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

MATERIALS SUITABLE FOR CLOTHING AIRCRAFT FIRE CRASH RESCUE WORKERS PART III - THE EFFECT OF A REFLECTING OUTER GARMENT

by

D. L. Simms and P. L. Hinkley

Summary

The use of a reflecting coating on the outside of a fabric has been shown to be very effective in increasing the protection against radiant heat, but it gives no extra protection against flames which transfer heat mainly by convection and which deposit soot on the aluminium surface. If the material is to be used to the limit of its protection a quick release from the clothing is essential.

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1. Introduction

It is well known that aluminised fabrics have a very high reflectivity and their use for giving protection to workers exposed to radiant heat has been suggested and adopted in some industries (1) It has also been suggested that they might be used for the outer garments of aircraft crash rescue workers; in particular, that an aluminised garment worn over a string vest might make a suitable uniform for crash fire workers in hot climates. Because of this, some aluminised fabrics were tested at Joint Fire Research Organization for their protection against radiation and flames since they might come into contact with flame. This report is concerned only with thermal transmission. Other aspects of aluminised fabrics such as their permeability to air and water vapour would need to be considered separately.

The materials tested are listed below.

Table 1

Materials tested

Ministry of Supply Reference No.	Material	J.F.R.O. Reference No.	wt/unit area gm/cm^2	Thickness cm
	Aluminised fabrics			
-	Cotton backing	R168	0·044	0·049*
D7019	Cotton backing	R166	0·048	0·107*
D7025	Asbestos backing	R167	0·095	0·041*
D7032	Asbestos backing	R165	0.1	0·130*
	Underclothing			
	Open mesh fabric (cotton)	R148	0·049	0·51
	Knitted string vest (cotton)	R63	0·092	0·54
	Cotton poplin	R147	0·012	0·01

*These are the mean of 4 readings.

2. Experimental procedure and results

2.1. Flame test

This test is described in detail in Part I of this report (2, 3). Horsemeat was placed in contact with the inner face of the clothing assembly and the outer face exposed to petrol flames. The time taken for the surface of the horsemeat to rise in temperature by 25°C was noted, the petrol flames were then extinguished and any further rise in temperature noted.

All the materials were tested with a backing consisting of one layer of open mesh fabric and a lining of cotton poplin. Samples were allocated between tests in a random manner and tested in random order.

Table 2

Results of flame tests. All samples tested with one layer open mesh fabric netting and cotton poplin

Material J.F.R.O. No.	Time for 25°C temperature rise - sec	Further temperature rise - °C	Additional time for further temperature rise - sec
R168	27	10·5	31
R166	35·5	4·0	46
R167	27	7·0	44
R165	33	8·0	46

2.2. Radiation test

This test, described in detail in Part 1 of this report is similar to the flame test except that the assembly is exposed to radiation of an intensity of 2 watt/cm^2.

The tests were carried out using one layer of string vest and cotton lining; only one specimen of each was tested. The results are given in Table 3.

Table 3

Results of radiation tests

J.F.R.O. No.	Interlining	Lining	Time for 25°C temperature rise - sec	Further temperature rise - °C	Additional time for further temperature rise - sec
R168	Knitted string vest	Cotton poplin	636	3	670
R166	"	"	910	10	930
R167	"	"	460	5	550
R165	"	"	600	1	630

To investigate the variation likely within these systems, four radiation tests were made using one material, R166. For convenience, asbestos wood was used instead of horsemeat.

For a mean time of 260 seconds to produce a rise in temperature of 25°C, the standard deviation was 55 sec.

3. Discussion of results

3.1. Flame test

The heat transfer by radiation from a small petrol fire will be low and the heat transfer to the surface of the material will be largely

by convection. The flames tend to soot up the surface of the fabric and therefore the protection afforded is almost wholly determined by its thermal insulating properties.

There is little difference between any of the samples tested. The heaviest coated fabric could be cleaned, but on the others the coating had melted slightly. At the end of the tests, both the backing materials on R168 and R166 and the string vests were scorched (Plate 1, 2).

3.2. Radiation test

As would be expected from the high reflectivity all the fabrics give very high protection times. At the end of the tests both the outer materials and the string vests were unmarked.

4. Conclusions

(1) Aluminised fabrics offer considerably more protection against radiated heat than do other fabrics.

(2) These fabrics soon become covered with soot when exposed to luminous flames and sometimes the aluminised surface is damaged by heat. Under these conditions, they seem to give no more protection than other fabrics.

(3) After radiant heating the temperature between the skin and the underclothing is maintained for a long time. This is not so marked with other clothing owing no doubt to the higher emissivity of the non-reflecting surface.

(4) Owing to the continued slow fall in temperature at the skin when the heating is removed, any garment designed with such material should be provided with a quick release fastening in order to enable the wearer to escape once conditions became uncomfortable. The increase in discomfort is likely to be rapid once a certain threshold temperature has been exceeded. This is due to the rapid increase in sensitivity of skin with rise in temperature (4); the effect is physiological and may be expected with all materials.

5. Acknowledgments

The authors would like to thank Miss M. Weston and Miss P. Cheshire for carrying out the experimental work.

6. References

(1) Slade, I. M. Clothing for protection against radiant heat. Research, 1955, 8 (5) 179-182.

(2) Pickard, R. W. and Simms, D. L. Materials suitable for clothing aircraft fire crash rescue workers, Part I. Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization. F.R. No. 153/1955.

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(4) Pesman, G. J. Appraisal of hazards to human survival in airplane crash fires. National Advisory Committee for Aeronautics. N.A.C.A. T.N. 2996, September, 1953.

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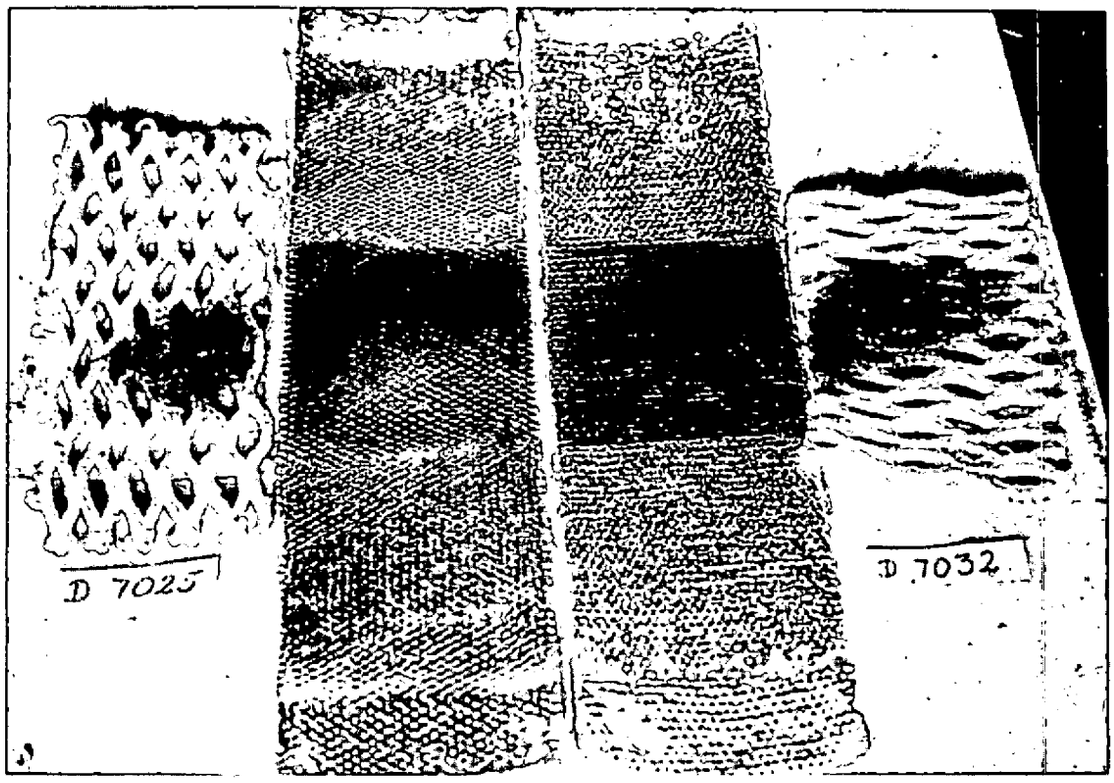

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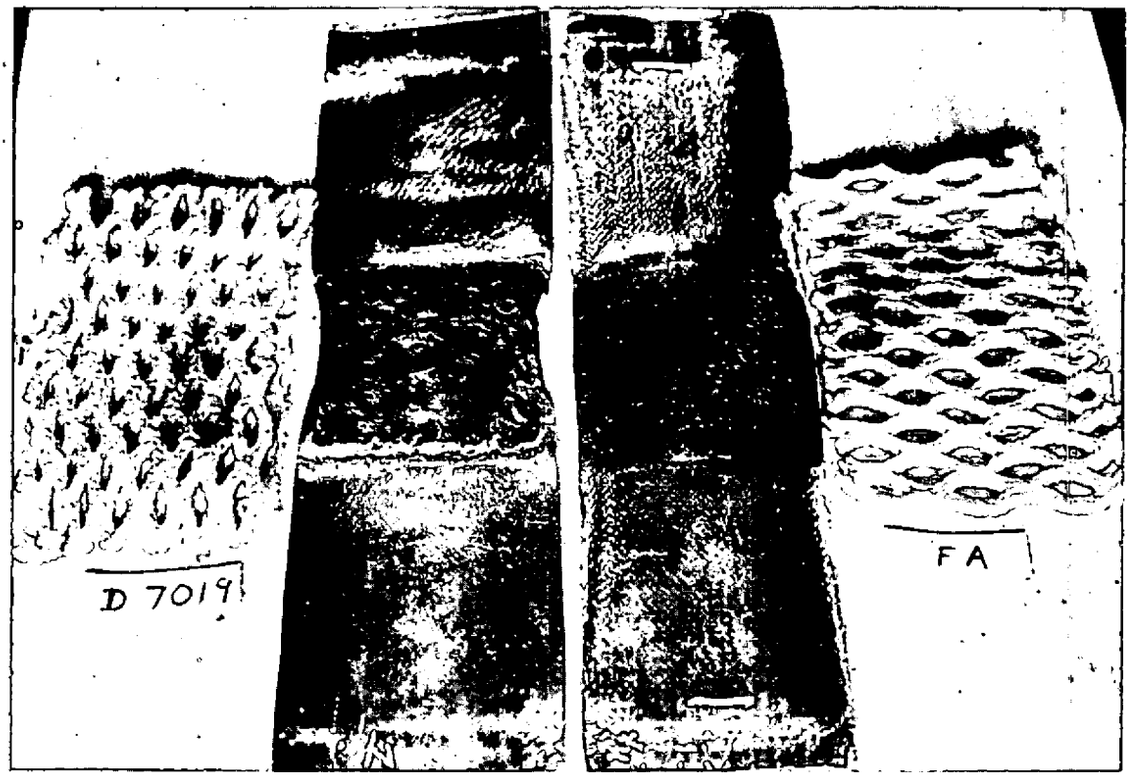

COTTON BACKED MATERIALS WITH OPEN MESH FABRIC

PLATE. I. SPECIMENS AFTER FLAME TESTS

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