

F.R. Note No.407/1959

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE  
JOINT FIRE RESEARCH ORGANIZATION

## CASUALTIES DUE TO THE DIRECT IGNITION OF CLOTHING

by

J. F. Fry and J.E.L. Hinton

Summary

Reports on 240 casualties caused by the direct ignition of clothing have been analysed. About three quarters of the casualties were female, and half of the total number were children under 10 years of age.

Two thirds of the garments ignited first were nightgowns, dresses, overalls and skirts, and the material most commonly reported was cotton, which was used in 68% of all garments. In about half the cases the garments ignited were in the medium flammability range, i.e. with flammability ratings between 30 and 60.

Fifty-seven per cent of the casualties were due to ignition by open coal fires.

In about 60 per cent of the casualties the area of the body burned was less than 20 per cent, but thirteen casualties suffered burns to the extent of more than 50 per cent of the body surface. In the reports considered there were twenty-six fatal accidents of whom nine were male and seventeen female.

July, 1959

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### INTRODUCTION

It was suggested by Colebrook<sup>(1)</sup> that the casualties associated with the ignition of clothing amount to about 20 000 a year, of which about 600 prove fatal, and that the average period of in-patient treatment in hospitals is about fifty-four days. In recent years public interest has been focussed on these accidents and methods of reducing their number and severity have been discussed by various bodies such as the Interdepartmental Committee on Accidents in the Home, the Royal Society for the Prevention of Accidents, an all-party committee of the House of Commons, etc. As a method of assessing the fire hazard of fabrics the British Standards Institution has adopted a test in which the speed of vertical propagation of flame is measured; the result is expressed as a "flammability rating" which is defined as the time in seconds for flame to travel vertically a distance of 100 ins.; thus the most flammable materials have a low rating and the least flammable a high one.

With the cooperation of the Ministry of Health and nineteen Plastic Surgery Units (listed in Appendix 'A') a survey has been made with a view to relating the injuries of casualties with the flammability of the fabrics involved. Each of the units received copies of a questionnaire (Appendix 'B'); these were completed for cases in which the ignition of clothing had played a part, and returned, together with samples of clothing, to the Joint Fire Research Organization. The samples of clothing were tested for flammability rating and the information given in the questionnaires was analysed. Some 250 returns were made during the period 1956-58 and 240 of these were used for the survey, the remainder being discarded either because there was no sample of clothing available or because it appeared that the direct ignition of clothing was not a feature of the accident.

### SOURCE OF IGNITION

The most usual source of ignition was the open coal fire (Table I) and 136 (57%) of the casualties were due to ignition by this means. Sixteen incidents were due to electric fires and 13 to fireworks; the accidents in the latter group were all caused by mischievous and careless handling, e.g. lighted fireworks being placed in trousers pockets.

### FLAMMABILITY RATING AND AREA BURNED

Table II shows the flammability rating of the garments ignited first together with the area of the body burned. In 53 per cent of the cases the garments ignited were in the medium flammability range with flammability ratings between 30 and 60. In seventeen (7 per cent) of the cases the garments had very high flammability ratings, i.e. were made of materials which are very difficult to ignite or do not readily propagate flame; in the majority of these cases there were some special circumstances mentioned to explain the casualty. For example in one instance the clothing had become impregnated with kerosine.

In 61 per cent of the casualties the body area burned was less than 20 per cent. Thirteen casualties received burns covering more than 50 per cent of the body's surface; in ten of these the injuries resulted in death.

Table III shows the area of the burns in relation to the flammability rating of the fabric both for cases in which assistance was at hand and for those in which no assistance was immediately available. In 41 per cent of the cases where there was no assistance at hand the burns covered more than 20 per cent of the body area; of the cases where there was immediate assistance available 32 per cent received burns covering more than 20 per cent

of the body area.

In cases where there was assistance and the flammability rating of the fabric was high (760) 76 per cent of the casualties had burns of less than 15 per cent of the body area; the corresponding proportion for the cases where there was no assistance was 36 per cent. With materials of a flammability rating less than 30 the difference in these proportions was smaller (67 per cent and 43 per cent), but the numbers, nine where there was assistance and seven where there was none, were too small to constitute a good statistical sample.

#### FATALITIES

In the reports considered there were twenty-six fatalities of whom nine were male and seventeen female. Six girls and two boys under 10 years old died as a result of nightgowns and dresses becoming ignited when no one was present to assist them; four boys, also under 10 years of age, died from their burns despite the fact that assistance was at hand. There were seven fatalities in the over sixty age group, in only one of which assistance was to hand.

#### FIRE GUARDS

Out of a total of 150 reports on which information was given on the use of guards with coal, gas or electric fires only sixteen stated that a guard was in use at the time of accident. In nine cases a guard was provided but was inadequate or had been moved by children.

#### DISABILITIES

In six cases the casualty was suffering from some disability at the time of the accident. Three women fell on or near the fire in epileptic fits, and one suffered from a stroke. The nightgown of a mentally retarded child became ignited when no other person was present and an elderly, partially-paralysed man ignited his dressing gown by unknown means.

In each of these cases of persons known to be liable to a disability there was no assistance at hand.

#### DISCUSSION AND CONCLUSIONS

In the sample of reports on patients admitted to hospital as a result of burning accidents there were about three times as many female as male casualties. This was to be expected since women's outer garments and sleeping wear tend to be of light-weight fabrics and also fuller in design than those of men. Indeed about two thirds of the garments which were ignited and caused accidents were dresses, overalls and nightgowns, the majority of which were made of cotton materials. It might also be expected from the design of the garments that the burns suffered by women would be more severe than those suffered by men and there is some evidence that this is the case (see Table IV). Fifty-nine per cent of the male casualties suffered burns covering less than 15 per cent of the body area, and a lesser proportion, 45 per cent, of the female casualties fell into the same group; in contrast 23 per cent of the male casualties suffered burns covering 15-30 per cent of the body area against 31 per cent of the female casualties while 16 per cent of the males and 21 per cent of the females received burns of an extent greater than 30 per cent of the body area. In the remaining reports the extent of burns was not given.

The materials of the garments ignited first fell mainly into a group with flammability ratings in the range 30-60, and there were few incidents in which materials of the lowest flammability ratings were involved. This is probably partly because of the frequency with which the materials in this range are used since it is a range which includes most weights of cotton used for women's dresses etc. Materials with low flammability ratings tend to be

used for women's clothing designed for only occasional use. Materials with high ratings are widely used in mens clothing and in womens suits etc.; these materials occurred only infrequently in the reports examined.

It was expected that there might be some relationship between the flammability rating of the fabric and the area of burns, fabrics of high flammability rating causing the less severe burns. No such relationship could, however, be discerned from the survey and the area of burns is probably dependent upon a complex combination of factors. The effect of the presence of assistance was investigated (Table III) and it seems that with fabrics of high flammability rating assistance immediately at hand reduces the area of the burns. With the more flammable fabrics, however, assistance appears, as might be expected, to be less effective.

Another factor which may influence the area of burns is the nature of garments other than that first ignited, e.g. the effect of woollen cardigans of a high flammability rating worn over cotton dresses, and underwear of a low flammability rating. This point was not considered when the survey was planned and there were too few cases in which the nature of the other garments worn was reported for any attempt to be made to assess the importance of this factor. Only a very large and complicated survey could be expected to provide such information.

In conclusion it seems that once a garment has become ignited the severity of the burns suffered does not depend entirely on the materials from which the garment is made but also on a number of incidental factors. While the development of flame resistant fabrics would undoubtedly play a part in preventing these accidents it is also certain that a large proportion of them could be avoided by simple, common-sense precautions such as the use of adequate fireguards.

#### References

(1) Colebrook C and Colebrook V. The prevention of burns and scalds. Lancet, 1949 2 (6570) 181-8.

TABLE I

THE CAUSE OF FIRE AND THE AREA OF THE BODY BURNED IN CASES WHERE CLOTHING WAS IGNITED DIRECTLY

Cause of fire	Area burned											Total	
	< 5%	5%-10%	10%-15%	15%-20%	20%-25%	25%-30%	30%-35%	35%-40%	40%-45%	45%-50%	> 50%		Unknown
1) Open coal fire	10	23	26	20	11	17	12	2	1	3	7	4	136
2) Gas fire	-	-	-	2	-	-	-	-	-	-	-	-	2
3) Electric fire	3	3	4	-	-	-	-	-	-	2	3	1	16
4) Oil stove	2	2	1	-	-	-	1	1	-	-	-	-	7
5) Closed stove	-	1	-	-	-	-	-	-	-	-	-	-	1
6) Gas cooker	2	1	2	1	3	-	1	-	1	-	-	-	11
7) Electric cooker	-	-	-	-	-	1	-	-	-	-	-	-	1
8) Smoking materials	1	1	-	1	-	-	-	1	-	-	-	-	4
9) Matches	1	-	1	-	1	-	-	2	-	1	1	-	7
10) Children playing with matches	1	2	-	1	1	-	-	-	-	1	-	1	7
11) Candle, taper	1	5	4	1	-	1	-	-	1	-	1	-	14
12) Bonfire, playing with fire	1	-	2	1	-	1	-	-	-	-	-	-	5
13) Explosives, fireworks	3	7	-	2	1	-	-	-	-	-	-	-	13
14) Oil lamp	-	-	-	-	-	-	1	-	-	-	-	-	1
15) Paper lit from fire	1	1	-	-	-	-	-	-	-	-	-	-	2
16) Brazier	-	1	-	1	-	-	-	-	-	-	-	-	2
17) Other	-	-	1	1	-	1	-	-	-	1	-	-	4
18) Unknown	1	1	-	-	-	1	-	-	2	-	1	1	7
Total	27	48	41	31	17	22	15	6	5	8	13	7	240

TABLE II

THE AREA OF THE BODY BURNED AND THE FLAMMABILITY RATING OF THE FABRIC  
(CASUALTIES CAUSED BY DIRECT IGNITION OF CLOTHING)

Flammability Rating	Area burned											Total		
	<5%	5%-10%	10%-15%	15%-20%	20%-25%	25%-30%	30%-35%	35%-40%	40%-45%	45%-50%	750%		Unknown	
0-9	-	1	1	-	-	-	-	-	-	-	-	-	-	2
10-19	2	-	-	1	-	-	-	-	-	-	-	-	-	3
20-29	2	2	1	4	-	-	2	-	-	-	1	-	-	12
30-39	7	7	14	3	10	1	6	1	2	2	1	-	-	54
40-49	6	6	8	11	3	7	1	2	-	-	1	3	-	48
50-59	2	7	2	2	1	2	2	1	-	2	3	1	-	25
60-69	2	3	-	1	-	-	-	1	-	-	-	-	-	7
70-79	2	3	1	-	-	1	-	-	1	1	-	-	-	9
80-89	-	3	1	-	-	1	-	-	-	-	-	-	-	5
90-99	-	2	-	-	-	-	-	-	-	-	-	-	-	2
100 and over	2	2	4	3	1	1	2	-	-	-	1	1	-	17
Unknown	2	12	9	6	2	9	2	1	2	3	6	2	-	56
Total	27	48	41	31	17	22	15	6	5	8	13	7	-	240

TABLE III

EFFECT OF THE PRESENCE OF IMMEDIATE ASSISTANCE  
(CASUALTIES CAUSED BY THE DIRECT IGNITION OF CLOTHING)

Area burned	Assistance present					No assistance present					Total number of casualties
	Flammability rating				Total	Flammability rating				Total	
	0-30	30-60	> 60	Unknown		0-30	30-60	> 60	Unknown		
< 5%	1	12	3	1	17	3	2	2	-	7	24
5%-10%	3	9	9	7	28	-	7	2	3	12	40
10%-15%	2	11	4	4	21	-	13	1	4	18	39
15%-20%	2	5	1	3	11	2	11	3	2	18	29
20%-25%	-	8	-	-	8	-	6	1	2	9	17
25%-30%	-	5	2	5	12	-	3	1	3	7	19
30%-35%	1	5	1	1	8	1	3	1	1	6	14
35%-40%	-	2	-	1	3	-	2	1	-	3	6
40%-45%	-	1	-	-	1	-	1	1	1	3	4
45%-50%	-	-	-	1	1	-	3	1	2	6	7
> 50%	-	2	1	1	4	1	3	-	4	8	12
Unknown	-	2	-	1	3	-	1	-	1	2	5
<b>Total</b>	<b>9</b>	<b>62</b>	<b>21</b>	<b>25</b>	<b>117</b>	<b>7</b>	<b>55</b>	<b>14</b>	<b>23</b>	<b>99</b>	<b>216</b>

N.B. In 24 cases it was not stated whether any assistance was at hand or not.

TABLE IV

THE TYPE OF GARMENT IGNITED AND THE AREA BURNED  
(CASUALTIES DUE TO THE DIRECT IGNITION OF CLOTHING)

TYPE OF GARMENT WORN	AREA BURNED											
	< 15%		15-30%		30-50%		7 50%		Unknown		Total	
	M	F	M	F	M	F	M	F	M	F	M	F
Nightgown	3	26	2	15	2	6	2	4	-	1	9	52
Pyjamas	3	2	-	2	1	-	-	-	-	-	4	4
Dressing gown	2	1	-	1	1	-	-	-	1	-	4	2
Underwear	2	3	-	-	-	1	-	-	-	-	2	4
Dress or frock	3	33	-	24	-	15	-	5	-	3	3	80
Trousers	13	3	4	1	1	-	1	-	1	-	20	4
Skirt	-	4	-	8	-	2	-	-	-	1	-	15
Shirt or blouse	11	2	5	-	2	-	-	-	-	-	18	2
Cardigan or pullover	-	3	1	1	-	2	-	1	-	-	1	7
Other garments	1	1	2	-	-	-	-	-	-	-	3	1
Unknown	-	-	1	3	-	1	-	-	-	-	1	4
<b>Total</b>	<b>38</b>	<b>78</b>	<b>15</b>	<b>55</b>	<b>7</b>	<b>27</b>	<b>3</b>	<b>10</b>	<b>2</b>	<b>5</b>	<b>65</b>	<b>175</b>



TABLE V

THE AGE OF THE CASUALTY AND THE GARMENT WORN  
(CASUALTIES CAUSED BY DIRECT IGNITION OF CLOTHING)

Garment first ignited	Age of casualty (in years)												Total	
	0-4	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90 and over		Unknown
Nightgown	20	24	5	-	3	-	1	1	-	-	2	-	5	61
Pyjamas	3	2	-	1	-	-	1	-	-	-	-	-	1	8
Dressing-gown	2	1	-	-	-	1	1	-	-	-	1	-	-	6
Underwear	3	-	1	1	-	-	-	-	1	-	-	-	-	6
Dress, frock, overall	17	23	10	4	4	2	4	5	-	3	2	-	9	83
Trousers	3	5	5	1	3	1	1	-	1	-	1	-	3	24
Skirt	1	3	3	1	5	-	-	-	-	-	-	-	2	15
Shirt	2	5	3	1	-	1	1	-	-	-	-	-	3	16
Blouse	3	-	-	-	-	-	-	-	-	1	-	-	-	4
Cardigan or pullover	-	2	-	-	-	-	2	2	1	-	1	-	-	8
Coat or jacket	1	-	-	1	-	-	-	-	-	-	-	-	-	2
Undecided and other garments	-	-	-	-	-	-	1	-	-	-	1	-	1	3
Unknown	2	2	-	-	-	-	-	-	-	-	-	-	-	4
<b>Total</b>	<b>57</b>	<b>67</b>	<b>27</b>	<b>10</b>	<b>15</b>	<b>5</b>	<b>12</b>	<b>8</b>	<b>3</b>	<b>4</b>	<b>8</b>	<b>-</b>	<b>24</b>	<b>240</b>

TABLE VI

THE GARMENT IGNITED AND THE MATERIAL FROM WHICH IT WAS MADE  
(CASUALTIES CAUSED BY THE DIRECT IGNITION OF CLOTHING)

Garment first ignited	Material of garment									Total
	Cotton	Wincyette	Rayon and brushed rayon	Wool	Wool-cotton	Cotton-nylon	Muslin	Rayon net	Unknown	
Nightgown	44	8	-	-	2	-	-	-	7	61
Pyjamas	6	-	-	-	-	-	-	-	2	8
Dressing-gown	3	-	1	1	-	-	-	-	1	6
Underwear	4	-	2	-	-	-	-	-	-	6
Dress, frock, overall	60	-	9	2	-	-	1	1	10	83
Trousers	14	-	-	4	1	-	-	-	5	24
Skirt	12	-	-	2	-	-	-	-	1	15
Shirt	13	-	-	-	-	1	-	-	2	16
Blouse	3	-	1	-	-	-	-	-	-	4
Cardigan or pullover	-	1	-	7	-	-	-	-	-	8
Coat or jacket	1	-	-	-	1	-	-	-	-	2
Undecided	-	-	-	-	-	-	-	-	1	1
Other garments	1	-	1	-	-	-	-	-	-	2
Unknown	1	-	1	-	-	-	-	-	2	4
<b>Total</b>	<b>162</b>	<b>9</b>	<b>15</b>	<b>16</b>	<b>4</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>31</b>	<b>240</b>

APPENDIX A

Plastic surgery and burns units taking part in survey

1. Birmingham Accident Hospital, Birmingham (M.R.C. Burns Unit)
2. Booth Hall Hospital, Manchester
3. Churchill Hospital, Oxford (Nuffield Department of Plastic Surgery)
4. Fleming Memorial Hospital for Sick Children, Newcastle-upon-Tyne
5. Frenchay Hospital, Bristol (Department of Plastic Surgery)
6. Glasgow Royal Infirmary, Glasgow
7. Guy's Hospital, London
8. Mount Vernon Hospital, Northwood
9. North Staffordshire Infirmary, Stoke-on-Trent
10. Oldstock Hospital, Salisbury (Plastic and oral surgery centre)
11. Rooksdown House Hospital, Basingstoke
12. Royal Belfast Hospital for Sick Children, Belfast
13. Royal Hospital for Sick Children, Edinburgh
14. Royal Victoria Infirmary, Newcastle-upon-Tyne
15. St. Lawrence Hospital, Chepstow (Plastic Surgery Unit)
16. St. Luke's Hospital, Bradford
17. Stoke Mandeville Hospital, Aylesbury (Nuffield Burns Unit)
18. West Norwich Hospital, Norwich (Burns and Plastic Unit)
19. Wythenshawe Hospital, Manchester

# APPENDIX B

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE  
JOINT FIRE RESEARCH ORGANIZATION

Station Road, Boreham Wood, Herts.

## REPORT FORM FOR INVESTIGATION ON BURNS DUE TO FABRICS

(For notes on completing form see back of envelope)

Name of patient .....  
Address .....

CODE	ITEM	COLS	CODE	ITEM	COLS	CODE	ITEM	COLS	
	Report No. .... Date .....	1-5 6-11		GARMENT FIRST IGNITED	26-27		LOCATION OF ACCIDENT	39	
	SEX	12	01	Nightgown		1	At home		
1	Male		02	Pyjamas		2	At work		
2	Female		03	Dressing gown		3	Out of doors		
	Age (years) .....	13-14	04	Underwear		4	Elsewhere		
			05	Dress or frock		5	Unknown		
	TYPE OF CASUALTY	15	06	Trousers			SOURCE OF IGNITION	40-41	
1	Fatal		07	Skirt		01	Open coal fire		
2	Non-fatal		08	Shirt		02	Gas fire		
	PARTS OF BODY BURNED (Indicate all parts burned)		09	Blouse		03	Electric fire		
1	Head	16	10	Cardigan or pullover		04	Oil stove		
1	One arm	17	11	Coat or jacket		05	Closed stove (coal or coke)		
2	Both arms		12	Bedding		06	Gas cooker or ring		
1	One leg	18		Other than above		07	Electric cooker or ring		
2	Both legs			.....		08	Smoking materials		
1	Trunk, upper front	19	99	Unknown		09	Matches		
1	Trunk, lower front	20	THIS SECTION FOR USE OF FIRE RESEARCH STATION				10	Matches - children playing with	
1	Trunk, upper back	21		FABRIC		11	Candle or taper		
1	Trunk, lower back	22		Type	28-29		Other than above		
	AREA OF BURNS (% of body area)	23-24		Wt./cm2(mg)	30-31		.....		
01	Less than 5%			Distance of spread	32-33	99	Unknown		
02	5-10%			Time round whole arc (sec)	34-36		USE OF GUARDS (Complete if source of ignition was any heating appliance)	42	
03	10-15%			Vert. flame speed (cm/sec)	37-38	1	Guard in use		
04	15-20%					2	Guard not in use		
05	20-25%					3	Unknown		
06	25-30%						ASSISTANCE TO INJURED PERSON	43	
07	30-35%					1	Other persons present to assist		
08	35-40%					2	No - one present to assist		
09	40-45%					3	Unknown		
10	45-50%						Remarks		
11	More than 50%						.....		
	DEPTH OF BURN	25					.....		
1	Full skin thickness						.....		
2	Partial skin thickness						.....		