NBSIR 75-902

# A Survey of Fire Accidents Involving Curtains and Draperies - Deaths, Injuries and Financial Loss

L. Dow Moore and Allan K. Vickers

Center for Fire Research
Institute for Applied Technology
National Bureau of Standards
Washington, D. C. 20234

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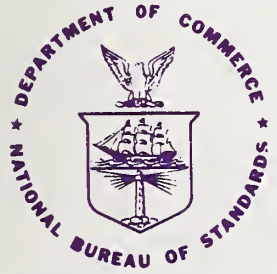
Final Report




U S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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**U.S. DEPARTMENT OF COMMERCE, Rogers C.B. Morton,** ***Secretary***
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**Dr. Betsy Ancker-Johnson,** ***Assistant Secretary for Science and Technology***

**NATIONAL BUREAU OF STANDARDS, Ernest Ambler,** ***Acting Director***

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# A SURVEY OF FIRE ACCIDENTS INVOLVING CURTAINS AND DRAPERIES
## - DEATHS, INJURIES AND FINANCIAL LOSS -

L. Dow Moore and Allan K. Vickers

A case history survey of 286 fire accidents was conducted. This survey was composed of three groups of case histories in which curtains or draperies (C/Ds) were involved. The cases were analyzed in detail, attempting to ascertain the extent to which these products represented fire hazards.

As none of the three files were chosen on a statistical basis, projection of the data to the overall fire hazard situation is not technically feasible.

To learn more of the physical nature of burning C/Ds, and to supply information that may be utilized to judge the extent of hazard, it is recommended that full-scale experiments be conducted.

Key words: Curtains; draperies; FFACTS system; fire; flammable fabrics; NFPA.

## 1. INTRODUCTION

The question arose concerning the severity of C/Ds as fire hazards. It is well known that they burn very rapidly; however, are they the primary product ignited and do they spread the fire or is their role only secondary in nature?

To gain information on the hazard severity a two step program was formulated. First, a survey would be made of the literature as well as fire accident case histories. Second, if this information did not appear conclusive, full-scale burn experiments would be conducted to supply missing physical data -- the data to be the physical conditions a person would be subjected to in a C/D fire.

This report summarizes the literature survey. The literature search included visits to the Programmatic Center for Fire Research Library at the National Bureau of Standards (NBS), a survey by their staff, and a visit to the National Fire Protection Association (NFPA) Library in Boston. In addition, fire accident cases at the National Bureau of Standards, i.e., the Flammable Fabrics Accident Case and Testing System (FFACTS) file; at NFPA; and at the Bureau of Epidemiology of the Consumer Product Safety Commission (CPSC) (the National Electronic Injury Surveillance System (NEISS)) in Bethesda, were studied in detail. Computer printouts were obtained from all three agencies summarizing the many data elements of each case.

## 2. CURTAIN AND DRAPE INVOLVEMENT

After reading the case histories it was evident that curtains and draperies are involved in fires in a vast number of ways. A minor accident might involve kitchen curtains blown into the burner of a gas range and the victim suffering a burnt hand when pulling them down -- to save the rest of the kitchen. A more serious accident could start late in the evening with a cigarette dropped in the seat of an upholstered sofa -- the family goes to bed -- an hour later the sofa bursts into flame and ignites the adjacent draperies. Fire spreads rapidly up the draperies and ignites the combustible ceiling. Combustion gases travel to the bedroom area and asphyxiate the parents and their children.

A total of 286 fire cases were studied in detail. They were examined for pattern of involvement and severity of the accident, both to life and property. One-hundred-forty-seven of the cases were contained in the FFACTS files (see table 1). At the time of this investigation this file contained 3,132 incident case histories in its data bank, involving 3,886 fabric items. It should be noted that when FFACTS was first implemented in 1970, the collection of information on fire accidents involving personal injury was stressed. A large percentage of the first one-thousand incidents involved accidental garment ignition. Therefore, the distribution of the types of fabric fires in the FFACTS file do not represent the actual proportions of such fires in the United States.

The source of other case histories studied are indicated in table 2. After eliminating those duplicated at NBS, 52 in-depth case history studies were on file at the Bureau of Epidemiology (CPSC). In addition, the NFPA computer printout listed 73 incidents, of which 43 occurred in dwellings, apartments, and mobile homes. (As defined by NFPA "Dwellings, One- and Two-Family" are defined as private dwellings and duplexes each occupied by members of a single family group; with total sleeping accomodations for no more than 20 persons, etc.) A separate literature search revealed fourteen more cases.

Table 1. Cases in FFACTS File Data Bank: 3,132

| | Total Cases | First-to-Ignite |
|---|---|---|
| Curtains and Draperies* | 147 | 60 |
| Other Furnishings | 625 | 471 |
| Garments | 2,478 | 1,752 |
| Bedding | 636 | 386 |
| TOTAL | 3,886* | 2,669 |

*93% in dwelling

## 3. LOCATION OF C/D ACCIDENTS

Within the total C/D cases the greatest number, 78 (41%), occurred in the living room of the residence as indicated in table 3. The bedroom was second in frequency of occurence with 68 (35%). (Nine accidents in the living room and 11 in the bedroom were started by children ages 2 to 7 playing with matches or a cigarette lighter. Of these 20 cases, the ignition sequence was known in 13 and in 6 cases the child ignited the C/Ds. They ignited bedding in 4 other cases and upholstered furniture in 3.)

When the data were tabulated for first-to-ignite C/Ds, the living room location was still first, and the bedroom second, but the kitchen incidents rose from 15% to 24% of the total. Incidently, 75% of the first-to-ignite kitchen curtain fires in the FFACTS file were ignited by the cooking range. In seven of these, flaming grease was an intermediary material.

### 3.1. Types of C/Ds Involved and Their Location

A detailed description of types of curtains and draperies involved in these accidents would be quite extensive because of many variables. Some of these variables are whether the C/D was a film or fabric, the weight per square yard, type of weave and construction, chemical nature of the yarn, and whether the C/D was lined or flocked. Many of the C/D samples received at NBS with the FFACTS case histories were analyzed for fiber type and weight per square yard. Table 4 lists individual weights of C/Ds' measurements, their location in the residence, and the ignition source which will be discussed later. Among these cases the average weight hanging in the living room and bedroom were 6.9 and 6.3 oz/sq yd, respectively, and the kitchen curtains averaged 2.4 oz/sq yd. The spread around these averages is quite large. This is expected since sheer "glass curtains" often placed next to the window glass and under overhanging draperies in a living room may weigh as little as 0.8 $oz/yd^2$. On the other hand heavy draperies that are lined with a layer of acrylic foam attached to the fabric may weigh as much as 14 to 16 $oz/yd^2$. However, the substantial fabric weight difference between kitchen C/Ds and those found in other rooms occurs consistently, as might be expected.

Of the 147 C/Ds involved in fires recorded in FFACTS, 62 C/D fabrics were analyzed for type of fiber. These data are shown in table 5. Of the many types of fiber and blends found, cotton, rayon, acetate and fiberglass were the predominant fibers. (Although fiberglass filaments themselves do not burn, some of the dyestuffs, flocking, and foam backing used in curtain fabrication will support combustion.)

Table 2. Other C/D Cases Reviewed

| | Total Cases | First-to-Ignite Cases |
|---|---|---|
| NEISS Files* | 52 | 20 |
| NFPA | | |
| Dwellings, Apartments, Mobile Homes | 43 | 43 |
| Public Occupancies | 30 | 25 |
| Literature Survey | 14 | -- |

*All dwelling fires

Table 3. Location of Curtain/Drapery Accidents
Summation of Case Histories in FFACTS, NEISS, and NFPA* Files

| | Total Cases | First-to-Ignite Cases |
|---|---|---|
| Kitchen | 28 (14.6%) | 28 (24.3%) |
| Living Room** | 79 (41.1%) | 46 (40.1%) |
| Bedroom | 68 (35.4%) | 32 (27.8%) |
| Misc.† | 17 ( 8.9%) | 9 ( 7.8%) |
| TOTAL | 192 (100.0%) | 115 (100.0%) |

* Only first-to-ignite cases

** Includes living room area designated as den, playroom, family room, lounge

† Includes hall, basement, bathroom, dining room, office

Table 4. C/D Weight/Sq Yard Distribution With Respect to Location and Ignition Source
(Ounces Per Square Yard)

| C/D Ignition Source | Kitchen | Living Room | Dining Room | Bedroom | Misc. |
|---|---|---|---|---|---|
| Ember:<br>Smoking Materials, Cigarettes | | 4.6<br>6.8 | | | |
| Small Flame<br>Matches, Candle, Gas Range, Lighter, Flaming Garment | 1.3<br>1.3<br>2.7 av 2.6<br>2.8<br>3.7<br>3.8 (7.2) | 5.8<br>5.8<br>9.1 | | 3.3<br>5.0<br>5.2 | 5.6 |
| Large Flame:<br>Open Fire (Leaf), TV Set, Flaming Sofa-Chair-Carpet-Bedding, Grease, Flammable | 1.2<br>1.3<br>3.3 | 4.2 7.2<br>4.2 7.4 av 7.0<br>4.4 7.9<br>5.5 10.1<br>5.6 10.6<br>6.1 10.6<br>6.8 (1.5) | 2.2 | 4.4<br>5.3<br>6.8<br>8.1<br>8.6<br>av 6.6<br>(1.2, 2.9) | 5.7<br>7.4 |
| High Heat Flux (No Flame):<br>Electric Range, Lightbulbs, Space Heater | | (0.8) | | 4.7 | 7.7 |
| Arc (Electrical):<br>Electric Wiring, Electric Blanket, Combustion Engine | | | | 6.2<br>12.1 | 4.7 |
| Average | 2.4 | 6.9 | | 6.3 | 6.2 |

()These weights were considered outliers and were not included in the averages.

Table 5. Fiber Type - C/D Fabric Analyzed At NBS (FFACTS)

| Fiber Type | Percent |
|---|---|
| Cotton | 21.0 |
| Rayon/Acetate | 16.1 |
| Fiberglass | 12.9 |
| Cotton/Rayon | 12.9 |
| Rayon | 9.7 |
| Plastic Film | 6.5 |
| Polyester | 6.5 |
| Rayon/Cotton | 4.8 |
| Misc. (5 blends) | 9.6 |
| Total of 62 samples | 100.0 |

## 4. IGNITION ORIGINATION AND FIRE SPREAD SEQUENCES

In general, the ignition sequence is recorded as often as possible in fire investigation cases for the purpose of later studying how the fire was ignited. For example, a 6-year-old boy playing with matches in his bedroom ignited a bed sheet, it spread to the blanket which set the curtains on fire - they in turn carried the flame to the combustible tile ceiling. The ignition source was, of course, the match - classified as a small flame in tables 4 and 6 - the sheet was first-to-ignite, and the blanket was second with curtain and ceiling tile third and fourth, respectively. (By definition the FFACTS system is concerned with fabrics and therefore, the ceiling tile would not be listed in the sequence order.)

A recent NFPA article [1][1] emphasizes the importance of first-to-ignite material. Although all combustible materials contribute fuel, some are much more likely to initiate a major fire by being ignited by a small heat flux. The process of ignition involves raising the temperature of an object to a sufficiently high level to generate combustible gases, applying a high temperature source to these gases, and providing sufficient contact with oxygen to support combustion. Most fabric can support and transfer such combustion under favorable circumstances.

The fabrics covered by FFACTS and NEISS case histories were examined for ignition sequence. Table 6 lists the order of ignition for four categories of fabric items tabulated in the FFACT System and for the C/D case histories covered in-depth by NEISS. In the 1,111 non-garment fires recorded by FFACTS, C/Ds and other furnishings were both first-to-ignite in 64% of their respective cases in which they were involved and for which the ignition sequence was known. Bedding was somewhat lower at 47%.

[1] Numbers in brackets refer to the literature references listed at the end of this paper.

Table 6. Ignition Sequences from FFACTS and NEISS Case Histories (All Exclusive of Flammable Liquids)

| | FFACTS | | | | NEISS |
|---|---|---|---|---|---|
| | Curtains/ Draperies | Other Furnishings | Bedding | Garments | Curtains/ Draperies |
| 1st-to-Ignite | 63.5% | 63.4% | 46.9% | 69.8% | 43.2% |
| 2nd-to-Ignite | 16.7% | 20.7% | 27.9% | 23.1% | 36.4% |
| 3rd-to-Ignite | 14.6% | 10.1% | 16.3% | 5.5% | 15.9% |
| 4th-to-Ignite | 5.2% | 5.8% | 8.9% | 1.6% | 4.5% |
| Total Cases - Known | 96 (100.0%) | 396 (100.0%) | 619 (100.0%) | 1,803 (100.0%) | 44 (100.0%) |
| Cases Order-of-Ignition Unknown | 51 | 229 | 17 | 675 | 7 |

Forty-four NEISS cases indicated that when C/Ds were involved in a household fire they were first-to-ignite 43% of the time.

How were these fires ignited? Ignition sources such as cigarettes, matches, gas ranges, TV sets, electrical wiring, etc. were separated into 5 categories as listed in table 7 (and previously in table 4). In addition, when the C/D was not the first product to ignite, but was set afire by a flaming sofa, grease or bedding, it was also included in the 5 categories. Of the 51 known first-to-ignite C/D cases in the FFACTS file, 43% were started by small flame and 29% by large flame sources. About this same ratio was maintained when ignition sources from all 3 files were tabulated in table 8.

Again, referring to table 7, it appears that cigarettes and cigars ignited C/Ds in 4 of the cases. It does not seem probable that a smoldering cigarette would ignite a curtain. In all 4 cases the resident and/or case inspector implied that factual information was "extremely meager." They implied that factural information was not available but had merely theorized about the ignition source.

Table 7. FFACTS File, Curtain Ignition Objects - Number of Cases Per Source and Percent of Known Causes

| C/D Ignition Source | 1st-to-Ignite | | Total C/D | | C/D Spread Cases | |
|---|---|---|---|---|---|---|
| | No. Cases Per Source | Percent of Known Causes | No. Cases Per Source | Percent of Known Causes | No. Cases Per Source | Percent of Known Causes |
| Ember: | | | | | | |
| Cigarettes, Cigars | 4 | 8 | 4 | 4 | -- | -- |
| Small Flame: | | | | | | |
| Matches, Candle, Gas Range, Lighter, Flaming Garment | 22 | 43 | 27 | 25 | 8 | 30 |
| Large Flame: | | | | | | |
| TV Set, Flaming Sofa-Chair-Carpet-Bedding, Grease, Flammable Liquid, Explosion | 15 | 29 | 66 | 61 | 16 | 59 |
| High Heat Flux (no flame): | | | | | | |
| Electric Range, Light Bulbs, Space Heater | 5 | 10 | 5 | 5 | 1 | 4 |
| Arc (Electrical) | | | | | | |
| Electric Wiring, Electric Blanket, Combustion Engine | 5 | 10 | 6 | 5 | 2 | 7 |
| Unknown: | 9* | | 39* | | 5* | |
| Total Cases: | 60 | 100 | 147 | 100 | 32 | 100 |

*Cases in which ignition was unknown were not included in percentages.

There was a large shift in large flame ignition from 29% for first-to-ignite to 61% for total cases. To illustrate this change, this ignition category, as well as the small flame category, was detailed in table 9. (As only the major ignition sources were plotted, the total cases will not add up to the 93 in table 7.) The sources in cases where the C/Ds were second (or later) to ignite are shown separately on the bottom half of the bar graph. It is evident that a large number of C/Ds were set afire by flaming bedding and upholstered furniture.

What did the flaming C/Ds ignite? In many accidents the fire sequence throughout the home was unknown or the ignition ended with the C/Ds. However, in 44 case histories in the FFACTS file they ignited other fabric or ceiling and wall materials.

| Item | No. Cases |
|---|---|
| Ceiling and Wall Materials | 17 |
| Rugs/carpets | 10 |
| Upholstered Furniture | 9 |
| Bedding | 5 |
| Misc. Fabrics | 3 |

## 5. DEATHS AND DAYS IN THE HOSPITAL RESULTING FROM C/D FIRES

In a review of the 3,132 cases in the current FFACTS file the 147 C/D cases revealed a total of 44 deaths and 39 hospital victims (see table 10). The death rate per case was 0.30 if the boarding home, Case No. 2413, involving 10 deaths was included and a rate of 0.23 if not. The first-to-ignite accidents had a lower death rate at 0.18 per case although the treated and released victims were almost twice as numerous on a per case basis.

During the in-depth study of the 147 FFACTS cases, it was evident that C/Ds were involved in a number of conflagrations and were instrumental in the spread of the fire from the ignition source to other items in the house. Thirty-two cases in this category were considered. In 60-70% of these cases the inspector stated in his report that C/Ds materially assisted in fire propagation. Each one of these cases is abstracted and contained in appendix A at the end of this report. For more convenient review they are also listed in table 11.

In table 10 the indicated death rate for these 32 accidents was 0.45 for dwellings, that is, when case 2,413 was excluded. In 63 percent of these "firespread" incidents C/Ds were first-to-ignite which was the approximate percentage listed in table 6 for the total C/D cases.

Table 8. Curtain and Drapery Ignition Sources: Total of FFACTS, NFPA and NEISS Files - All First-to-Ignite

| C/D Ignition Source | First-to-Ignite |
|---|---|
| Ember | |
| Cigarettes, Cigars | 6 (6%) |
| Small Flame: | |
| Matches, Candle, Gas Range, Lighter, Flaming Garment | 43 (42%) |
| Large Flame: | |
| TV Set, Flaming Sofa-Chair-Carpet-Bedding, Grease, Flammable Liquid, Explosion | 24 (24%) |
| High Heat Flux (No flame) | |
| Electric Range, Light Bulbs, Space Heater | 15 (15%) |
| Arc (Electrical) | |
| Electric Wiring, Electric Blanket, Combustion Engine | 14 (14%) |
| Unknown: | 17 (-)* |
| Total | 119 (-) |

*Unknown ignitions not included in percentages.

Table 9. Tabulation of Small and Large Flame Ignitions and Their Locations: K=Kitchen, L=Living Room, B=Bedroom, M=Misc.

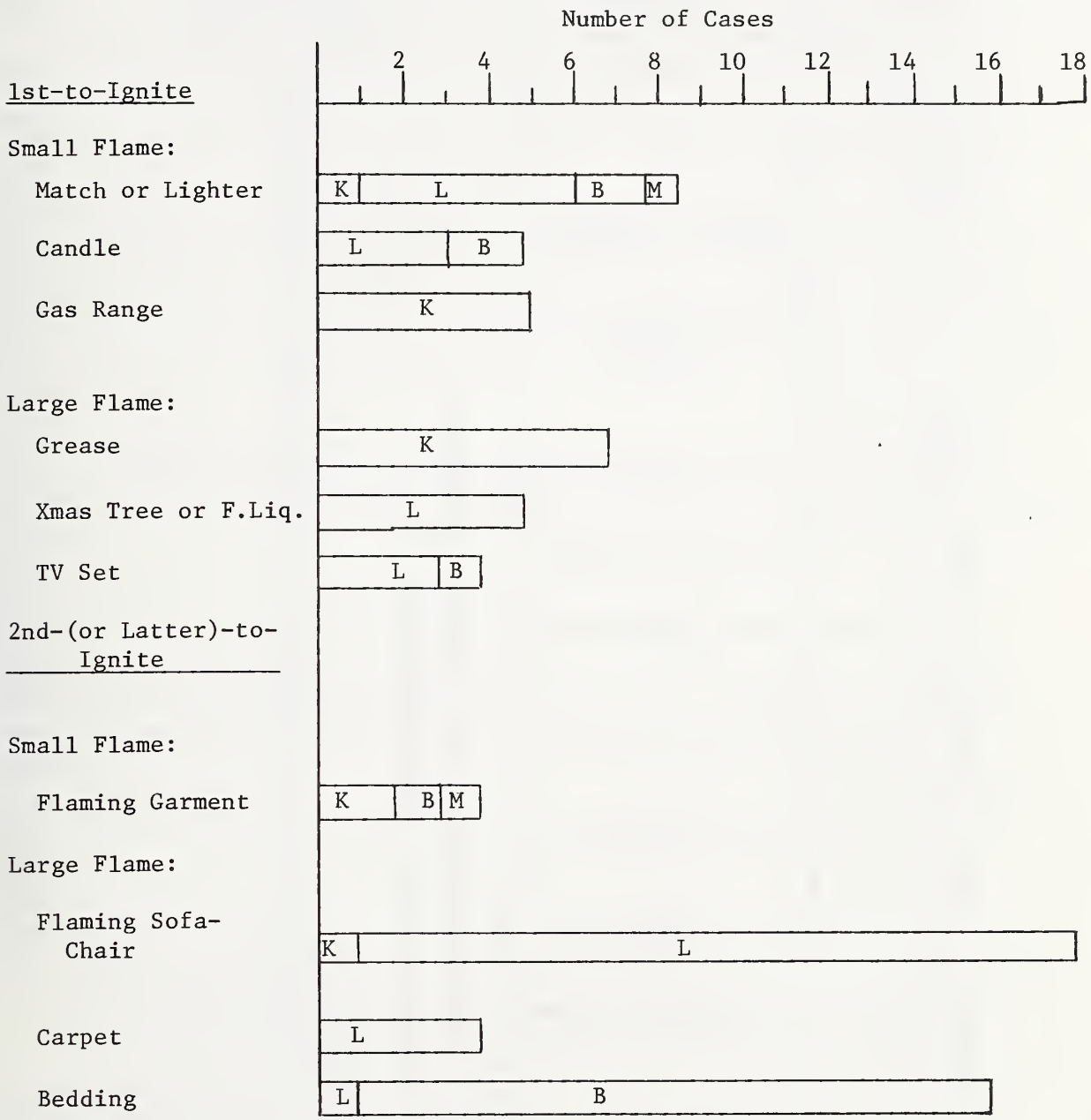

Table 10. Disposition of Victims in Fires Involving C/Ds - FFACTS File

| | Total C/D Cases | | First-to-Ignite | | Fire Spread Cases | |
|---|---|---|---|---|---|---|
| | Victims | Victims/Case | Victims | Victims/Case | Victims | Victims/Case |
| Dead on Arrival* | 44 | .30** | 11 | .18 | 24 | .75† |
| Hospitalized | 39 | .27 | 13 | .22 | 6 | .19 |
| Treated and Released | 25 | .17 | 17 | .28 | 5 | .16 |
| Total Cases | 147 | -- | 60 | -- | 32 | -- |



* Includes those who died in hospital

** When the 10 deaths in the nursing home case No. 2413 were not included

† When case No. 2413 was excluded this value decreased to .45.

Table 11. Summary of "32 C/D Fire Spread Cases" in FFACTS File
Deaths and Financial Damage

| Case No. | C/D Position in Ignition Sequence | Deaths or Hospital Cases | Total Damages |
|---|---|---|---|
| 1093 | 2nd | - | $ 8,000 |
| 1116 | 1st | - | 30,000 |
| 1528 | 2nd | - | 6,000 |
| 1533 | 1st | - | 20,000 |
| 1591 | 2nd | - | 8,500 |
| 1669 | 3rd | 3 Hosp. - 2 Deaths | - |
| 1789 | 1st | - | 6,000* |
| 1824 | 1st | - | 25,000 |
| 1860 | 1st | 3 Deaths | - |
| 2373 | 1st | 3 Deaths | - |
| 2413 | 2nd | 10 Deaths | - |
| 2597 | 2nd | - | 6,000 |
| 2993 | 2nd | - | 2,000 |
| 3027 | 2nd | 1 Death | 6,500 |
| 3064 | 2nd | - | 25,000 |
| 3125 | 1st | - | - |
| 3168 | 2nd | - | 7,000 |
| 3244 | 1st | 1 Hosp. - 1 Died | 21,000 |
| 3267 | 1st | - | 5,000 |
| 3276 | 1st | 1 Hosp. | - |
| 3329 | 1st | - | 500 |
| 3424 | 2nd | - | 10,000* |
| 3466 | 1st | - | 10,000* |
| 3471 | 1st | - | 6,600 |
| 3524 | 2nd | - | 1,200* |
| 3545 | 1st | - | 8,000* |
| 3561 | 1st | 3 Deaths | - |
| 3665 | 1st | - | 900 |
| 3668 | 1st | - | 5,000 |
| 3673 | 1st | 1 Death | 8,000 |
| 3768 | 1st | 1 Hosp. | - |
| 3793 | 1st | - | 8,000 |
| | 63% 1st<br>34% 2nd<br>3% 3rd | Total 24 Deaths<br>Average $/Case | $234,200<br>$ 9,760 |

*Estimated by L. D. Moore

Tabulation of the 52 cases in the files at the Bureau of Epidemiology (NEISS), i.e. those not duplicated at NBS, gave a death rate of 0.25 per case (see table 12). The 25 NFPA cases (according to NFPA personnel) had been chosen for investigation because they were extraordinarily disastrous accidents. This accounts for the very high 0.84 deaths per case.

The spread of fire by C/Ds seemed especially pronounced in 12 of the 52 NEISS cases. In these accidents, which are also abstracted and attached as appendix B, ten (10) victims were killed and two hospitalized.

To obtain a possible comparison of the death per case rate within fabric item groups consistent with the method of coding used in the FFACTS computer system, table 13 restricts data listing to Case No. 1650 through No. 3838. Proper computer entry had not been made prior to case No. 1650. the total first-to-ignite cases in the group was 1926. Because of some case rejections all numbers between 1650 and 3838 were not used. Only first-to-ignite cases were selected to eliminate any double counting of incidents.

The "Other Furnishings Group" consisting primarily of upholstered furniture and carpeting had the highest number of deaths per case at 0.40. Garments was lowest at 0.12; however, the 162 deaths involved with these garment cases is of indisputable significance.

## 6. MAJOR FIRES INVOLVING C/Ds

There have been a number of fires in public places which have taken a heavy toll of human lives. In a number of cases draperies or fabrics used as wall or partition covers have been cited as contributing to very rapid flame spread and generation of panic among the inhabitants. The following are examples of these instances:

Ref [3] Coconut Grove Night Club Fire (Boston, 1942) — 489 died

It is believed fire started in Melody Lounge (basement) of night club. False partition walls were covered with fabrics as were ceilings. These materials as well as other decorations such as artificial palm trees caused fire to spread very rapidly throughout the building. Fire spread and toxic gas generation was so rapid that some victims did not even leave their tables.

[4] Sao Paulo 1974 Fire — 188 died

Flames reaching up from a lower floor shattered glass in windows above setting curtains afire which in turn promoted spread to that particular floor. This was a vertical chain reaction that helped pass the fire from floor to floor.

Table 12. NEISS and NFPA Files -
Average Deaths Per Case

| | No. Cases | Total Deaths | Deaths Per Case |
|---|---|---|---|
| NEISS | 51 | 13 | .25 |
| NFPA* | 25 | 21 | .84 |

*Dwelling and apartment fires

Table 13. Deaths Resulting from Fabric Involvement
(FFACTS File, Case No. 1650 through 3838)

| | First-to-Ignite Cases | | |
|---|---|---|---|
| | No. Cases | Total Deaths | Deaths Per Case |
| Curtains and Draperies | 31 | 10 | .32 |
| Other Furnishings | 340 | 145 | .40 |
| Garments | 1,315 | 162 | .12 |
| Bedding | 240 | 63 | .26 |

[5] Greek Night Club "Oscar" (1973) 32 died

Overheated electrical wires on floor under synthetic velvet type floor covering ignited covering and fire spread to walls which were profusely covered with combustible curtains of several kinds.

[6] Night Club Detroit (1929) 22 died

Fire of unknown cause started at the foot of a stairway. Entrance hall and stairway were lined with flammable draperies and decorations. Fire traveled swiftly up the stairs to the main dance hall on the second floor.

[7] Watervliet, Michigan Nursing Home (1954) 8-10 died

A glassed-in porch was lined with combustible draperies. They were ignited by a portable heater and the two-story wooden nursing home was destroyed.

[8] Restaurant - New York City (1936) 9 died

Flames ignited draperies and wall hangings decorating the walls and ceiling of a restaurant and caused 150 persons to panic. Nine were killed and 34 injured when they rushed for the only stairway.

[9] Nursing Home - Billings, Montana (1953) 6 died

Nursing home was destroyed when curtains were accidently ignited.

## 7. FINANCIAL LOSS RESULTING FROM C/D IGNITION

Table 14 lists only dollar loss to the residential property and contents in the dwelling. No attempt is made to put a value on work days lost or hospital and doctor bills. Approximately 50% of the C/D case histories in the NEISS and FFACTS files recorded an estimated financial loss. The losses per case were $5,670 and $5,070, respectively. The severe fire accidents within the FFACTS cases which were especially attributed to curtains and draperies had an average dollar loss of $9,760 - almost twice that of the other cases. These 32 cases were not chosen because of their high dollar loss - loss was not tabulated at the time - but because burning C/Ds promoted fire intensity and flame spread to other parts of the dwelling. When the NEISS case histories were reviewed in the same manner, of twelve cases selected (appendix B), seven recorded loss estimates averaging $8,280.

The 25 NFPA cases listed in table 14 were selected by NFPA because they were especially disastrous fires. Eighteen of these averaged $22,700 each, with the losses ranging between $400 and $75,000. The dollar losses for the FFACTS and NEISS cases ranged from a low of $50 to a high of $30,000.

Table 14. Total Property and Content Loss for C/D Involvement Cases

| Case Files | Total Cases | Total Dollars | Cases, ($) Recorded | Loss Per Case ($) |
|---|---|---|---|---|
| FFACTS | 147 | $344,600 | 68 | $5,070 |
| C/D Spread | 32 | 234,200 | 24 | 9,760 |
| NEISS | 52 | 152,400 | 27 | 5,670 |
| NFPA | 25 | 408,400 | 18 | 22,700 |

In the September 1973, Fire Journal [2], NFPA published an estimated loss for one- and two-family dwelling fires for the year 1972. There were 562,500 dwelling fires in the Nation which caused an estimated $638,500,000 loss. The average loss per fire of $1,100 indicates many minor fires were included in the tabulation. Although it is difficult to assess the situation accurately, it appears from the accident case records that fires involving C/Ds and other furnishings are much more devastating than the average.

Is it possible to compare the financial loss of C/D fires with those in which carpets, upholstered furniture, bedding, and garments are involved? The first-to-ignite tabulation in the FFACTS file yielded the information in table 15. As indicated previously the accident incidents listed in this file were not collected for the purpose of statistical extrapolation. However, considering just this group of cases, the loss per C/D involvement fire was slightly higher than, but essentially comparable, to cases wherein other furnishings were the first-to-ignite. The average loss per first-to-ignite bedding fires at $1,280 per case was approximately one-fourth that of the furnishings loss per case. Bedding was low possibly because of the presence of people near the accident scene.

## 8. OTHER SURVEYS AND OPINIONS

A number of surveys and "opinion polls" have been conducted regarding the fire hazards of C/Ds. A recent U.S. household survey conducted by the Bureau of Census and jointly sponsored by NBS and CPSC was extrapolated to the total U.S. population. Counting fabric items that were first-to-ignite gave C/Ds 19,000 incidents with 124,000 for upholstered furniture, 142,000 for carpets and rugs, 115,000 for bedding, and 159,000 for clothing. Do these figures represent the true picture?

Rexford Wilson, Fire Record Editor of NFPA, at the 1962 Textile Flammability Conference in his paper titled "Fires Involving Non-clothing Fabrics" stated:

"Hanging textiles, i.e., curtains, tapestries, cubicle curtains in hospitals, wall coverings, can greatly increase the initial rate of fire spread. Large cloth panels, often with both surfaces exposed to air, can create a very rapidly spreading fire. Burning hanging textiles often generate intense heat that is sufficient to ignite other combustibles. The panic that is apt to result at the sight of a rapidly spreading sizeable flame is another hazard of hanging fabrics."

In a 1974 residential fire survey [10] copyrighted by the National Curtain, Drapery and Allied Products Association Inc., a total of 355,916 fire accidents was covered by 248 respondents, i.e., fire marshals, fire chiefs and insurance claim representatives. Incidently, approximately 2,500 fire accidents were unveiled by the flammable liquids, electrical wiring, refuse/garbage, plastic products, and others. Of this group fabric was the highest at approximately 26%. Within this group which included C/Ds upholstered furniture covers, clothing, mattresses, bedding and others, C/Ds were the highest contributors to "Most Fire Spread," "Severest Hazard in the Home," and "Greatest Property Loss."

The last two references above were based largely on opinions although they were educated opinions) and the Census Bureau report on a small sample of the U.S. population. Who is correct?

Table 15. Total Property and Content Loss for First-to-Ignite, FFACTS File Cases

| | First-to-Ignite Cases Only | | | |
|---|---|---|---|---|
| | Number of Cases for which $ Recorded | Total Loss | Loss Per Case | $ Recorded Cases % of Total |
| Curtains & Draperies | 23 | $115,000 | $5,000 | 40% |
| Other Furnishings | 150 | 657,000 | 4,380 | 30% |
| Garments | 91 | 162,000 | 1,780* | 5% |
| Bedding | 206 | 263,600 | 1,280 | 50% |

*If flammable liquids and other intermediary materials are excluded, the loss per case is $398.

## 9. SUMMARY AND CONCLUSIONS

A survey was made of 281 fire accident case histories in which curtains and draperies (C/Ds) were involved. The survey included a review of these fire incidents contained in files at the National Bureau of Standards, the Bureau of Epidemiology - National Electronic Injury Surveillance System - of the Consumer Product Safety Commission, and National Fire Protection Association as well as these from a literature search.

A major portion (41%) of the fires started in the living room with bedroom and kitchen incidents comprising 35% and 15% of the total respectively. Cotton was the most frequently involved fabric with blends of rayon/acetate, and cotton/rayon as well as fiberglass also significantly represented. Fabric weights of the C/Ds averaged 6.9, 6.3, and 2.4 oz/sq yd for the living room, bedroom and kitchen locations, respectively.

Fire records in the Flammable Fabrics Accident Cases and Testing System (FFACTS) File at NBS indicate C/Ds were the first materials to be ignited by matches, grease, electrical shorts, candles, and gas ranges in decreasing order of frequency. If C/Ds ignited later in the fire spread sequences they usually caught fire from flaming upholstered furniture or bedding. In the known fire spread sequences, burning C/Ds most frequently ignited ceiling and wall materials of the house.

Excluding commercial establishments 223 case histories reviewed listed a total of 78 deaths. The death incidence per case ranged from 0.23 for some of the FFACTS cases to 0.84 for the 25 NFPA accident histories. A total of 44 incidents selected because C/Ds were instrumental in spreading the fire throughout the house claimed 2 to 3 times as many death victims per case as the overall C/D cases.

In 113 cases where the property and house contents financial losses were recorded the average was $8,000 per incident.

The fire accident case histories reviewed were not chosen on a statistical basis and therefore the data should not be extrapolated to apply to the U.S. population as a whole. However, based on the information available the following conclusions are drawn:

1. The largest percentage of C/D fires started in the living room (see section 3).

2. When C/Ds were involved in a fire, 64% of the time they were the first furnishings to be ignited (see section 4).

3. The match was the most common source of ignition (see section 4, and table 11).

4. In cases where C/Ds were involved in the fire sequence, they appeared to play an important part in spreading the fire, often to produce a serious incident. When C/Ds were involved in the

spread, the likelihood of a fire death occuring increased 50% above the average death rate for a C/D related fire.

5. In the FFACTS file the "Garments Category" had 16 times as many deaths as listed for C/Ds (see table 13).

6. The first-to-ignite C/D cases had the highest property loss per case although the number of cases was small (table 15).

Other surveys strengthen the conclusions above - especially number 4. One survey accounting for 355,916 fire accident cases lists C/Ds as the highest contributor to "Most Fire Spread," "Severest Hazard in the Home," and "Greatest Property Loss." On the other side of the picture a Bureau of Census survey listing approximately 2,500 fire cases placed C/Ds low on the frequency of occurrence list.

## 10. RECOMMENDATIONS

To analyze the consequences of burning C/Ds further, it is recommended that full-scale experiments be performed for the purpose of simulation and verification of patterns of involvement. To learn more of the hazards to which a person might be exposed, the experiments should include measuring the rate of burning, air temperatures radiant energy, and measurement of smoke and toxic gas concentrations. The C/Ds to be burned should be chosen to represent types of fiber, fabric weight and lining materials.

Limiting test conditions should be chosen to control the extent of the investigation. The most frequent fires started in the living room and the match was the most common source of ignition. It is therefore recommended that the investigation concentrate upon the ignition by smoke sources of pinch pleated draperies, which are by far the most common style found in living rooms.

## 11. REFERENCES

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[5] Fire Kills 32 in Greek Night Club, Fire International 40 (June 1973).

[6] The Study Club Fire - Detroit 1929, NFPA Quarterly (October 1929).

[7] Non-Flameproofed Curtains, NFPA Quarterly (July 1957).

[8] Restaurant Fire - NYC, NFPA Quarterly (April 1936).

[9] Non-Flameproofed Curtains, NFPA Quarterly (July 1957).

[10] Residential Fire Survey - A Report to The National Curtain, Drapery, and Allied Products Association, January 1974) (Copyrighted 1974).

## APPENDIX A. ABSTRACTS OF 32 " FIRE SPREAD" FFACTS CASES

### - SUMMARY OF FIRE SPREAD MECHANISM -

Case No. 1093

At 8:50 A.M. fire occurred in the kitchen of a one-year-old story-and-a-half residence. A sofa in the kitchen was apparently ignited by an electrical short in a wall outlet. Kitchen draperies were ignited by the flaming sofa and fire then spread along the ceiling to the other areas of the kitchen. Although the fire was essentially contained in the kitchen there was much smoke and heat damage to the rest of the house. The family was alerted by one of three children crying out. There were no injuries. Property and contents damage was $8,000.

Case No. 1116

Draperies and glass curtains in a family room were ignited by an electrical short from a floor level socket. Next-to-ignite was the varnished wood paneling and/or furnishings in the room. The paneling fire was so intense the walls of plaster board were destroyed. Fire spread to other rooms of the house causing a total damage of $30,000.

Case No. 1528

A flaming sofa, presumably ignited by a cigarette, ignited draperies from where the fire spread to the ceiling and the interior of the $12,000 house. There was heavy smoke stain throughout the entire house and the loss was estimated at $6,000. No victims.

Case No. 1533

Seven-year-old boy set fire to curtain in playroom with matches. Fire spread to wood paneling and gutted the entire central living area of the house. No victim; but $20,000 damage to house and contents.

Case No. 1591

Four-year-old child set fire to couch throw covers in living room of home. The draperies were the second-to-ignite followed by the couch itself, a chair, and rug. The front living area of the first floor of the 2-1/2 story house was consumed and the estimated loss was $8,500. No victims.

Case No. 1669

A living room couch, probably ignited by a cigarette, ignited a rug, curtains and wallpaper in that order. Heat and smoke spread to second floor of house killing two boys. In addition the father and two sisters were injured also.

Case No. 1789

A electrical arc is believed to have ignited the living room drapes of a 3-year-old mobile home. They ignited a sofa, the trailer wall and the $6,000 unit was completely demolished. The wife lost 15 work days due to this accident.

Case No. 1824

Curtains lining a sun porch were ignited by a defective extension cord. Fire spread across the porch to the interior of the two-story house which was completely damaged due to the smoke and intense heat. No victims; but $25,000 property and contents loss.

Case No. 1860

Fire occurred in a second-story apartment in San Antonio, Texas. Plastic curtains at a kitchen window were ignited by a gas range and fire spread to entire kitchen area. This rapidly generating fire produced smoke which killed a mother and two children aged 4 and 7. The mother's body was found in a room adjoining the kitchen and the two children were in the bedroom.

Case No. 2373

Fire originating in the second floor living room of a three-story row house resulted in the death of a mother and 2 children, they were trapped and died in a third-story bedroom. The ignition source was either a TV set or faulty extension cord. The fire was spread by draperies and stair carpeting up to the third floor.

Case No. 2413

A boarding home fire in Wisconsin claimed the lives of 10 residents ranging in age from 60 to 88. Fire started in an upholstered chair in the living/dining room of this 15-room 2-story structure. It spread to polyethylene film type window draperies and from there, or from the flaming chair, to the combustible fiber tile ceiling. Fire then spread to the first floor hallway which also had the same type ceiling tile and

wood wainscoting as the dining room. After much smoke was generated a flashover occurred in the dining room area. This intense heat penetrated throughout the house except where bedroom doors were closed.

Case No. 2597

This fire occurred in a single-story wood frame duplex and the financial loss was about $6,000 - no victims. Two children apparently started a fire under the lower bunk in their bedroom. Fiberglass curtains behind the bed burst into flame igniting the top bunk, walls, and ceiling of the room. The fire subsequently spread through both sides of the duplex.

Case No. 2993

A fire occurred in a single-family dwelling in Miami - confined to a bedroom. Apparently it was started by a youngster's smoking and it involved a bed, curtains, chest of drawers, and clothing on the floor. The fire investigator stated that the floor length draperies undoubtedly contributed to the spread of the blaze. The damage totaled $2,000; no victims.

Case No. 3027

This fire which resulted in the death of its 66-year-old victim and $6,500 in property damage started in an upholstered chair by smoking materials. It ignited a rayon/cotton drapery and spread around the corner of the living room to a couch the victim was sleeping on.

Case No. 3064

The game room of an apartment building was the scene of a fire accident which had no victims but resulted in losses of $25,000. A discarded cigar butt ignited an upholstered chair stuffed with urethane chunks. Draperies next to the chair then burst into flame which then traveled throughout the room. Photographs indicated the carpeting was burned and the wood paneling charred on the surface.

Case No. 3125

Ignition of cafe-type curtains in a second-story bedroom was likely caused by an electrical short in a radio or extension cord. It was surmised the flaming curtains then fell down, ignited the plastic seat of the valet on which the radio had been placed, the carpeting, and then the mattress and box springs. The fire eventually gutted the entire upstairs consisting of 4 bedrooms and one bath.

Case No. 3168

A cigarette ignited a couch in the family room of a $25,000 home in Miami. Because of large windows the room was essentially lined with curtains which ignited from the couch. Everything in the room was destroyed. The acoustical ceiling which was labeled as fire proof did not burn but the wooden backing did. The loss was estimated at $7,000 total.

Case No. 3244

A residential fire ignited by a religious candle killed the husband, hospitalized the wife for 52 days, and caused property and contents damage amounting to $21,000. The candle had been placed on top of a TV set located near curtains in a living room. Although the ignition sequence is not known for all the furnishing near the TV set, evidence indicates the draperies ignited first.

Case No. 3267

An incense burner apparently ignited an adjacent straw basket containing unburned incense sticks in a bedroom. Rayon/acetate draperies then ignited and fire spread to the telephone stand on which the incense was placed - to a chair, and to bedding. Total loss was $5,000.

Case No. 3276

A television set apparently ignited fiberglass draperies which in turn ignited wood wall paneling and other materials in the room. A woman was seriously burned when she attempted to pass through the burn area.

Case No. 3329

A defective extension cord ignited fiberglass curtains and a rayon/acetate/metallic yarn fabric used as a dressing table skirt-order of first ignition unknown. The curtains appeared to give off "pops" and "sparks" which spread the fire more rapidly (possibly a metallic thread was woven with the fiberglass yarn). Fire spread to the small throw rug, bedding, and rayon/acetate curtain at the other end of the room. Total damage estimated at $500.

Case No. 3424

This fire occurred in the rear bedroom of a two story brick dwelling. Ignition likely resulted from a cigarette being dropped on a shag rug. Fire spread to the bedding and curtains and although the bedroom door had been finally closed property damage extended throughout the house. No injuries. $10,000 in property and contents damage.

Case No. 3466

Shorts in Xmas tree lights ignited and artifical tree reported to be polyvinyl-chloride. The second-to-ignite was draperies hanging at a nearby window. The house was eventually completely destroyed and its value and contents was estimated at $10,000.

Case No. 3471

An overfilled fondue pot containing peanut oil ignited in a dining room. The husband when attempting to dispose of it in the kitchen accidently ignited the kitchen curtains. The fire from these polyester curtains then ignited the kitchen cabinets and ceiling panels. Melting and buckling ceiling panels fell and burned the husbands shirt, pants and his wifes' hairpiece. He was treated at the hospital for first, second and third degree burns. Total damage to the house was $6,600.

Case No. 3524

Two young children, ages 4 and 5, with matches ignited the cover of a mattress which had been torn loose and was hanging down below the bed. Other bedding ignited and the fire spread to adjacent window curtains as well as some draperies being used as a closet door. Another bedroom and a bathroom were eventually involved for a total of $1,200 loss.

Case No. 3545

A four-year-old boy most likely ignited this fire with matches in a downstairs bedroom. First-to-ignite was either the bedding or a curtain adjacent to the bed. Very little information is known about the fire spread sequence. In any case the inside of the house was destroyed at a loss of approximately $8,000.

Case No. 3561

It is assumed a seven-year-old boy set fire to draperies in the living room of a small one-story house. Fire or hot gases spread to the bedroom where he and a two-year-old child died of carbon monoxide

poisoning. Neither child nor the mother received severe burns. The mother died later in the hospital with a cardiac arrest.

Case No. 3665

$900 property and contents damages occurred to a bedroom when a six-year-old boy set fire to the cotton curtains. The respondents reported that the curtains burned very rapidly and the fire spread over the entire wall in a matter of seconds.

Case No. 3668

A seven-year-old grandson ignited casement curtains in a living room. Although the 52-year-old female received burns on the fingertips and neck she required no medical treatment. Fire spread to the overhanging draperies and also to the rug, tablecloth and furniture. Total damage was $5,000.

Case No. 3673

The ignition of curtains in a sitting room was initiated by their being pushed back against an electric baseboard heater by a piece of furniture. Flame spread up the wall, across the ceiling and into the adjacent living room. The 72-year-old housewife coming down from the second floor collapsed in the living room and later died in the hospital. Damage to the home was a total of $8,000.

Case No. 3768

Flames burst from the back of a TV set and ignited curtains in a bedroom. Fire propagated to the rug, bedding, and furniture. During the act of attempting to extinguish the flames a 39-year-old female walked into the bedroom and fainted. She was hospitalized for 55 days.

Case No. 3793

An overheated electric fan simultaneously (assumed) ignited bedding and a curtain on a porch being used as a bedroom. Fire rapidly spread through the wood frame house destroying it and its contents. Damage estimated at $8,000.

APPENDIX B
ABSTRACTS OF 12 "FIRE SPREAD" NEISS CASES
- SUMMARY OF FIRE SPREAD MECHANISM -

Case No. A22587

Two children, male aged 3 and female 2 years old, were left alone in a house while their mother worked. One of them ignited with a match clothing draped on a hobby horse. The fire spread to the walls of the bedroom and via drapes ("highly flammable" according to the fire chief) to the bunk bed. The children were driven to another bedroom by the smoke and hot gases where they were overcome. They both died about an hour later in a hospital. The property and contents damage totaled about $900.

Case No. A07276

Defective Xmas tree lights set the tree on fire in the living room of a house at 6:56 P.M. The fire spread to the draperies and carpet. Minor injuries to face and hands of victim occurred when she attempted to remove articles of furniture from the room.

Newspaper Clipping: At about 6:00 P.M. a Halloween candle ignited curtains in the living room. The fire quickly spread to the rest of the room and up a stairway to the second floor. The fire was very intense (a flashover probably occurred). Two children (female) aged 2 and 1 were killed on the second floor and the parents died in the living room. 4 killed and home gutted.

Case No. A27832

At approximately 10:00 P.M. cigarette ashes were dropped on a sofa in a den. Although it was thought they had been extinguished, fire broke out about 11:30 and the resulting smoke overcame the sleeping family of five. All eventually escaped from the house with minor injuries except the three-year-old son who was apparently burned by the hot metal bed frame and overcome with smoke. He was hospitalized for 11 days. The investigation indicated the cigarette had ignited the couch which in turn set fire to the draperies. The ceiling was also heavily damaged even back into the hallway.

Case No. A22585

It was theorized that two fires started simultaneously. A 56-year-old female ignited her clothing while smoking in the living room at 11:00 P.M. and the wind (very strong) knocked a lamp over. The broken bulb ignited cotton draperies at a picture window. The draperies apparently ignited the knotty pine wall paneling. The victims husband said the wind was so strong the flames were blown like a torch. The wife was DOA.

Case No. A39975

Although the source of ignition was not definitely known it was believed to be either children playing with matches or an electrical short. Clothes ignited in a bedroom closet and the fire spread to curtains on a nearby window and to bedding. Fire damage was confined to the bedroom but smoke damage was extensive throughout the rest of the house. No victims, but $2,500 damage.

Case No. A14476

Hot grease in a skillet being heated by a gas range ignited after being left unattended. The flaming grease ignited the fiberglass (composition not confirmed) curtains which in turn set fire to the ceiling and shelving simultaneously. No victim but $800 damage. (Fire contained in kitchen).

Case No. A17031

A 66-year-old widow apparently dropped a cigarette in a chair - then eventually went to sleep on a couch (living room). The chair ignited and set draperies on fire. The fire spread by way of the wall covering or carpeting to the couch on which victim was sleeping. The victim died by smoke inhalation. Property and contents loss was $6,500.

Case No. A17534

A light bulb ignited a Xmas tree in the living room of a home. The drapes which were touching the tree were first-to-ignite and they spread the blaze to a couch, piano and ceiling. Financial loss totaled $18,000 with second degree burns which hospitalized the mother for 6 days.

Case No. A17517

A six-year-old girl ignited curtains in a bedroom about 9:26 one morning. Flame spread to the wall covering (10% Dacron and 90% Cotton) and then to the bedding. Contents of the entire bedroom were destroyed. No victim.

Case No. A39997

Although there is no proof, a seven-year-old boy probably ignited draperies in a living room with a match. Fire spread to the ceiling and to the bedroom killing the boy and a two-year-old child.

Case No. A44056

It was hypothesized that sunlight shining through a window ignited a bag of matches left on a window sill. They ignited the window curtain which in turn set fire to bedding and clothing. Eventually the entire contents of the bedroom was consumed. No injury and $300 of damage.

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**15. SUPPLEMENTARY NOTES**

**16. ABSTRACT** *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

A case history survey of 286 fire accidents was conducted. This survey was composed of three groups of case histories in which curtains or draperies (C/Ds) were involved. The cases were analyzed in detail, attempting to ascertain the extent to which these products represented fire hazards.

As none of the three files were chosen on a statistical basis, projection of the data to the overall fire hazard situation is not technically feasible.

To learn more of the physical nature of burning C/Ds, and to supply information that may be utilized to judge the extent of hazard, it is recommended that full-scale experiments be conducted.

**17. KEY WORDS** *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Curtains; draperies; FFACTS system; fire; flammable fabrics; NFPA.

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