	130
14001-16000	15000	15500	2	3.2	55	87.3	19	2950	560000	190
16001-18000	17000	-	0	0	-	-	-	-	-	-
18001-20000	19000	19000	4	6.4	59	93.6	19	3600	295000	130
20001-22000	21000	21200	1	1.6	60	95.2	18	3760	340000	840
22001-24000	23000	22370	2	3.2	62	98.4	11	2570	512000	190
24001-26000	25000	-	0	0	-	-	-	-	-	-
26001-28000	27000	-	0	0	-	-	-	-	-	-
28001-30000	29000	28400	1	1.6	63	100.0	8	2380	272000	140

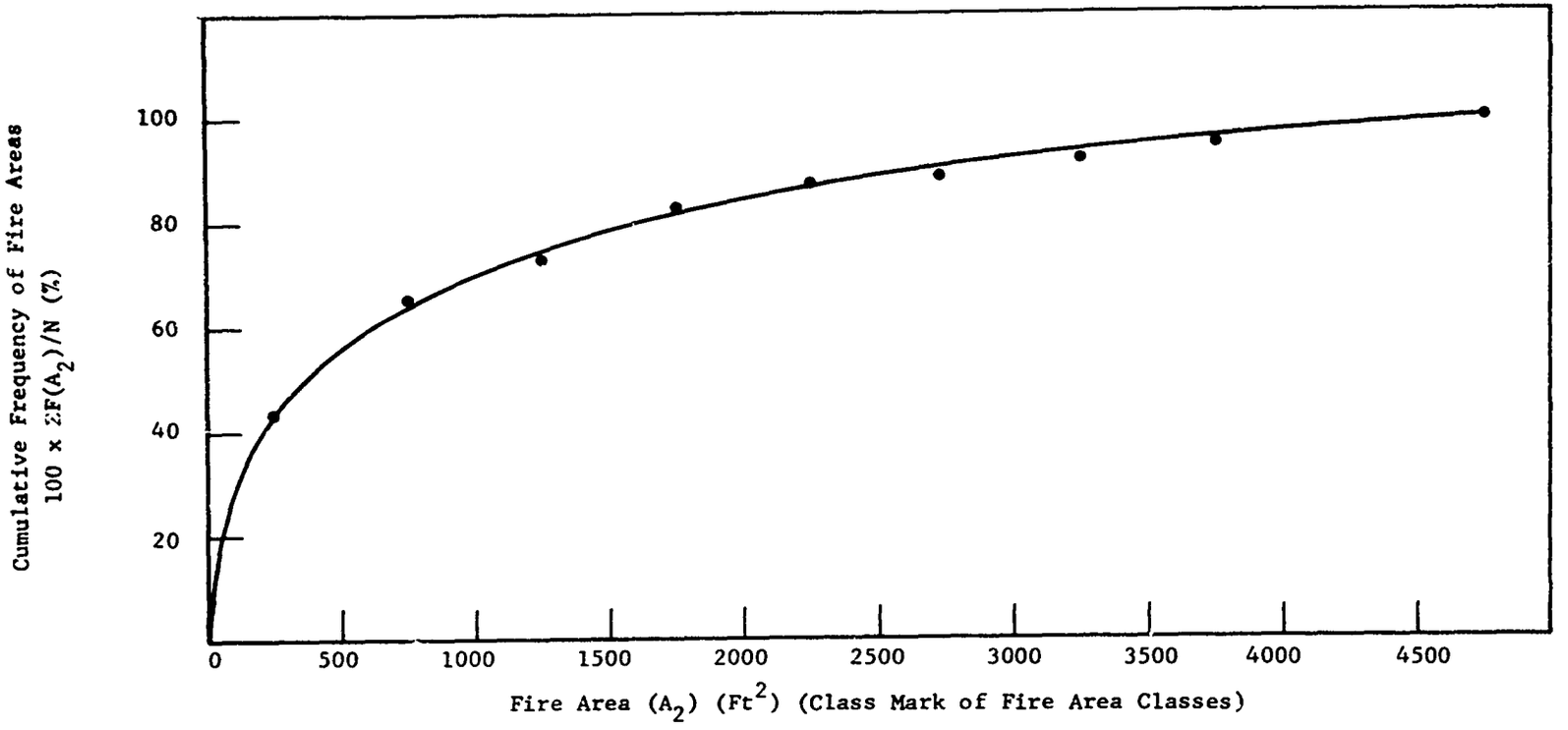

Fig. 2 CUMULATIVE FREQUENCY VS FIRE AREA FOR 64 RESIDENTIAL FIRES

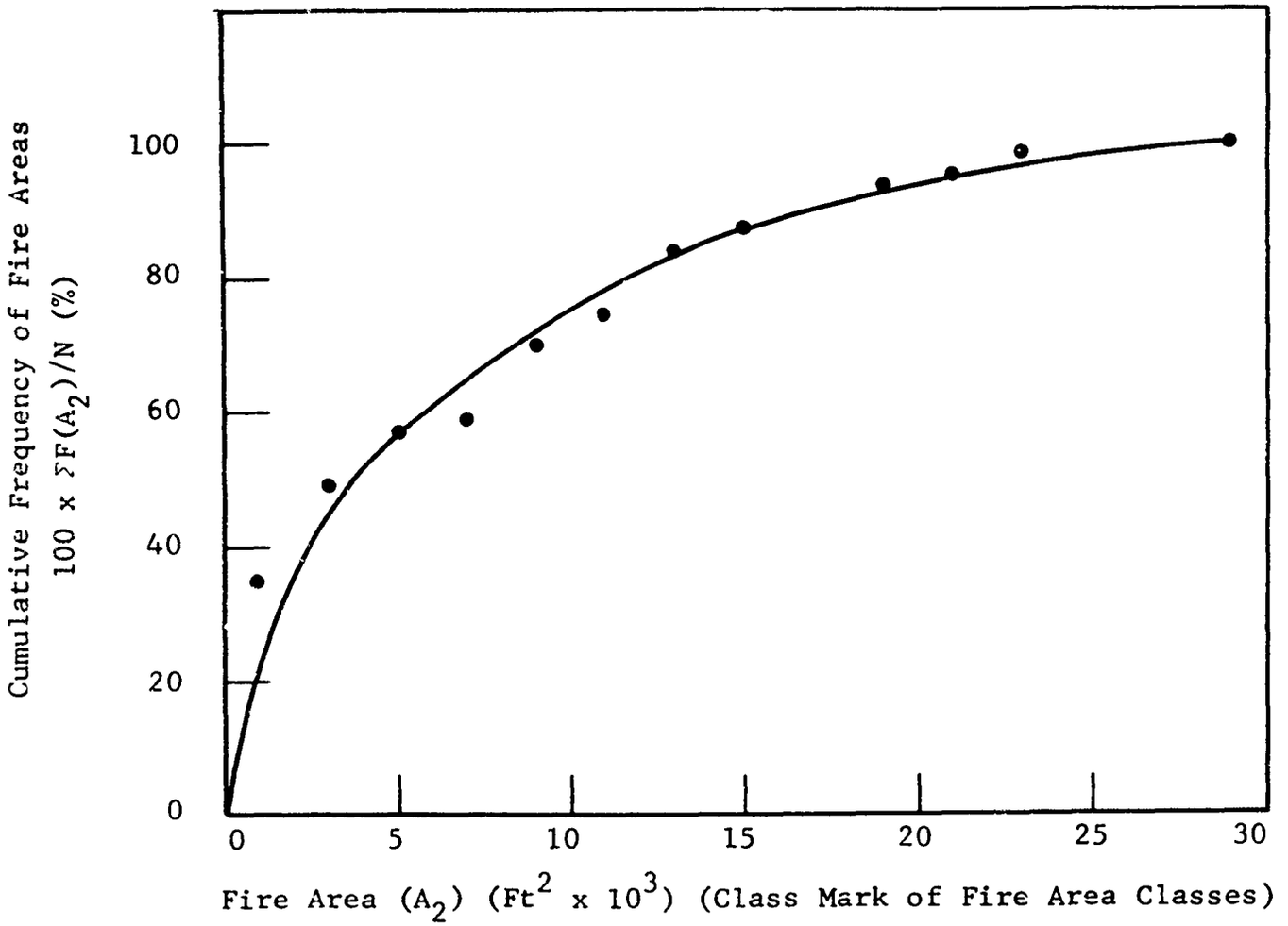

Fig. 3 CUMULATIVE FREQUENCY VS FIRE AREA FOR 63 NON-RESIDENTIAL FIRES

data are always available. A reliable value of preburn time is sometimes available; the reported value generally is an estimate deduced from conditions found on arrival, or reported by witnesses. Frequently only a minimum preburn time is indicated.

Perusual of data pertaining to the water, equipment, and manpower used to overcome fires, within a fairly narrow range of building areas involved, indicates a rather wide variation in values in some cases. Such scatter may be attributed to operational differences between various fire departments, between various companies within departments, variations in judgments of fire officers, as well as certain variations in fireground details. Important also is the degree of difficulty experienced in obtaining data on water, equipment and manpower usage. Specific observations on some of the items are listed below:

1. In some organizations, the response to fireground commands is by companies, while in other organizations assignments are made to individuals. Manpower used in each case could be quite different.
2. Equipment and manpower response to an alarm varies somewhat from one department to another.
3. For the same general fire size, only small streams are used in some cases, while one or more heavier streams may be used in other cases. The level at which fire originates, number of floors involved, and the extent of structural involvement would have an important influence on the strategy of attack.
4. The fact that (by prearrangement) a department provides for a minimum equipment and manpower response to any fire tends to produce

rather high values of certain parameters for small fires. This is true particularly of the manpower usage. Water usage is influenced in some instances by equipment and manpower response.

5. As the complexity of the fire fighting operations increases, greater difficulty may be experienced in obtaining reliable data. Since the hose and nozzle layout is known, the water application rate is usually well defined. However, the time of application of each stream is difficult to determine; hence, the numerical value assigned to the quantity of water used is less reliable.

The correlations with respect to fire area within each group of fires are shown in Figs. 4 and 5. For each of the curves, the abscissa is the average within each class of the maximum area (A_2) attained by the fire at the time of control (T_2) (column 3 in Tables III and IV). For Curve I in each figure, the ordinate is the average water application rate density (P) for control within each fire area class (column 8 in Tables III and IV). The equations for Curves I in the figures are given as follows:

Curve I, Fig. 4, Residential Fires, is limited to conditions where A_2 is between 200 and 5000 ft^2.

$$P = -9 \times 10^{-3} A_2 + 50 \qquad (3)$$

Curve I, Fig. 5, Non-Residential Fires, is limited to conditions where A_2 is between 1000 and 30,000 ft^2.

$$P = -1.3 \times 10^{-3} A_2 + 42 \qquad (4)$$

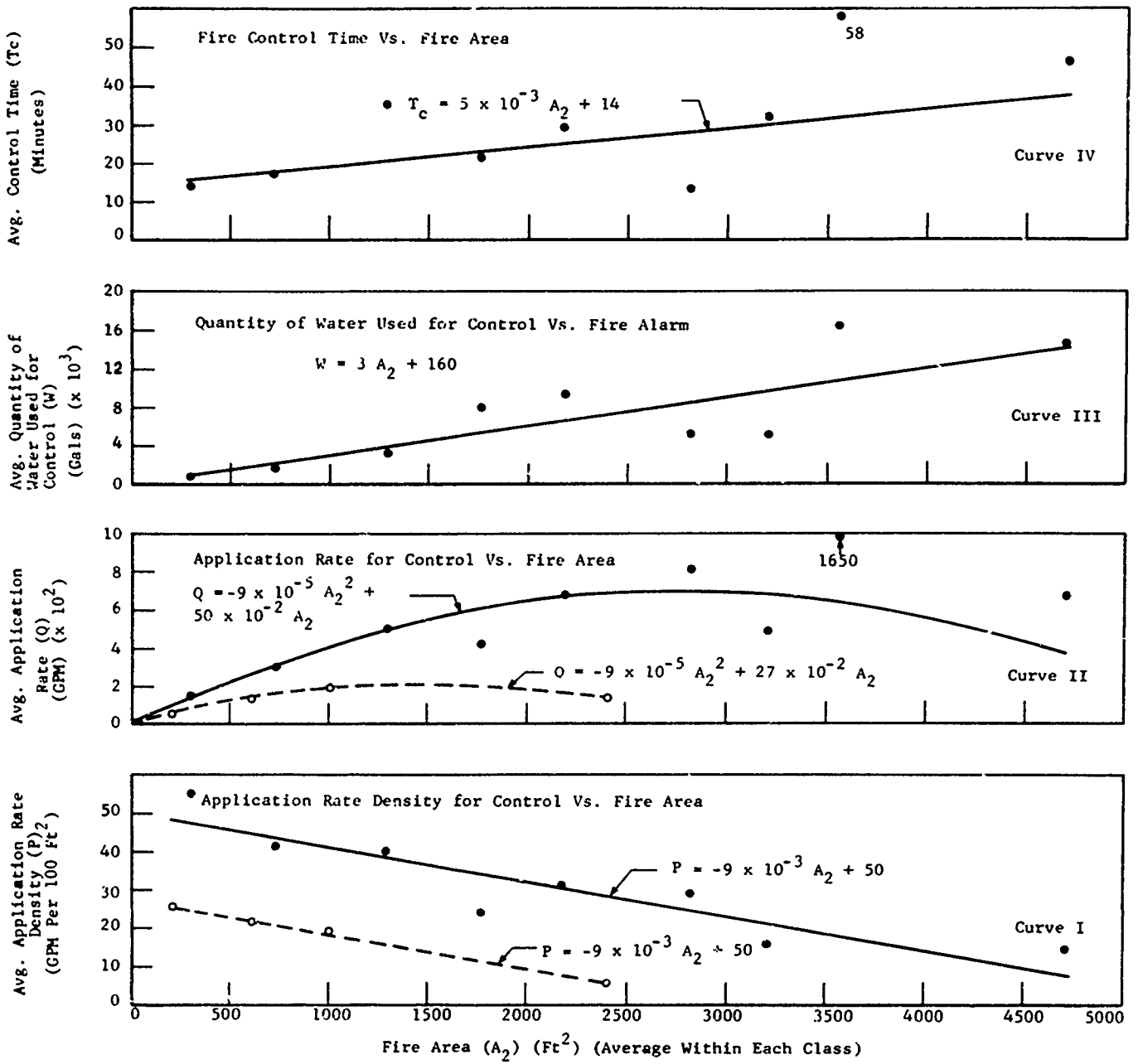

Fig. 4 WATER APPLICATION, QUANTITY OF WATER USED AND CONTROL TIME FOR 64 RESIDENTIAL FIRES
(The dashed curves are for experimental room fires. Cf. p. 20.)

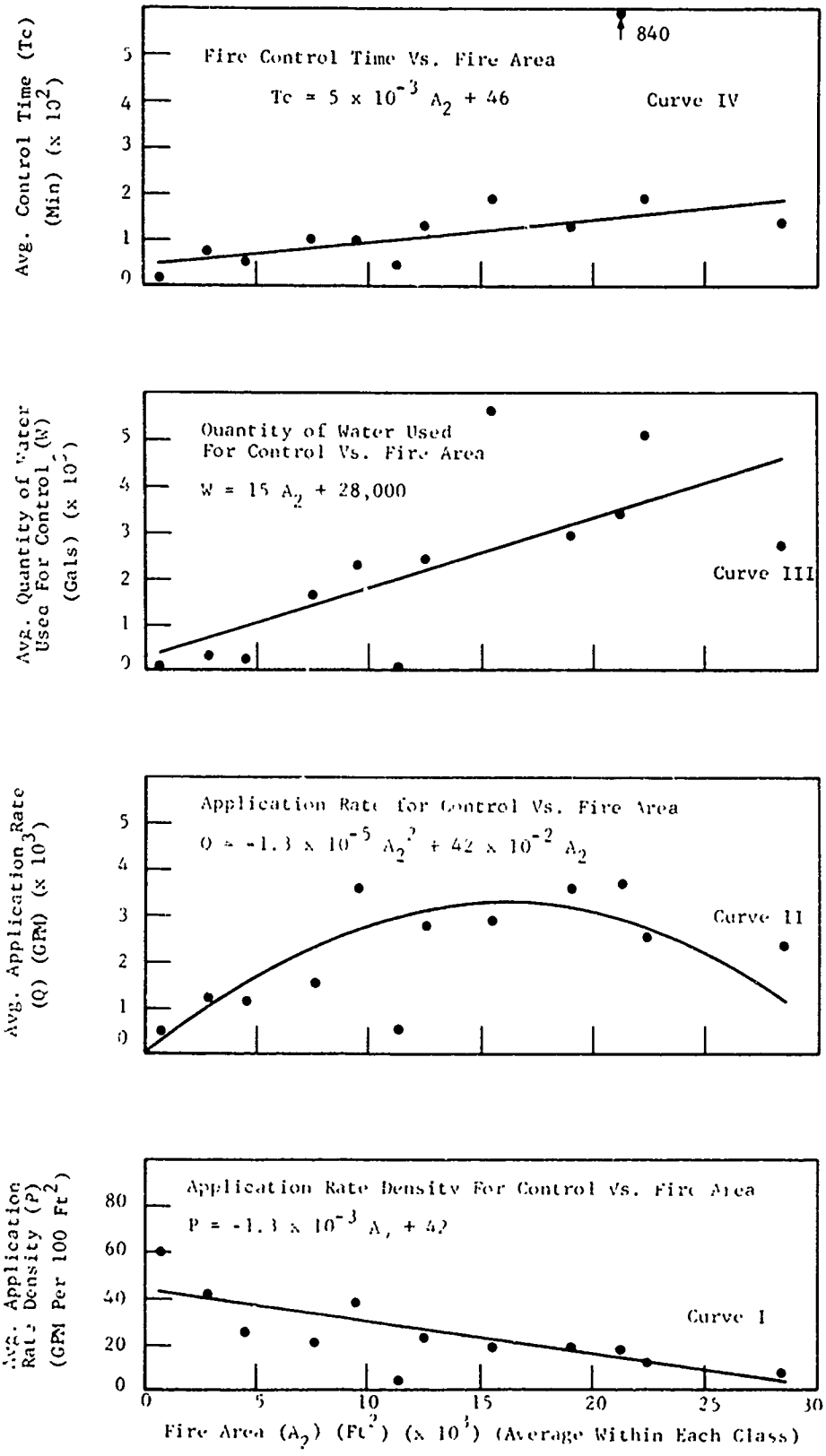

Fig. 5 WATER APPLICATION, QUANTITY OF WATER USED AND CONTROL TIME FOR 63 NON-RESIDENTIAL FIRES

The water application rate Q in gpm is related to the water application rate density P in gpm/100 ft^2 by the equation,

$$Q = P\ A_2/100 \tag{5}$$

The equations for Curves II in Figs. 4 and 5, therefore, may be derived by combining Eqs. 3 and 5, and Eqs. 4 and 5, respectively; the results are as follows:

Curve II, Fig. 4, Residential Fires, is limited to conditions where A_2 is between 200 and 5000 ft^2.

$$Q = -9 \times 10^{-5}\ A_2^{\ 2} + 50 \times 10^{-2}\ A_2 \tag{6}$$

Curve II, Fig. 5, Non-Residential Fires, is limited to conditions where A_2 is between 1000 and 30,000 ft^2.

$$Q = -1.3 \times 10^{-5}\ A_2^{\ 2} + 42 \times 10^{-2} A_2 \tag{7}$$

For the seventy-three (73) fires analyzed in the interim report[2], no organization of data points was found to produce a correlation of total quantity of water (W) used for control versus fire area (A_2). With fair success, the additional data included in this report resulted in the correlation shown in Curve III in Figs. 4 and 5. In each figure, the ordinate of Curve III is the average within each fire area class of the quantity of water used for control (W) (column 10 in Tables III and IV). The equations of the lines for Curves III are given in Figs. 4 and 5. The data do not permit determination of the shape of the curve for small fires in each group.

The ordinate for Curves IV in Figs. 4 and 5 is the average control time (T_c) within each fire area class (column 11 in Tables III and IV). The curves correspond fairly well to the data points. In view of the judgment factors involved,

this relatively good correlation may be somewhat surprising. As previously explained, the time at which control was established (T_2) was judgment made by the fire officer-in-charge, while the time (T_1) at which fire fighting units began work was quite accurately recorded. For this correlation, the control time (T_c) given by the equation $T_c = T_2 - T_1$ (averaged within each fire area class) was plotted against the fire area (A_2).

The amounts of water for the control of 21 experimental room fires are listed in Table V. The fire areas ranged from 125 to 2400 ft^2 of floor area. A complete set of notes accompanies Table V to reference the source of the data and to provide useful comments on the experiments. Comparison was made with the experimental data in Fig. 4 by calculation of average values corresponding to the fire area classes in the group of residential fires. These average values of fire area, application rate density, and application rate are listed in Table VI, and are plotted as dashed lines below Curves I and II in Fig. 4.

From comparison of Curve I with the experimental data line, it is apparent that the application rate densities used by fire departments on the average exceed the values used by investigators to control experimental fires approximately by a factor of 2. This is not unexpected. Experimental fires generally are well defined and reasonable ease of water application has been provided for. Also, fire fighting units often experience great difficulty in locating a fire, as well as in directing water to reach the seat of a fire. In the latter case, structural conditions are unknown; for experimental fires, structural conditions are known in detail.

It is interesting to note that in Fig. 4 the experimental curve below Curve II is concave downward; and that, for the largest experimental fire considered, (2400 ft^2) the water application rate was smaller than for a real fire of less than

TABLE V

THE USE OF WATER FOR CONTROL OF EXPERIMENTAL ROOM FIRES

Item Number	Reference to Notes	Room Volume Ft^3	Ceiling Height Ft - In.	Fire Area (Room Floor Area) Ft^2	Water Application Rate For Control GPM	Quantity of Water Used For Control GAL.	Application Density For Control $GAL/100Ft^2$	Application Rate Density For Control $GPM/100Ft^2$	Type of Nozzle Stream	Number and Size of Hose Lines
1	1	1750	8-6	206	6	8.4	4.1	2.9	Spray	
2	1	1750	8-6	206 *	30 *	20.4	9.9	14.6 *	Spray	
3	2	1670	8-6	196	6	8	4.1	3.1	Spray	
4	2	1670	8-6	196 *	30 *	19	9.7	15.3 *	Spray	
5	3	1152	8-0	144	6.6	2.4 - 8	1.7 - 5.5	4.6	60° and 90° Spray	1 - 1"
6	3	1152	8-0	144 *	18 *	7.5 - 11	6.1 - 7.7	12.5 *	60°Spray	1 - 1"
7	3	1152	8-0	144	20	8.3 - 18.7	5.8 - 13	13.9	Solid	1 - 1"
8	3	2640	8-0	330	18		6.9	5.5	60°Spray	1 - 1"
9	3	2640	8-0	330 *	30 *	31.9 - 64	9.7 - 19.5	9.1 *	30,60 and 90° Spray	1 1"
10	3	2640	8-0	330	61.2	107.5	32.8	18.7	60°Spray	1 - 1 1/2"
11	3			608 **	133 **	102	16.8	21.9 **	60°Spray	1 - 1 1/2"
12	3			608 **	128 **	99.5	16.4	21.0 **	60°Spray	1 - 1 1/2"
13	3			996	189	82	8.3	19.0	60°Spray	2 - 1 1/2"
14	3		8-0	211 *	94 *	102.5	48.6	44.5 *	60°Spray	1 - 1" and 1 - 1 1/2"
15	3		8-0	188 *	94 *	43.2	23.0	50.0 *	60°Spray	1 - 1" and 1 - 1 1/2"
16	3		8-0	164 *	30 *	26.5	16.2	18.1 *	60°Spray	1 - 1"
17	3		8-0	345 *	30 *	66.2	19.2	9.6 *	60°Spray	1 - 1"
18	4			125 *	28 *	308	24.6	22 *	30°Spray	1 - 1"
19	4			156 *	85 *	404	26	54 *	30°Spray	1 - 1 1/2"
20	4			2400 ***	35 ***	1698	71	3.5 ***	30°Spray	1 - 1 1/2"
21	4			2400 ***	180 ***	1362	57	7.5 ***	30°Spray	1 - 1 1/2"

NOTES FOR TABLE V - REFERENCES AND COMMENTS

1. RASBASH, D. J., "The Extinction of Fires By Water Sprays", National Academy of Sciences, Fire Research Abstracts and Reviews, Vo. 4, Nos. 1 & 2, January and May, 1962 (Pages 45 and 46).

2. FIRE RESEARCH 1957 and 1958 (Page 18, both issues), Department of Scientific and Industrial Research and Fire Offices' Committee, London, England.

   Comment: Contents fire loading 52,000 BTU/ft^2 (approximately 6.5 lbs/ft^2 for wood). Some 55 tests were made using flow rates of 6, 12, 18, 24 and 30 U.S. gpm at spray nozzle pressures of 80, 125, 225 and 500 psi. The test results show only a slight indication that the nozzle pressure or rate of flow affects the amount of water used to control the fire and no indication that either of these variables affects the total amount of water used to extinguish the fire.

3. SALZBERG, F., MAATMAN, G. L , AND VODVARKA, F. J., "An Approach To Trans-Attack Fire Suppression In Urban Areas", Contract No. OCD-OS-62-210 with the Office of Civil Defense, Washington 25, D.C., March, 1964, Pages 54 to 64.

   Comment:
   Single Room Fires - Items 5, 6 and 7 in the table were selected from the results of this series. Contents fire load 4-1/2 lb/ft^2 Twenty-two experiments were conducted. In terms of water usage for fire control, the 6.6 gpm application rate in Item 5 produced the most effective results However, the increased control time and the physical punishment which the fire fighters encountered suggests the use of a higher application rate, i.e., 18 gpm produced the best results in terms of water usage and operational ease (Item 6). Item 7 shows the results of solid stream application of this fire.

   Two-room Fires - Items 8, 9, and 10 were selected from the results of this series. Contents fire load 4-1/2 lb/ft^2. Eight experiments were conducted. In terms of water usage for fire control, the 18 gpm application rate in Item 8 produced the most effective results. The physical punishment incurred by the fire fighters suggests the use of a higher application rate, i.e., 30 gpm gave effective fire control and operational ease (Item 9). Further, in Item 9, the 31.9 gallons of water

used pertains to indirect attack simultaneously on both rooms. The larger quantity of water (64 gallons) was necessary to achieve control using a room-to-room type of attack. The use of a 1-1/2" hose line (Item 10) and 61.2 gpm spray application rate produced a significantly larger water usage without a corresponding reduction in control time.

Building Fires - The results of 6 experiments were selected from this series.

Item 11 - Simulated furniture store; 19' x 32' x 9'; contents fire load approximately 5 lb/ft^2; preburn time 40 minutes; ceiling temperatures 1100 to 1700 F.

Item 12 - Simulated clothing store; 19' x 32' x 9'; contents fire load consisted of 7 parallel 8-foot racks loaded with clothing; also 60 feet of counter space loosely piled with miscellaneous items of apparel on top as well as on lower shelves and in drawers; preburn time 19 minutes; ceiling temperatures about 1100 F.

Item 13 - Simulated furniture store; 40' x 32' x 9'; contents fire load 3.1 lb/ft^2; preburn time 5 minutes; ceiling temperature about 1200 F.

Item 14 - Dwelling; wood construction; 53' x 26' x 8' ceilings; origin of fire in rear bedroom; fire spread into hollow walls and attic before water application; preburn time 35 minutes.

Item 15 - Dwelling; wood construction; 53' x 26' x 8' ceilings; origin of fire in closet; preburn time 14 minutes; ceiling temperature 905 F.

Item 16 - Dwelling; wood construction; 18' x 40' x 8' ceilings; origin of fire in rear bedroom; preburn time 6 minutes; ceiling temperatures 1270 F.

4. FINAL REPORT OF THE EXPLORATORY COMMITTEE ON THE APPLICATION OF WATER, Miami, Florida Tests, February, 1952

Test Building 30' x 40', two stories high, fire resistive construction, with reinforced concrete columns 10 feet on centers. All windows had angle-iron frames and were equipped with steel and vermiculite concrete shutters. First story divided into eight 10' x 10' rooms by partitions constructed of 1-inch pine boards.

All of these test results pertain to the indirect application of water spray.

Test No. 1 (Item 18) Room of origin of fire 10' x 10'; final fire area approximately 125 ft^2. Fire load about 10 lb/ft^2. Preburn time 12 minutes; ceiling temperature about 1200 F.

Test No. 2 (Item 19) Room of origin of fire 10' x 10'; final fire area approximately 156 ft^2. Fire load about 10 lb/ft^2. Preburn time 12 minutes; ceiling temperature about 1000 F.

Test No. 3 (Item 20) This fire involved the entire building on both floors. Fire load about 10 lb/ft^2. Preburn time 27 minutes; temperature range 300 to 1100 F.

Test No. 4 (Item 21) This fire involved the entire building on both floors. Fire load about 10 lb/ft^2. Preburn time 15 minutes; temperature range 450 to 1500 F.

TABLE VI

AVERAGED VALUES
FROM TABLE V

Average Fire Areas Ft^2	Average Application Rate Density For Control GPM/100 ft^2	Average Application Rate For Control GPM
206 *	25 *	47
608 **	21.5 **	130
996	19.0	189
2400 ***	5.5 ***	133

* Average of single-asterisk values in columns 5 and 9 of Table V.

** Average of double-asterisk values in columns 5 and 9 of Table V.

*** Average of triple-asterisk values in columns 5 and 9 of Table V.

half that area. This situation may indicate a change in mechanism of extinction, application technique or some other unknown factor.

Manpower usages for residential fires and non-residential fires are given in Tables VII and VIII, respectively. Columns 1, 2 and 3 in each table are identical with columns 1, 2 and 3 in Tables III and IV; that is, within each group of fires, the same classification of fire areas has been maintained. The values in columns 3 and 4 in Tables VII and VIII have been plotted to form Curve I in Figs. 6 and 7, representing (within each fire area class) the average manpower present per 100 ft^2 of fire area. For the small fires in each Group, the manpower (and equipment) response per 100 ft^2 of fire area is very large, relative to the very large fires. This is understandable, since the fire departments have no way of knowing the time of fire origin, the preburn time, and fire area expected upon arrival. Also, since no assurance exists that each man who responded is working to capacity during the fireground operation, the term "manpower present" has been used to more clearly define the situation. Inspection of Curve I of Fig. 6 indicates an average response of 36 to 40 men to residential fires, regardless of ultimate size; also, inspection of Curve I of Fig. 7 indicates an average response of 50 to 75 men to non-residential fires, regardless of ultimate size. The data in Tables VII and VIII has been divided into two parts to differentiate between various fireground duties: the man hours expended for salvage and overhaul (columns 11 and 12) have been summed separately from the man hours expended for rescue, forcible entry, ventilation, exposure protection and extinguishment (columns 5, 6, 7, 8 and 9). These data have been plotted separately in Curves II A and B of Figs. 6 and 7. For the Residential Group of fires (Fig. 6) the curves correspond fairly well to the data points; while for the Non-residential Group of fires (Fig. 7) the poor fit is quite apparent - hence, the use of dashed lines, intended to indicate a lesser degree

TABLE VII

MAN POWER USAGE IN 64 RESIDENTIAL FIRES

1	2	3	4	5		6		7		8		9		10	11		12		13
Classes of Maximum Fire Area A_2 Ft^2	Class Mark of Fire Area Classes	Avg. Fire Area Within Each Class A_2 Ft^2	Avg. Manpower Per 100 Ft^2 Fire Area Within Each Class	USE OF MAN HOURS EXPENDED: Rescue		Forcible Entry		Ventilation		Exposure Protection		Final Extinguishment		Total Man Hrs. Columns 5,6,7,8 & 9	Salvage		Overhaul		Total Man Hrs. Columns 11 & 12
				Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total		Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total	
0 - 500	250	304	12	1.3	16	1.8	22	1.0	12	0.9	11	3.2	39	8.2	0.9	9	9.6	91	10.5
501- 1000	750	730	4	1.0	11	1.6	18	0.9	10	1.3	14	4.2	47	9.0	1.0	6	15.8	94	16.8
1001- 1500	1250	1290	4	None	0	5.2	28	2.5	14	0.9	5	9.7	53	18.3	1.9	9	19.1	91	21.0
1501- 2000	1750	1760	2	0.8	6	2.5	18	1.3	10	None	0	8.8	66	13.4	1.9	12	14.1	88	16.0
2001- 2500	2250	2180	2	0.1	1	5.2	25	1.7	8	2.2	11	11.2	55	20.4	0.3	1	31.6	99	31.9
2501- 3000	2750	2820	1	U*	-	U	-	U	-	U	-	U	-	-	U	-	U	-	-
3001- 3500	3250	3200	1	U	-	U	-	U	-	U	-	U	-	-	U	-	U	-	-
3501- 4000	3750	3560	4	2.9	3	37.0	43	4.0	5	0.4	1	41.3	48	85.6	4.9	6	81.6	94	86.5
4001- 4500	4250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4501- 5000	4750	4700	1	None	0	3.6	11	1.1	3	6.0	18	22.7	68	33.4	2.1	4	55.8	96	57.9
Average Use of Man Hours Expended, as a Per Cent of the Total					5		24		9		9		53			7		93	

*U denotes Unknown

TABLE VIII

MAN POWER USAGE IN 63 NON-RESIDENTIAL FIRES

1	2	3	4	5		6		7		8		9		10	11		12		13
Classes of Maximum Fire Area A_2 Ft^2	Class Mark of Fire Area Classes	Avg. Fire Area Within Each Class A_2 Ft^2	Avg. Manpower Per 100 Ft^2 Fire Area Within Each Class MP/100 Ft^2	USE OF MAN HOURS EXPENDED: Rescue		Forcible Entry		Ventilation		Exposure Protection		Final Extinguishment		Total Man Hrs. Columns 5,6,7,8 & 9	Salvage		Overhaul		Total Man Hrs. Columns 11 & 12
				Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total		Avg. Man-Hrs.	Per Cent of Total	Avg. Man-Hrs.	Per Cent of Total	
0 - 2000	1000	665	7.6	0.4	3	2.7	22	1.3	10	1.9	15	6.2	50	12.5	1.3	11	11.0	89	12.3
2001 - 4000	3000	2830	1.7	0.8	2	8.3	20	3.5	8	4.9	12	24.8	58	42.3	15	26	41.8	74	56.8
4001 - 6000	5000	4510	1.1	None	0	2.3	4	5.0	9	14.7	27	33	60	55.0	None	0	31.1	100	31.1
6001 - 8000	7000	7500	0.4	U*	-	U	-	U	-	U	-	U	-	U	U	-	U	-	U
8001 - 10000	9000	9480	1.1	2.3	1	15.7	10	7.6	5	5.0	3	132	81	162.6	7	7	98	93	105
10001 - 12000	11000	11250	0.2	None	0	0.3	1	None	0	13.8	35	25	64	39.1	0 5	8	6.0	92	6.5
12001 - 14000	13000	12510	0.5	None	0	2.1	3	1.6	3	None	0	58	94	61.7	None	0	84	100	84
14001 - 16000	15000	15500	0.6	U	-	U	-	U	-	U	-	U	-	U	U	-	U	-	U
16001 - 18000	17000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18001 - 20000	19000	19000	0.9	None	0	3.8	1	11.4	4	7.0	3	249	92	271.2	2.2	1	178	99	180
20001 - 22000	21000	21200	0.2	None	0	1.0	1	None	0	16	14	93	85	110	None	0	44	100	44
22001 - 24000	23000	22370	0.3	None	0	None	0	None	0	None	0	185	100	185	None	0	360	100	360
24001 - 26000	25000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26001 28000	27000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28001 30000	29000	28400	0.1	None	0	0.8	1	0.3	Nil	4.0	7	56	92	61.1	None	0	45	100	45
Average Use of Man Hours Expended as a Per Cent of the Total					1		6		4		15		74				5	95	

*U denotes Unknown

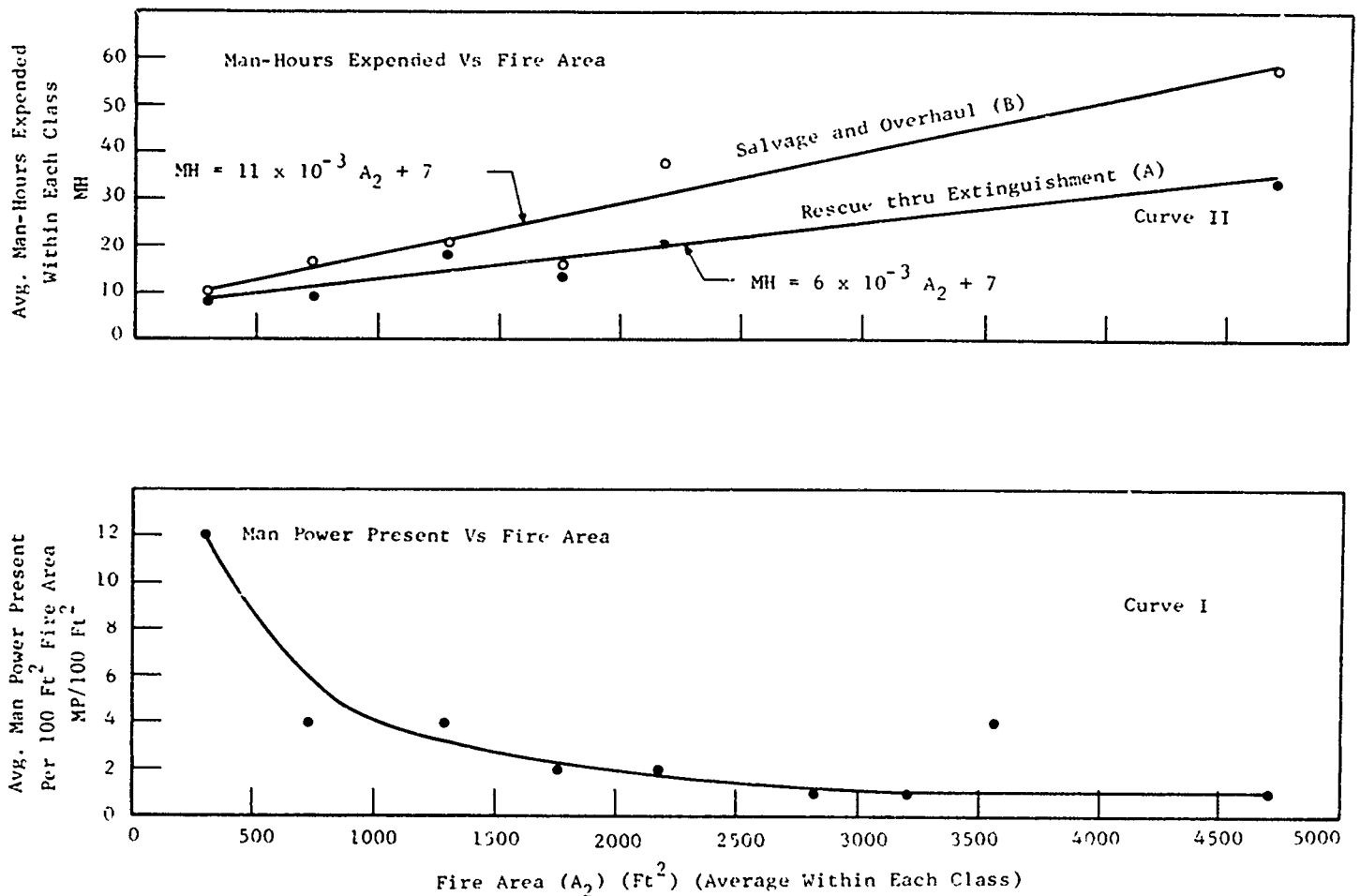

Fig. 6 MAN POWER PRESENT AND MAN-HOURS EXPENDED FOR 64 RESIDENTIAL FIRES

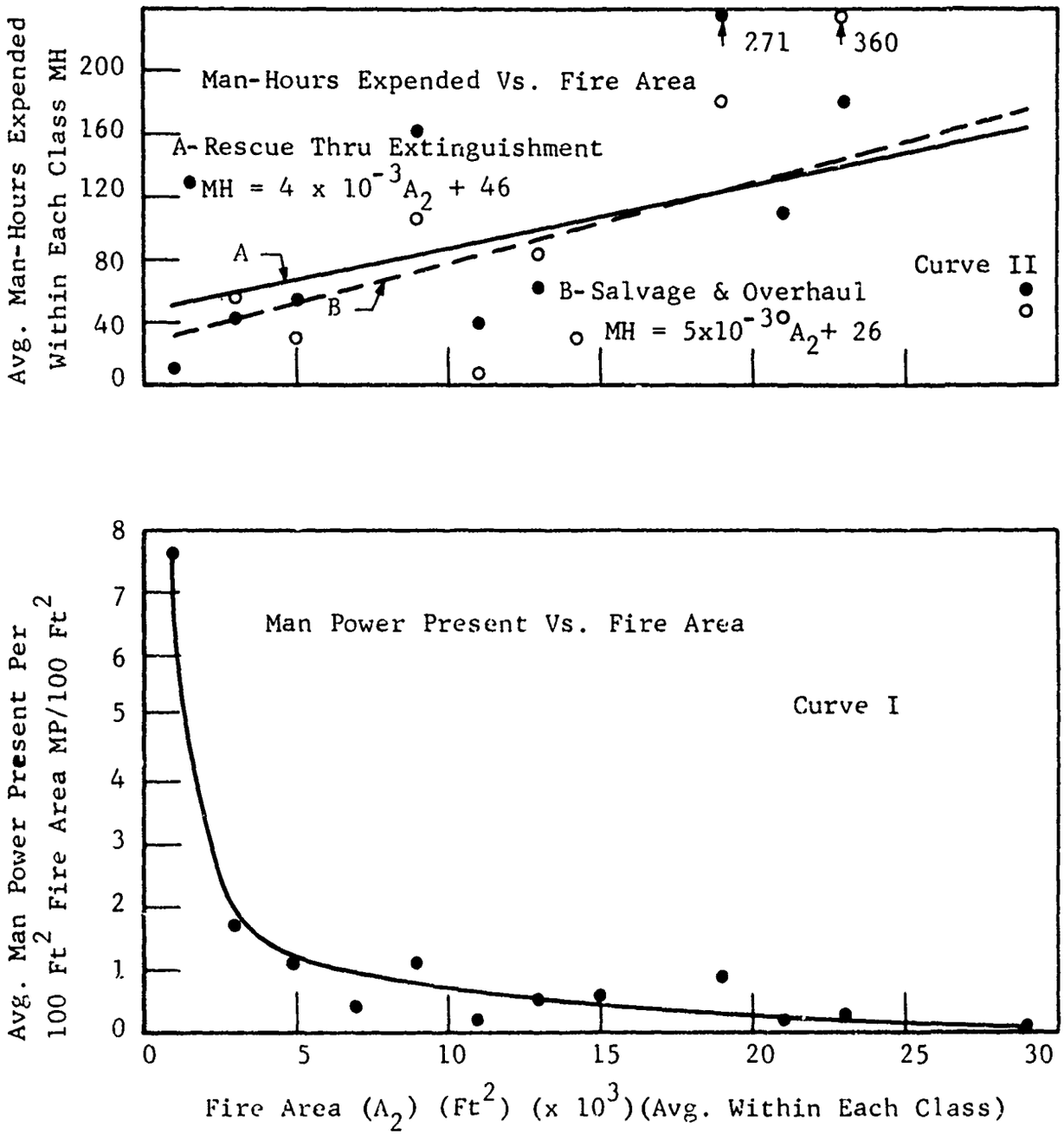

Fig. 7 MAN POWER PRESENT AND MAN-HOURS EXPENDED FOR 63 NON-RESIDENTIAL FIRES

of confidence in the data. The equations for the respective lines are given in Figs. 6 and 7.

IV. APPLICATION OF CORRELATIONS

Salzberg[1] considered the fire defense of an urban area to depend on the potential capabilities of three distinct levels of suppression effort. These are:

1) Self-help effort by relatively untrained civilians
2) The use of well trained civilian volunteer fire brigades
3) Operations of organized public fire departments of various sizes and types

The self-help level of effort would be provided by civilians possessing only a few hours of training in the use of portable fire-extinguishing devices on actual fires. The potential effectiveness of this type of effort depends on: 1) the maximum size of fire which such a person would be willing to attack and will be capable of extinguishing; 2) the length of time after the ignition occurred during which the environmental conditions within a room would permit such a person to enter for extinguishment purposes.

The trained civilian volunteer fire brigades would consist of persons participating in a continuing training program, such that they would be capable of utilizing emergency breathing apparatus, operating both hand extinguishing devices and 1" and 1-1/2" fire department hand lines, and using basic fire service equipment. The need for 2-1/2" hose streams is anticipated for large fires and for exposure protection. The brigade fire fighting unit is visualized as a group of trained individuals, equipped for fighting fires which have progressed beyond the stages which would permit their extinguishment by the self-help personnel.

Each trained brigade team should consist of four or five men provided with the necessary equipment for effective

fireground operation. This should include means to supply two one-inch hand lines, one 1-1/2 inch hand line, or one 2-1/2 inch hose line per team. The need for an eight to ten man team capable of handling two 2-1/2 inch streams is anticipated for use on large fires and for exposure protection. The types of brigade teams suggested are described in Table IX. Depending upon fire size or the extent of fireground duties, one or more teams may be needed to move-in, "knockdown" a fire, and then move on to another fire. Where necessary, other more lightly equipped teams such as Type A in Table IX or possibly self-help teams may be assigned for final extinguishment, salvage, and overhaul work. "knockdown" of a fire here refers to suppression beyond control until no flaming appears, however, a rekindle may occur and final extinguishment and overhaul is essential.

Combination of the information on the types of brigade teams described in Table IX with the previously described correlations on fire department operations leads to information such as that given in Table X for residential fires and Table XI for non-residential fires. These tables show the number of teams required to "knockdown" fires of various sizes. other information extracted from the correlated data such as water application rate (Q), control time (T_c), quantity of water for control (W), man-hours expended for control, and man-hours expended for control, and man hours expended for salvage and overhaul, is also included.

Application of Tables X and XI requires prediction of fire area (A_2) in order that the number of brigade teams needed to suppress a given fire can be estimated. For fire fighting operations under peacetime conditions the time of origin of a fire is unknown upon arrival at the fire scene. On the other hand under wartime conditions the time of ignition can be considered to correspond with the time of the nuclear explosion this time of ignition may also be referred to as "zero fire time."

According to Salzberg[1] the probability that fires could be suppressed by the self-help effort as a function of

TABLE IX

TYPES OF BRIGADE TEAMS

Brigade Team Type Designation	Number of Men Per Team	Size of Hose Lines	Number of Hose Lines	Potential Water Application Rates Per Team
A	4 or 5	1"	2	2, 30 gpm streams totaling 60 gpm
B	4 or 5	1-1/2"	1	80 gpm
C	4 or 5	2-1/2"	1	150 gpm
D	8 or 10	2-1/2"	2	2, 250 gpm streams totaling 500 gpm

TABLE X

BRIGADE TEAMS REQUIRED FOR RESIDENTIAL BUILDING FIRES

Fire Area A_2 Ft^2	Water App. Rate Q GPM	Control Time T_c Min.	Quantity of Water W Gallons	Man Hours For Control MH	Man Hours For Final Ext. and Overhaul MH	Number of Brigade Teams For Knockdown			
						Type A 60 GPM/Team	Type B 80 GPM/Team	Type C 150 GPM/Team	Type D 500 GPM/Team
100 or less	49 or less	15 or less	460 or less	8 or less	8 or less	1	1	-	-
200	96	15	760	8	9	2	2	-	-
300	142	16	1060	9	10	3	2	1	-
400	186	16	1360	9	11	3	3	2	-
500	227	17	1660	10	13	4	3	2	1
750	324	18	2410	12	15	6	4	3	1
1000	410	19	3160	13	19	7	5	3	1
1250	485	20	3910	15	21	8	6	4	1
1500	550	22	4660	16	24	9	7	4	2
1750	600	23	5410	18	26	10	8	4	2
2000	640	24	6160	19	29	11	8	5	2
2250	670	25	6910	21	32	11	9	5	2
2500	690	27	7660	22	35	12	9	5	2

TABLE XI

BRIGADE TEAMS REQUIRED FOR NON-RESIDENTIAL BUILDING FIRES

Fire Area A_2 Ft^2	App. Rate Q GPM	Control Time T_c Min.	Quantity of Water W Gallons	Man Hours For Control MH	Man-Hours For Final Ext. and Overhaul MH	Number of Brigade Teams For Knockdown			
						Type A 60 GPM/Team	Type B 80 GPM/Team	Type C 150 GPM/Team	Type D 500 GPM/Team
500 or less	207 or less	49 or less	35500 or less	48 or less	29	4 or less	3 or less	2 or less	1
1000	410	51	43000	50	31	7	5	3	1
2000	790	56	58000	54	36	13	10	5	2
3000	1140	61	73000	58	41	-	14	8	3
4000	1470	66	88000	62	46	-	-	10	3
5000	1780	71	103000	66	51	-	-	12	4
6000	2050	76	118000	70	56	-	-	14	4
7000	2300	81	133000	74	61	-	-	-	5
8000	2530	86	148000	78	66	-	-	-	5
9000	2730	91	163000	82	71	-	-	-	6
10000	2900	96	178000	86	76	-	-	-	6

time after ignition is shown by the solid curve (P_e) of Fig. 8. Hypothetically, the longest time period after ignition, at which self-help effort can commence, corresponds to the flashover of the room. This is shown by the dashed curve (P_f) of Fig. 8, indicating the probability that flashover of the room has not occurred.

Limited information on the spread of fire through a building divided into various interconnecting spaces was obtained from experimental full-scale building burns[3]. The fire growth curves in Fig. 9 were developed using Eq. 2 with a time constant of m = 20.2 minutes, found to apply during the first 30 minutes of an experimental fire in a three-story apartment building. These curves represent the building area subject to flashover as a function of time after flashover in the room of origin. Curves are shown for floor areas of the room of origin (A_o) of 100, 200, 300, 400 and 500 ft^2. These curves indicate, for example, that five minutes after the initial flashover the fire area may vary from 130 to 640 ft^2 in size, depending on whether the area of the room origin was 100 or 500 ft^2. According to Table X, these fires would require 2 to 5 Type A, 2 to 4 Type B and 1 to 2 Type C brigades. Fifteen (15) minutes after the initial flashover the fire areas may be 210 to 1050 ft^2 in size, requiring 2 to 7 Type A, 2 to 5 Type B and 1 to 3 Type C brigades. The importance of prompt fire suppression operations is apparent.

For buildings with large undivided areas, such as industrial and storage occupancies, the space-time relationship of fire spread has not been determined.

Certain fireground decisions will have to be made regarding the capabilities of available fire brigades to cope with the sizes of fires at hand. In some cases the decision made will be to extinguish; in other cases it must be recognized by those in command that extinguishment is impossible (or very unlikely) and all effort will be directed toward

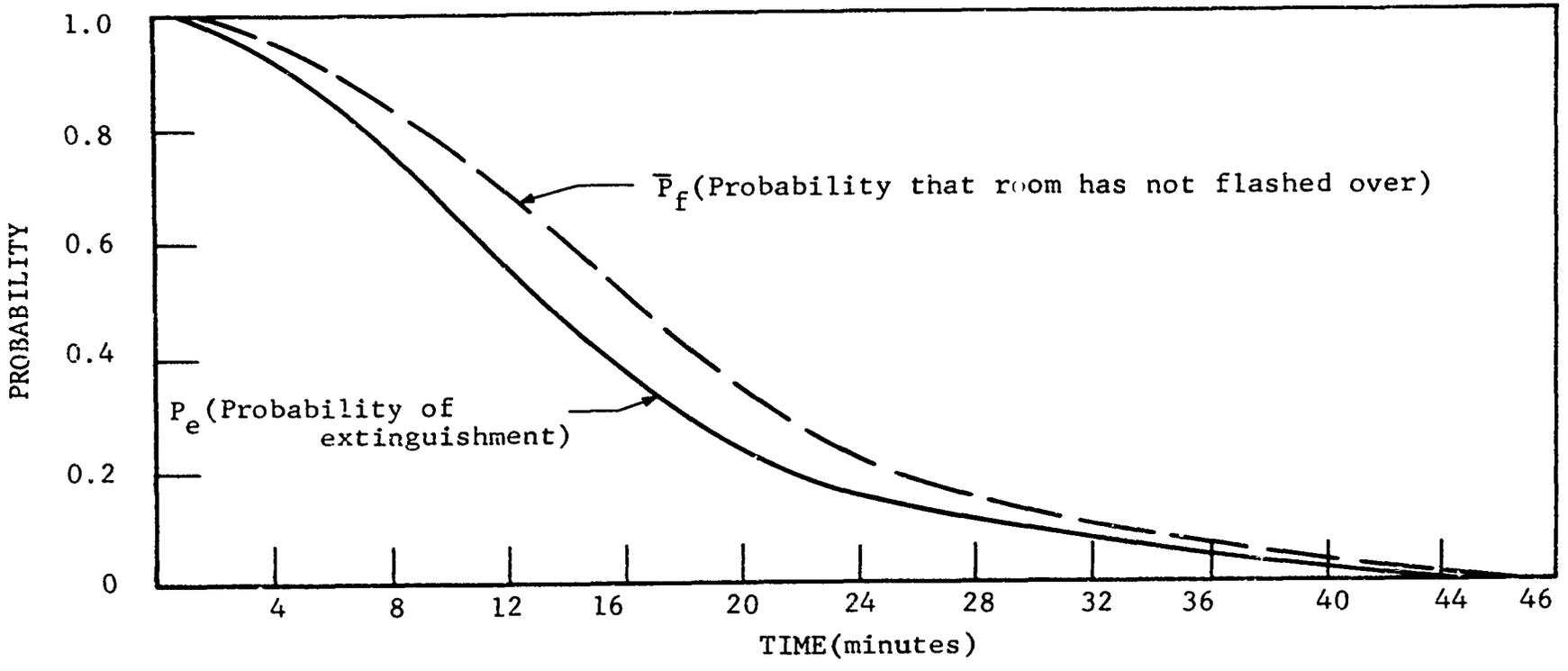

Fig. 8 PROBABILITY OF ROOM EXTINGUISHMENTS BY SELF-HELP EFFORT AS A FUNCTION OF TIME

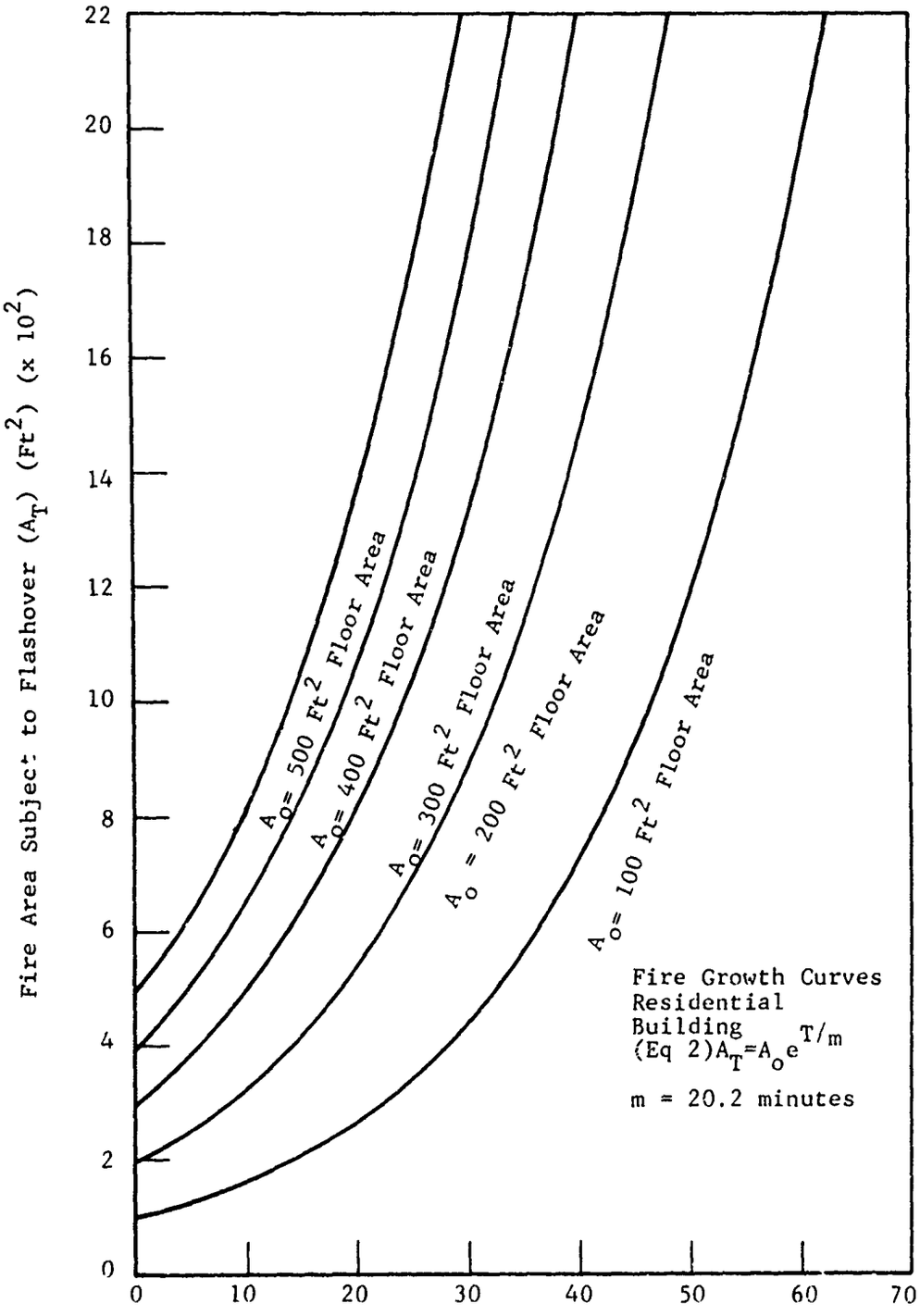

Fig. 9 BUILDING AREA SUBJECT TO FLASHOVER VS. TIME AFTER FLASHOVER IN ROOM OF ORIGIN

preventing spread to other structures. Knowledge of the behavior of various types of building construction will aid in arriving at these decisions. For example, by definition, a building of fire-resistive construction should be able to withstand a burnout of contents without collapse; also, protection of vertical openings in a well designed and maintained multi-story, fire-resistive building in many cases will prevent spread of fire from story-to-story, requiring only a minimum of suppression effort. Of course, ignition on more than one floor of such a building may be overcome only by prompt fire fighting operations at each level.

In contrast to fire-resistive construction, buildings with masonry walls and wood floors and roof (also wood buildings), will ultimately be completely destroyed by fire if an unsuppressed ignition occurs at any place within the structure. In these buildings, fire extinguishment must be complete. Inherently, these structures contain many hollow spaces in wall, floor, and roof assemblies; the complexity of the fire suppression effort increases considerably, if extinguishment is not accomplished before fire penetrates these interior spaces.

Information on the approximate penetration time for various finishes over wood frame is given in Table XII[4]. To be effective with a minimum of effort and the greatest probability of success, brigade fire suppression efforts should begin as soon as possible after self-help capabilities have been exceeded. After flashover, brigade efforts should begin before the penetration times for the various finishes given in Table XII. If this condition is met for residential buildings, it is believed that for a given area, the required water application rate for control (Q) would be somewhat less than that given by the solid Curve II of Fig. 4, but more than that given by the dashed Curve II developed from experimental data. A more definite statement on this point would require realistic experimentation utilizing brigade teams responding to preset fires.

TABLE XII

APPROXIMATE PENETRATION TIME* FOR VARIOUS FINISHES OVER WOOD FRAMING

Fire-protective finishes over wood framing

Facings	Limit of protection
	min
1/2-in. fiberboard	5
1/2-in. fiberboard flameproofed	10
1/2-in. fiberboard with 1/2-in. 1:2, 1:2 gypsum plaster	15
7/8-in. flameproofed fiberboard with 1/2-in. 1:2, 1:2 gypsum plaster	30
3/8-in. gypsum wallboard	10
1/2-in. gypsum wallboard	15
3/8-in. plain or indented gypsum lath with 1/2-in. 1:2, 1:2 gypsum plaster	20
3/8-in. perforated gypsum lath with 1/2-in. 1:2, 1:2 gypsum plaster	30
Wood lath with 1/2-in. 1:2, 1:3 gypsum plaster	15
Wood lath with 1/2-in. 1:5, 1:7.5 lime plaster	15
Metal lath (no paper backing) with 3/4-in. 1:2, 1:2 gypsum plaster	15
Metal lath (no paper backing) with 3/4-in. neat gypsum plaster	30
Metal lath (no paper backing) with 1-in. neat gypsum plaster	35
Metal lath (no paper backing) with 3/4-in. 1:5, 1:7.5 lime plaster	10
Metal lath (no paper backing) with 3/4-in. portland cement plaster	10
Paper-backed metal lath with 3/4-in. 1:2, 1:3 gypsum plaster	20
1-in. magnesium oxysulfate woodfiberboard with 1/2-in. 1:3, 1:3 gypsum plaster	20

*NOTE: The limit of protection (protection period) is assumed to be reached when an average temperature rise of 250°F above the initial occurs on the face of the wood members, or a rise at any one thermocouple location of 325°F.

V. CONCLUSIONS

Based upon reports of 64 residential and 63 non-residential fires, the following conclusions are presented:

1. Within each category, residential and non-residential, it is possible to represent the frequency of occurrence versus fire area in terms of statistical parameters. However, the sampling procedure used eliminated both very large and very small fires from consideration, and any conclusions drawn from statistical analysis would not necessarily be valid for the overall situation.
2. Correlations have been obtained between maximum floor area involved in fire and the following variables:
   - Water application rate density for fire control
   - Water application rate for fire control
   - Quantity of water used for control
   - Fire control time
   - Man-hours expended for complete fire-fighting operation: (a) Rescue through extinguishment, (b) Salvage and overhaul.
3. Water application rate densities used by fire departments to control real fires are about twice those reported by various investigators for control of experimental fires.
4. Fire brigade teams with selected water application rate capabilities are postulated, and designated as Types A, B, C and D. The number of these types of brigade teams required for "knockdown" of fires of various sizes is indicated.

5. In order that the number of brigade teams required to suppress a given fire can be estimated, a method is presented to predict the growth of fire as a function of time. The application of this method presently is limited to a residential building divided into various interconnecting spaces. For buildings with large undivided areas, the space-time relationship of fire spread has not been determined.

VI. RECOMMENDATIONS FOR FUTURE WORK

1. It is recommended that additional fires be investigated in order to determine whether the data thus far collected is applicable to areas other than the Chicago Metropolitan Area. These data should be obtained from fires investigated in each of two moderately large cities with full paid departments and two cities or towns with part paid or 100 percent volunteer departments located outside of the Chicago Metropolitan Area. The selected departments should be provided with sufficient instruction to enable the fire data to be gathered in a suitable manner.

2. It is recommended that the data included in this report, together with data gathered from additional fires to be investigated, be further analyzed, perhaps by computer so that the utmost in trends, correlations, and interactions between the many variables can be investigated.

3. It is recommended that a research program be originated to determine the minimum training program, equipment, and manpower required for self-help teams and brigade teams. The capabilities and needs of these teams should be evaluated under realistic circumstances unknown to the teams; these conditions should include various fire situations and preburn times; also, the teams should not know the fire locations within a given building. Data should be gathered on essential variables, including equipment and manpower needs, water

application rates, quantity of water used and knockdown time.

4. It is recommended that a series of full-scale experimental building fires, equipped with suitable instrumentation, and provided with the necessary observation techniques be originated to study fire spread in buildings of various types of construction, occupancies and fuel configurations. The experiments should include compartmented buildings, as well as those with large undivided areas. Such experiments would contribute greatly to the verification of existing information, as well as to extension of the prediction of fire spread rates to other conditions of interest.

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APPENDIX A

FIRE REPORT OUTLINE AND SAMPLE REPORT

The following is a copy of the fire report outline used by consultants as a guide to the preparation of their reports.

The report outline is followed by a sample fire report prepared by one of the consultants for this project.

OPERATIONAL RESEARCH STUDY

EXTINGUISHMENT OF BUILDING FIRES

IIT Research Institute
Chicago, Illinois

PURPOSE

A study of the characteristics of fire spread from incipiency to full involvement of structure or structures, including effect of extinguishment efforts during the various stages of development. This includes a consideration of the time factors from ignition to discovery, discovery to alarm, alarm to arrival of major fire fighting units, arrival to initial extinguishment application, initial extinguishment application to control and control to final extinguishment, including overhaul; also observations pertaining to the use and apparent failure of portable fire appliances by building occupants or employees during the initial phases will be made. The effects of construction, occupancy, exposure and weather conditions on fire spread will also be evaluated. Rates of water discharge during various fire stages and total quantity used will be estimated.

I. GENERAL INFORMATION

Use as an initial heading the following information:

FIRE REPORT

for

IIT RESEARCH INSTITUTE
Chicago, Illinois

Prepared by:

Report dated:

Date of fire: (include day of the week)

Time of first alarm:

Name of property or properties:

Addresses involved:

City or fire district:

State:

1. General Type of Occupancy commercial, industrial, educational, institutional, residential, assembly, lumber yard, farm, etc.

2. Detailed Type of Occupancy: (Describe in detail the functional operation of the occupancy or each occupant if multiple occupancy, unless self-evident by General Type.)

3. Weather Conditions: temperature, direction and velocity of wind, clear or cloudy, rain, snowing or dry, ice, fog or other conditions, humidity (if available), etc.

II. DESCRIPTION OF STRUCTURES

Give the following general details in narrative description of each structure involved. Bureau can assist in details if in urban, rated or mapped area.

1. General Construction Type: frame, masonry, incombustible, fire resistive or other.
2. Wall Materials: wood, brick, block, tile, concrete, metal or other.
3. Floors and Floor Covering. wood joist, plank and timber, incombustible, fire resistive, etc.; concrete, wood, floor tile, etc.
4. Roof Construction and Roof Covering: wood joist, plank and timber, incombustible, fire resistive, etc.; approved composition roofing, built-up roofing, wood shingles, slate, tile, etc.
5. Interior Wall and Ceiling Finish
6. Floor Openings: stairway and elevator shafts, open or enclosed, type and nature of enclosure, etc.
7. Exterior Wall Features, Exposures. fire walls, parapets, unprotected window and door openings, nature of window and door protection, if protected, etc.
8. Special Superstructures and Construction Thereof: towers, steeples, tanks, etc.
9. Details of Occupancy: functional uses, processes, operating or dormant at time of fire, etc.

10. General Age of Structure

III. STORY OF FIRE

In narrative form describe fire and fire fighting operations from incipiency to final extinguishment. Cover the following details as applicable.

1. Time the Fire Started: (If possible. Otherwise, estimate time fire burned before discovery.)
2. Cause of Ignition: (If determined. If not determined, give possible cause.) room or place of origin, which story
3. Material Initially Ignited: (If not definitely known, state possibility.)
4. Time Fire Discovered
5. Time and Type of Alarm Transmission: box, telephone, automatic device, in person, etc.
6. By Whom Fire Discovered and Reported: automatic device, watchman, employee, police, outsiders, etc.
7. Extent of Fire Fighting by Occupants with Private Portable Equipment: Include types of equipment and amount used, including temporary effectiveness, if any, of operation.
8. Delayed Alarm (How Long). Because of vacancy or unoccupancy, occupants asleep, initial fire fighting effort by occupant or employee without calling Fire Department, alarm defective or destroyed by fire, mistakes in alarm transmission, panic, etc.

9. Give general details of Fire Department response, including departments and units thereof involved, on first alarm and subsequent alarms, as well as mutual aid; approximate times of multiple alarm transmissions and arrivals, including mutual aid.

10. Give general details of Fire Department operations throughout various stages of fire to full involvement and extension, if fire spread beyond building of origin; give smoke and heat conditions at time of initial fire department operations.

11. Details of fire spread from incipiency through structure to full involvement and extension: if beyond building of origin; extent of fire brand exposure and spread incident thereto. Include time to reach various stages of development and spread.

12. Fire spread due to Unprotected openings, including stairways and floors, lack of fire walls, open elevator shafts, lack of fire wall parapet, large undivided areas, unprotected passageways, roof covered with combustible material, ordinary or plain glass windows, concealed or inaccessible spaces, highly combustible interior or finish, uneven floors, special hazard areas not cut off, etc.

13. Time fire control established

14. Time of final extinguishment and overhaul

15. Give details of any general inadequacy in water supply.

16. If public waterworks or private waterworks, give estimate of amount of water used for fire fighting from the water authorities during the fire period.

17. If sprinklered, did sprinklers fail; were sprinklers shut off after fire went out of control, or did water waste during the entire fire period through full involvement; or if not, how long?

18. Extent of physical fire damage in each floor of each structure involved (neglect water and smoke damage).

19. Extent and direction of structural collapse, including walls, floors, and roof. "Extent" means, how much of the building collapsed at various stages of the fire, as well as how far did the wall or other part fall.

20. Casualties, if any, and effect of rescue operations on fire fighting activity.

IV. PLAN VIEW SKETCHES

Prepare to scale (50' = 1 inch or 100' = 1 inch), Plan View of property in Sanborn map method. Consult Bureau for map details as necessary. Supplement with sketch as necessary to show fire operational details and individual floor plan sketches as needed to show the extent of fire spread on individual floors. The following details should be included.

1. Height in feet and number of stories of each structure or portion thereof involved. (Indicate basement and/or attic).

2. Outline, including height and distance to exposed structures in the area; briefly describe the exposed structures and occupancies.

3. Indicate exterior window and door openings.

4. Crosshatch, or by other means, indicate extent of fire.

5. Indicate approximate location of origin of fire and floor thereof and show approximate involvement of structure at time of Fire Department arrival.

6. Block and street outlines, including street names and addresses.

7. Location and size of water mains in the vicinity.

8. Location and type of fire hydrants in area.

9. Location of other water supplies such as surface water supplies in the area, if these were used.

10. Location of Apparatus used (identify by department and number) and indicate layout, size, length and type of hose lines used.

Use the following symbols to identify Fire Department apparatus and various officers in command:

□	Engine Company	×	Batallion Chief
○	Ladder Company	✳	Division Marshall
△	Squad Company	✳	Chief Fire Marshall
◇	Snorkel Company		Command Post

Indentify different companies of the same type of apparatus within the same department by a number inside

the symbol. Use some other identifying number or letter for various departments operating at the same fire.

11. North arrow, direction of wind.

V. DETAILS OF INDIVIDUAL FIRE APPARATUS OPERATION

Use the forms supplied with this report outline to give details of invidivual fire apparatus actually working at the fire. One set of forms consists of six (6) pages. The numbered items across the top of a set of forms correspond to the numbered items listed under heading of the report outline.

1. Name of Fire Department: truck No. (relate to sketch and story of fire).

   (a) Was this first response unit, subsequent response unit, mutual aid unit, etc.

2. Type of apparatus: Pumper, service ladder truck, aerial ladder truck, aerial platform (Snorkel), pumper-service ladder, pumper-aerial ladder, squad, tanker, etc.

3. Capacity of pump and water tank; length of aerial ladder or aerial platform (Snorkel).

4. Manning of apparatus: Full paid or volunteer, number of men.

5. Location of quarters: Response distance to fire scene over what type of roads - paved, gravel, dirt, wet, dry, snow, icy, etc.

6. Traffic, man-made barriers, natural topography, road repairs, detours, etc. involved in response.

7. Method of alarm receipt: (Box, telephone, radio, persone notification, etc.)

8. Time alarm received; time of arrival; time of initial service at fire.

9. Source of water supply, including length, type, and size of incoming hose lines - water tank, hydrants, draft, pumper or hydrant feed lines, etc.

10. Incoming residual pressures. Pumper suction gage, gage at base of aerial ladder or aerial platform (Snorkel), if available, etc.

11. Length, type, and size of hose lines served at discharge, cluding nozzle used on each line: Size, if smooth bore, make and model and approximate rated capacity (100# nozzle pressure) if fog type nozzles, or other special types such as Cellar Distributors, partition nozzles, foam, etc.

12. Discharge pressure on lines.

13. Details on ladder pipes or aerial ladder platform (Snorkel) nozzles; elevation of nozzle above street.

14. Standpipe or automatic sprinkler connections used.

15. Details on advancement and placement of lines, including effectiveness; elevation of nozzle above street.

16. Approximate time each hose line and nozzle was used.

17. Amount of water used from water tanks (booster tank and tanker supply).

18. Time of discontinuance of control operations: Time involved in extinguishment and overhaul operations: time of return to quarters.

19. Damaged apparatus or equipment; casualties, if any.

20. Use of manpower: give time and total hours for rescue, forcible entry, ventilation, extinguishment, salvage, overhaul, exposure protection, etc.

VI. GENERAL REMARKS AND CONCLUSIONS

(Include any photographs or newspaper accounts of fire which may be helpful in evaluating the situation).

FIRE REPORT

for

IIT RESEARCH INSTITUTE

CHICAGO, ILLINOIS

Prepared by: -

Report Date: -

Report No. : - 5 Table I-B

Date of Fire:
Time of 1st Alarm:
Name of Property:
Addresses Involved:
City:

Page 2. General Information:

1. Residential.

2. Multiple Dwelling.

3. Temperature: 40° F.
   Wind: West, approximately 5 MPH.
   Weather: Clear - Streets dry.

Page 3. Description of Structures.

1. Ordinary.

2. Brick.

3. Wood joist.

4. Wood joist, wood sheathing, tar and gravel covering.

5. Wood lath and plaster.

6. Enclosed stairways, front and center.

7. No exterior protection other than parapeted walls.

8. None.

9. Occupied by single-family units on all three floors.
   Basement: Heating plant, utilities, laundry, and

general storage.

10. Approximately 40 years old.

Page 4. Story of Fire:

1. It is estimated that the fire was burning 10 minutes before it was discovered and the alarm reported.

2. The cause of the fire was undetermined. Possible causes: Faulty electrical appliance or careless smoking. The fire originated in the kitchen of the 2nd floor apartment.

3. Kitchen cabinets.

4. Approximately 8:00 A.M.

5. Telephone alarm called in at 8:01 A.M.

6. The fire was discovered and reported by occupants of the 2nd floor apartment from a telephone located in the rear bedroom where they were trapped by the heat and smoke.

7. Apparently no attempt was made by the occupants to extinguish the fire. No fire extinguishers were available.

8. The delay in the discovery of the fire was due to the occupants being in another part of the apartment.

Page 5.

9. 8:01 A.M. Still Alarm.

Engine 72	Approximate	time	of	arrival - 8:04 A.M.
" 47	"	"	"	8:05 A.M.
H & L 34	"	"	"	8:05 A.M.
Squad 5	"	"	"	8:08 A.M.
Battalion 19	"	"	"	8:04 A.M.

8:03 A.M. Box 1384. (Box alarm transmitted by the Fire Alarm Office due to several telephone calls reporting the fire).

Engine 82	Approximate	time	of	arrival - 8:07 A.M.
" 87	"	"	"	8:10 A.M.
H & L 42	"	"	"	8:07 A.M.
Snorkel Squad 2	"	"	"	8:15 A.M.
Battalion 8	"	"	"	8:11 A.M.
Division 5	"	"	"	8:11 A.M.

8:05 A.M. Call for an ambulance requested by Battalion 19.
Ambulance 22 Approximate time of arrival - 8:14 A.M.

10. The first engine company to arrive at the scene (Engine 72) stretched a 1 1/2" line up the rear stairs to the 2nd floor. Meanwhile, the chief of the 19th Battalion and his aide raised a painter's ladder, which they found in the rear yard, to a 2nd floor rear window and removed a woman and a man via the ladder from a bedroom. All other means of escape were cut off because of heat and smoke. The woman was removed to a hospital by Fire Department Ambulance 22. Oxygen was administered enroute because of smoke inhalation.

The main body of the fire in the kitchen was extinguished within seconds upon application of water. Final extinguishment was delayed for several minutes until smoke and heat could be ventilated and visibility cleared. Engine 47 stretched a line of 1 1/2" hose up the front stairway to the 2nd and 3rd floors. This line was not charged or used. Hook and Ladder 34 raised a 38' extension ladder to the 2nd floor front. The members of this company then proceeded to ventilate the 2nd and 3rd floors by opening front and rear windows from inside the building. Squad 5 assisted in ventilation and pulled down the kitchen ceiling to determine whether or not the fire had extended above the ceiling. Hook and Ladder 34, under the supervision of the Chief of the 19th Battalion, checked the 3rd floor for possible fire extension. Hook and Ladder 34 and Squad 5 removed the kitchen window and door frames during overhaul operations. Engine 72 gave the fire area a final wash down before picking up their line. All other units reported to the 5th Division Marshal and were ordered to stand by and then to return to their quarters.

11. Upon arrival of the fire department, the entire kitchen was involved in fire and the fire was spreading into the hallway and the living room of the apartment. There was considerable heat and smoke damage to the adjoining rooms.

12. Very little fire spread beyond the room of origin (see sketch).

13. The fire was under control and the box was struck out by orders of the 5th Division Marshal at 8:21 A.M. (17 minutes after the arrival of the first fire department units).

14. Final extinguishment and overhaul completed at 8:56 A.M. (Time required for overhaul operations = 35 minutes).

15. No inadequacy of water supply.

16. Not known. (Water usage estimated at 300 gallons, 150 gallons for fire control, and 150 gallons used during overhaul).

17. No sprinklers.

18. 2nd floor: Total loss to wood trim, cabinets, and ceiling of the kitchen, plus total loss to the kitchen table and chairs.
Extensive heat damage to wood trim, wall paper, and furnishings of hallway and living room.

19. No structural collapse.

20. Two persons trapped by the fire were rescued by the fire department via ladders from the 2nd floor. One of these persons was hospitalized because of smoke inhalation. The rescue operation had no material effect on the fire fighting activity which was being performed simultaneously.

DETAILS OF INDIVIDUAL FIRE APPARATUS OPERATION

Apparatus No.	1. Fire Apparatus Unit	(a) Alarm Purpose	2. Apparatus Type	3. Capacity or Size	Manpower
1	Engine 72	Still Alarm	Pumper	1,000 GPM	5
2	Engine 47	" "	Pumper	1,000 GPM	4
3	Hook & Ladder 34	" "	Aerial Ladder Truck	85' Aerial	5
4	Squad 5	" "	Squad Truck	-	4
5	Battalion 19	" "	Station Wagon	-	2
6	Ambulance 22	" "	Ambulance	-	2
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

DETAILS OF INDIVIDUAL FIRE APPARATUS OPERATION

Apparatus No.	5. Response Distance	6. Traffic Conditions	7. Receipt of Alarm	Time: 8. Alarm-Arrival-At Work
1 72	1.4 miles	Normal morning rush traf.	Station Amplif.	8:01 8:04 8:05
2 47	1.5 miles	"	" "	8:01 8:06 8:08
3 344	1.5 miles	"	" "	8:01 8:04 8:04
4 515	2.6 miles	"	" "	8:01 8:07 8:07
5 249	1.4 miles	"	" "	8:01 8:04 8:04
6 232	2.6 miles	"	Alarm Register	8:03 8:14 8:14
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

DETAILS OF INDIVIDUAL FIRE APPARATUS OPERATION

Apparatus No.	9. Water Supply	10. Intake Pressure psi	11. Hose Layout and Nozzle	12. Discharge Pressure psi
1	Double 4 1/2" Hydrant on 8" C.W.P. 20'-4" Soft Suction	Hose 30 PSI	300' of 1 1/2" Hose 1 1/2" Elkhart Mystery Fog Nozzle	Engine Pressure =
2	Double 4 1/2" Hydrant on 8" C.W.P. 20'-4" Soft Suction	Hose 30 PSI	200' of 1 1/2" hose + 300' of 3" hose 1/2" Elkhart Mystery Fog Nozzle	(Hose line not charged)
3344	-	-	-	-
4515	-	-	-	-
5249	-	-	-	-
6 82	-	-	-	-
7 87	-	-	-	-
8352	-	-	-	-
9552	-	-	-	-
10238	-	-	-	-
11225	-	-	-	-
12832	-	-	-	-
13				
14				
15				
16				
17				
18				
19				
20				

DETAILS OF INDIVIDUAL FIRE APPARATUS OPERATION

Apparatus No.	Ladder 13. Pipes	F. D. 14. Connections	Place and 15. Operation of Lines	16. Times Lines Operated
1 12	-	-	2nd Floor Kitchen	Approximately 4 minutes
2 2	-	-	2nd Floor Front Entrance (not used)	0 minutes
3 344	-	-	-	-
4 515	-	-	-	-
5 249	-	-	-	-
6 82	-	-	-	-
7 87	-	-	-	-
8 352	-	-	-	-
9 552	-	-	-	-
10 238	-	-	-	-
11 225	-	-	-	-
12 832	-	-	-	-
13				
14				
15				
16				
17				
18				
19				
20				

DETAILS OF INDIVIDUAL FIRE APPARATUS OPERATION

Apparatus No.	Water Used 17. From Pumps	Time of Operations: 18. Control	Overhaul	in Quarters	19. Damage to Apparatus
1 72	0	Stream operated 0:02 other work 0:17	0:02 0:35	9:11 AM	None
2 47	0	Stream operated 0:00 other work 0:16	0:00 0:00	8:51 AM	"
3344	-	0:16	0:35	9:01 AM	"
4515	-	0:13	0:35	9:01 AM	"
5249	-	0:17	0:35	9:01 AM	"
6 82	-	0:00	0:00	8:28 AM	"
7 87	-	0:00	0:00	8:28 AM	"
8352	-	0:00	0:00	8:28 AM	"
9552	-	0:00	0:00	8:33 AM	"
10238	-	0:00	0:00	8:33 AM	"
11225	-	0:00	0:00	8:36 AM	"
12832	-	0:00	0:00	8:55 AM	"
13					
14					
15					
16					
17					
18					
19					
20					

DETAILS OF INDIVIDUAL FIRE APPARATUS OPERATION

Apparatus No.	Time of Use of Manpower						
	20. Rescue	Forcible Entry	Ventilation	Extinguishment	Salvage	Overhaul	Exposure Protection
1 72	-	-	-	0:17 x 5 = 1:25	-	0:35 x 5 = 2:55	-
2 47	-	-	-	-	-	-	0:20 x 4 = 1:20
3 344	-	-	0:05 x 5 = 0:25	-	-	0:35 x 5 = 2:55	-
4 515	-	0:02x4=0:08[2]	0:03 x 4 = 0:12	-	0:15x4=1.00[4]	0:20x4=1:20	-
5 249	0:02 x 2 = 0:04	-	-	0:15 x 1 = 0:15[3]	-	0:35 x 1 = 0:35[3]	-
6 82	-	-	-	-	-	-	-
7 87	-	-	-	-	-	-	-
8 352	-	-	-	-	-	-	-
9 552	-	-	-	-	-	-	-
10 238	-	-	-	-	-	-	-
11 225	-	-	-	0:10 x 2 = 0:20	-	-	-
12 832	0:31 x 2 = 1:02[1]	-	-	-	-	-	-
13							
14							
15							
16							
17							
18							
19							
20							

Notes: (1) Removal to hospital.
(2) Pulled down kitchen ceiling.
(3) Battalion chief only, his aide assumed his post in communication's car.
(4) Removed water from 2nd and 1st floor.
(5) Positioned line to cut off fire advance toward front of apartment.

GENERAL REMARKS AND CONCLUSIONS

This fire is thought to be report worthy because it involved a rescue operation, which does not occur too frequently. The fire did not warrant a box alarm. The box was transmitted by the fire alarm office as a precautionary measure after the office received several telephone calls reporting the fire. This is standard operating procedure.

In my own personal fire performance rating system, I rated the operations of this fire as follows:

Rescue operation...	Excellent
Fire Extinguishment	Good
Ventilation	Poor (Too slow)
Salvage	Poor (No covers on 1st Fl.)
Overhaul.	Poor (Water used needlessly)

APPENDIX B

COMPILATION OF DATA FROM FIRE REPORTS

Table B-I represents the primary body of data extracted from reports on 134 fires considered in this report. All data in Table B-I has been arranged in ascending order of building area involved by fire, referred to as the "fire area"; consecutive fire numbers have been assigned according to this listing.

A brief remark about each fire is given in a list following Table B-I. Following the remarks, a list of notes on the preparation of the data for Table B-I is included. The last item in Appendix B is a list of the symbols used as abbreviations in Table B-I.

TABLE B-1 COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Occupancy Class and Description	Building Construction Class	Number of Stories (Height) (Feet)	Total Building Area Ft^2	Building Area Involved By Fire (Fire) (Area) A_2 Ft^2 (See Note 2)	Extent of Structura Involvement (See Note 3)	No. of Stories Involved by Fire	Elevation of Fire Origin (Stories)	Fire Time (Minutes) (See Note 5) Preburn Tp	Control Tc	Final Ext. and Overhaul Te
1	2		3	4	5	6	7	8	9	10	11
1	Residential	W	1B (13)	2,280	75	1	1	1	7^+	2	60
2	Residential (Vacant)	W	1 (15)	480	80	2	1	1	U	U	U
3	Mercantile and Residential	M-J	2B (27)	5,700	100	1	1	1	29	2	29
4	Residential	M-J	3B (45)	8,000	105	2	1	1	35	12	38
5	Residential	W	2 (20)	790	144	2	1	1	10^+	15	60
6	Residential	W	1 (15)	624	144	2	1	1	33^+	5	60
7	Residential	M-J	2B (24)	5,100	160	2	1	1	3	7	30
8	Business and Mercantile	25% M-J 20% W	1A (15) 2 (20)	9,235	160	2	2	1	66^+	5	200
9	Residential	M-J	3B (46)	10,400	180	2	1	1	14	9	17
10	Residential	M-J	3BA (40)	36,100	200	3	2	2	55	23	32
11	Business and Residential	M-J	3B (38)	12,500	210	2	1	2	19	12	23
12	Residential	W	2B (25)	2,700	230	4	1	2	13	10	27
13	Hotel (Apartment)	M-J	4B (48)	26,500	240	2	1	2	31	17	60
14	Residential	W	1A (20)	2,000	240	2	1	1	26	4	45
15	Assembly Church	45% M-J 55% F-R	1B=8B (90) 5B (60)	34,200	240	2	1	3	19	34	62
16	Industrial	M-J	2 (20)	1,900	240	3	1	2	5	9	21
17	Residential	M-J	2B (25)	2,400	250	4	2	1	8	12	30
18	Residential	M-J	3B (45)	6,000	270	2	1	2	15	16	35
19	Residential	W	1 (8)	650	310	3	1	1	8	8	60
20	Residential	M-J	3B (45)	7,900	310	2	1	1	10	14	16
21	Mercantile and Residential	M-J	3B (40)	7,350	350	2	2	2	6	16	27
22	Residential	W	1A (16)	2,000	360	2	1	Attic	U	13	25
23	Residential	M-J	3B (38)	9,600	380	3	2	2	60	23	48

TABLE B-1 COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Occupancy Class and Description	Building Construc-tion Class	Number of Stories (Height) (Feet)	Total Building Area Ft^2	Building Area Involved By Fire (Fire) (Area) A_2 Ft^2 (See Note 2)	Extent of Structural Involvement (See Note 3)	No. of Stories Involved by Fire	Elevation of Fire Origin (Stories)	Fire Time (Minutes) (See Note 5) Preburn Tp	Control Tc	Final Ext. and Over-haul Te
1		2	3	4	5	6	7	8	9	10	11
24	Residential	M-J	2B (22)	5,000	380	3	1	2	20	10	25
25	Residential	M-J	4B (55)	36,500	400	3	1	4	15	25	35
26	Industrial	M-J	60% 1 (25) 40% 2 (28)	15,000	400	2	1	1	5	12	33
27	Residential	W	2B (25)	3,300	400	2	1	2	U	10	15
28	Residential	M-J	3B (46)	27,690	420	4	1	3	34	17	62
29	Residential	M-J	3B (46)	46,000	425	3	2	2	26	14	41
30	Residential	M-J	2B (24)	3,360	435	4	1	2	9	6	55
31	Residential	W	2B (20)	1,100	440	2	1	2	8+	3	60
32	Residential	M-J	3B (35)	12,000	450	3	3	2	9	33	173
33	Mercantile & Residential	M-J	3B (46)	32,160	450	3	1	3	26	29	35
34	Mercantile & Residential	M-J	2BA (34)	6,500	460	2	1	Attic	18	11	63
35	Hotel	M-J	7B (75)	30,000	475	3	3	1	18	56	19
36	Mercantile	W	1 (15)	500	500	3	1	1	24	11	70
37	Hotel	M-J	3 (40)	16,200	500	2	2	1	6	10	120
38	Business & Residential	W	2 (20)	3,000	500	2	1	2	27	23	70
39	Residential	M-J	3B (45)	4,400	500	2	2	2	38	8	24
40	Residential	M-J	2 and 3B (20 and 30)	13,716	550	2	3	1	15	13	22
41	Mercantile	N-C	55% 1 (15) 45% 2 (25)	7,800	550	1	2	1 & 2	17	30	30
42	Residential	W	1A (16)	2,400	590	3	1	1	13	8	25
43	Residential	M-J	2B (24)	5,300	600	2	1	2	19	15	36
44	Residential	M-J	3B (46)	32,400	600	2	1	3	29	11	75
45	Residential	M-J	3B (32)	6,000	625	3	3	Bsmt.	14	36	116

TABLE B-1 COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Occupancy Class and Description	Building Construction Class	Number of Stories (Height) (Feet)	Total Building Area Ft^2	Building Area Involved By Fire (Fire) (Area) A_2 Ft^2 (See Note 2)	Extent of Structural Involvement (See Note 3)	No. of Stories Involved by Fire	Elevation of Fire Origin (Stories)	Fire Time (Minutes) (See Note 5) Preburn Tp	Control Tc	Final Ext. and Overhaul Te
1		2	3	4	5	6	7	8	9	10	11
46	Residential	M-J	3B (38)	10,000	650	2	1	3	11	5	7
47	Residential	W	1BA (14)	1,380	680	3	2	1	64	11	49
48	Mercantile & Residential	M-J	2B (24)	6,360	700	2	1	2	33+	5	60
49	Residential	M-J	2B (30)	4,125	720	3	3	Bmt	11	26	38
50	Residential	W	2B (22)	4,375	750	2	1	1	13	3	60
51	Residential	W	2BA (34)	6,000	800	4	2	2	11	26	91
52	Business & Residential	M-J	2 (34)	6,300	870	3	2	1	U	60	150
53	Residential	M-J	3B (35)	4,800	870	3	3	Grade	20	20	90
54	Residential (Vacant)	M-J	2B (25)	8,960	880	4	2	1	28	13	19
55	Industrial	M-J	2B (20)	20,000	900	2	2	Grade	12	8	55
56	Residential	M-J	2BA (20)	2,260	910	3	2	Bmt	21	20	60
57	Mercantile & Business	F-R	8B (82)	20,300	960	1	2	1	54	5	45
58	Residential	W	2A (25)	2,100	1000	3	2	1	190	25	165
59	Industrial	M-J	3 (40)	212,000	1000	2	1	1	15	35	75
60	Mercantile	95% M-J 5% W	2BA (25) 1 (17)	6,720	1000	4	3	1	8	17	50
61	Mercantile & Residential	M-J	3B (45)	21,890	1075	2	2	1	U	30	38
62	Farm Bldg. (Shop & Stge.)	M-J	2 (20)	2,000	1200	4	2	1	17	10	55
63	Assembly & Residential	M-J	3B (46)	6,800	1200	4	3	1	12	23	22
64	Residential	W	2BA (28)	3,311	1220	4	4	Bmt	14	60	180
65	Residential	M-J	2BA (40)	4,160	1240	3	3	1	4+	36	55

TABLE B-1 COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Occupancy Class and Description	Building Construction Class	Number of Stories (Height) (Feet)	Total Building Area Ft^2	Building Area Involved By Fire (Fire) (Area) A_2 Ft^2 (See Note 2)	Extent of Structural Involvement (See Note 3)	No. of Stories Involved by Fire	Elevation of Fire Origin (Stories)	Fire Time (Minutes) (See Note 5) Preburn Tp	Control Tc	Final Ext. and Overhaul Te
1		2	3	4	5	6	7	8	9	10	11
66	Residential	M-J	2B (30)	4,680	1260	3	2	1	8	17	45
67	Residential	M-J	3B (45)	9,880	1320	3	3	2	27	25	88
68	Residential	M-J	2B (25)	3,740	1400	3	2	Bmt	7	36	57
69	Assembly and Residential	M-J	2B (25)	7,700	1550	3	2	1	45	23	37
70	Residential	M-J	3B (46)	10,880	1620	4	3	1	7	21	45
71	Residential	W	2BA (28)	3,100	1630	3	3	1	22^+	20	110
72	Residential	M-J	3B (46)	6,490	1700	4	2	2	14	27	63
73	Residential	W	2 (20)	2,180	1730	4	2	1	14^+	16	60
74	Residential	M-J	3B (38)	37,420	1900	3	2	Bmt	8	22	40
75	Residential	W	1-1/2B (22)	3,000	2000	3	3	Bmt	14	U	145
76	Storage	93% W 7% M-J	1 (12) (10)	2,000	2060	4	1	1	10^+	30	23
77	Residential	M-J	3B (32)	5,600	2100	4	3	1	7	26	62
78	Residential	W	2A (25)	2,740	2220	4	3	1 (Ext.)	4	20	85
79	Residential	W	1&2 BA (10) (25)	6,250	2230	4	3	1	10	40	108
80	Mercantile and Res.	W	2-1/2B (34)	13,375	2250	3	2	1	14	31	75
81	Mercantile and Residential	W	2B (22)	13,900	2300	3	2	Grd. Ext.	9	39	107
82	Mercantile and Residential	W	3A (33)	6,400	2560	4	2	2	57	44	134
83	Industrial	M-J	1 (15)	8,750	2800	4	1	1	44^+	125	45
84	Residential	M-J & W	2B (26)	4,488	2820	3	4	Bmt	12	13	125
85	Mercantile and Residential	M-J	3B (32)	18,900	2950	3	3	Bmt	63	252	90

TABLE B-1 COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Occupancy Class and Description	Building Construction Class	Number of Stories (Height) (Feet)	Total Building Area Ft^2	Building Area Involved By Fire (Fire) (Area) A_2 Ft^2 (See Note 2)	Extent of Structural Involvement (See Note 3)	No. of Stories Involved by Fire	Elevation of Fire & Origin (Stories)	Fire Time (Minutes) (See Note 5) Preburn Tp	Control Tc	Final Ext. and Overhaul Te
1		2	3	4	5	6	7	8	9	10	11
86	Mercantile	M-J	1 (25)	5,000	3000	4	1	1	23	22	85
87	Residential	W	2 (26)	7,990	3130	3	3	1	88	U	135
88	Residential	W	3 (28)	10,620	3275	3	3	1	15	32	145
89	Hotel Apart.	M-J	3BA (40)	37,400	3550	4	2	3	14	71	117
90	Mercantile	M-J	14 (18) 2A (24)	4,300	3550	4	2	U	U	65	70
91	Residential	M-J	4BA (45)	42,780	3560	4	3	2	15	45	110
92	Mercantile and Manufacturing	M-J	3B (45)	18,000	4000	4	2	1	49	36	115
93	Farm Building (Barn)	W	2 40	4,050	4050	4	2	U	21^+	84	300^+
94	Mercantile	M-J	2 28	17,530	4200	3	2	1	15	90	72
95	Industrial	75% F-R 25% M-J	1-B (15) 2 (30)	52,850	4600	4	1	Bmt	13	U	40
96	Residential (Vacant)	M-J	4B (50)	42,780	4630	4	3	2	14	26	107
97	Industrial	M-J & W	1 (15)	75,000	4700	4	1	1	16	5	210
98	Residential	50% W 50% M-J	2BA (34) 2B (26)	10,400	4730	4	3	1	16	68	180
99	Residential	W	2A (25)	11,340	4760	4	3	1	15	45	210
100	Industrial	M-J	1 & 2 (12) (24)	14,600	5000	4	1	1	20^+	39	290
101	Mercantile	W	1 (15)	7,500	7500	4	1	1	67^+	103	240
102	Industrial	W M-J	1 (15)	8,740	8740	3	1	U	20^+	185	750
103	Industrial	M-J	2 & 3B (37)	21,600	8800	3	3	1	4^+	125	490
104	Storage	M-J	1 (14)	9,375	9375	4	1	1	65^+	37	217
105	Mercantile & Residential	W	2BA (28)	12,600	9600	4	3	Bmt	4	99	435

TABLE B-1 COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Occupancy Class and Description	Building Construction Class	Number of Stories (Height) (Feet)	Total Building Area Ft^2	Building Area Involved By Fire (Fire) (Area) A_2 Ft^2 (See Note 2)	Extent of Structural Involvement (See Note 3)	No. of Stories Involved by Fire	Elevation of Fire Origin (Stories)	Fire Time (Minutes) (See Note 5) Preburn T_p	Control Tc	Final Ext. and Overhaul Te
1		2	3	4	5	6	7	8	9	10	11
106	Business	M-J	2BA (27)	19,950	9,850	3	3	Bmt	11	81	208
107	Industrial	M-J	1 (14)	10,560	10,000	4	1	1	U	72	180
108	Mercantile	M-J	1 (15)	61,800	10,000	4	1	1	18	100	120
109	Business	S-F, W & Concrete	2BA (42)	10,500	10,500	4	3	U	U	60	360
110	Residential	M-J	2A (30)	13,870	10,870	4	2	1	10^+	70	60
111	Business	M-J	1A (15)	31,400	11,500	2	1	2	15	9	20
112	Storage (Junk Yard)	W	1 (15)	12,730	11,700	4	1	1	35^+	78	675
113	Mercantile	M-J & W	2B (28)	14,100	12,100	4	2	U	39^+	210	630
114	Industrial	M-C & H-T	5 (60)	15,200	12,160	4	4	4	47^+	165	315
115	Industrial	M-J	1 (22)	27,375	12,300	4	1	1	17	28	121
116	Mercantile & Residential	M-J & W	3 (35)	19,000	12,350	4	3	1	27	100	150
117	Mercantile	M-J	2B (26)	31,725	12,420	4	2	1	68^+	148	30
118	Industrial	M-J	1 (12)	16,250	13,750	4	1	1	28	145	135
119	Residential (Vacant)	80% M-J 20% W	2B (25) 1B (18)	16,750	14,150	4	2	U	U	18	42
120	Residential	W	2A (25)	23,380	14,700	4	2	1	60	60	390
121	Storage	W	1 (30)	15,000	15,000	4	1	1	71^+	160	180
122	Mercantile	M-J	1 (14)	16,000	16,000	4	1	1	25^+	215	85
123	hotel	M-J	5B (75)	85,200	18,000	4	5	5	16	240	660
124	Mercantile	M-J	1 (15)	18,350	18,350	4	1	1	38^+	240	420
125	Mercantile	M-J	2B (26)	18,750	18,750	4	3	1	U	124	160
126	Mercantile & Residential	M-J	2B (26)	18,800	18,800	4	3	Bmt & 1	U	U	U
127	Mercantile & Residential	M-J	1,2 & 3 (16 & 26) 32	23,500	18,900	4	3	1	4^+	75	196

TABLE B-1 COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Occupancy Class and Description	Building Construction Class	Number of Stories (Height) (Feet)	Total Building Area Ft^2	Building Area Involved By Fire (Fire) (Area) A_2 Ft^2 (See Note 2)	Extent of Structural Involvement (See Note 3)	No. of Stories Involved by Fire	Elevation of Fire Origin (Stories)	Fire Time (Minutes) (See Note 5) Preburn Tp	Control Tc	Final Ext. and Overhaul Tc
	1	2	3	4	5	6	7	8	9	10	11
128	Mercantile	M-J	1 (14)	20,000	20,000	4	1	1	43	72	480
129	Lumber Yard	W & M-J	1 (13 & 16)	25,365	21,200	4	1	1	25^+	840	510
130	Mercantile	50% M-J	1 (15)	22,320	22,320	4	1	1	35^+	300	1800
131	Lumber Yard	W	1 (35)	22,420	22,420	4	1	1	65^+	83	1000
132	Industrial	M-J	1 & 2 (24)	39,900	28,400	4	2	1	50^+	138	330
133	Industrial	50% F-R 50% M-CW	50% 3-8B 50% 1 (U)	126,550	63,400	4	1	1	20	90	1020
134	Storage (Vacant)	M-J (Mill)	4B (55)	121,000	121,000	4	5	1	U	120	U

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Water Used For Control				Water Used For Final Exting. and Overhaul (See Note 7)		Fire Streams (See Note 8)			Fire Department (See Note 9)		
							Hand (Hose Size) Inches	Master				
Fire Number	Max. Applic. Rate (Q) (G.P.M.)	Total Quantity of Water Used (Gals.)	Applic. Density Gal/100 Ft^2	Max. Applic. Rate Density GPM/100 Ft^2 (P)	Total Quantity of Water Used (Gals.)	Applic. Density Gal/100 Ft^2			Type	Number of Working Companies	Total Manpower	Manpower Per 100 Ft^2 Fire Area
	12	13	14	15	16	17	18	19	20	21	22	23
1	30	50	67	40	300	400	1-3/4	None	Vol.	2E	28	37
2	30	85	44	38	"	U	1-3/4	None	Paid	1HPF	5	6
3	100	200	2	1	100	1	1-1-1/2	None	Vol.	2E, 1L, 1S	16	16
4	368	203	193	350	814	775	1-1-1/2, 1-2-1/2	None	Paid	1E, 2L	19	18
5	100	300	200	69	300	200	2-1, 1-1-1/2	None	Vol.	3E, 1S	21	15
6	99	50	35	69	150	100	1-1, 1-1-1/2	None	Vol.	1E, 2S	17	12
7	84	160	100	53	160	100	1-3/4, 1-1-1/2	None	Paid	1E, 1L, 1S, 1HPF	27	17
8	180	260	250	102	150	85	1-1, 2-1-1/2	None	Vol.	2E, 1S	15	9
9	78	312	173	43	156	87	1-1-1/2	None	Paid	4E, 2L, 1S	46	26
10	78	312	156	37	156	78	1-1-1/2	None	Paid	1E, 2L, 2S	35	18
11	93	570	271	44	470	224	1-3/4, 1-1-1/2	None	Paid	2E, 1L, 1AP, 1HPF	36	17
12	220	380	165	96	160	70	2-3/4, 2-1-1/2	None	Paid	2E, 2L, 1S, 1HPF	35	15
13	156	1400	580	65	312	130	2-1-1/2	None	Paid	4E, 2L, 1AP 1ES	48	20
14	23	12	5	10	23	10	1-1	None	Vol.	4E, 1S	23	10
15	98	1310	550	40	156	65	1-3/4, 1-1-1/2	None	Paid	3E, 2L, 1AP 1S, 1HPE	44	18
16	110	570	238	46	240	100	1-3/4, 1-1-1/2	None	Paid	3E, 2L, 1S, 1HPF	40	17
17	190	910	360	76	470	190	1-3/4, 2-1-1/2	None	Paid	4E, 2L, 1S	43	17
18	90	180	67	34	180	67	1-1-1/2	None	Paid	2E, 1L, 1S	22	8

TABLE B-1 (Continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Water Used For Control: Max. Applic. Rate (Q) (G.P.M.)	Water Used For Control: Total Quantity of Water Used (Gals.)	Water Used For Control: Applic. Density Gal/100 Ft^2	Water Used For Control: Max. Applic. Rate Density GPM/100 Ft^2 (P)	Water Used For Final Exting. and Overhaul (See Note 7): Total Quantity of Water Used (Gals.)	Water Used For Final Exting. and Overhaul (See Note 7): Applic. Density Gal/100 Ft^2	Fire Streams (See Note 8): Hand (Hose Size) Inches	Fire Streams (See Note 8): Master	Fire Department (See Note 9): Type	Fire Department (See Note 9): Number of Working Companies	Fire Department (See Note 9): Total Manpower	Fire Department (See Note 9): Manpower Per 100 Ft^2 Fire Area
	12	13	14	15	16	17	18	19	20	21	22	23
19	46	320	100	15	180	58	2-1	None	Vol.	3E, 1L	18	6
20	84	570	184	27	250	8	1-3/4, 1-1-1/2	None	Paid	3E, 2L, 1S, 1HPF	45	15
21	234	1330	380	67	625	179	3-1-1/2	None	Paid	3E, 2L, 2AP	42	12
22	290	580	161	80	620	172	1-2-1/2	None	Paid	1E, 1L	14	4
23	173	900	237	46	75	20	1-3/4, 2-1-1/2	None	Paid	4E, 2L, 1S	47	12
24	250	1050	276	66	470	124	3-1-1/2	None	Paid	2E, 1L, 1S	29	8
25	78	624	156	20	312	78	1-1-1/2	None	Paid	2E, 2L, 1AA, 1S	40	10
26	160	490	123	40	780	195	1-3/4, 2-1-1/2	None	Paid	3E, 2L, 1S	39	10
27	78	470	120	20	U	U	1-1-1/2	None	Paid	1E, 1L	14	4
28	180	2465	587	43	780	186	1-3/4, 2-1-1/2	None	Paid	4E, 2L, 2AP, 1HPF	49	12
29	276	1780	420	41	625	147	1-3/4, 2-1-1/2	None	Paid	2E, 2L, 1S, 1AP, 1HPF	44	10
30	480	1370	315	11	470	110	1-3/4, 2-1-1/2, 1-2-1/2	None	Paid	3E, 2L, 1S	35	8
31	46	140	32	10	60	14	2-1	None	Vol.	2E, 1L	12	3
32	237	1740	387	53	460	100	3-1-1/2	None	Paid	3E, 2L	30	7
33	840	4720	1050	187	940	210	1-3/4, 3-1-1/2, 2-2-1/2	None	Paid	2E, 2L, 2S, 2AP	53	12
34	156	312	68	34	U	U	2-1-1/2	None	Paid	2E, 1L, 1S	36	8
35	180	1455	310	38	390	82	1-3/4, 2-1-1/2	None	Paid	2E, 2L, 3S, 2AP	48	10
36	180	1350	270	36	115	23	1-1, 2-1-1/2	None	Vol.	2E, 1Tnk	14	3
37	190	1160	230	38	2000	400	2-1, 2-1-1/2	None	Vol.	3E, 1S	17	3
38	468	1620	324	94	350	70	1-3/4, 2-1-1/2, 1-2-1/2	None	Paid	3E, 2L, 2S, 1AP	46	9

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Water Used For Control				Water Used For Final Exting. and Overhaul (See Note 7)		Fire Streams (See Note 8)			Fire Department (See Note 9)		
							Hand (Hose Size) Inches	Master				
Fire Number	Max. Applic. Rate (Q) (G.P.M.)	Total Quantity of Water Used (Gals.)	Applic. Density Gal/100 Ft^2	Max. Applic. Rate Density GPM/100 Ft^2 (P)	Total Quantity of Water Used (Gals.)	Applic. Density Gal/100 Ft^2		Type	Number of Working Companies	Total Manpower	Manpower Per 100 Ft^2 Fire Area
	12	13	14	15	16	17	18	19	20	21	22	23
39	170	740	148	34	470	94	1-3/4, 2-1-1/2	None	Paid	3E, 2L, 1AP, 1HPF	43	9
40	446	611	111	81	156	30	2-1-1/2, 1-2-1/2	None	Paid	2E, 2L	24	4
41	176	1270	230	32	1660	300	1-3/4, 2-1-1/2	None	Paid	2E, 2L, 2S	39	7
42	130	230	39	22	180	31	1-1, 1-1-1/2	None	Vol.	2E, 1S	12	2
43	110	375	63	18	75	13	2-1-1/2	None	Paid	2E, 2L, 1S	30	5
44	450	2400	400	75	470	78	2-1-1/2, 1-2-1/2	None	Paid	3E, 2L, 1S	32	5
45	310	U	U	50	U	U	1-3/4, 3-1-1/2	None	Paid	5E, 3L	59	10
46	95	119	18	15	50	8	2-1-1/2	None	Paid	2E, 1L, 1S	20	3
47	160	400	59	24	1000	147	2-1-1/2	None	Vol.	2E, 2L	15	2
48	195	950	136	28	1550	220	2-3/4, 2-1-1/2	None	Vol.	2E, 1HPF, 1ES	16	2
49	171	1200	168	24	470	66	1-3/4, 2-1-1/2	None	Paid	2E, 2L, 1AP	36	5
50	185	233	31	25	480	64	2-1-1/2	None	Paid	2E, 1L, 1S	22	3
51	400	1800	225	51	1100	138	1-3/4, 4-1-1/2, 1-2-1/2	None	Paid	5E, 2L, 3S	49	6
52	1092	17500	2000	126	U	U	4-1-1/2, 3-2-1/2	None	Vol.	4E, 1L, 2S	17	2
53	780	6360	734	90	6300	782	3-1-1/2, 2-2-1/2	None	Paid	3E, 3L, 1S	37	4
54	450	2700	307	51	780	89	2-1-1/2, 1-2-1/2	None	Paid	2E, 2L, 1S	35	4
55	565	2100	232	63	1650	183	1-1-1/2, 2-2-1/2	None	Paid	4E, 2L, 1S	39	4
56	158	632	69	17	U	U	2-1-1/2	None	Paid	2E, 1L, 1S	26	3
57	375	1000	100	39	475	50	1-1-1/2, 1-2-1/2	None	Paid	2E, 1L, 1S	19	2
58	380	3380	338	38	2185	219	1-1, 4-2-1/2	None	Vol.	4E	32	3
59	1170	27900	2790	117	17500	175	2-1-1/2, 3-2-1/2	1 AP	Vol.	3E, 1AP	24	2
60	950	13200	1320	95	2800	280	1-1-1/2, 3-2-1/2	None	Paid	4E, 2L, 1S	45	5

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Water Used For Control: Max. Applic. Rate (Q) (G.P.M.)	Water Used For Control: Total Quantity of Water Used (Gals.)	Water Used For Control: Applic. Density Gal/100 Ft^2	Water Used For Control: Max. Applic. Rate Density GPM/100 Ft^2 (P)	Water Used For Final Exting. and Overhaul (See Note 7): Total Quantity of Water Used (Gals.)	Water Used For Final Exting. and Overhaul (See Note 7): Applic. Density Gal/100 Ft^2	Fire Streams (See Note 8): Hand (Hose Size) Inches	Fire Streams (See Note 8): Master		Fire Department (See Note 9): Number of Working Companies	Fire Department (See Note 9): Total Manpower	Fire Department (See Note 9): Manpower Per 100 Ft^2 Fire Area
	12	13	14	15	16	17	18	19	20	21	22	23
61	171	357	33	16	312	29	1-3/4, 2-1-1/2	None	Paid	2E, 2L, 1AP, 1HPF	31	3
62	136	1360	111	11	740	62	2-1, 1-1-1/2	None	Vol.	3E, 1ES	11	1
63	430	1950	163	36	620	52	2-3/4, 1-1-1/2, 1-2-1/2	None	Paid	2E, 1L, 1S, 1HPF	32	3
64	1045	52,500	5150	86	U	U	2-3/4, 4-1-1/2, 2-2-1/2	None	Paid	5E, 2L, 4S	54	5
65	170	680	55	14	470	38	1-3/4, 2-1-1/2	None	Paid	2E, 2L, 1S	34	3
66	450	1810	144	36	550	44	2-1-1/2, 1-2-1/2	None	Paid	4E, 2L, 1S, 1HPF	47	4
67	243	5320	400	18	U	U	1-3/4, 3-1-1/2	None	Paid	4E, 2L, 1S	51	4
68	630	5000	360	45	U	U	1-3/4, 4-1-1/2, 1-2-1/2	None	Paid	4E, 2L, 1S	46	3
69	1030	12,990	840	67	1400	90	2-1-1/2, 12-2-1/2, 1-3	None	Paid	5E, 4L, 2S, 1AP	77	5
70	320	1530	94	20	1720	110	3-3/4, 3-1-1/2	None	Paid	4E, 2L, 1S, 1HPF	45	3
71	480	10,650	650	30	1000	61	2-3/4, 5-1-1/2	None	Vol.	4E, 2L	27	2
72	614	3680	216	36	1230	72	3-3/4, 6-1-1/2	None	Paid	4E, 2L, 1S, 2AP 1HPF	50	3
73	226	3600	208	13	300	17	2-1, 2-1-1/2	None	Vol.	4E, 1S	16	1
74	180	1090	57	10	550	29	1-3/4, 2-1-1/2	None	Paid	3E, 2L, 1AP, 1HPF	49	3
75	700	30,140	1500	35	5000	250	4-1-1/2, 2-2-1/2	None	Paid	5E, 3L, 1S	49	2
76	435	6300	300	20	9200	450	2-3/4, 3-1-1/2, 1-2-1/2	None	Vol.	4E, 2Tnk	27	1
77	580	4900	230	28	940	45	2-3/4, 3-1-1/2, 1-2-1/2	None	Paid	4E, 2L, 1S, 2AP 2AP, 1HPF	50	2
78	1160	21,460	970	52	6900	310	1-3/4, 4-2-1/2	None	Paid	4E, 2L, 1HPF	35	2
79	280	7700	346	13	1870	84	4-1-1/2	None	Paid	4E, 2L, 3S	51	2

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Water Used For Control				Water Used For Final Exting. and Overhaul (See Note 7)		Fire Streams (See Note 8)			Fire Department (See Note 9)		
							Hand (Hose Size) Inches	Master				
Fire Number	Max. Applic. Rate (Q) (G.P.M.)	Total Quantity of Water Used (Gals.)	Applic. Density Gal/100 Ft^2	Max. Applic. Rate Density GPM/100 Ft^2 (P)	Total Quantity of Water Used (Gals.)	Applic. Density Gal/100 Ft^2		Type	Number of Working Companies	Total Manpower	Manpower Per 100 Ft^2 Fire Area
	12	13	14	15	16	17	18	19	20	21	22	23
80	1920	29,560	1310	85	U	U	1-3/4, 3-2-1/2	1-AP	Paid	4E, 3L, 2S, 1AP	63	3
81	950	17,890	778	41	U	U	3-1-1/2, 3-2-1/2	None	Paid	4E, 2L, 1S	45	2
82	324	8,680	339	13	5790	230	1-3/4, 4-1-1/2	None	Paid	4E, 2L, 1S, 1AP	52	2
83	395	49,375	1760	14	7650	300	4-1-1/2, 2-2-1/2	None	Paid	3E, 1L, 1S	30	1
84	810	5210	184	29	U	U	1-3/4, 2-1-1/2, 2-2-1/2	None	Paid	3E, 1L, 1S	30	1
85	915	U	U	U	31	U	4-1-1/2, 2-2-1/2	1LP, 1DS	Paid & Vol	3E, 1L	42	1
86	2000	17,600	590	67	36,400	1200	4-2-1/2	1AP	Paid	4E, 2L, 1S, 1AP	52	2
87	590	6550	210	19	1140	37	4-1-1/2, 2-2-1/2	None	Pd. & VL.	2E, 1L	20	1
88	380	3700	113	12	3300	100	4-1-1/2	None	P & V	2E, 1L, 1S	21	1
89	1170	19,800	560	33	5450	154	2-3/4, 1-1-1/2, 2-2-1/2	None	Paid	8E, 4L, 5S, 3AP, 1ES, 2SE, 1HPF	26	4
90	2140	84,500	2380	60	50,000	1400	2-1, 2-1-1/2, 2-2-1/2	1-AP 1-T	Vol.	6E, 1L, 1AP	44	1
91	2136	12,800	360	60	4200	118	3-1-1/2, 3-2-1/2	2-AP	Paid	8E, 4L, 3S, 3AP, 2LW	111	3
92	2040	24,700	620	51	16,500	410	6-1-1/2, 5-2-1/2	None	Paid	4E, 4L, 3S, 2AP, 1HPF	100	3
93	174	2000	U	U	U	U	1-3/4, 3-1, 1-1-1/2	None	Vol.	4E, 1S, 1Tnk	22	U
94	1690	57,700	1374	40	37,300	888	7-1-1/2, 4-2-1/2	1-LP	Vol.	6E, 2L	73	2
95	1060	40,000	875	23	9000	195	2-1-1/2, 2-2-1/2	1 LP	Paid	2E, 1L	22	1
96	340	4520	98	7	2340	51	1-3/4, 4-1-1/2	None	Paid	4E, 2L, 1S, 2AP	49	1
97	945	12,200	260	20	1680	36	2-1-1/2, 1-2-1/2	None	Vol.	2E	20	0.4
98	1250	21,000	444	26	5200	110	2-3/4, 5-1-1/2	None	Paid	4E, 2L, 2S, 2HPF	54	1
99	414	18,630	390	9	20,310	427	6-1-1/2	None	Vol.	3E, 3S	30	1
100	960	8,500	170	19	33,500	670	4-1-1/2, 3-2-1/2	None	Vol.	3E, 1S	32	1

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Water Used For Control				Water Used For Final Exting. and Overhaul (See Note 7)		Fire Streams (See Note 8)			Fire Department (See Note 9)		
							Hand (Hose Size) Inches	Master				
Fire Number	Max. Applic. Rate (Q) (G.P.M.)	Total Quantity of Water Used (Gals.)	Applic. Density Gal/100 Ft^2	Max. Applic. Rate Density GPM/100 Ft^2 (P)	Total Quantity of Water Used (Gals.)	Applic. Density Gal/100 Ft^2			Type	Number of Working Companies	Total Manpower	Manpower Per 100 Ft^2 Fire Area
	12	13	14	15	16	17	18	19	20	21	22	23
101	1580	164,600	2195	21	204,000	2730	4-2-1/2	1-T	Paid	3E, 1L	31	0.4
102	3100	471,800	5400	36	U	U	12-1-1/2, 5-2-1/2	1-LP 2-DS	Vol.	3E, 1L	53	1
103	7170	383,000	4350	81	U	U	1-1-1/2, 7-2-1/2, 43	5-AP	Paid	14E, 5L, 3S, 5AP 1ES, 1LW	135	2
104	6200	230,000	2460	66	195,000	2100	6-2-1/2	4-AP, 2-T	Paid	15E, 4L, 3S, 4AP	149	2
105	2930	65,000	677	30	30,000	310	2-1-1/2, 3-2-1/2	1-AP, 1-T	Paid	4E, 2L, 1S, 2AP	46	1
106	2800	21,800	220	28	5,600	57	3-1-1/2, 4-2-1/2	1-AP	Paid	8E, 4L, 3S, 2AP 2LW	111	1
107	880	U	U	9	U	U	4-1-1/2, 2-2-1/2	None	Vol.	5E, 1L	28	0.3
108	2130	212,000	2130	21	9,600	96	7-2-1/2	None	Vol.	4E	28	0.4
109	230	14,000	130	2	6,000	57	4-1-1/2, 1-2-1/2	None	Vol.	3E, 1S	26	0.3
110	1970	120,000	1100	18	40,000	470	5-1-1/2, 1-2-1/2	1-DS, 1-AP	Vol.	5E, 1L, 1S, 1AP	42	0.4
111	200	1,000	9	2	None	None	2-1-1/2	None	Vol.	1E, 1S	15	0.1
112	1190	U	U	10	U	U	6-1-1/2, 2-2-1/2	None	Vol.	4E, 1L	27	0.2
113	2615	476,600	3940	22	159,100	1320	6-1-1/2, 3-2-1/2	3-DS	Vol.	5E, 1L	32	0.3
114	535	82,300	676	4	23,600	194	4-1-1/2, 1-2-1/2	None	Vol.	4E, 1L, 1Tnk	36	0.3
115	4540	75,970	620	37	51,400	420	9-2-1/2	2-AP	Paid	11E, 5L, 3S, 2AP	116	1
116	410	3,450	28	3	3,450	28	2-3/4, 2-1-1/2, 1-2-1/2	None	Vol.	2E, 1Tnk	26	0.2
117	6700	580,000	4660	54	82,500	665	2-2-1/2	4AP3-T	Paid	15E, 4L, 4AP, 3S	119	1
118	2100	224,000	1630	15	5,200	38	2-1-1/2, 4-2-1/2	1-LD	Vol.	5E	36	0.3
119	1590	14,600	103	11	U	U	2-3/4, 1-1-1/2, 5-2-1/2	None	Paid	4E, 2L, 1S, 1HPF	44	0.3
120	440	24,000	180	3	56,000	380	2-3/4, 4-1-1/2, 1-2-1/2	None	Paid & Vol.	3E, 7Tnk	43	0.3

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

Fire Number	Water Used For Control: Max. Applic. Rate (Q) (G.P.M.)	Water Used For Control: Total Quantity of Water Used (Gals.)	Water Used For Control: Applic. Density Gal/100 Ft^2	Water Used For Control: Max. Applic. Rate Density GPM/100 Ft^2 (P)	Water Used For Final Exting. and Overhaul (See Note 7): Total Quantity of Water Used (Gals.)	Water Used For Final Exting. and Overhaul (See Note 7): Applic. Density Gal/100 Ft^2	Fire Streams (See Note 8): Hand (Hose Size) Inches	Fire Streams (See Note 8): Master	Fire Department (See Note 9): Type	Fire Department (See Note 9): Number of Working Companies	Fire Department (See Note 9): Total Manpower	Fire Department (See Note 9): Manpower Per 100 Ft^2 Fire Area
	12	13	14	15	16	17	18	19	20	21	22	23
121	687	110,000	733	5	75,600	500	6-1-1/2, 2-2-1/2	None	Vol.	4E, 4Tnk	44	0.3
122	5215	1005,000	6275	33	578,000	3600	2-1-1/2, 2-2-1/2	5-LD, 3-DS	Paid	7E, 4L, 1S	122	1
123	5730	1360,000	7549	32	U	U	2-2-1/2	2-LD, 7-DS	Paid	8E, 2L, 3S	55	0.3
124	1900	424,000	2300	10	U	U	2-2-1/2	2-LP, 1-DS	Paid & Vol.	3E, 1L, 1S, 1AP	56	0.3
125	6570	460,000	2453	35	7,650	41	1-3/4, 1-1-1/2, 9-2-1/2 4-3	5-T	Paid	12E, 5L, 3S, 3AP 2HPF, 2LW, 2SE	327	2
126	U	U	U	U	U	U	U	None	Paid	(See Remarks)		
127	4330	181,700	960	23	11,270	60	2-1-1/2, 9-2-1/2	1-AP	Paid	13E, 6L, 3S, 1AP 2LW, 2ES	136	1
128	1615	112,750	563	8	87,250	436	2-2-1/2	1-DS	Vol.	3E, 1L	40	0.2
129	3760	340,000	1600	18	134,000	630	12-1-1/2, 6-2-1/2	1-AP, 1-LP	Vol.	7E, 1L, 1S, 1AP	48	0.2
130	3330	814,000	3650	15	3,424,000	15,340	5-2-1/2	1AS, 1-AP	Vol.	4E, 2S, 1AP	37	0.2
131	1800	210,000	938	8	48,000	214	4-1-1/2, 7-2-1/2	None	Vol.	9E	58	0.3
132	2380	272,000	960	8	154,000	540	6-1-1/2, 3-2-1/2	1-AP, 1-LP	Vol.	6E, 2L, 1AP, 1ES	37	0.1
133	2190	145,000	230	4	1,277,000	2000	2-2-1/2	3-AP, 1-LP	Vol.	4E, 1L, 3AP	75	0.1
134	3360	U	U	3	U	U	4-1-1/2, 3-2-1/2	2-DS	Vol.	7E, 2L	44	0.04

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Use of Manpower (Manhours) (See Note 10)									Weather Data		
Fire Number	Rescue	Forcible Entry	Ventilation	Exposure Protection	Extinguishment	Total Manhours Cols. 24 thru 28	Salvage	Overhaul	Total Manhours Cols. 30 & 31	Temp. °F	Visibility	Wind Speed (MPH)
	24	25	26	27	28	29	30	31	32	33	34	35
1	1	0.1	0.3	None	0.1	1.5	None	2.0	2.0	40	Clear	Light
2	None	U	U	None	U	U	None	U	U	48	Clear	5
3	0.1	0.1	0.5	None	0.5	1.2	0.5	2.5	3	42	Clear	15-20
4	None	0.4	0.3	None	2.3	3.0	1.0	8.3	9.3	22	Clear	5
5	None	None	1.0	None	6.0	7.0	None	6.0	6.0	50	Clear	5
6	None	0.3	1.0	None	1.0	2.3	None	10.0	10.0	56	Clear	5-10
7	None	0.7	0.7	None	1.2	2.6	None	8.6	8.6	38	Clear	5
8	None	0.5	2.0	None	5.0	7.5	2.0	10.0	12.0	18	Snowing	Calm
9	0.2	1.1	0.7	None	1.7	3.7	None	4.7	4.7	38	Clear	15
10	None	7.0	1.4	None	4.0	12.4	1.0	9.0	10.0	1	Clear	15
11	0.2	2.2	0.4	None	1.5	4.3	None	4.6	4.6	20	Clear	3
12	None	0.9	1.1	None	2.9	4.9	0.3	5.4	5.7	74	Clear	4
13	4.0	2.6	0.3	None	3.2	10.1	1.7	10.3	12.0	25	Clear	18
14	None	0.1	0.5	None	0.3	0.9	0.1	12.3	12.4	20	Clear	20
15	None	5.7	0.3	None	7.4	13.4	0.3	20.8	21.1	34	Clear	8
16	None	1.6	1.3	None	2.5	5.4	0.9	4.5	5.4	72	Clear	5
17	None	1.3	1.2	None	3.7	6.2	0.3	10.7	11.0	77	Clear	7
18	0.1	0.1	1.6	1.3	2.0	4.1	1.0	7.8	8.8	40	Clear	5
19	None	None	0.5	None	1.3	1.8	None	8.0	8.0	50	Clear	10
20	None	2.5	1.4	None	2.8	6.7	None	3.6	3.6	38	Clear	3

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Use of Manpower (Manhours) (See Note 10)									Weather Data		
Fire Number	Rescue	Forcible Entry	Ventilation	Exposure Protection	Extinguishment	Total Manhours Cols. 24 thru 28	Salvage	Overhaul	Total Manhours Cols. 30 & 31	Temp. °F	Visibility	Wind Speed (MPH)
	24	25	26	27	28	29	30	31	32	33	34	35
21	None	4.0	0.6	None	2.7	7.3	None	5.0	5.0	22	Clear	5
22	None	0.5	None	None	2.2	2.7	None	4.5	4.5	48	Clear	5
23	None	3.5	0.9	None	7.0	11.4	1.5	19.0	20.5	35	Clear	5
24	None	1.2	None	None	2.5	3.7	0.4	7.1	7.5	45	Clear	3
25	None	1.4	2.1	None	3.4	6.9	0.8	7.4	8.2	25	Clear	10
26	None	1.3	None	None	2.9	4.2	None	7.9	7.9	42	Clear	16
27	None	0.5	None	None	2.2	2.7	None	4.5	4.5	48	Clear	5
28	None	1.4	2.4	None	4.3	8.1	0.8	11.1	11.9	26	Clear	5
29	None	3.3	0.6	None	4.6	8.5	0.3	14.3	14.6	26	Clear	5
30	None	0.1	0.7	0.5	1.0	2.3	0.5	17.9	18.4	91	Clear	10
31	None	None	0.5	None	1.5	2.0	None	6.0	6.0	50	Clear	20
32	None	1.3	0.8	None	5.0	7.1	1.7	34.0	35.7	-6	Clear	12
33	None	6.9	2.6	None	15.2	24.7	0.6	15.0	15.6	8	Clear	12
34	None	0.7	1.0	None	3.0	4.7	3.0	13.0	16.0	30	Clear	5
35	1.6	10.7	None	None	6.2	18.5	None	2.4	2.4	12	Clear	55
36	None	0.1	None	None	2.1	2.2	None	14.2	14.2	20	Clear	10
37	None	None	3.0	None	14.0	17.0	3.0	20.0	23.0	42	Clear	3
38	None	6.7	0.8	None	6.0	13.5	None	20.0	20.0	30	Clear	8
39	0.6	1.1	0.3	None	0.3	2.3	0.4	3.3	3.7	35	Clear	10
40	None	0.4	0.1	0.1	2.6	3.2	0.2	4.1	4.3	25	Clear	5

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Use of Manpower (Manhours) (See Note 10)									Weather Data		
Fire Number	Rescue	Forcible Entry	Ventilation	Exposure Protection	Extinguishment	Total Manhours Cols. 24 thru 28	Salvage	Overhaul	Total Manhours Cols. 30 & 31	Temp. °F	Visibility	Wind Speed (MPH)
	24	25	26	27	28	29	30	31	32	33	34	35
41	None	0.5	1.5	None	10.6	12.6	0.5	9.1	9.7	41	Clear	10
42	None	None	0.1	None	2.8	2.9	None	3.8	3.8	84	Clear	5
43	None	3.0	0.5	None	5.0	8.5	2.0	7.0	9.0	5	Clear	15
44	1.0	0.3	None	None	2.1	3.4	0.5	14.4	14.9	61	Rain	8
45	U	U	U	U	U	U	U	U	U	10	Clear	10
46	U	U	U	U	U	U	U	U	U	45	Clear	5
47	None	None	None	None	1.3	1.3	None	8.2	8.2	60	Clear	Light
48	1.0	None	2.0	None	5.0	8.0	3.0	11	14.0	70	Clear	8
49	None	1.4	0.8	None	7.9	10.1	0.5	7.7	8.2	11	Cloudy	8
50	U	U	U	U	U	U	U	U	U	42	Clear	5
51	None	1.2	1.1	2.5	4.0	8.8	1.2	35	36.2	45	Clear	5
52	None	2.0	1.5	None	17	20.5	1	20	21	42	Clear	15
53	U	U	U	U	U	U	U	U	U	40	Cloudy	3
54	None	2.3	1.6	None	3.2	7.1	None	8.3	8.3	68	Clear	14
55	U	U	U	U	U	U	U	U	U	38	Clear	5
56	None	0.9	2.3	None	5.0	8.2	1.3	13	14.3	25	Clear	10
57	U	U	U	U	U	U	U	U	U	63	Clear	5
58	None	3.0	0.4	None	7.8	11.2	None	56.8	56.8	15	Clear	18
59	None	None	None	2	10	12	None	9	9	6	Clear	15
60	None	2.5	1.4	2.4	4.4	10.7	None	9.4	9.4	38	Clear	5

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Use of Manpower (Manhours) (See Note 10)									Weather Data		
Fire Number	Rescue	Forcible Entry	Ventilation	Exposure Protection	Extinguishment	Total Manhours Cols. 24 thru 28	Salvage	Overhaul	Total Manhours Cols. 30 & 31	Temp. °F	Visibility	Wind Speed (MPH)
	24	25	26	27	28	29	30	31	32	33	34	35
61	None	3.2	1.5	None	6.7	11.4	1.1	7.5	8.6	22	Clear	5
62	None	None	None	None	2.8	2.8	1.0	8.0	9.0	38	Clear	5
63	None	3.3	1.4	None	6.6	11.3	None	4.9	4.9	51	Clear	8
64	U	U	U	U	U	U	U	U	U	-4	Clear	5
65	None	6.3	1.5	None	9	16.8	1.5	13	14.5	36	Clear	10
66	None	2.4	1.3	None	5.6	9.3	0.7	15.3	16.0	52	Clear	5
67	None	5.0	3.3	None	11.0	19.3	3.5	28.0	31.5	30	Clear	5
68	None	7.0	4.0	0.9	13.0	24.9	None	20.0	20.0	12	Cloudy	15
69	None	3.8	2.6	1.4	11.6	19.4	None	21.7	21.7	26	Clear	10
70	None	None	1.7	None	7.5	9.2	None	14.5	14.5	81	Clear	16
71	0.8	None	1.0	None	10.0	11.8	None	24.0	24.0	50	Clear	Light
72	None	3.3	2.3	None	10.1	15.7	0.7	18.9	19.6	57	Raining	16
73	None	None	0.5	None	14.0	14.5	3.0	4.5	7.5	37	Clear	8
74	0.8	1.6	1.2	None	2.3	5.9	None	8.6	8.6	15	Clear	15
75	U	U	U	U	U	U	U	U	U	-15	Clear	10
76	None	None	None	6.3	39	45.3	None	10	10	65	Partly Cloudy	12-18
77	0-1	5.5	3.2	None	10.5	19.3	None	19.8	19.8	86	Clear	8
78	None	2.2	0.7	1.3	6.0	10.2	None	26.0	26.0	40	Clear	20
79	None	8.0	1.2	3.0	15.0	27.2	6.0	49.0	55.0	10	Clear	10
80	U	U	U	U	U	U	U	U	U	55	Clear	10

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Use of Manpower (Manhours) (See Note 10)									Weather Data		
Fire Number	Rescue	Forcible Entry	Ventilation	Exposure Protection	Extinguishment	Total Manhours Cols. 24 thru 28	Salvage	Overhaul	Total Manhours Cols. 30 & 31	Temp. °F	Visibility	Wind Speed (MPH)
	24	25	26	27	28	29	30	31	32	33	34	35
81	None	3.0	0.9	None	19	22.9	None	43	43	22	Clear	5
82	0.8	16.0	0.8	None	19	36.6	15	61	76	8	Clear	15
83	U	U	U	U	U	U	U	U	U	-20	Clear	5
84	U	U	U	U	U	U	U	U	U	45	Clear	5
85	U	U	U	U	U	U	U	U	U	40	Clear	10
86	None	3.0	1.3	None	12	16.3	None	30	30	0	Clear	15
87	U	U	U	U	U	U	U	U	U	75	Clear	Calm
88	U	U	U	U	U	U	U	U	U	92	Clear	5
89	2.8	35.0	5.9	None	52.7	96.4	2.8	79.2	82.0	34	Clear	17
90	None	None	None	5	35	40	None	14	14	48	Cloudy	Calm
91	3.0	29.0	2.0	0.4	32.0	66.4	7.0	84.0	91.0	29	Clear	10
92	None	11.0	11.0	3.3	25.0	50.3	None	93	93	75	Clear	10-15
93	None	None	None	34.0	None	34.0	None	None	None	42	Cloudy	20-30
94	None	2.0	8.0	None	62.5	72.5	None	26.5	26.5	16	Cloudy	Light
95	None	None	None	6.0	8.0	14	None	12.0	12.0	32	Clear	Calm
96	None	6.4	0.8	None	10.2	17.4	None	39.4	39.4	74	Clear	12
97	None	None	2.0	None	10.0	12.0	None	45.0	45.0	26	Clear	20
98	None	0.8	0.6	6.0	39.0	46.4	1.3	60.0	61.3	25	Clear	20
99	None	None	2.0	None	19.0	21.0	3.0	65.0	68.0	-2	Clear	5
100	None	2.5	5.0	4.0	52.0	63.5	None	41.0	41.0	40	Clear	25

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Use of Manpower (Manhours) (See Note 10)									Weather Data		
Fire Number	Rescue	Forcible Entry	Ventilation	Exposure Protection	Extinguishment	Total Manhours Cols. 24 thru 28.	Salvage	Overhaul	Total Manhours Cols. 30 & 31	Temp. °F	Visibility	Wind Speed (MPH)
	24	25	26	27	28	29	30	31	32	33	34	35
101	U	U	U	U	U	U	U	U	U	-18	Clear	5
102	U	U	U	U	U	U	U	U	U	65	Cloudy	10
103	2.3	29.0	16.0	None	494	541	7.7	202	209.7	40	Clear	10
104	U	U	U	U	U	U	U	U	U	13	Clear	10
105	None	3.2	1.7	2.2	20.0	27.1	None	156.0	156.0	65	Clear	10
106	None	15.0	5.0	None	68.0	88.0	6.4	12.0	18.4	38	Clear	3
107	None	None	None	7.8	22.0	29.8	None	24.5	24.5	20	Cloudy	14-25
108	None	U	U	None	55.0	55.0	None	10.0	10.0	50	Clear	28
109	None	None	None	22.0	30.0	52.0	None	60.0	60.0	65	Clear	8
110	None	1.0	1.0	13.5	48.5	64.0	12.0	36.0	48.0	70	Partly Cloudy	20-30
111	None	None	None	None	5.0	5.0	0.5	2.0	2.5	60	Clear	3
112	None	0.3	None	5.5	40.0	45.8	None	117.0	117.0	-2	Cloudy	14
113	U	U	U	U	U	U	U	U	U	6	Cloudy	5
114	U	U	U	U	U	U	U	U	U	10	Cloudy	20
115	None	2.1	1.6	None	29	32.7	None	84	84	20	Clear	15
116	U	U	U	U	U	U	U	U	U	70	Clear	10
117	U	U	U	U	U	U	U	U	U	40	Clear	10
118	None	None	None	None	87	87	None	U	U	33	Clear	20-25
119	None	2.9	0.2	0.9	4.9	8.9	None	23.4	23.4	48	Clear	5
120	None	None	None	6.0	42.0	48.0	None	70.0	70.0	56	Cloudy	40

TABLE B-1 (continued) - COMPILATION OF DATA ON FIRE DEPARTMENT OPERATIONS

	Use of Manpower (Manhours) (See Note 10)									Weather Data		
Fire Number	Rescue	Forcible Entry	Ventilation	Exposure Protection	Extinguishment	Total Manhours Cols. 24 thru 28	Salvage	Overhaul	Total Manhours Cols. 30 & 31	Temp. °F	Visibility	Wind Speed (MPH)
	24	25	26	27	28	29	30	31	32	33	34	35
121	U	U	U	U	U	U	U	U	U	-13	Clear	5
122	U	U	U	U	U	U	U	U	U	8	Clear	10
123	U	U	U	U	U	U	U	U	U	4	Clear	27
124	U	U	U	U	U	U	U	U	U	1	Clear	15
125	None	0.6	16.8	None	408.0	425.4	202	202.0	204.2	26	Clear	7
126	U	U	U	U	U	U	U	U	U	5	27-inch snow on ground	8
127	None	7.0	6.0	7.0	90.0	110.0	None	156.0	156.0	39	Cloudy	18
128	U	U	U	U	U	U	U	U	U	90	Clear	Calm
129	None	1.0	None	16.0	93.0	110.0	None	44.0	44.0	28	Cloudy	25-40
130	None	None	None	None	185.0	185.0	None	360.0	360.0	25	Clear	Light
131	U	U	U	U	U	U	U	U	U	20	Clear	15
132	None	0.8	0.3	4.0	56.0	61.1	None	45.0	45.0	45	Clear	10-12
133	U	U	U	U	U	U	U	U	U	0	Clear	5
134	None	0.3	None	84.3	9.3	93.9	None	4.5	4.5	60	Cloudy	12-20

REMARKS FOR TABLE B-I

FIRE NUMBER

1. Two persons died as a result of this early-morning fire which started in the living room. The fire was minor, but very dense smoke was generated.
2. This was one of four arson fires started at about the same time, during the same evening, in the same locality. A mattress and floor were burned. The fire was started by a "fire bomb".
3. Originating on the first floor office of a meat sales processing and locker plant, this fire was quickly discovered, easily accessible and quickly controlled.
4. After a rather long preburn time, this first story living room fire was quickly controlled.
5. A slow-spreading fire started in a closet and spread into the bedroom of this residence.
6. A slow-spreading fire started in a closet and spread into the bedroom of this residence.
7. This fire originated from a "fire bomb" thrown into the front entrance of an apartment building. The fire was quickly overcome.
8. This slowly developing fire originated in a closet in a first-story barber shop and spread into an overhead attic space. All water was taken from booster tanks. A good stop was made.
9. Fire originated in a first-story kitchen and spread to an adjoining room in the apartment.
10. Fire rekindled, after occupants attempted to extinguish, and spread throughout one room and spread through hollow walls from the second story into a blind attic.
11. Originating in the living room of a second-story apartment, this fire spread into adjoining rooms, but was stopped before it spread to other stories. Rescue

of three persons from the third-story apartment was necessary.

12. This fire occurred in a second-story bedroom, spread to the dining room and involved part of the roof. The fire was discovered by neighbors. A good stop was made.
13. A slowly developing fire in a one-room apartment on the second story, together with a delayed alarm resulted in the death of one building occupant and required the rescue of three others.
14. Originating in the utility room of the dwelling, this fire was quickly brought under control. Water used was from a booster tank.
15. Of unknown origin, this fire occurred in a room adjoining the choir loft of the church and was beginning to penetrate the ceiling into the loft over the entire building when it was brought under control.
16. Fire originated in the second floor of a commercial printing shop and was confined to the room of origin.
17. This arson fire was set on a rear wood porch at the first story level, and spread into two rear rooms of the second-story apartment. A good stop was made.
18. This second-story fire was confined to the story of origin. Two persons were rescued.
19. Located in an area without a public water system, this dwelling fire was controlled and extinguished by water from booster tanks.
20. Fire originated in the living room of a first-story apartment and began to spread into the dining room.
21. This fire originated in the kitchen of a second-story apartment and spread down a hall to nearby rooms. Although fire did penetrate a bathroom ceiling to the third story, a good stop was made.

22. This was one of four arson fires started at about the same time, during the same evening, in the same locality. The fire originated in the attic of this dwelling and resulted in a burnout of one attic room. The fire was started by a "fire bomb".

23. A second-story apartment was fully involved when the first fire fighting units arrived. Due to a pipe opening in a fire wall, fire spread into a third-story apartment in an adjoining fire section.

24. Fire originated on the second story in an enclosed rear porch and spread through an open window into a rear bedroom.

25. This was a good stop of a fire which almost completely involved a three-room apartment on the fourth story of the building. The fire was confined to the apartment of origin. Fire penetrated the roof.

26. Fire originated in the clothes dryer of a commercial laundry, and spread up the vent into the lint house on the roof. The dryer vent was burned out, the lint house was destroyed and a section of roof was burned.

27. This was one of four arson fires started at about the same time, during the same evening, in the same locality. Fire originated in a room on the second story. The fire was started by a "fire bomb".

28. A good stop was made of a delayed-discovery fire which was well developed upon arrival of the first fire fighting units.

29. This fire originated in a bedroom of a second-story, four-room apartment; the apartment was almost totally involved before discovery. Fire spread to the third story via an open stairway, openings around pipes and through windows.

30. Fire originated in a second-story, enclosed rear porch and spread into the apartment; two rear rooms and the roof were involved. A good stop was made.

31. Located in an area without a public water system, this dwelling fire was controlled and extinguished by water supplied from booster tanks.

32. Originating in a second-story interior partition, this fire spread up and down within the partition and involved a second story room on each side of the partition by the time the first fire fighting units arrived.

33. This fire was confined to the apartment of origin, a three-room apartment located on the third story. Fire also penetrated the roof.

34. A good stop was made or a relatively small attic fire.

35. An excellent stop was made of a fire which originated in a first story laundry room and spread via open spaces in walls and floor to the second story, and was well on its way to the third story when brought under control.

36. An overheated stove caused ignition of a wood bench. Due to delayed discovery, the building was fully involved by fire when the alarm went in. All water was carried to the fire by tanker or in booster tanks.

37. Fire in a hotel restaurant kitchen spread into a hollow wall without fire stops.

38. A good stop was made of a well developed fire which originated in a second-story "vacant" apartment over a store.

39. A good stop was made of a well-developed fire. Due to delayed discovery, when fire fighting units arrived, the fire had spread from the second to the third story via an interior stairway and window in a light well.

40. Originating in a first-story apartment, this fire spread across a light well to the second and third story apartments.

41. Upon arrival, fire fighting units found three separate fires, and suspect arson in this supermarket. The fires resulted in stock damage only; no structural damage was reported.

42. Fire originated in the kitchen of a dwelling, spread to the utility room, living room, breezeway and garage. A good stop was made. All water was supplied from booster tanks on pumpers.

43. A second-story apartment fire originated in the living room; flashover had occurred by the time the first fire fighting units arrived.

44. Fire originated in a third-story living room, initially involving an upholstered chair. While an attempt was being made to push the chair out of the front window, the chair burst into flames and also became lodged in the opening. A woman was rescued from a third-story bedroom; also, a search and rescue effort was made for another person; it was later found that this other person had escaped.

45. This was a basement fire which spread upward through hollow walls.

46. This was a third-story fire, confined to the story of origin.

47. This was a delayed discovery fire in an unoccupied dwelling. All water was supplied from booster tanks.

48. This roominghouse fire originated in or near a bed in a front room on the second story. Three men overcome by smoke were found in rooms well away from the fire and rescued. No loss of life was reported.

49. An overheated flue pipe from a coal-fired water heater caused ignition of the basement ceiling. Fire spread to the first story due to hollow walls without firestops. An open heating duct caused fire spread to the second story.

50. This was a first story fire confined to that level.
51. A good stop was made in a building with seven apartments.
52. This fire started in a small printing shop located on the first story, and spread to an adjoining tavern and to apartments on the second story. A good stop was made, even though considerable difficulty due to concealed spaces in walls, floors and shelving was encountered.
53. This was a back porch fire which spread upward and into the building.
54. Fire originated under a rear wood porch of this vacant duplex and spread into the first and second stories of one apartment. Discovery of this fire was delayed, and was reported by a passerby.
55. This was an outside rubbish fire which spread into the rear of the building.
56. This was a basement fire which spread through an open door into the first story and through a ceiling into the story above.
57. This first-story restaurant fire spread downward into a basement clothing store.
58. Caused by a defective fireplace igniting a wood floor base, this slowly developing fire spread through hollow walls and floors. Located in a rural lake region, all water was carried to the fire in tanks on pumpers. Two of the four pumpers which responded were used as tankers.
59. This fire involved flammable liquids stored on an exterior concrete platform which exposed the main manufacturing building.
60. Fire originated in a wood auto repair garage and spread to two nearby residential buildings, involving a portion of two stories and an attic.

61. Due to a faulty stoker, a previous fire occurred in the basement of this building. The fire being reported on resulted from a rekindle six hours later, involving a liquor storage room in a tavern. The basement was not involved in the second fire. Fire spread to the second story due to openings around steam pipes.

62. An eight-to-ten minute delayed alarm allowed this farm building fire to gain considerable headway by the time fire fighting units arrived. All water was carried to the fire in booster tanks, some tanks were refilled from a hydrant one-half mile away.

63. Fire originated in the rear wood porch of a first story tavern and spread to the upper two stories. A good stop was made.

64. This basement fire spread upward through hollow walls and ducts.

65. This fire originated on a rear porch at the first story level and spread to the second story and attic via windows and hollow walls.

66. Fire originated at the bottom of a rear stairway of an enclosed wood porch and spread into first and second story apartments.

67. Originating in the bedroom of the second-story apartment, fire ultimately involved the central portion of the apartments on all three stories, including the roof; fire burned through the second floor and dropped to the first story.

68. This was the second of two fires in this building on the same day, as a result of a defective heating system.

69. The first story was well-involved when fire fighting units arrived. A smoke explosion occurred after ventilation of the second story resulting in some structural damage.

70. This fire originated on a rear wood porch at the first-story level, spread up into the wood porches at the second and third stories, and then spread into the rear of the second-and third-story apartments. A good stop was made.

71. This fire was well developed in the first story when discovered by occupants of the second story when their alarm clock rang at 7:10 am. A 4-year old child could not be rescued from a second-story bedroom. Fire did not penetrate the attic. A good stop was made.

72. Fire originated in the second story, spread to the third story via the front stairway and penetrated the roof. Prior to the arrival of fire fighting units, two children jumped from the second and third stories and were caught or aided by police officers and watchers.

73. This fire developed rapidly in an attached garage and spread to the second story dwelling, requiring some occupants to jump from windows. Located in a rural area without public water supply, all water was supplied from booster tanks.

74. Originating in the basement ceiling due to an overheated furnace, this fire burned out the basement, spread to the first story and to the rear wooden porches. Dense smoke filled all spaces, requiring rescue of occupants.

75. This basement fire spread upward through hollow walls.

76. This open salt storage shed was well involved by fire upon discovery. Exposure protection was a major part of this effort. All water was tanked to the fire ground.

77. Fire originated in a first story clothes closet and spread via the front stairway to involve all of the second story, the stairway and roof at the third story level. A child was rescued from the first story.

78. This fire started from a "fire bomb" thrown at the front of the building; fire penetrated exposed buildings 3 to 4 feet away.

79. This fire started in a one-story, detached garage and spread to the dwelling.

80. This was a well-developed fire, with some spread to an adjacent building.

81. Fire originated under a rear open porch and entered the second story via rear windows.

82. A delayed discovery permitted a second-story apartment to become totally involved by fire before arrival of fire fighting units.

83. A well-developed fire in a metal reclaiming plant, fought under conditions of cold weather, darkness and poor water supply.

84. This was a basement fire which spread upward through walls to the first story and then to an adjacent dwelling.

85. This basement fire spread upward through hollow walls.

86. This fire was well-established in a vacant building, the telephone alarm was delayed because of delayed discovery.

87. This first-story fire spread up a stairway to involve a part of the second story.

88. This first-story fire spread up a stairway to the third story.

89. Fire originated in a third-story room and penetrated the ceiling to an unfirestopped concealed space under the roof, ultimately involving about 1250 square feet of floor area and 2300 square feet of concealed space. This was a good stop Six persons were rescued.

90. This fully developed fire in a vacant building spread into an adjoining building through unprotected openings in a common wall.

91. Fire walls divided this 24-apartment building into three fire sections. Fire originated in the second story of an end section; upon arrival of fire fighting units, the fire had spread via two stairways to the third and fourth stories.

92. A delayed discovery permitted 75% of the ultimate fire area to become involved before arrival of fire fighting units.

93. The unoccupied barn on a farm was totally involved upon arrival of the first fire fighting units. Water carried to the fire in booster tanks or tank truck was used almost exclusively for exposure protection.

94. This delayed alarm fire originated in the stockroom of a drygoods store stocked for Christmas Holiday business. Customers were evacuated safely, while employees tried in vain to fight the fire with portable extinguishers.

95. This was a well-developed fire, with some spread to an adjacent building.

96. Vacant since a previous fire about six months ago, fire originated (vandals suspected) in a second story and spread via open light well, stairways and doors to third and fourth stories.

97. Thirty-three sprinklers operated in this building for about 20 minutes to discharge about 10,000 gallons of water. Fire origin was near the boundary of sprinklered and unsprinklered area under construction.

98. Originating at the first story on a rear porch, this fire spread to all levels of the building of origin, and to two other nearby buildings. Burning brands exposed buildings one block away.

99. This fire started on the first story of a sixteen unit apartment building and spread to adjoining apartments on the first and second stories.

100. A good stop was made of a well-developed fire in an adjoining shed, which spread through unprotected windows and door into the main manufacturing building. The fire department was recalled after 4 hours due to a rekindle.

101. 100% involvement of a bus garage.

102. This was a fully developed factory fire.

103. This fire totally destroyed a flour mill while a cut-off warehouse was saved.

104. 100% involvement of a warehouse.

105. An explosion, followed by fire caused a broken gas line to feed the fire. Floor and roof collapse resulted in a long overhaul period.

106. A basement fire which quickly spread upward through an interior hollow partition to involve the first and second stories and a blind attic. Spread of fire was aided by a fuel gas flame burning at the meter.

107. This fire was well-developed when discovered by a passer-by, resulting in a primary effort to protect exposures. At least 78,000 gallons of water were used for this operation; however, there seemed to

be no way in which to estimate how much water was used for control with the remainder used for overhaul.

108. This one-story building was divided into eight fire sections by fire walls with 18-inch parapets. Fire damage was practically total in the fire section involved.

109. This was a fully developed fire in an unoccupied race track club house. Fire fighting operations were primarily directed toward protection of exposed buildings.

110. Before discovery, this fire had spread via exterior wood porches and stairway from a grade level storage room to the roof. This was a good stop, considering that water was pumped from a nearby lake, pond and stream.

111. This was a fire condition in which the indirect application of "fog" produced remarkable results. The fire involved the attic space over a supermarket.

112. This fire was well developed when discovered. When fire fighting units arrived, the primary effort was directed toward protecting exposures. Over 200,000 gallons of water were used for this operation; however, the available information did not permit division into the quantity of water used for control and that used for overhaul.

113. This was a mercantile fire involving three adjacent buildings.

114. This large building fire in a rural area was fought entirely with water hauled-in by tank truck.

115. This well-established fire in a vacant building was started by vandals using a cutting torch to remove junk metal. A delayed alarm was reported by a passer-by.

116. This fully developed fire in a three-story restaurant and office section was fought entirely with water hauled in by tank truck.

117. This was a mercantile fire which penetrated a large concealed space above the ceiling.

118. This fire resulted in practically a total loss of a metalworks; the fire was well developed upon arrival of fire fighting units.

119. This was one of four arson fires started at about the same time, during the same evening, in the same locality. Upon arrival of the first fire department units, this two-story brick apartment building was completely involved by fire and fire was communicating to the adjoining frame dwelling. The fire was started by a "fire bomb".

120. This was a well-developed fire in a large wood residential building (32 apts.) under construction in a real estate development located in an unincorporated area, with poor public water supply.

121. 100% involvement of a wood frame warehouse.

122. This was a downtown mercantile fire, involving four adjacent stores.

123. This hotel fire originated in the fifth (top) story, and spread into the attic space, and downward by means of open stairwells.

124. This fully developed fire spread into a concealed space above a ceiling beneath a large wood roof on steel trusses.

125. This fire of suspicious origin occurred after a heavy snow storm. After ventilation of the building upon arrival, a "backdraft" occurred and fire spread quickly to the second story and basement; following this, operations were conducted from outside the building.

126. During a heavy January snowfall, two separate fires were set by vandals, one in the first story and the other in the basement. The first-story fire was controlled by a "plug-stream"; but the unknown basement fire spread to the second story before discovery.

127. This fire started on the first story and spread through hollow walls and unprotected openings to the second and third stories, as well as to an adjoining building. The water supply from the pumping station was very limited.

128. This fully developed fire spread into the attic space.

129. This lumber yard fire spread rapidly to adjoining and nearby buildings due to high wind and relatively small exposure distances; a serious flying brand hazard existed.

130. This fire resulted in the total loss of a lumber, hardware and millwork sales plant. More than 50% of the building was involved by fire upon arrival of fire fighting units.

131. 100% involvement of a large lumber yard storage shed.

132. This was a fully developed fire in a plant manufacturing foamed plastic seats for chairs, cars, boats, etc. Fire spread to adjoining and nearby buildings.

133. This large, multi-structure, warehouse fire was well developed in the building of origin upon arrival of fire fighting units.

134. When discovered, this fire was well-established in these vacant (former cotton mill) buildings in process of being demolished. No effort was made to extinguish the fire in the vacant buildings; the

fire burned out the following day. The primary effort was to protect three exposures which became ignited. The estimated total quantity of water used was 250,000 gallons. Large brands were formed, some of which damaged nearby automobiles; at least one roof fire was reported started by brands.

NOTES ON THE PREPARATION OF DATA FOR TABLE B-1

1. Column 1, 2, 3 and 4 self-explanatory; also, see list of symbols for columns 2 and 3.
2. Column 5 - Building area involved by fire (fire area) Ft^2. This data represents the maximum floor area of a building involved by fire, determined by the sum of the fire areas on each floor of a building (or buildings) including basement and attic.
3. Column 6 - Extent of structural involvement - depending upon the extent of structural involvement of the building by fire, a number was assigned to each fire according to the following table:

Minor	1
Moderate	2
Severe	3
Collapse	4

4. Columns 7 and 8 - Self-explanatory.
5. Columns 9, 10 and 11 - Fire Time (Minutes)
   Preburn Time - Time from the origin of the fire until the first fire fighting unit is at work.
   Control Time - Time from when the first fire fighting unit is at work until the fire is no longer increasing in area and flames are beginning to recede.
   Final Extinguishment and Overhaul Time - Time from control until the fire is completely out.
6. Columns 12, 13, 14 and 15 - Water Used For Control
   Maximum Application Rate (G.P.M.) - Represents the sum of the flow rates from each hand stream and master stream used during the fire control time.

Total Quantity of Water Used (Gals.) - Represents all water used during the fire control time.

Application Density (Gal/100 Ft^2) - Represents the total quantity of water used (as given in Column 12) divided by the fire area (as given in Column 5), in hundreds of square feet.

Maximum Application Rate Density (GPM/100 Ft^2) Represents the maximum application rate (as given in Column 11) divided by the fire area (as given in Column 5), in hundreds of square feet.

7. Columns 16 and 17 - Water Used for Final Extinguishment and Overhaul

   Total Quantity of Water Used (Gals.) - Represents all water used after fire control has been attained.

   Application Density (Gal./100 Ft^2) - Represents the total quantity of water used (as given in Column 16) divided by the fire area (as given in Column 5), in hundreds of square feet.

8. Columns 18 and 19 - Fire Streams - see list of symbols for Columns 18 and 19.

9. Columns 20, 21, 22 and 23 - Fire Department Data

   Type - Pertains to type of fire department organization which responded, paid, volunteer or paid and volunteer.

   No. of Working Companies - Self-explanatory; also see list of symbols for Column 21.

   Total Man Power - Represents the total number of officers and firemen which responded with the working companies. Men on standby units excluded.

Man Power Per 100 Ft^2 Fire Area - Represents the total man power (as given in Column 22) divided by the fire area (as given in Column 5), in hundreds of square feet.

10. Columns 24 thru 32 - Use of Man Power (Man Hours) - Represents the number of man hours expended for each phase of the fire fighting operation. Forcible Entry includes opening ceilings and walls, as well as gaining entrance to a building.

11. Columns 33, 34 and 35 - Self-explanatory.

LIST OF SYMBOLS USED IN TABLE B-I

GENERAL

U	Data Unknown

With Reference to Building Construction - Columns 2 and 3

M-J	Masonry - Joist; refers to a building with brick, concrete block or other masonry walls, and wood floors and roof.
M-C	Metal Clad
H-T	Heavy Timber
F-R	Fire Resistive
W	Wood
S-F	Steel Frame
B	Basement
A	Attic

With Reference to Fire Streams - Columns 18 and 19

3/4, 1, 1-1/2, 2-1/2, 3 - Refers to the nominal size of hose (inches) supplying a stated number of hand streams.

AP	Aerial Platform Master Stream
T	Turret Nozzle Master Stream
LP	Ladder Pipe Master Stream
DS	Deluge Set Master Stream

With Reference to Fire Apparatus - Column 21

E	Engine Company
L	Ladder Company
S	Squad Company
AP	Aerial Platform Company
Tnk	Tanker
ES	Emergency Squad or Ambulance
LW	Light Wagon
HPF	High Pressure Fog Company

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13. ABSTRACT

This is a final report on a study designed to evaluate public fire fighting operations. Information is developed on how fire fighting operations are performed under a variety of field conditions. The primary body of data consists of information extracted from reports on one hundred thirty-four (134) fires. Useful correlations between the following parameters are presented;

1.	Water Application Rate Density for Control	vs	Fire Area
2.	Water Application Rate for Control	vs	Fire Area
3.	Quantity of Water Used for Control	vs	Fire Area
4.	Fire Control Time	vs	Fire Area
5.	Man-Hours Expended for the Complete Fire Fighting Operation	vs	Fire Area

In this case the fire area represents the maximum floor area of the space involved in the fire.

An application of these correlations to the fire suppression effort at the time of a nuclear emergency is presented.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Fire Department Operations						
Fire Fighting, Manpower						
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