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Space Heater Involvements in Fabric Fires

Warren D. Hayes, Jr.

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

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Final Report

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U.S. DEPARTMENT OF COMMERCE, Elliot L. Richardson, *Secretary*
James A. Baker, III, *Under Secretary*
Dr. Betsy Ancker-Johnson, *Assistant Secretary for Science and Technology*

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

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SPACE HEATER INVOLVEMENTS IN FABRIC FIRES

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Abstract

Space heaters are number six in the ranking of most frequently involved direct fabric ignition sources in the Flammable Fabrics Accident Case and Testing System (FFACTS). Eighty-two of the 1573 direct fabric ignition incidents in FFACTS were caused by space heaters. Gas heaters were responsible for 83 percent of all direct garment ignitions where heater type was known. Nightgowns, dresses and robes account for 82 percent of all the garment items directly ignited. Forty-seven percent of the direct garment ignition incidents would probably not have occurred if the presently existing fabric flammability standards had been in effect at the time.

Key words: Burns; fabric fires; FFACTS; garments; ignition sources; space heaters.

1. INTRODUCTION

1.1. Role of Ignition Sources

The ignition of fabric, which so frequently leads to fire injury, would not occur if the fabric were noncombustible or if there were no ignition sources. Therefore, one approach to reducing the possibility of fabric ignition is to increase the consideration given to the fabric ignition potential in the design of heat producing devices and equipment. This report on space heaters is the third in a series of studies to characterize the nature of the involvement of the ignition sources most frequently identified with unwanted fabric fires — two previous studies being on kitchen ranges [1][1] and on matches and lighters [2]. This report presents a summary of an analysis of information on the ignition of fabric by space heaters, and was derived from the National Bureau of Standards (NBS) Flammable Fabrics Accident Case and Testing System (FFACTS) file now maintained by the Consumer Product Safety Commission. For the purpose of this report, space heater is defined as home heating equipment for use within the principal space to be heated excluding floor furnaces.

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

1.2. The Flammable Fabrics Accident Case and Testing System

Section 14a of the Flammable Fabrics Act, as revised and amended December 14, 1967, stated that the Secretary of Health, Education and Welfare in cooperation with the Secretary of Commerce should conduct a continuing study and investigation of deaths, injuries, and economic losses resulting from the accidental burning of fabric products. From the time of passage of that act until the formation of the Consumer Product Safety Commission, which took over the entire responsibility, NBS on behalf of the Department of Commerce (DOC), and the Food and Drug Administration (FDA) on behalf of the Department of Health, Education and Welfare (HEW) were working together to that end. FDA investigators, using questionnaires developed cooperatively by FDA and NBS, investigated accidental fabric fires and collected remnants of the burned fabrics. The incidents investigated were not selected on a statistical basis and therefore do not constitute a statistically representative sample of all the fabric fires in the United States. In particular, regional geographical biases could easily distort the apparent importance of space heaters as an ignition source.

The FDA reports with fabric remnants when available were sent to NBS, where they were processed for inclusion in the computerized FFACTS file. The processing included physical and chemical identification of the fiber in the fabric remnants, and physical characterization of the construction and burn characteristics of the fabric remnants. The incident reports and the laboratory results were then analyzed and 130 different elements of this information and data were coded for entry into the computer file.

2. FINDINGS

The findings in this report are based upon the 3132 incident reports incorporated into FFACTS between July 1970 and February 1974.

2.1. Ranking of Ignition Sources

Space heaters rank sixth in the tabulation of direct sources of fabric ignition in descending order of frequency of their involvement as shown in table 1. There were actually 82 fabric ignitions from space heaters in the total of 1573 fabric ignitions where the source was known and directly applied to the fabric without the involvement of any intermediary material or flammable liquid. They thus account for 5 percent of all direct fabric ignitions.

It should be pointed out that FFACTS contained 127 fabric ignition incidents wherein space heaters were involved, but in 28 of these, there was definite involvement of an intermediary material and in 17 others there was possible involvement of an intermediary material. The remaining 82 incidents were categorized as direct fabric ignitions. Seventy-seven of these direct fabric ignitions were garment ignitions and were categorized as direct garment ignitions.

2.2. State Distribution of FFACTS Cases

Table 2 shows the state distribution of all the cases in FFACTS and of the different types of space heaters. One must remember that the incidents were not investigated on a statistical sample basis; and therefore a comparison of frequency of incidents between states is not valid. The comparison between the number of space heater incidents in a state to the total number of incidents within a state does however indicate the relative seriousness of the space heater hazard problem in that state. In the states of West Virginia, Alabama, Louisiana, and Tennessee, space heaters accounted for at least 30 percent of the fabric ignitions.

2.3. Patient Disposition

Table 3 shows the disposition of the persons involved in space heater ignition incidents. One can readily deduce that these incidents are quite serious. Thirteen percent of the people involved in 127 incidents are known to have died and 69 percent were hospitalized. Those hospitalized, whether they recovered or not, spent an estimated 46 days on the average in the hospital. It is interesting to note that the average for all the incidents in FFACTS is 5 percent dying and 33 percent requiring hospitalization for an estimated 37 days on the average per hospitalization.

It must be pointed out that the patient disposition was estimated within several days after the incident and only in a few but indeterminate number of cases was there a follow-up to verify either the outcome or the hospital days estimate.

2.4. Heater Types vs Intermediary Materials

Table 4 shows the relationship between the various intermediary materials that were involved in the incidents. Gasoline, at the top of the list, was present about twice as frequently as oil, the next most frequently involved intermediary material. In six of the eleven incidents involving gasoline, it was being used as a cleaning fluid in the room where the heater was located. The presence of oil as an intermediary material occurred five times. Three of these incidents were precipitated by a malfunction of the fuel supply system of an oil-fueled heater.

Also shown here are the cases wherein an explosion was reported. In the case of gas heaters, the fuel itself was the largest contributor to explosion, and in the case of oil heaters the fuel was the only contributor.

It is important to note that there was no intermediary material in 82 incidents or 75 percent of the cases where the involvement or non-involvement of an intermediary material was reported.

2.5. Age of Victim vs Garment and Heater Type

Injury from garment ignition has been more prevalent among very young and very old people. Apparel flammability standard development until now has been concentrated on garments for the young. It is therefore of interest to consider the impact of the recently enacted mandatory apparel flammability standards on the accidents involving space heaters. Since existing standards specify garment usage types by size range, it is appropriate to look at the frequency of incidents with respect to garment type and age of the victim. As a matter of information, sizes 0 to 6X normally fit persons 0 to 5 years old, and sizes 7 to 14 normally fit persons 6 to 12 years old. Since the involvement of intermediary materials would obscure the relationship between the heater and the garment type, these incidents were removed from consideration. The 77 remaining incidents are included in table 5 which shows the relationship between age, garment and heater type for direct garment ignitions. Nine of these incidents involved persons probably wearing sleepwear sizes 0 to 6X, and twenty-seven involved persons probably wearing sleepwear sizes 7 to 14. The total number of incidents involving persons in both of these garment size groups is thirty-six and thus accounts for forty-seven percent of the direct ignition incidents. The reason for qualifying the sizes worn as probable is that the size was derived from data on the age of victims who may not have been wearing the normally selected garment size for the age. Sleepwear includes nightgowns, pajamas and robes.

In every age group, incidents involving females outnumber those involving males.

Gas heaters were involved in eighty-three percent of the 70 direct garment ignition incidents where the type of heater was known.

2.6. Fabric Characterization

Nightgowns, dresses, and robes account for 49, 15 and 13 percent respectively for a total of 77 percent of the 82 fabric items ignited directly by space heaters. Table 6 shows the fiber content and burn time of the nightgown, robe and dress, samples received. The fiber composition was determined by a combination of microscopic and chemical solubility techniques. The burn time was determined by the CS 191-53 method except that if ignition did not occur during the one second exposure specified for the test, the ignition was forced in order to obtain a burn time. The CS 191-53 test is not very useful since it passes almost every fabric except brushed cellulosics, but it was the test being used by the Federal Trade Commission to exclude fabrics of excessive flammability from the market place at the time FFACTS was initiated. The weight was determined by the weighing of 5.1 cm (2 in) squares. Many of the burn time and weight determinations were run with fewer than the specified number of samples because of insufficient fabric in the remnants. Eighty-one percent of the nightgown samples were identified as cotton flannel with a weight average of 132.2 g/m^2 (3.9 oz/sq yd).

Fifty-six percent of the dress fabrics were identified as plain woven 100 percent cotton weighing an average of 122.0 g/m^2 (3.6 oz/sq yd). Thirty-three percent of the dress fabrics were identified as plain woven cotton and synthetic fiber blends weighing an average of 108.5 g/m^2 (3.2 oz/sq yd). It is important to note that none of the samples failed the CS 191-53 test which requires that the specimen ignite during a one-second exposure and burn 5 inches within 3-1/2 seconds in order to be considered failing. In fact, most of the samples did not even ignite in one second. The seven samples that did ignite in one second included plain woven cotton with a weight averaging 101.7 g/m^2 (3 oz/sq yd), cotton flannel with weight averaging 308.5 g/m^2 (9.1 oz/sq yd). The average burn time for the forced ignition tests on the nightgowns was 15-1/2 seconds for the 12.7-cm (5-in) gage length. This is roughly 5 times longer than the failing time. A nightgown made from a cotton blend weighing 64.4 g/m^2 (1.9 oz/sq yd) yielded the fastest burn time which was 9.5 seconds. This is almost 3 times the maximum time in which failure is considered to occur.

The kinds of fabrics in the data base are a function of both the fabrics in the fire incidents and the market-place mix at the time of the investigations.

2.7. Activity of the Victim

The activity of the victim categories established for FFACTS were intended for a wide range of ignition sources and did not include some aspects of the circumstances of peculiar importance to space heater incidents. After reviewing all of the space heater case histories in the file, it was decided that the human activity being engaged in at the time of the ignition incidents would fit into the eight categories that follow: (1) Warming — the person intentionally approaches the heater to warm himself presumably with some caution so as not to receive a burn or ignite clothing; (2) Occupied near — the person may or may not consciously select a position in proximity to the heater, and is primarily attentive to some other activity which includes either standing or moving near the heater; (3) Flammable liquids — the person is engaged in an activity which includes the use of a flammable liquid such as gasoline, oil, adhesives, or hair spray and where the presence of the flammable liquid is presumed to significantly effect the outcome; (4) Falls on — the person makes intimate contact with the heater; (5) Light/adjust — the person is performing a normal operator function required by the equipment; (6) Play with — the person is playing with the heater and while attentive to what he is doing is not aware of or prepared for the consequences of his actions; (7) Other — includes explosions, malfunctions, and situations where the human activity is not significant or relevant to the outcome; (8) Unknown - the activity is not known.

The activity of the victim as related to age and sex is given in table 7 which shows that the activity most frequently being engaged in at ignition is "warming," which accounts for 35 percent of the incidents in which the activity was known. Eighty-six percent of these incidents

involved females and 40 percent of these were in the 6-to 12-year age bracket. The next most frequent activity was "occupied near" which accounts for 28 percent of the incidents in which the activity was known. Eighty-five percent of these incidents involved females, and 46 percent of these were in the 6-to 12-year age bracket.

The incidents, where flammable liquids had a significant effect on the outcome, account for 13 percent of the known activities. Apparently, many people fail to realize that flammable liquids produce flammable vapors that may drift considerable distances to reach a source of ignition.

2.8. Heater Types vs Direct Ignition

Table 8 shows the incident counts for direct ignitions by the different type heaters and also classifies the incidents as to whether the heaters were or were not reported to be unguarded. One can see that gas heaters were involved in 76 percent of all the direct ignition incidents and that this is a little over six times the frequency with electric heaters, the next highest category. Thirty-nine percent of the gas heaters and 20 percent of the electric heaters were reportedly unguarded.

3. ANALYSIS OF DATA AND CONCLUSIONS

Space heaters are not major contributors to fire injury in terms of frequency of involvement even though they rank sixth in the FFACTS file. In terms of severity of personal injury, however, they appear to achieve some significance. A comparison of these accident data with those from matches and kitchen ranges reveals that deaths occur in incidents involving these leading ignition sources as follows: 16 percent of all kitchen range incidents, 13 percent of all match incidents, 13 percent of all space heater incidents. There are twice as many deaths from space heater incidents and additionally twice as many persons hospitalized as is the average for all FFACTS ignition sources.

Nightgowns, dresses and robes accounted for 82 percent of all the garments directly ignited. Discounting the sleepwear incidents in the category covered by existing flammability standards (sizes 0 thru 14) leaves a total of 41 garment incidents. Thirty-two, or 78 percent of these, are almost equally divided among nightgowns, dresses, and robes. Therefore, while the recently enacted flammability standards covering garments in sizes 0 to 14 will considerably reduce the number of incidents involving space heaters, there will continue to be problems associated with the remainder of these long loose garments.

The activities engaged in at ignition were predominantly "warming" and "occupied near," which account for 36 percent and 28 percent, respectively, of the known activities. If we discount the sleepwear incidents in the age groups covered by existing flammability standards, these same activities will continue to be the main contributors to space heater fire incidents. Judging from the body area burned, 29 of 43 ignitions

in the "warming" incidents were low on the back of the garment. This suggests that persons usually back-up to a heater to gain warmth. Re-enactments of this activity demonstrated the possible occurrences. Many persons showed a definite tendency to project their posterior towards the heat source. This action not only positions the hem of long loose garments closer to the heat source because the garments hang from the hipline, but it also has a tendency to elevate and flare the hem toward the source. In fact, the action usually begins with the person leaning forward from the waist thereby raising the hem first and is followed by projecting the posterior which thrusts the hem toward the heater. It would therefore appear that the ignition incidents involving long loose garments and classified as "warming" probably involve a downward, but mostly horizontal, thrust of the hemline toward the heater. Additionally, there will be at increasing velocity of thrust, an increasing tendency for contact with a horizontal element of a guard to result in whipping of the free end of the fabric toward the heat source. The deflection of this free end needs to be only slightly more than the thickness of the guarding elements to gain penetration. Once penetration has occurred, small movements of the fabric are likely to increase the penetration.

In the incidents classified as "occupied near," there are subclassifications that might have provided very meaningful information had they been defined before FFACTS was begun. These are standing still, turning around, walking past and a combination of the three. Examples of the latter are changing clothes, brushing teeth, mopping the floor, playing, washing hair, and working. In the data base, all of these activities are somewhat indistinguishable in the incident report narratives even though some of the incident investigators did use terms such as "standing" and "walking by."

Turning around produces centrifugal forces which tend to cause the entire hemline of a long loose garment to flare out. The amount of flaring depends on several factors including the weight of the fabric, the length of the hem, and the velocity of the spin. The stiffness of the fabric will also affect the amount of the flaring, but primarily, this is because of its significance in determining whether the spin velocity of the garment follows that of the wearer. Without stiffness, the garment will usually tend to just wrap around the wearer rather than be accelerated to the same spin velocity.

Walking produces air forces which will cause flaring out in the back of a continuous hemline garment. The degree of flaring will depend primarily on the weight of the fabric and the walking velocity. A garment that is open in the front (a noncontinuous hemline garment) will usually entrap air and balloon at the sides as well as the back. The extent of the ballooning will depend upon the fabric weight, porosity and stiffness, the length of the hem, and the walking velocity.

Therefore, as previously mentioned, walking and turning will tend to flare out long loose garments. The flaring caused by these air pressure and centrifugal forces will actually result in the hem being thrust at a heater within range. In addition, concurrent horizontal movement of

the hem, parallel to the front of the heater resulting from walking or turning will result in a swiping action. A guard incorporating mostly horizontal elements could actually direct such a swiping garment toward the heating elements. This phenomenon could be aggravated by ballooning of the fabric within the guard, caused by the aforementioned air pressure, convection air currents around the heater, and air pressure waves from body movement.

There is adequate evidence to show that guarding has been and may still be deficient in providing protection from fabric ignition. Thirty-five percent of the direct ignition incidents were reported to have involved heaters that were unguarded presumably either because the design failed to include one or because it had been detached or defeated in some way. In 65 percent of the incident reports, the guard was noted as present or there was no mention of the guard, and it is considered reasonable to assume that in most of these incidents the guard was present and in fair condition. In two cases, the heater was described as being completely enclosed which probably implies that the investigator considered the guarding to be very good. Unfortunately, the incident reports usually lacked important detail related to the make, model and character or condition of the heater that may have contributed to the incident. One must remember that the main interest and emphasis of the flammable fabrics program was on determining how the fabric characteristics of items were related to burn injury. Attempts to get design information on heaters involved in ignition incidents failed primarily because of the lack of identifying information on the heaters. It must be added, however, that the manufacturers have no incentive to provide design information on heaters that predate the Consumer Product Safety Act. In fact, they can by such assistance put themselves in jeopardy that would result from disclosure of a safety design defect. Without design information on the heaters involved in ignition incidents to relate to the circumstances of the incidents previously described as indistinctively grouped, one cannot make an accurate evaluation of the problem or specific recommendations for a solution. It is, however, apparent that some guards are inadequate. The following guard deficiencies are suspect:

1) They get too hot or permit fabric penetration to areas sufficiently hot to ignite fabric.

2) They are, or become detached for one of the following reasons:

   a) They are too fragile and become nonfunctional;

   b) They cause excessive inconvenience in normal use;

   c) They present another hazard that the user recognizes and chooses to avoid.

None of the fabrics tested were determined to be highly flammable by the test method of CS 191-53, and most did not ignite during the one-second exposure to the gas pilot flame. Direct comparison of these

fabric characteristics with results by other laboratories could not be made, but Heskestad [3] and Fourt [4] have reported ignition times of less than one second for these same fabric types in the Government-Industry Research Council on Fabric Flammability (GIRCFF) samples group, except for the synthetic blend, but with slightly lower fabric weights. Tests run at the National Bureau of Standards by J. J. Loftus whose method was later described by Gobeil [5] confirmed these results. These fabrics were scrutinized for characteristics related to use as ignition test materials. The FFACTS analysis showed only 2 of 21 cotton flannel samples igniting in one second, but three other investigators found ignition times of less than one second for a similiar GIRCFF fabric. The explanation may be that FFACTS samples are from remnants of apparel that had been used for some period of time and that use had changed the flammability characteristics. After use, flannel has been observed to suffer loss of nap, which is the more easily ignited part of the fabric and, occasionally, has been observed to spread flame across the surface without burning the base material. Another interesting observation is that Loftus got a 1.4-second ignition time for flannel conditioned at 50 percent relative humidity and a 0.5-second time for the same fabric dried at 105 °C (221 °F) and cooled in a desiccator. This implies high sensitivity to conditioning. This sensitivity was not revealed by any other of the GIRCFF fabrics. It means that as a test fabric cotton flannel probably would require carefully controlled conditioning and use.

Cotton terry cloth from the GIRCFF fabrics has yielded ignition times almost as low as the flannel, but it has displayed another characteristic worthy of note. Heskestad found that it would ignite in 0.9 seconds when exposed horizontally to a premixed methane flame, but when exposed at an inclination of 41°, it took about 3 seconds. It would seem that such sensitivity to angle of exposure should be explained before it is considered as an ignition test fabric.

The ignition of the cotton, polyester, nylon blend in one second is not surprising considering its weight of 64.4 g/m^2 (1.9 oz/sq yd), but it is rarely used. The 100 percent plain woven cotton fabric remnants performed as would be expected. Loftus found a similar cotton fabric to be only slightly sensitive to conditioning since it ignited in about one second when conditioned at 50 percent relative humidity and had about a 0.1-second lower ignition time when conditioned at 105 °C (221 °F) and cooled in a desiccator. Heskestad found its ignition time to be insensitive to orientation between 0 and 41 degrees from the horizontal over a premixed methane flame. Its reaction to a methane diffusion flame is in the median range of the aforementioned fabrics. It therefore appears to have the more predictable ignition behavior of the fabric remnant types here discussed for use as a direct flame contact ignition test fabric.

Lastly, it is important to recognize that a test fabric intended for other than direct flame contact requires consideration of characteristics other than ignition time. For the situation where a test sample is held in contact with a guard and excluding the possibility that the guard gets hot enough to be a severe skin contact burn hazard, the radiative or

convective mode of heat transfer probably dominates. If the radiative mode dominates, the absorptance of the fabric will be a very important characteristic. The effect of both of these modes is increased as the ability of the fabric to conduct heat away from the exposed surface is decreased. The importance of this has been demonstrated for example in carpet burn tests where the presence of a backing pad has caused failure that did not occur when the pad was absent. The effect of the pad is to reduce the heat loss thru the back of the carpet thereby increasing the heat retained to sustain combustion. Heat retention will contribute to ignition in the same manner. The thermal conductivity of the fabric is therefore another important characteristic to consider.

4. RECOMMENDATIONS

1. Comparisons should be made by CPSC of designs of heaters involved in incidents in order to identify similarities that could point to safety design defects.

2. A program should be initiated to develop improved methods for evaluating the effectiveness of the fabric ignition protection afforded by space heaters. The methods should include determination of functional durability, penetrability, surface temperatures and heat flux levels. Functional durability means that the parts of the heater incorporated in the protection should be durable enough to perform their intended function as long as the appliance is capable of producing heat. This would be determined by appropriate strength and life cycle tests. If operation or maintenance of the appliance requires disabling of the protection, the associated mechanisms and the procedures recommended by the manufacturer should be evaluated for safety impact in light of this requirement. For example, if a guard must be removed to re-ignite a heater, the operator should be able to do so within a stated and reasonable period of time without causing burns to himself or household furnishings. Furthermore, the mechanisms for disabling the guard should be childproof, but not so difficult that an adult of normal dexterity would neglect to restore the protection. An alternate solution to these rather complex evaluations would be to require that the guard be permanently attached.

   Ease of penetration of the fabric ignition protection should be determined by a method that takes into account the problem of flapping and flaring of long loose garments. A fabric exposure test should detail techniques for testing the ease of penetration of the protection. It is obvious that for this test sample weight and stiffness can be as important as ease of ignition. The realization that fabric characteristics are frequently changed by the manufacturers, suggests the need for experimentation with the use of a well standardized non-fabric material such as filter paper or glasine weighing paper.

An alternate technique would be to use a heat flux sensing probe. For example, a probe could be designed with geometry that would define guard penetration limits for simulating exposure to common household flammables with emphasis on garment-related phenomena such as thrusting of pleats and folds, swiping edges and ballooning within the guard which are believed to be attendent with the ignition of long loose garments. A reference material attached to the tip of such a probe could be used to indicate whether it penetrates to a zone where heat flux is sufficient to ignite the materials in question. The heat flux indication could be accomplished with a thermocouple, but a small piece of the aforementioned non-fabric material might be more indicative.

Surface temperature and heat flux measurements or a draped fabric type of test are needed to evaluate the long time exposure circumstance, such as when a garment touches but does not penetrate the guard, and when there is focusing of radiant energy.

3. Future collection of data related to space heater accidents should be more detailed with regard to the following information: The description of the activity should distinguish between walking up to or by, backing up to, and turning around near. The heater should be characterized as wall, floor, ceiling, by energy source, whether or not certified by a testing laboratory, and by a detailed description of the appropriate protection devices. The part of the fabric item ignited by the heater should be noted. In the case of wearing apparel this would be the front or back, and the edge or distance from the hem. The point of ignition on the item should be related to the height of significant parts of the heater.

5. REFERENCES

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Table 1. FFACTS Ranking of Direct Ignition Sources (3132 Case Data Base)

Rank	Direct Ignition Source	Count
1	Matches	336
2	Cigarettes	312
3	Gas Ranges	233
4	Electric Ranges	122
5	Open Fires	90
6	Space Heaters	82
7	Unspecified Smoking Materials	65
8	Lanterns/Candles	61
9	Lighters	57
10	Electric Blankets	32
11	Other Appliances	26
12	Electric Wiring	25
13	Light Bulbs/Lamps	20
14	Unknown	19
15	Other	17
16	Fireworks	16
17	Cutting/Welding Torch	16
18	Cigar/Pipe	11
19	Furnace	7
20	Unspecified Range	6
21	Extension Cords	6
22	Other Heater	4
23	Matches or Lighter	4
24	Hot Water Heater	2
25	Other Range	2
26	Other Work Tools	1
27	Combustion Engines	1
Total		1573

Table 2. State Distribution of FFACTS Cases (3132 Case Data Base)

State	All Cases	Space Heater Cases							Percent Space Heater Cases
		Gas	Electric	Oil	Wood	Coal	Unknown	Total	
Alabama	18	6						6	32
Arkansas	1							0	
Arizona	27							0	
California	252	3	1					4	2
Colorado	294	7	2					9	3
Connecticut	9							0	
District of Columbia	28		1					1	3
Florida	112	2	1	1				4	4
Georgia	34	4	1			1		6	18
Illinois	143	1						1	1
Indiana	40	2						2	5
Iowa	181	3		1				4	2
Kansas	16							0	
Kentucky	10							0	
Louisiana	40	8	1				4	13	32
Maine	5							0	
Maryland	97							0	
Massachusetts	299							0	
Michigan	162			1				1	1
Minnesota	23		1					1	4
Mississippi	1							0	
Missouri	63				1			1	2
Montana	3							0	
Nebraska	1							0	
Nevada	2							0	
New Hampshire	14							0	
New Jersey	25							0	
New Mexico	3							0	

Table 2. State Distribution of FFACTS Cases (3132 Case Data Base), cont'd

State	All Cases	Space Heater Cases							Percent Space Heater Cases
		Gas	Electric	Oil	Wood	Coal	Unknown	Total	
New York	290	9	1					10	3
North Carolina	9							0	
North Dakota	1							0	
Ohio	109	3	1					4	4
Oklahoma	27	6						6	22
Oregon	23	1	1					2	9
Pennsylvania	266	2						2	1
Puerto Rico	3							0	
Rhode Island	1							0	
South Carolina	3							0	
South Dakota	2							0	
Tennessee	23	6					1	7	30
Texas	197	14			1		8	23	12
Utah	27							0	
Vermont	3							0	
Virginia	25			1				1	4
Washington	122		5	1				6	5
West Virginia	6	2	1					3	50
Wisconsin	30				1			1	3
Wyoming	6							0	
Unknown	56	6		2	1			0	
Total	3,132	85	17	7	4	1	13	127	

Table 3. Patient Disposition
(3132 Case Data Base)

Disposition	Count
No Injury	8
No Treatment	0
First Aid	2
Treated and Released	10
Hospitalized	88
Died in Hospital	11
Dead on Arrival	5
Other	0
Unknown	3
Total	127

Table 4. Heater Types vs Intermediary Materials
(3132 Case Data Base)

Intermediary Material	Heater Type						Total Materials
	Gas	Electric	Oil	Wood	Coal	Unknown	
Gasoline	7[2]*	1				[1]	11
Oil			[4]		[1]		5
Gas	[3]					1	4
Adhesive	[1]	1					2
Hairspray		1					1
Wood Stick	1	1					2
Anti Freeze				[1]			1
Ceiling Material				1			1
Plastic Comb	1						1
None	62	10	3	1		6	82
Unknown	7	4				6	17
Total	84	18	7	3	1	14	127

*Numbers in brackets [] refer to explosions

Table 5. Age vs Garment/Heater (Direct Ignition)
(3132 Case Data Base)

Age Group	Dress				Nightgown				Robe/ Housecoat				Pajamas				Shirt/ Blouse				Pants/ Overalls				Other				Total
	G	E	L	S	G	E	L	S	G	E	L	S	G	E	L	S	G	E	L	S	G	E	L	S	G	E	L	S	
0-5	2				8								1				1				1			1*	1				15
6-12	5		1		18		1	3*	1				3			1*	1												34
13-20					2	1				1																			4
21-45					1				1	1																			3
46-65	1				3			1	1								1				1				1				9
66+	1	1		1*	1	1			2	2		1*									1								11
Unknown										1																			1
Total	9	1	1	1*	33	2	1	1(3*)	5	4	1	1*	4			1*	3				3			1*	1	1			77
	12				40				11				5				3				4						2		

G = Gas
E = Electric
L = Liquid
S = Solid
* = Unknown

Table 6. Direct Ignition Fabric Characteristics

Item	No. Samples	Fiber	Weave	Average Weight (oz/yd^2)	Average Weight (g/m^2)	Ignite One Second	Average Burn Time (s)
Nightgown	2	Cotton	Plain	3.0	101.7	Yes	15.8
	2	Cotton	Plain	3.8	128.8	No	16.3
	2	Cotton	Flannel	4.0	135.6	Yes	17.8
	19	Cotton	Flannel	3.9	132.2	No	15.5
	1	Blend	Plain	1.9	64.4	Yes	9.5
Dress	1	Cotton	Plain	3.0	101.7	Yes	13.2
	4	Cotton	Plain	3.8	128.8	No	17.7
	1	Cotton	Knit	4.0	135.6	No	16.9
	3	Blend	Plain	3.2	108.5	No	11.6
Robe	1	Cotton	Plain	3.0	101.7	No	19.8
	1	Cotton	Terry	9.1	308.5	Yes	10.0

Table 7. Age vs Activity vs Sex
(3132 Case Data Base)

Age Group	Warming		Occupied Near		Flammable Liquids		Fell On		Light Adjust		Play With		Other		Unknown		Sub-Total	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
0-5	3	9		3	1			1				2	1	1			5	16
6-12	2	15	1	13	2	1	1			1		1				1	6	32
13-20		2	1	2	3	2							1				5	6
21-45		2	1	5	2	4				2			1		1		5	13
46-65	1	4		1	1		1	2	3				1		1	1	8	8
66+		4	1	4			2	1		1				1	2		5	11
Unknown		1		1*								1*		1		3*		2
Sub-Total	6	37	4	28	9	7	4	4	3	4	0	3	4	3	4	2	34	88
Total	43		33		16		8		7		4		7		9		127	

*Unknown Sex (Not included in Subtotals)

Table 8. Heater Types vs Direct Ignition
(3132 Case Data Base)

Type	Unguarded	Guarding Unknown	Total	Percent
Gas	24	38	62	76
Electric	2	8	10	12
Oil	3		3	4
Coal	0	0	0	0
Wood		1	1	1
Unknown		6	6	7
Total	29(35%)	53(65%)	82	100

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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.)*

Space heaters are number six in the ranking of most frequently involved direct fabric ignition sources in the Flammable Fabrics Accident Case and Testing System (FFACTS). Eighty-two of the 1573 direct fabric ignition incidents in FFACTS were caused by space heaters. Gas heaters were responsible for 83 percent of all direct garment ignitions where heater type was known. Nightgowns, dresses and robes account for 82 percent of all the garment items directly ignited. Forty-seven percent of the direct garment ignition incidents would probably not have occurred if the presently existing fabric flammability standards had been in effect at the time.

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)*

Burns; fabric fires; FFACTS; garments; ignition sources; space heaters.

18. AVAILABILITY

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