FIRE DEATHS IN THE UNITED STATES:

REVIEW OF DATA SOURCES AND RANGE OF ESTIMATES

National Fire Data Center • National Fire Prevention and Control Administration
U.S. DEPARTMENT OF COMMERCE

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Executive Summary

Over the past decade, it has often been reported that approximately 12,000 fire deaths occur in the United States each year. To check the validity of this estimate and to identify the population groups most affected and the causes of the fires in which deaths occur, a study of fire death data was undertaken.

Death Rates

The fire death data examined revealed large differences in estimates derived from various data sources in the annual rate of fire deaths in the United States. The range was 6,000 to 12,000 deaths per year. We think the range 7,000 to 9,000 is most plausible, but further analysis is needed to be sure. However, all sources indicated that the fire death rate in the United States has declined during the period 1970–1974.

Annual fire death rates based on data in State fire marshal reports from the years 1970–1975 indicate that between 29 and 35 fire deaths per million population occur each year. These death rates projected nationally mean that 6,000 to 7,400 fire deaths occur in the United States each year.

The U.S. Department of Health, Education and Welfare vital statistics mortality data for the 1970 to 1974 period provide another source of fire death rates, but they exclude motor vehicle accident fire deaths. The number of annual fire-related motor vehicle accident deaths were calculated from data in special studies of motor vehicle accident deaths and added to the HEW reported fire deaths. The maximum yearly number of motor vehicle accident fire deaths was estimated to be 1,270, the minimum 280.

Adjustments were also made to the HEW data for fire deaths which might not be included in the tabulations due to omissions of fire on death certificates as the underlying cause of death. The maximum number of such deaths, based on two recent in-depth studies of fire deaths, was estimated to be 670 per year. The absolute minimum number of such deaths would, of course, be zero.

Addition of the maximum estimates for vehicle fire deaths and death certificate omissions to the HEW tabulated fire deaths resulted in annual fire death estimates ranging from 8,600 to 9,320 per year between 1970 and 1974, or fire death rates between 41 and 46 deaths per million population. Addition of the estimated minimum number of these fire deaths to HEW tabulations resulted in an annual number of fire deaths between 7,000 and 7,700 per year, and fire death rates ranging from 33 to 38 deaths per million population during these years. The range of minimally adjusted fire death rates overlaps that calculated from State fire marshal reports data; that is, these two estimates are in general agreement.

Estimates of annual numbers of fire deaths published by the National Fire Protection Association during the years 1970–1974 range from 11,600 to 12,200 and the corresponding death rates from 55 to 60 deaths per million population. These estimates contain larger numbers of annual motor vehicle fire deaths than would be estimated from most of the motor vehicle accident studies reviewed. If the difference between the number of motor vehicle fire deaths known to be included in the 1971 NFPA estimate and the maximum number of such deaths estimated from the transportation studies reviewed is subtracted from the NFPA estimated total number of fire deaths for this year, the total number of fire deaths becomes 9,135 and the fire death rate 45 deaths per million population. This value is exactly equal to the fire death rate estimated from the maximally adjusted HEW fire death tabulations for 1971. 1971 is the only year for which an NFPA estimate of the actual number of motor vehicle fire deaths was found in the literature.

Victim Types

According to the data from all sources, the populations most affected by fire are males, nonwhites, the young, and the old.

- Males have accounted for 62-63% of annual fire deaths, females for 37-38%. The proportion of males in the general population was constant at 49%. Much but not all of the disproportion was due to the exceptionally high death rates among nonwhite males.
- Nonwhites have accounted for 25-27% of annual fire deaths, twice that to be expected from their proportion (12%) in the general population.
- Nonwhite males have accounted for 15-16% of the annual fire deaths, nearly three times their proportion (6%) in the general population.
- Fire deaths among the young (ages 0-13) and the old (over 60) have accounted for over 50% of annual fire deaths, although the proportion of these two age groups in the general population was only 34%.

The first three of these four facts appear to be relatively little known. They have major implications for new directions needed in targeting fire prevention programs, especially those for nonwhite males. Detailed analysis of the reasons for this disproportionate loss are required before the problem can be adequately attacked.

Residential Fires

State fire marshal reports and the 30,000 fire records in the NFPA Fire Incident Data Organization (FIDO) file indicate that 72-74% of all fire deaths occur in residential occupancies. NFPA annual estimates of the proportion of fire deaths occurring in residential occupancies is approximately 60% of the total fire deaths; however, if the total number of annual estimated fire deaths is adjusted downward to account for possible overestimates of motor vehicle fire deaths, the percentage of residential fire deaths increases to 72%, in good agreement with the other sources. Thus residential fires account for almost three-fourths

of annual fire deaths, making the residential problem even greater than previously thought. Residential fires probably deserve the most attention in increased prevention efforts.

Clothing Ignitions

Fire deaths due to clothing ignitions was the only cause category where data could be compared between data sources. According to NFPA and HEW data, these ignitions account for from 8-11% of annual fire deaths. HEW data show that the number of fire deaths due to clothing ignitions has decreased 42% between 1970 and 1974.

I. Introduction

Present information indicates that the United States annual fire deaths per capita are among the highest of all the major industrialized nations (1). The National Fire Prevention and Control Administration (NFPCA) was established by Congress in 1974 and given the task of reducing these losses as rapidly as possible. In order to accomplish this task, the factors influencing these losses must be understood and their magnitude measured accurately to assess progress.

Published fire fatality data from various sources were examined in an effort to check the validity of recent estimates of total annual fire deaths, to identify causes of fire in which these deaths occur, and to identify which populations are most affected by fire. The present major sources of data are the Department of Health, Education and Welfare (HEW), Vital Statistics Division; the National Fire Protection Association (NFPA) publications; and State Fire Marshal Annual Reports. The information collected by each of these sources is described and recent data are presented in this report. Comparisons of data are made where appropriate. Data from special in-depth studies of fire deaths are utilized to make the data from the different sources comparable.

II. Fire Fatality Data and Data Sources

Department of Health, Education and Welfare

The Department of Health, Education and Welfare (HEW), National Center for Health Statistics, publishes annual fire fatality tabulations in *Vital Statistics of the United States: Mortality Volume II* (2). Data are available each September for the preceding calendar year. Data are compiled from analysis of death certificates submitted by the fifty States. Deaths are classified according to the *Eighth Revision, International Classification of Diseases* (3). Deaths due to fire and flames are listed in the E 890-899 codes; and deaths due to explosion, fire, or burning in water transport in the E 877 codes; and deaths due to explosive materials in the E 921-923 codes. Deaths involving high explosives are not included in these explosive materials codes. Table 1 lists the sub-categories of these mortality classifications. Information on sex and race is given in the published annual tables and more detailed information such as age and place of residence may be retrieved from HEW computer records.

Table 1. HEW National Center for Health Statistics Mortality Classifications

Code	*Mortality Class*
E 890–899	**Accidents Caused by Fire and Flames**
890	Conflagration in private dwelling
891	Conflagration in other buildings and structures
892	Conflagration not in building or structure
893	Ignition of clothing*
894	Ignition highly flammable material*
895	Controlled fire in private dwelling
896	Controlled fire in other buildings and structures
897	Controlled fire not in building or structure
898	Other specified fires or flames
899	Unspecified fire
E 837	**Explosion, Fire, or Burning in Water Transport**
837.0	Accidents, small boats
837.1	Accidents, other water craft, crew
837.2	Accidents, other water craft, non-crew
837.3	Stevedore
837.8	Specified persons
837.9	Unspecified persons
E 921	**Accidents Caused by Explosion Pressure Vessels**
921.0	Boilers
921.1	Gas Cylinders
921.8	Other
E 923	**Accidents Caused by Explosive Material**
923.0	Fireworks
923.1	Blasting material
923.2	Gas, explosive
923.8	Other
923.9	Unspecified

* Deaths resulting from clothing and highly flammable material ignitions are included in these separate categories and *not* under structure or non-structure codes.

Table 2. HEW FIRE DEATH STATISTICS 1970–1974

Year		1970	1971	1972	1973	1974
		Fire Related Deaths				
Total		7355	7416	7254	7109	6764
Males		4540	4590	4514	4393	4259
Females		2815	2826	2740	2716	2505
	% of Total Population	*% of Total Fire Deaths*				
White males	42.7	46.0	45.8	46.7	46.4	48.2
White females	44.9	27.9	27.5	27.1	28.1	27.2
Nonwhite males	6.0	15.7	16.1	15.5	15.4	14.8
Nonwhite females	6.4	10.4	10.6	10.7	10.1	9.8

* Excludes motor vehicle, air, and rail accident fire deaths; includes those from water transport accidents.
Source: *Vital Statistics of the United States: Mortality Section*. United States National Center for Health Statistics, Department Health, Education and Welfare.

For analyzing fire-related fatalities the HEW data have several limitations. Deaths occurring in motor vehicle, rail, or air transportation accidents where fire accompanied the accident are included in the total accidental deaths for these types of transportation and not in the fire death tabulations regardless of whether fire caused the death. Deaths in the explosive materials codes may include deaths not due to fire. Some fire fatalities may not be included in the tabulations because the death certificates of individuals who expire some time after the fire incident may not indicate fire as a related death factor. However, all State death certificates are analyzed and coded by the HEW Mortality Statistics Branch and since death certificates are required legal documents in all States, the Mortality Branch believes that registration is nearly 99.9% complete and that these documents are as accurate as is possible to obtain.* The HEW fire death tabulations are the only detailed national tabulations available and represent a lower bound on yearly national fire deaths.

HEW mortality data on deaths attributable to fire, flame, and explosion for the years 1970 through 1974 are given in Table 2. In addition to the total number of fire deaths, sex and race of the fatalities are shown. Males accounted for 61.7 to 63.0% of the fire victims during this period while their percentage in the general population remained constant at 48.7% (4). Nonwhites have accounted for 24.6 to 26.7% of fire deaths during this period while their percentage in the general population increased only slightly from 12.4 to 12.9%. These data show that nonwhites have double their expected proportion of fire deaths. Nonwhite males accounted for 15 to 16% of annual fire deaths; however, they represent only 6% of the general population, experiencing nearly triple their expected proportion of fire deaths.

The mortality data examined attribute 91 to 93% of the yearly recorded fire deaths to fire and flames, the rest to explosion and water

* Accuracy of death certificate registrations has not been tested formally. HEW studies of birth certificate registrations determined these to be 99.2% complete. (Robert Armstrong, Mortality Health Statistics Branch, HEW).

transportation accident fires. Table 3 lists the total deaths by fire and flames and the percent and number of deaths in each of the fire and flames sub-categories by year. Deaths due to asphyxia or poisoning by combustion products are included in the fire and flame categories. "Private dwellings" includes all residential occupancies except institutions. Deaths resulting from "clothing ignitions" and "highly flammable materials" (such as gasoline or matches) are recorded in these sub-categories regardless of where they occurred.

Although the total number of deaths by fire and flames is shown to have decreased somewhat during the period 1970 through 1974, the percentage of the deaths occurring in private dwellings (residential occupancy) increased from 63% in 1970 to 70% in 1974. Deaths resulting from clothing ignitions are shown as having decreased continually, down 42% over this 5-year period from 760 to 437. Non-building fire deaths have also decreased. The unidentified death sub-categories for these years account for 14 to 16% of the total deaths attributable to fire and flames.

The 6 to 8% of all fire deaths recorded as due to explosive materials, explosion of pressure vessels, and explosion, fire, or burning in water vessel accidents are predominately male (greater than 81% of all categories for all five years). Gas explosions and boiler explosions are the major causes of explosion deaths. Small

Table 3. HEW MORTALITY STATISTICS 1970–74

Deaths by Fire and Flames

Year	1970		1971		1972		1973		1974	
Total Deaths by Fire and Flames	6718		6776		6714		6503		6236	
Classification	*% and Number of Deaths by Fire and Flames*									
	%	*Number*	%	*Number*	%	*Number*	%	*Number*	%	*Number*
Private dwellings	62.9	4226	64.9	4401	69.3	4654	67.1	4362	69.6	4340
Other buildings and structures	4.8	325	3.9	265	4.0	268	4.3	280	4.4	274
Fire not in buildings or structures	2.2	147	1.8	123	1.4	92	1.3	87	1.2	75
Clothing ignitions	11.3	760	9.7	655	8.1	542	8.0	517	7.0	437
Highly flammable material	3.8	253	3.3	223	3.3	224	3.9	254	2.9	181
Other (specified and unspecified)	15.0	1007	16.4	1109	13.9	934	15.4	1003	14.9	929

Source: *Vital Statistics of the United States: Mortality Section*, United States National Center for Health Statistics, Department Health, Education and Welfare.

boat accident fatalities and water-craft crew fatalities account for all but one death associated with water-craft during the period examined.

National Fire Protection Association

Annual Estimates

The National Fire Protection Association (NFPA) publishes annual estimates of United States fire fatalities in their publication *Fire Journal*. The "Fires and Fire Losses Classified" report, which usually appears in the September issue of this journal, carries estimates of total fire deaths, fire incidents, and dollar losses for the preceding year. Information on the proportion of annual fire deaths occurring in residential occupancies is usually given.

NFPA prepares these fatality estimates from HEW mortality data, State fire marshal reports, fire department reports, motor vehicle accident studies, and special studies and investigations of the NFPA. Since 1971, NFPA has stated in "Fires and Fire Losses Classified" that the estimates in the report are prepared from surveys of approximately 2,000 fire departments of all sizes (500 to 8 million people protected) located in all fifty States, State fire marshal reports, other fire department reports, insurance reports, special studies, and incidents entered in the NFPA Fire Incident Data Organization (FIDO) system. These data are extended by statistical techniques and allowances for unreported fires and losses are included. Details of the statistical techniques used by NFPA have been unavailable.

A new edition of the NFPA *Fire Protection Handbook* which contains a chapter on fire casualities is published every six or seven years. Data in the "Handbooks" represent the cumulative fire experience for the past years. In addition to total yearly fire fatality estimates for recent years, occupancies where deaths occurred, age of fire victims, time of day when fatal fires occur, factors influencing failure of occupants to escape fires, and factors responsible for spread of smoke and fire are examined. In both recent editions of the *Fire Protection Handbook* (5,6) a large portion of the death data is given in terms of the numbers of or the percentage of fatal fires. In order to compare this information with that in other NFPA publications and data from other sources, it must be converted into terms of the number of or the percentage of total fire deaths occurring in various occupancy types or due to various causes, etc.

FIDO

The NFPA has been accumulating fire data in its FIDO file since 1971. There are presently approximately 36,000* fire incidents in this system from which information on cause, occupancy, ignition source, item ignited, etc. can be retrieved. Age and sex of the fire victims are not recorded in the computer file but can be obtained from hard copy files maintained by NFPA. The NFPA originally designed the FIDO file as an indexing tool for retrieving information on significant fires for engineering purposes and, therefore, it may be biased towards fires in which multiple deaths occur.* However, NFPA does make an effort to acquire and include information on all fire deaths reported to them. A report utilizing this file to prepare descriptions of the type fires most frequently responsible for fire deaths has recently been published in the NFPA *Fire Journal* (7). This report lists the percent of fire deaths occurring in various occupancy types and the percent of deaths due to "apparel ignitions" (clothing fires) recorded in the years from 1971 to 1975.

Table 4 was prepared from these NFPA publications. The values which were obtained by conversion of published occupancy data to percent of total fire deaths are noted. This conversion was made utilizing the 1971 occupancy distribution of fire fatalities prepared for the National Commission on Fire Prevention and Control by NFPA (1). For example, the 1976 "Handbook" states that 93.4% of building fire deaths occur in residential occupancies. The 1971 fire death estimates supplied by NFPA to the Commission indicate that 63.9% of yearly fire deaths occur in building fires. The percent-

* Information received by telephone from Dr. L. Derry, Manager, Fire Analysis Department, NFPA, on June 28, 1977.

Table 4. NFPA FIRE DEATH ESTIMATES

Year	1969	1970	1971	1972	1973	1974	1976	1971–1975
Sources:	*Fire Protection† Handbook, 13th ed.*	*Fire Journal*					*Fire Protection† Handbook, 14th ed.*	*FIDO* file*
Annual fire fatalities	12,000	12,200	11,850	11,900	11,700	11,600	12,000	—
Classification				*% of Annual Fire Fatalities*				
Residential	48.6	51.3††	55.7**	—	62.1	57.0	59.7††	72.0†††
Private Dwellings (1 and 2 family dwellings)	—	—	—	—	55.5	—	40.6††	44.6†††
Cause of death in building fires* **								
Asphyxiation	62.3	—	—	—	—	—	62.3	—
Burn	26.0	—	—	—	—	—	26.0	—
Other	11.7	—	—	—	—	—	11.7	—
Motor Vehicles (includes tank trucks)	5.1	—	33.3**	—	—	—	—	4.0
Clothing ignitions	—	—	—	—	—	—	—	11.0
Age* ** 0–4	17.6	—	—	—	—	—	17.6	—
5–14	10.0	—	—	—	—	—	10.0	—
over 65	27.7	—	—	—	—	—	27.7	—

† Data in the *Fire Protection Handbook* represent cumulative fire experience for past years.

* "A Summary of Fire Deaths in the United States 1971–1975," Ottoson, John, National Fire Protection Association, August 8, 1975. Prepared for the Fire Research Center, National Bureau of Standards. "Fire Death Scenarios and Firesafety Planning," Clark, F. B., and Ottoson, J., *Fire Journal*, May 1976, p. 20.

†† Computed value using the percentage deaths by property type from NFPA 1971 estimates supplied to the National Commission on Fire Prevention and Control.

** Estimates supplied by NFPA to the National Commission on Fire Prevention and Control, 1971, *America Burning*, 1973.

††† Actual count in FIDO file adjusted downward to exclude deaths independent of structure, i.e., deaths due to apparel and apparel plus flammable fluid ignitions.

*** Values given in the 1969 and 1976 editions of the *Fire Protection Handbook* are based on the same data.

age of yearly fire deaths occurring in residential occupancies is then 93.4% of the 63.9% building fire deaths or 59.7% of the total. This 1971 occupancy distribution of fire deaths is the most recent national tabulation released by NFPA.

Residential occupancy covers all property used as residences exclusive of institutional properties such as nursing homes and hospitals. "Private dwellings" are one and two family dwellings. (Note that this is a much narrower category than HEW uses for "private dwellings.") Only the cause of fatalities occurring in building fires was available.

The fatality occupancy data in *Fire Protection Handbook, 13th Edition* represents 35 years of fire incidents reported to NFPA. It is stated in the "Handbook" that roughly 10% of the total estimated fire fatalities are included. However, it is now believed that less than 10% of the fire deaths are included and that these data are probably biased towards multiple death fires.* The data on fire deaths by age group in this edition of the "Handbook" are National Office of Vital Statistics data (now the National Center for Health Statistics, HEW, that was previously discussed). The values from the 1976 *Fire Protection Handbook* for causes of death in building fires and age of fire victims are based on the data in the 1969 "Handbook".*

The NFPA annual fire fatality estimates show a slight decrease over the years 1970 through 1974. Fatalities occurring in residential occupancies have increased. Actual records in the FIDO file show that 84% of all fire fatalities occur in residential occupancies (7). However, when those deaths classified as independent of structure, i.e. deaths resulting from apparel and apparel plus flammable fluid ignitions, are excluded, the percentage of residential fire deaths is reduced to 72%.

The number and percentage of fire deaths associated with motor vehicle accidents computed from the 1969 "Handbook" data and that computed from data in the FIDO file (7,8) differ greatly from the estimated number of these deaths reported to the National Commission on Fire Prevention and Control (604 and 474 vs. 3,950). This estimated figure as well as other NFPA yearly motor vehicle fire fatality estimates in recent years was based on a 1951 study of Dunn and Halpin (9). This study reviewed a one-tenth sample of 1949 death certificates for specified vehicular accident types on file at the National Center for Health Statistics, in order to obtain statistics on accident fatalities in which fire was identified as an associated cause. The results of this study and estimates based on it have been questioned in the literature (10,11). Cooley (10) suggests that an error by a factor of 10 may have been made in the original study computation. In view of the considerably different findings of more recent studies and the relatively strong agreement among the reviewers of the Dunn and Halpin study (10,11), it was concluded that the study should not be used as a basis for estimating motor vehicle fire deaths.

State Fire Marshal Reports

Annual State fire marshal reports contain fire fatality information of varying completeness and detail. Some list only total deaths for a year, while others give detailed data on age, sex, occupancy, ignition source, and cause of death. Some motor vehicle fire fatality data can be obtained from these reports; however, this classification varies widely from State to State. Some States give only total motor vehicle fire deaths, while others include not only vehicle wrecks and fires, but also stationary vehicle ignitions involving use of flammable liquid and fire in mobile property of all types including motorized lawn mowers and building equipment such as tractors, bulldozers, etc. Even when sub-categories such as wreck and fire are given, it is almost impossible to distinguish whether the fatality was a result of fire or occurred in an accident which was only accompanied by fire.

Most State fire marshal reports are prepared from reports of individual fire departments within the State. Some States have complete reporting from local jurisdictions, others do not.

* Information received by telephone from Dr. L. Derry, Manager, Fire Analysis Department, NFPA, on June 28, 1977. No estimate of the percentage of fire deaths that is included in the "*Handbook*" is available.

The reporting of fire scene fatalities is probably the most complete since these events are likely to be reported to the news media as well as through other sources and State Fire Marshals often will request such incident data from local departments. The deaths resulting from fire which occur after hospitalization are not as completely reported. Local fire departments do make efforts to follow the severely injured fire victims, often with the aid of news media; and if the deaths occur a short time after hospitalization, the fatality will likely be recorded. Longer term hospitalized fire injuries which result in fatalities will probably not be reported. Some State fire marshal reports such as those of Louisiana, North Carolina, and South Carolina use fire fatality data prepared by the State Health Department Vital Statistics Divisions from death certificates, which should contain these later occurring fire fatalities. As with the national fire fatality data prepared by HEW, this data is dependent on the inclusion of fire as an underlying cause on the death certificate by local medical authorities.

Annual State fire marshal reports for various years, 1970–1975, for 31 States were examined. The fire death rates (summation of yearly State deaths divided by the summation of State pop-

Table 5. STATE FIRE MARSHAL REPORTS: FIRE DEATH RATES

State	1970	1971	1972	1973	1974	1975
	Fire deaths per million population					
Alabama	60	62	44	53	43	—
Alaska	118	114	123	88	134	92
Illinois	—	—	33	36	38	—
Iowa	30	26	27	31	29	—
Michigan	29	39	34	33	37	35
Nebraska	35	35	31	20	24	—
Pennsylvania	—	—	28	31	32	30
Ohio	30	24	24	23	24	25
Oregon	43	31	39	38	37	38
Utah	17	21	20	16	14	—
Vermont	31	40	46	62	30	21
Average Rate (total deaths ÷ total population)	33	35	32	33	33	30

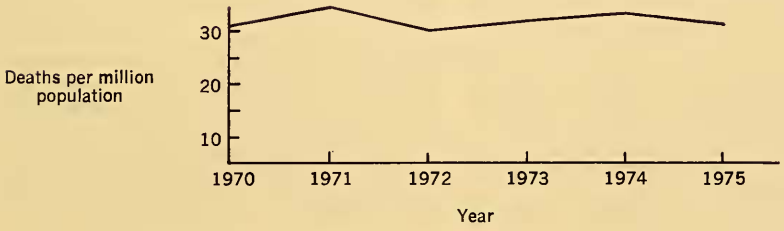

Table 6. STATE FIRE MARSHAL FIRE DEATH RATES

State	Fire Deaths Per Million Population 1970	1974
Alabama	—	43
Alaska	119	134
Arizona	—	8
California	25	17
Connecticut	19	20
Delaware	44	33
Florida	19	—
Illinois	—	37
Iowa	30	29
Kansas	29	—
Kentucky	36	—
Louisiana	52	43
Maryland	35	35
Michigan	29	37
Minnesota	24	—
Missouri	—	15
Montana	29	—
Nebraska	34	24
Nevada	—	28
New Mexico	63	33
North Carolina	—	42
North Dakota	28	—
Ohio	30	24
Oklahoma	44	35
Oregon	46	37
Pennsylvania	—	32
South Carolina	—	23
South Dakota	26	—
Tennessee	56	—
Texas	17	—
Utah	17	14
Vermont	31	30
West Virginia	56	32
Wyoming	—	50
Range	17–119	8–134
Mean (weighted by population)	30	29

ulations) for each year 1970 through 1975 for five States and for some of these years for six other States are tabulated in Table 5. There appears to be no general trend in deaths per million population of these States during this period. Six of the eleven States show fairly constant fire death rates since 1972 while sporadic increases and decreases are noted in all States over the entire period for which data were available. The average fire fatality rate computed using data for all years for these 11 States is 32.7 fatalities per million population. Computing a fire fatality rate for each year with the State data available for that year results in a maximum rate of 34.9 fire deaths per million population in 1971 and a minimum of 30.1 in 1975. These 11 States represent both large industrial States and agricultural States from all sections of the country.

Fire death rates from 25 State fire marshal reports for the years 1970 and 1974 are listed in Table 6. The State death rates for 1974 were obtained directly from State fire marshal reports. This was the most recent year for which a large number of reports were available. The State fire death rates for 1970 were published in the NFPA *Fire Journal* (12). The data from 16 States for both years showed that the total number of fire deaths in these States decreased 17% during this period while the total population increased 4% (4). The fire death rates calculated using the data from all 25 States for both years are 30.1 deaths per million population (1970) and 28.9 deaths per million population (1974).

Detailed fire fatality information from the State fire marshal reports examined is summarized in Table 7. The number of States reporting each item and the number of yearly reports averaged is given. The reports from all States for all years covered listed males as the majority of fire deaths.

Of the States using the term "children" to delineate age of fire victims, only two defined the term. One State included persons under 18 years; the second State included legal minors, giving no age limit. There was little consistency in age groupings used in the various State reports. From the State reports where fire fatalities in the young and elderly population could be compared, the average propor-

Table 7. STATE FIRE MARSHAL FIRE DEATH DATA

Classification	Percent of Total Deaths	Number of States Reporting	Number of Reports
Sex: male	63.8%	8	18
female	36.2	8	18
Age: children (unspecified)	23.6	6	10
0–10	17.6	6	11
0–12	21.6	4	10
over 65	20.9	6	16
over 70	18.6	3	4
Residential occupancy	74.1	14	31
Cause of death:			
Asphyxiation	50.5	5	12
Burn	32.3	3	8
Clothing ignitions	5.2	5	12
Flammable liquids	4.3	3	10
Motor Vehicles	10.8	12	25

tion of fire deaths in these populations showed a higher percentage of deaths than would be expected from their proportion in the general population (4).

Residential occupancies were defined by some States to be all property used as residences exclusive of institutional property; the number of fatalities are listed by this broad occupancy type. Other States listed where individual deaths occurred and these were grouped by the residential category above which allows comparison with the HEW and NFPA data.

The State fire marshal reports which listed deaths due to clothing ignitions and flammable liquid ignitions did not include these in any property class. The few States which listed the percent of deaths due to asphyxiation, burn, or other did not define these terms.

Entries into the percentage of fire fatalities occurring in motor vehicles ranged from 2 to 26% of the total State fire deaths. The State with the lowest percentage gave detailed information on the deaths and included one victim who was burned in a fire resulting from a vehicle wreck which was caused by a heart attack. The States which included all types of mobile property had rates near the average of the extremes. The State which reported the highest rate (26%) had this rate for only one year. A second State reported a rate near this value for two years. Neither State defined deaths classified as motor vehicle fire fatalities.

Transportation Accident Studies

The United States Public Health Service in *Vital Statistics of the United States* (13) publishes total yearly deaths occurring in all modes of transportation. Yearly total deaths occurring in motor vehicle accidents are published by the National Safety Council in *Accident Facts* (14). With the exception of water transport accident fatalities, neither of these sources provide data on the proportion of transportation accident fatalities that are attributable to fire. Data from these sources for the years 1970, 1972, and 1973 show that motor vehicle accident fatalities were approximately 93% of the total transportation accident fatalities. Water transport accident fatalities accounted for approximately 3% of the total transportation accident fatalities for each of these years. The proportion of these water transport fatalities attributable to fire (computed with the HEW

Table 8. TRANSPORTATION ACCIDENT FIRE FATALITIES 1973

Transportation Mode	Number of deaths attributed to fire	Fire deaths as percentage of transportation accident fire deaths	Fire deaths as percentage of accident deaths in transportation mode
Rail	10	0.3%	1.2%
Air	115	3.6%	6.9%
Marine	57	1.8%	3.3%
Motor Vehicles	3,027	94.3%	5.6%

Fire deaths from "A National Program for Fire Safety in Transportation" Lauriente, M. and Wiggins, J.H. Fourth Intersociety Conference on Transportation, July 18-24, 1976, Los Angeles, California
Transportation deaths from *Statistical Abstracts of the United States 1975*, Bureau of the Census, U.S. Department of Commerce.

mortality code E 877 data) decreased from 2.2% in 1970 to 1.2% in 1973.

The Department of Transportation (DOT) maintains records of commercial transport accident fatalities. Reports of the National Transportation Safety Board (NTSB), the Bureau of Motor Carrier Safety, and the National Highway Traffic Safety Administration (NHTSA) are used as sources of air, marine, rail, and motor vehicle accident information. DOT has established a Fatal Accident Reporting System (FARS) and a National Accident Sampling System to collect detailed transportation accident data; however, these systems will not be fully operational for several years. DOT does not publish regular annual estimates for transportation accident fatalities or transportation accident related fire fatalities. Data on the occurrence of fire in transportation accidents and estimates of fatalities occurring in transportation accidents which are accompanied by fire do appear in DOT reports and funded research studies.

A recent report on a "National Program for Fire Safety in Transportation" cites 13 independent sources which give widely different estimates of the annual number of motor vehicle fire fatalities (15). Seven sources estimated the number to be between 500 and 1,000; two sources estimated between 1,000 to 1,500; one source each estimated between 1,500 and 2,000 and 2,000 and 2,500; and two sources estimated between 3,000 and 3,500. Many of these sources were DOT funded studies. This report also gives the number of 1973 fire fatalities occurring in each type of transportation accident, noting the uncertainty of the values. Table 8 lists these numbers, the percent 1973 vehicle accident fire deaths occurring in each transportation type, and the percentage these fire fatalities were of the total accident fatalities for that type of transportation. Motor vehicle accidents accounted for 94% of the total transportation accident fire deaths. These fire deaths were about 6% of all deaths from motor vehicle accidents.

Another recent DOT report, "Federal Motor Vehicle Safety Standards: Fuel System Integrity," *Federal Register*, March 1974, (16) gives an estimate of yearly motor vehicle accident fire deaths of between 500 and 1,000.

The widely varying proportion of transportation accident deaths attributable to fire is also found in marine transport accidents. The data in the DOT transportation fire safety study attribute 3.6% of the marine transport accident deaths to fire. HEW data for 1973 attribute only 1.2% of water transport deaths to fire.

The primary reason for the great differences in the estimated numbers of fire deaths occurring in transportation accidents is the difficulty of determining without thorough investigation and possibly autopsy whether the death was

due to the accident or fire. The detailed NFPA study of a Boeing 727 crash at JFK airport, New York 1975, illustrates this problem (17). Originally all the victims were recorded as fire deaths; however, after investigation, only 15 of the 114 fatalities were considered fire victims.

Because of the large proportion of transportation accident deaths occurring in motor vehicle accidents, these accidents have been more extensively studied than other transportation accidents. Studies during the past decade which provided information of fire deaths occurring in motor vehicle accidents were reviewed by the Highway Safety Research Institute (HSRI), University of Michigan in the 1974 report "Fire in Motor Vehicle Accident Studies" (10). The sources of the DOT transportation fire safety report were covered. These studies and the HSRI conclusions are briefly summarized in Table 9 and below.

"Research Report 1969-72 of the New York State Department of Motor Vehicles" (18) studied State accident data to determine incidence of fire in motor vehicle accidents and identified fatalities resulting from accidents accompanied by fire. State police reports for two separate months of 1968 were examined. It was determined that 0.07% of all reported motor vehicle accidents involved fire and that 2.38% of all fatal accidents were accompanied by fire.

A "Vehicle Post Collision Consideration Study" (19) in Los Angeles City and County examined fire department records for the period 1966 to 1969 to delineate post-crash factors in accidents. Vehicle fires were found to have occurred in less than 0.5% of all vehicle collisions and burn fatalities numbered 50 for the City of Los Angeles during the 3-year study period. This number of fire fatalities equals 2.7% of the total vehicle crash fatalities for the period.

The University of Oklahoma Research Institute under a NHTSA contract (20) studied "Escape Worthiness of Vehicles and Occupant Survival." The 1970 report, based on Oklahoma data, states that traffic deaths in motor vehicle accidents involving fire account for about 3,500 fatalities per year. This is an upper bound since the deaths are not necessarily from fire. A second study of "Escape Worthiness of Vehicles for Occupant Survivals and Crashes" for NHTSA in 1972 (21) at the Oklahoma Research Institute examined Oklahoma and Kansas accident data for 1970 and 1971. Information from death certificates and newspaper clippings was compared with accident file data. The conclusions of the study were that 4.7% of all Oklahoma vehicle fatalities and 4.9% of all Kansas fatalities were deaths in accidents accompanied by fire. Deaths resulting from fire as opposed to deaths coincident with fire in motor vehicle accidents were 3.3% of vehicle accident deaths for Oklahoma and 2.5% for Kansas.

The Highway Safety Research Institute, University of Michigan, under NHTSA contract studied Wayne County, Michigan, morgue reports of fatal automobile accident victims from 1967 to 1969 (22). From these pathological examination reports, it was determined that 1.3% of the accident victims had died as the result of burns.

The University of Michigan, HSRI, conducted an independent study of Michigan police reports on all fatal motor vehicle accidents for the period 1968 through 1971 (10). Most of these incident reports included death certificates as well as witness narrative statements and follow-up investigator reports. Fatalities occurring in motor vehicle accidents accompanied by fire were found to be 1.6% (average of each year's rate) of the total motor vehicle accident fatalities and fatalities resulting from fire in motor vehicle accidents 0.98% of the total motor vehicle accident fatalities.

The Michigan Highway Safety Research Institute also examined State fire statistics from Oregon, Iowa, and Illinois (10). Analysis of Oregon statistics for the period 1969 to 1973 established that 1.25% of deaths in all motor vehicle accidents in the State were attributable to fire. The Iowa records for 1971 and 1972 examined showed that deaths from fire in motor vehicle accidents represented 1.42% of all vehicle accident deaths in the State. Illinois mortality records for the period 1963 to 1972 were examined. Over this period 1.7% of all "in car" motor vehicle accident deaths were fire-related fatalities.

The conclusions drawn from these data by

Table 9. SUMMARY OF TRAFFIC FIRE DEATH STUDIES

Studies	Scope	Estimated fire deaths as % yearly vehicle accident deaths	Estimated number of deaths per year (calculated using average of 45,000 vehicle accident deaths per year*)
Lauriente and Wiggins, Fourth Intersociety Conference on Transportation, Los Angeles, California, July 18–24, 1976	1973 National estimate	6.7%	3,027
DOT, Federal Register Vol. 39, No. 56, March 1974	National estimate	1.1–2.2	500–1,000
New York State Department Motor Vehicles Research Report 1969–72, September 1969	New York State Police reports 1968	<2.4	<1,080
Siegel and Nahum, 1970 International Automobile Safety Conference Compendium, Society Automobile Engineers 1970	Los Angeles City and County fire department records 1966–1969	2.7	1,215
University of Oklahoma Research Institute, Final Report for NHTSA under contract FH–11–7303 December 1970	Oklahoma accident records 1968	<7.8	<3,500
University of Oklahoma Research Institute, Final Report for NHTSA under contract FH–11–7512 July 1972	Oklahoma, Kansas accident file data and death certificates 1970–1971	3.3 2.5	1,485 1,125
Highway Safety Research Institute, University of Michigan Special Report for NHTSA under Contracts FH–11–6555 and FH–11–7129, June 1972	Wayne County Michigan morgue reports 1967–1971	1.3	585

Table 9 cont'd.

Studies	Scope	Estimated fire deaths as % yearly vehicle accident deaths	Estimated number of deaths per year (calculated using average of 45,000 vehicle accident deaths per year*)
Highway Safety Research Institute, University of Michigan, UM–HSRI–SA–74–3, April 1974	Michigan State Police reports 1968–1971	1.0	450
	Michigan fire statistics 1972	1.4	630
	Oregon fire statistics 1969–1973	1.3	585
	Iowa fire statistics 1971–1972	1.4	630
	Illinois fire statistics 1963–1972	1.7	765
NFPA *Fire Protection Handbook*, 13th edition and National Safety Council accident data	National: 10% sample motor vehicle fire deaths over 35-year period	1.5	675
Johns Hopkins University Applied Physics Laboratory Fire Problems Program: Fire Casualty Studies 1971–1976	State of Maryland 1971–1976	0.7	309
Flammability Research Center University of Utah, Progress Report "Fire Injuries—Case History Studies" under NSF Grant Ert 72–03406–1904, July 1975	Greater Salt Lake City, June 1972 to February 1975	0.6	280
Range		0.6–7.8	280–3,500

* *Statistical Abstracts of the United States 1975.* Number of yearly in vehicle traffic deaths during years 1970–1973 were averaged.

HSRI are that annual fatalities resulting from fire in motor vehicle accidents are 1 to 1.5% of the fatalities of vehicle occupants in United States motor vehicle accidents. The annual fatalities occurring in motor vehicle accidents accompanied by fire in the United States are between 1.7 and 2.8% of the total "in car" fatalities resulting from motor vehicle accidents. Based on National Safety Council reports of motor vehicle deaths over the period 1970 to 1974, these percentages convert into a minimum of 450 and a maximum of 1,270 "in car" motor vehicle accident fire fatalities per year.

HSRI compares this estimate with data in the NFPA *Fire Protection Handbook, Thirteenth Edition,* which covers the years 1935 to 1969 (10). NFPA reports 2,035 fire deaths associated with motor vehicles (except tank trucks) which are estimated by NFPA to be approximately 10% of the total motor vehicle fire fatalities during this 35-year period. The National Safety Council reports 1,388,915 motor vehicle deaths for the same period. The average of motor vehicle fire deaths computed with these data is 1.5% of the total motor vehicle deaths. This figure equals the upper bound of annual fatalities of vehicle occupants resulting from fire in motor vehicle accidents reported in the HSRI study.

Two current on-going, in-depth studies of fire fatalities provide further information on motor vehicle accident fire deaths. Since 1971, the Fire Problems Program at the Applied Physics Laboratory, Johns Hopkins University (APL/JHU), has been conducting investigations of all fire fatalities in the State of Maryland. An early report of this group (11) states that approximately six percent of the fire fatalities occurring in the State during 1967 and 1968 were transportation fire-related. This figure was obtained from the Maryland Fire Marshal's Office reports. Since 1971, the in-depth study of State fire fatalities, including on-site incident investigations and autopsies, has reduced the percentage of fire fatalities associated with motor vehicle accidents to between 3 and 4% of all fire fatalities (23). Based on the average total number of fire deaths occurring in the State between 1972 and 1975, this percentage extrapolates nationally to approximately 300 deaths annually.

An in-depth study of fire injuries in metropolitan Salt Lake City by the Flammability Research Center, University of Utah, began in 1972. A report "Fire Injuries: Case Studies" (24) covering the period June 1972 through February 1975 details 60% of the total reported fire injuries (including fatalities) investigated. Twenty-five fatalities were reported, one of which resulted from fire in an automobile. Thus, 4% of the fire fatalities studied over the 32-month period were motor vehicle fire-related. Applying this percentage to the average number of yearly fire deaths occurring in the State since 1970 and extrapolating on the basis of population, approximately 280 motor vehicle fire–related deaths would be expected to occur in the United States annually.

III. Comparison of Fire Death Rates Estimated by Various Approaches

The two most complete data sources of total fire deaths in the United States today are the HEW vital statistics mortality data and NFPA records. In order to make comparisons of the annual fire fatalities reported by these sources, it is necessary to adjust HEW data for motor vehicle accident fire fatalities not included in their fire death codes.

Air and rail transport accident deaths account for only about 4% of the total transportation accident fatalities and the few estimates of the annual number of these fatalities attributable to fire are small and of doubtful accuracy. Therefore, attempting to adjust HEW fire fatality data for air and rail deaths probably is of minor importance.

The HEW data should also be adjusted to account for fire victims not recorded as such, especially those expiring long after the fire. The death certificates of these victims may record only pneumonia, liver or heart failure, etc. with no mention of the initiating fire incident.

Motor Vehicle Fire Deaths

Estimates of the maximum and minimum number of national motor vehicle accident fire-related deaths can be made from the various independent studies discussed previously: State fire marshal reports, incidents recorded in the NFPA/FIDO file, and the NFPA data in *Fire Protection Handbook, 13th Edition*. As noted earlier, the Michigan University HSRI review of data on motor vehicle accidents accompanied by fire from 1963 to 1973 (10) concluded that between 1.7 and 2.8% of all motor vehicle accident fatalities occurred in accidents accompanied by fire and that deaths resulting from fire in motor vehicle accidents are from 1 to 1.5% of the annual "in car" motor vehicle accident fatalities. Utilizing the Department of Commerce, Bureau of the Census, *Statistical Abstracts of the United States 1975* (4), data for "in car" motor vehicle fatalities for the years 1970 through 1973 and the upper and lower limit percentages, the values for yearly fire deaths occurring in motor vehicle accidents in Table 10(a) were calculated.

The State fire marshal reports surveyed in this fire data study indicated that on the average 10.8% of the total fire deaths in the years 1970 to 1974 could be attributed to fire associated with motor vehicles. Table 10(b) lists the motor vehicle fire deaths computed using this percentage and the HEW vital statistics mortality data and the NFPA national fire death yearly estimates. The annual motor vehicle related fire deaths calculated from the HEW data for these years range from 800 to 900 per year. The values calculated with NFPA data range from 975 deaths per year to 1,050.

The number of annual motor vehicle fire deaths calculated from the 4% estimate of all fire deaths derived from NFPA/FIDO data, and HEW annual fire death figures are tabulated in Table 10(c). The number of annual deaths in motor vehicle accidents accompanied by fire calculated using the 1.5% estimate of all motor vehicle traffic accident deaths derived from data in NFPA *Fire Protection Handbook, 13th Edition* and National Safety Council data are listed in Table 10(d), (14). The annual motor vehicle fire fatality estimates calculated in this manner are more than twice the values computed with the FIDO percentage which is in agreement with that of the in-depth fatality studies in Maryland and metropolitan Salt Lake City.

The annual motor vehicle fire death estimates calculated from the NFPA/FIDO percentage and HEW annual fire death tabulations and those calculated with the HSRI (10) minimum percentage for deaths resulting from fire in motor vehicle accidents fall in the range of 300 to 450 per year. The maximum estimates of annual motor vehicle accident fire deaths are calculated with the HSRI percentage of deaths in motor vehicle accidents accompanied

Table 10. FIRE RELATED MOTOR VEHICLE ACCIDENT DEATHS

Method	1970	1971	1972	1973	1974
(a) Calculated using HSRI, University of Michigan factors and total highway deaths.[1]					
Maximum (2.8%x total vehicle occupant deaths)	1,253	1,235	1,257	1,268	1,253[2]
Minimum (1.0%x total vehicle occupant deaths)	447	441	449	453	447[2]
(b) Calculated from average of State Fire Marshal data as factor applied to total fire deaths.					
Maximum[3] (calculated with NFPA annual fire death estimates).	1,048	1,012	1,011	983	976
Minimum[4] (calculated with HEW annual fire death data).	890	897	878	860	818
(c) Calculated using NFPA-FIDO[5] factors applied to total annual fire deaths.					
Based on HEW annual fire deaths.	308	311	304	299	284
(d) Calculated using NFPA fire death data in *Fire Protection Handbook, 13th edition.*[6]					
Total vehicle accident occupant deaths × 1.5%	670	661	673	680	671[2]
(e) NFPA unofficial estimate in *America Burning*[7]		3,950			

[1] Motor vehicle accident occupant deaths from *Statistical Abstracts of the United States, 1975.* HSRI, University of Michigan report No. UM–HSRI–SA–74–3, April 1974.

[2] 1974 motor vehicle accident occupant deaths unavailable, average of values from 1970–1973 used in calculation.

[3] Motor vehicle fire deaths = 10.8%x (NFPA annual fire death estimates − annual motor vehicle fire deaths based on Dunn and Halpin study + motor vehicle fire deaths). Dunn, H. L. and Halpin, E. H., "Fire Casualty Statistics," *National Fire Protection Quarterly.* Vol. 45, No. 1, 1951, p. 45.

[4] Annual motor vehicle fire deaths = 10.8%x (HEW annual fire deaths + motor vehicle fire deaths).

[5] Ottoson, J. "A Summary of Fire Deaths in the United States, 1971–1975," NFPA, Boston, MA., August 1975. Prepared for Fire Research Center, National Bureau of Standards, Washington, D.C.
Annual motor vehicle fire deaths = 4.0%x (HEW annual fire deaths + motor vehicle fire deaths).

[6] Motor vehicle accident occupant deaths from *Statistical Abstracts of the United States, 1975. Fire Protection Handbook, 13th Edition,* NFPA, Boston, MA., 1969.

[7] *America Burning, The Report of the National Commission on Fire Prevention and Control,* U. S. Gov't Printing Office 052–000–00004–1, 1973.

by fire and range from 1,235 to 1,270 per year. The values calculated from the NFPA, *Handbook, 13th Edition* percentage are near the average of these extremes.

Since the HSRI percentages were based on review of many studies over the past 10 years and the other values calculated from different data sources fall near or within the limits calculated with these percentages, *the range of annual fire deaths associated with motor vehicle accidents in the United States is most probably between 300 and 1,300 per year.* The lower number represents those deaths attributable to fire rather than accident, while the higher number represents an upper bound estimate of deaths in motor vehicle accidents accompanied by fire which may or may not be true fire deaths.

Death Certificate Omissions of Fire Causality

Estimates of the percentage of fire victims expiring in hospitals some time after the fire incident may be made from the detailed fire casualty studies of the Fire Problems Program at APL/JHU and the fire injury studies of the Flammability Research Center, University of Utah. The in-depth studies of Maryland fire deaths (25) show that 80% of all fire deaths in the study occur the first day after the fire incident. Data from a study of all fire victims reported by the Baltimore City Fire Department during a 14-month period (26) showed that 85% of the total fire deaths occurred within one week of the fire incident, 91% within two weeks, and 96% within one month. The Flammability Research Center study of fire injuries in the greater Salt Lake City area indicates that 85% of all fire deaths studied occurred within one day of the fire incident and 96% within one week. The remaining 4% survived longer than two weeks.

These figures indicate that 4 to 9% of all fire deaths may be hospitalized for a sufficient length of time that fire may not be indicated on the death certificate as related to the cause of death. Of the fire victims in the Baltimore City study who survived greater than one day, 77% ultimately died of burns and 15% of pulmonary problems. With these patients, complicating medical problems such as kidney and liver failure and respiratory infection begin to appear late in the first week. If the patient survives long enough, these complications may be listed as the cause of death with the underlying fire casuality omitted. Applying the maximum 9% of fire fatalities possibly not recorded on death certificates to the HEW vital statistics mortality data for the years 1970 to 1974 would add an average of 646 deaths per year to those listed. (The minimum value of such death certificate omissions is zero.)

Total Annual Fire Deaths and Death Rates

Table 11 shows that the total annual fire fatalities recorded in HEW vital statistics mortality data for the years 1970 to 1974, with the maximum and minimum adjustments for fire-related deaths occurring in motor vehicle accidents and death certificate omissions. NFPA fire death estimates for these years and the deaths per million population for both data sets are given. The NFPA death rates were obtained from reference 27. Annual death rates calculated from the State fire marshal reports examined (Tables 5 and 6) are included.

Utilizing all available data, the estimated fire deaths obtained from making maximum upwards adjustments to HEW mortality data differ greatly—by 2,500 to 3,000 deaths—from the NFPA estimates. This difference in the maximally adjusted HEW data and the NFPA fire death estimates over the five years examined ranges from 34 to 44% of the HEW reported fire deaths.

The yearly fire death rates obtained with minimal adjustments to HEW mortality data and the annual fire deaths calculated from State fire marshal reports data ranged from 29 to 38 fire deaths per million population during the years examined. The minimum difference between the HEW and averaged State data rates for a given year is three deaths per million population (1971 and 1973) and the maximum difference is eight fire deaths per million population in 1970. Since HEW tabulations include data from all 50 States and the adjust-

Table 11. ANNUAL UNITED STATES FIRE DEATH ESTIMATES

Source	1970	1971	1972	1973	1974
	Estimated Number of Fire Deaths				
HEW Data with "minimum" adjustment [1]	7,663	7,727	7,558	7,408	7,048
HEW Data with "maximum" adjustment [1]	9,270	9,318	9,164	9,017	8,625
NFPA annual estimates	12,200	11,850	11,900	11,700	11,600
	Estimated Fire Death Rates (Deaths per million population)				
State fire marshal reports (11 States—Table 5)	32.7	34.9	32.4	32.8	33.3
State fire marshal reports (25 States—Table 6)	30.1				28.9
Survey of selected U.S. cities (1973) [2]				37.9	
HEW Data with "minimum" adjustment	37.6	37.5	36.3	35.3	33.3
HEW Data with "maximum" adjustment	45.5	45.2	44.0	43.0	40.8
NFPA estimates—total [3]	59.9	57.2	57.1	55.7	55.4

[1] *Minimum Adjustments*
The minimum number of annual motor vehicle fire deaths equaled 4.0% × (HEW annual fire deaths plus motor vehicle fire deaths). NFPA FIDO records (Ottoson, J. "A Summary of Fire Deaths in the United States, 1971–1975, NFPA, Boston, MA., August 1975. Prepared for the Fire Research Center, National Bureau of Standards) show that 4% of all fire deaths occurred in road transport accidents. These calculated numbers of yearly motor vehicle fire deaths were added to HEW annual fire death tabulations. An absolute lower limit of zero was used for fire deaths not recorded in HEW tabulations due to omission of fire as the underlying cause on death certificates.

Maximum Adjustments
The maximum numbers of annual motor vehicle fire deaths were estimated as 2.8% of all annual occupant deaths occurring in motor vehicle accidents. Studies of HSRI, University of Michigan (Report No. UM–HSRI–SA–74–3, April 1974) showed that 2.8% of all motor vehicle accident occupant deaths occurred in accidents accompanied by fire. Annual numbers of motor vehicle occupant deaths from *Statistical Abstracts of the United States 1975* were used in the calculation. The maximum number of fire deaths possibly not included in HEW fire death tabulations due to death certificate omissions of fire as the underlying cause of death equaled 9% of HEW tabulated annual fire deaths. This percentage was estimated from indepth studies of fire casualties. (Levine, M. S. "Fire Victims: Medical Outcomes and Demographic Characteristics," *Am. J. Public Health*, accepted; and Einhorn, I. N. "Fire Injuries—Case History Studies," Progress Report under NSF Grant Ert 72–03406–ADH, Flammability Research Center, University of Utah, July 1975). The yearly values computed for these two categories of fire deaths were added to the annual HEW fire death tabulations.

[2] Yamazaki, T., et al. "Statistics of the Fire Service 1973," *International Fire Chief* Vol. 41, No. 4, 1975, p. 6.

[3] "Fires and Fire Losses Classified, 1975," *Fire Journal* Vol. 70, No. 6, 1976, p. 17.

ments made are of unknown accuracy, differences of these magnitudes are not too surprising.

The lower HEW estimate for 1973 lies in the middle of the rate estimated from State data and the rate computed from a survey of 14 geographically dispersed United States cities whose populations varied from 800 thousand to 2 million (28). The total fire deaths in those cities divided by the total populations represented gives a fire fatality rate of 37.9 deaths per million population compared to the 35.3 deaths per million population of the HEW adjusted data.

IV. Selected Characteristics of Fire Deaths

This section briefly summarizes who are the victims of fire, and some categories of death by occupancy type and cause. This is not a comprehensive review of this data; rather, only the information associated with the sources examined for "numbers of fire deaths" is described.

The proportion of fire deaths in different categories show greater agreement among the sources than do the estimates of yearly total United States fire deaths. Table 12 gives data on sex, age, fatalities occurring in residential occupancies, and fatalities due to clothing and flammable material ignitions from HEW, NFPA, and State fire marshal reports. Data from the previously mentioned in-depth fire death studies are included. Ranges and averages for the years 1970 to 1974 are stated.

Sex

The categories of greatest agreement are sex and age. HEW mortality data and State fire marshal reports indicate that 62 to 64% of annual United States fire deaths are males, versus 36 to 38% females. Clearly fire prevention programs should be especially focused on the male fire problem, and reasons for the imbalance explored.

Age

The State fire marshal reports and NFPA data show significant proportions of fire deaths occurring in the young and elderly populations relative to their percent in the general population. Children under 13 account for 23.8% of the population and people over 65 for 10.3% (4). Thus, although these two groups account for one third of the population, they experience roughly half of the annual United States fire deaths. Prevention efforts have been focused on these groups, and should continue to be.

Residential Occupancy

The data on the percentage of fire deaths occurring in residential occupancies show larger variations between sources, largely because definitions of "residential" vary. HEW data for the years 1970 to 1974 indicate that an average of 61% of the fire deaths they report occur in private dwellings. Adding the maximum estimated number of motor vehicle accident fire deaths to the HEW reported deaths reduces the percentage of total fire deaths that are residential to 55%. The HEW definition for private dwellings is equivalent to NFPA residential occupancy classification with the large exception that NFPA includes deaths due to clothing and flammable liquid ignitions occurring in this type occupancy, while HEW does not. NFPA annual estimates for residential fire deaths over this period have averaged 58% of all fire deaths.

However, if NFPA annual estimates of total fire deaths are adjusted downward for motor vehicle accident fire deaths on the basis of the studies reviewed in this report (Table 9), the proportion of fire deaths occurring in residential occupanies increases to 72%. Independently, a second NFPA source, the data in the NFPA FIDO file also indicates that residential fire deaths account for 72% of all fire deaths. State fire marshal reports from 15 States indicate that 74% of annual fire deaths occur in residential occupancies. This 72 to 74% range for residential deaths is probably the best estimate at present.

The HEW percentage for residential fire deaths would be expected to be lower than that of the other sources since they use separate categories for deaths resulting from clothing and flammable material ignitions, many of which occur in residential occupancies. Further, HEW might not include some residential fire fatalities due to lack of information on occupancy on death certificates. Although only

Table 12.

SELECTED CHARACTERISTICS OF FIRE DEATHS: 1970–1974

Sources	HEW Vital Statistics		NFPA [1]		State fire marshal reports		Maryland [2]	Salt Lake City, Utah [3]
	% total fire deaths							
	Mean	Range	Mean	Range	Mean	Range		
Sex: male	62.1	61.7–63.0	—	——	63.8	51.9–80.0	57	65
female	37.9	37.0–38.3	—	——	36.2	20.0–48.1	43	35
Age: 0-13 [4]	—	——	24.0	——	21.6 [5]	11.2–31.4	25 [6]	25 [6]
over 65 [4]	—	——	27.7	——	20.9	14.6–30.0	16	19
Residential occupancy	61.4	57.5–64.6	59.6	51.3–72.0	74.1	48.4–94.3	—	77
Clothing ignitions	8.1	6.6–10.3	11.0	——	5.2	0.2–9.0	—	8
Flammable liquids	3.2 [7]	2.7–3.6	4.2 [8]	——	4.3	2.3–7.3	—	19

[1] *Fire Protection Handbook*, 13th and 14th editions. "Fires and Fire Losses Classified," *Fire Journal*, annual. Clarke, J. B. and Ottoson, J. *Fire Journal* Vol. 70, No. 3, 1975. Ottoson, J. "A Summary of Fire Deaths in the United States 1971–1975, prepared for the Fire Research Center, National Bureau of Standards, August 1975. *America Burning*, U. S. Government Printing Office, 052–000–00004–1, 1973.

[2] "Fire Casualty Studies, 1971–1976, Fire Problems Program, Applied Physics Laboratory, Johns Hopkins University under grant NSF GI–44088 and NFPCA grant 75007. APL/JHU FFP TR 20 Bibliography of Reports, February 1976.

[3] Einhorn, I. N. "Fire Injuries—Case History Studies," Progress Report under NSF grant Ert 72–03406–A04, Flammability Research Center, University of Utah, July 1975.

[4] Children 0–13 years represent 24% of the population; people over sixty-five 10%.

[5] Children ages 0–12 years

[6] Children ages 0–10 years

[7] Deaths due to ignition flammable materials

[8] Deaths due to flammable liquid ignitions in residential occupancies

one-third of the States for which data on fire deaths by occupancy class were available gave sufficient information to establish equivalency of occupancy class to that of the NFPA definition, the percentage of residential fire deaths calculated with this data agrees well with that based on NFPA FIDO data.

Apparel Ignitions

The average percentage of fire deaths that were due to clothing ignitions over 1970–1974 was 5.2% according to State fire marshal reports. Only six of the 31 State fire marshal reports examined reported clothing ignitions separately. Since incidents in which clothing was the only item to ignite may not be reported to fire departments, the number of such deaths reported to the State Fire Marshal's Office probably will be low.

The scenario report of Ottoson and Clarke (7), a second source, states that the number of deaths due to apparel ignitions recorded in the NFPA FIDO file are under-represented because the file is maintained from reports submitted by fire departments and often the apparel fire is small and not reported to the fire service. In this Ottoson and Clarke report the fire death records in the FIDO file were adjusted with data from the Flammable Fabrics

Accident Case and Testing System (FFACTS) and Consumer Product Safety Commission (CPSC) file for apparel ignition deaths. The authors estimated that 11% of the total annual fire deaths are attributable to apparel ignitions.

A third source, the HEW tabulated data, indicates an average of 8% of the annual fire deaths result from clothing ignitions. This percentage is reduced roughly 1% if estimated motor vehicle fire fatalities are added to the HEW yearly tabulations.

Thus, the percent of fire deaths from clothing ignitions during 1970–1974 ranged from 5 to 11%—considerable variation in the estimate but a significant problem by any source. Encouragingly, the trend was sharply downward according to HEW data, decreasing from 760 deaths in 1970 to 437 in 1974.

Flammable Liquids

The percentage of residential fire deaths attributable to flammable liquid ignitions calculated with FIDO data is essentially equal to that in State fire marshal reports. The average of the deaths by fire and flames reported by HEW as due to highly flammable materials is slightly lower than both the NFPA and State fire marshal value. Although these data sets are not strictly comparable, the data indicate that flammable materials are involved in between 3 and 5% of annual fire deaths.

Other Sources

The in-depth studies of fire fatalities in the State of Maryland (29) and the greater Salt Lake City area (24) provide fire death data similar to that of the national sources. Both studies list males as approximately 60% of the total fire deaths and children through 10 years of age as 25%. Fire deaths among the elderly were 16% of the total fire fatalities in one study and 19% in the other. The Utah study listed 77% of the fire deaths as occurring in residential occupancies and 8% due to clothing ignitions. Fire deaths attributable to flammable liquid ignitions in this study, however, were 19.2% of the total fire deaths investigated. Residential occupancy fire deaths resulting from flammable liquid ignitions were 5% of the total residential occupancy fire deaths.

References

1. National Commission on Fire Prevention and Control. *America Burning, The Report of the National Commission on Fire Prevention and Control.* Washington, D.C.: U.S. Government Printing Office, No. 052–000–0004–1, 1973.
2. National Center for Health Statistics, U.S. Department of Health, Education and Welfare. *Vital Statistics of the United States: Mortality.* Vol. II, Parts A and B. Washington, D.C.: U.S. Government Printing Office.
3. National Center for Health Statistics, U.S. Department of Health, Education and Welfare. *International Classification of Diseases Adapted for Use in the United States.* 8th Revision. Washington, D.C.: U.S. Government Printing Office, 1967–1969.
4. Bureau of the Census, U.S. Department of Commerce. *Statistical Abstracts of the United States: 1975.* Washington, D.C.: U.S. Government Printing Office, No. 0324–01049–6, 1975 July.
5. National Fire Protection Association. *Fire Protection Handbook.* 13th edition. Boston. 1969.
6. National Fire Protection Association. *Fire Protection Handbook.* 14th edition. Boston. 1976.
7. Clarke, F. B., and Ottoson, J. Fire Death Scenarios and Fire Safety Planning, *Fire Journal* 70(3) 1975, p. 20.
8. Ottoson, J. *A Summary of Fire Deaths in the United States, 1971–1975.* Boston: National Fire Protection Association, 1975. Prepared for the Center for Fire Research, National Bureau of Standards, Washington, D.C.
9. Dunn, H. L., and Halpin, E. H. Fire Casualty Statistics. *National Fire Protection Quarterly* 45(1) 1951, p. 45.
10. Cooley, P. *Fire in Motor Vehicle Accidents.* Special Report UM–HSRI–SA–74–3, Highway Safety Research Institute. Ann Arbor: University of Michigan, 1974.
11. Halpin, B. M. *Survey and Evaluation of United States National Fire Death Statistics.* Topical Report FFP, TR6, Applied Physics Laboratory, The Johns Hopkins University, 1971 December.
12. Fires and Fire Losses Classified, 1970, *Fire Journal* 65(5) 1971, p. 21.
13. National Center for Health Statistics, U.S. Department of Health, Education and Welfare. *Vital Statistics of the United States.* Washington, D.C.: U.S. Government Printing Office.
14. National Safety Council. *Accident Facts.* Chicago.
15. Lauriente, M., and Wiggins, J. H. A National Program for Fire Safety in Transportation. In Fourth Intersociety Conference on Transportation, Los Angeles, California, July 18–24, 1976.
16. Federal Motor Vehicle Safety Standards; Fuel System Integrity, *Federal Register* 38(160) 1973 August.
17. Multiple Death Fires, 1975. *Fire Journal* 70(4) p. 51.
18. Moore, J. O., and Negri, D. B. *Fire in Automobile Accidents.* Research Report 1969–2. Albany, N.Y.: New York State Department of Motor Vehicles, 1969 September.
19. Siegel, A. W., and Nahum, A. M. Vehicle Post Collision Considerations. *1970 International Automobile Safety Conference Compendium.* New York: Society of Automobile Engineers, Inc., 1970.
20. Sliepchevich, C. M., et al. *Escape Worthiness of Vehicles and Occupant Survival.* Final Report under NHTSA Contract No. FH–11–7303, Oklahoma Research Institute, University of Oklahoma, 1970 December.
21. Sliepchevich, C. M., et al. *Escape Worthiness of Vehicles for Occupancy Survivals and Crashes.* Final Report under NHTSA Contract No. FH–11–7512, Oklahoma Research Institute, University of Oklahoma, 1972 July.
22. Filkins, L. *Alcohol Abuse and Traffic Safety.* Special Report under NHTSA Contract No. FH–11–6555 and FH–11–7129, Highway Safety Research Institute, University of Michigan, 1972 June.
23. Halpin, B. H. *Fire Casualty Studies,* 1971–1976. Fire Problems Program, Applied Physics Laboratory, The Johns Hopkins University, unpublished data.

24. Einhorn, I. N. *Fire Injuries-Case History Studies.* Progress Report under NSF Grant ERT 72–03406–A04, Flammability Research Center, University of Utah, 1975 July.

25. Radford, E. P., Levine, M. S., and Halpin, B. M. *Fire Casualty Studies* Annual Summary Report July 1, 1974–June 30, 1975. FPP A75. Applied Physics Laboratory, The Johns Hopkins University, 1975 August.

26. Levine, M. S. Fire Victims: Medical Outcomes and Demographic Characteristics. *American Journal of Public Health* (accepted).

27. Fires and Fire Losses Classified, 1975. *Fire Journal* 70(6) 1976, p. 17.

28. Yamazaki, T., Ohmi, M., and Naoi, Y. Statistics of the Fire Service 1973. *The International Fire Chief* 41(4) 1975, p. 6.

29. *Fire Casualty Studies, 1971–1976* Fire Problems Program, Applied Physics Laboratory, Johns Hopkins University under grant NSF GI–44088 and NFPCA grant 75007. APL/JHU FFP TR 20 Bibliography of Reports, 1976 February.

Fire in the United States

Each year the United States experiences approximately:

- 7,500 fire deaths
- $4.2 billion in direct property loss from fires
- 2.6 million fires that are attended by the fire service, and another 30 million, mostly minor fires, that are not reported to the fire service
- 110,000 reported fire injuries and an estimated 200,000 additional injuries from fires not reported to the fire service
- High statewide fire-death rates in the Southeast and low rates in the West and a scattering of other States
- Roughly, two-thirds of the U.S. fire deaths occurring in ones and twos in the victims' own homes; and less than 4% occurring in what are commonly thought of as "catastrophe" fires
- Striking differences from place to place in important aspects of the fire problem

NFPCA's National Fire Data Center has recently completed its first comprehensive report on the fire problem in the United States. These major findings, as well as extensive information on the occurrence of fires, dollar loss, death, and injury were derived from data from the National Fire Incident Reporting System, the National Fire Protection Association, the U.S. Department of Health, Education and Welfare, the National Household Fire Survey, State Fire Marshal reports, and other sources.

The report, "Fire in the United States," will be available by late winter through the Superintendent of Documents, Washington, D.C. 20402. For a brief summary of the findings and conclusions of the report, contact the Fire Reference Service, National Fire Prevention and Control Administration, P.O. Box 19518, Washington, D.C. 20036.