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PATTERN OF HEAT LOSS FROM A SUBJECT WEARING CF TEMPERATURE - CL--ETC(U)

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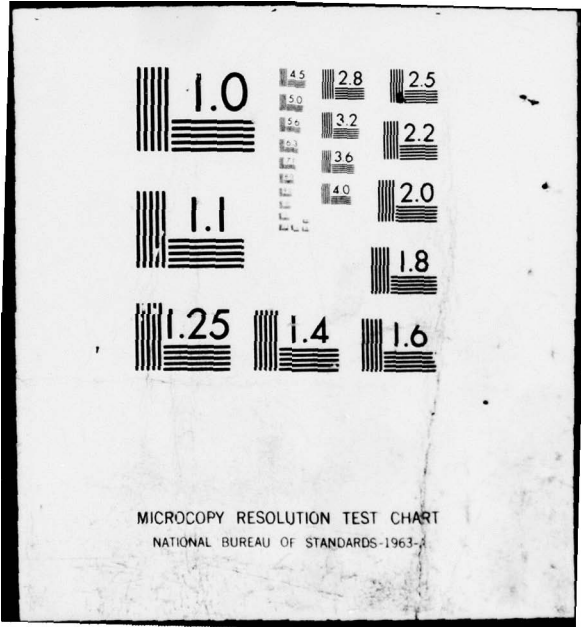
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PATTERN OF HEAT LOSS FROM A SUBJECT
WEARING CF TEMPERATE-CLIMATE
COMBAT CLOTHING.

by

D.J. Hidson and R.M. Crow

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David J. / Hidson
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DEFENCE RESEARCH ESTABLISHMENT OTTAWA

TECHNICAL NOTE NO. 78-5

**PATTERN OF HEAT LOSS FROM A SUBJECT WEARING CF
TEMPERATE-CLIMATE COMBAT CLOTHING**

by

D.J. Hidson and R.M. Crow
Environmental Protection Section
Protective Sciences Division

**JUNE 1978
OTTAWA**

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ABSTRACT

This study examines the heat-loss patterns of a subject wearing CF temperate-climate combat clothing using thermal imaging techniques. It shows that the greatest heat loss is from exposed areas of the body and from areas where the clothing and/or equipment is in close contact with the body.

RÉSUMÉ

Cette étude examine à l'aide de techniques de visualisation thermique la répartition des pertes de chaleur subies par une personne portant la tenue de combat que les Forces armées utilisent en climat tempéré. Elle démontre que les pertes sont maximales où les vêtements ou le matériel sont en contact étroit avec le corps.

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INTRODUCTION

The purpose of this paper is to examine the patterns of heat loss from a subject wearing CF temperate climate combat clothing using thermal imaging techniques. Measurement of surface temperatures with thermistors is laborious and time-consuming. It has the disadvantage that the contact between the probe and the surface can alter the surface temperature and even then the temperature is known only at a few selected points. The main advantage of thermal imaging is that it presents a complete picture of the surface with a continuous map of temperatures displayed as a black-and-white TV image. This image is both qualitative and quantitative. The thermogram can be compared directly with a photograph of the same subject and the positions of the main areas of heat loss are immediately apparent.

METHOD

The thermograms of the subject in this report were taken with a Dynarad Model 209A Fast Scan Infrared Camera. The characteristics and capabilities of this camera have been described earlier in some detail (1, 2). A brief description will be presented here.

All objects above zero K emit electromagnetic radiation and at normal temperatures (250 to 300 K) this radiation lies in the infrared region of the spectrum. The camera receives this naturally emitted radiation and processes it into a picture called a thermogram. Incoming radiation first strikes a framing mirror in the camera, which scans the object vertically, and then a lining mirror which scans horizontally. The incident radiation is then focussed through an infrared lens system on to a mercury cadmium telluride cell cooled to 77K by liquid nitrogen. The electrical signal from this cell is then translated into a real-time TV picture which is presented on an oscilloscope screen at 15, 30 or 60 frames per second. These framing rates give a picture of 400, 200 and 100 lines respectively. The thermograms presented in this report were all taken in the 400-line mode at 15 frames per second. Records of thermograms were made using a polaroid camera attached to the oscilloscope screen.

The exposure time on the polaroid film was one second which enabled a clearer picture to be obtained as most of the thermal noise was integrated out.

The infrared camera also has variable temperature scales, that is the variation on the image from black to white can be varied from 3°C to 150°C. In the thermograms, the white represents the warmer areas, and the black the colder areas. All the thermograms presented in this report were taken on the 20°C scale.

The subject was a member of the DREO/CF Test Team. He was initially clothed in underwear, and photographs and thermograms of the front and back view were taken. The general procedure then was to add a few additional articles of clothing for each subsequent front- and back-view photograph and thermogram. Time was allowed for the subject to attain thermal equilibrium before recording thermograms. The photographs and thermograms were taken indoors where the ambient temperature was constant at 22°C and the relative humidity was 63%. In the display of the results, each thermogram is shown alongside its corresponding photograph to facilitate direct visual comparison. The clothing worn by the subject was standard CF temperate-climate combat clothing. The CF rainwear outfit and the CF Chemical Protective clothing were also examined.

The particular items of clothing and equipment the subject was wearing are presented with each set of photographs and thermograms. Details of the clothing and equipment items are given in Appendix A.

RESULTS

The pairs of thermograms and photographs are given in Figures 1 to 10. Since the heat-loss patterns for all the thermograms are similar, they will be described in general terms.

First, the heat loss is greatest from exposed areas of the body, such as the bare head, hands and feet. Further, great heat loss occurs where the clothing is in close contact with the body, such as the shoulder area where the body acts as a hanger, and the gloved hands and shod feet. Conversely, heat loss from the body is least where the clothing stands away from the body due to fabric folding, fabric stiffness (rainwear) or construction details (knapsack pockets). Further, heat loss is low where there are multiple layers of fabric, that is, where the jacket overlaps the trouser tops, and where there is multi-layer fabric pockets, collar, cuffs etc. The foregoing confirms scientifically the heat loss patterns which have been previously postulated.

CONCLUSION

This paper has examined the heat loss patterns of a subject wearing CF temperate climate combat clothing, and has shown that the greatest heat loss is from exposed areas of the body and from areas where the clothing and/or equipment is in close contact with the body.

REFERENCES

1. D.J. Hidson. "The Dynarad Model 209A Fast Scan Infrared Camera", DREO TN 75-29, Jan. 1976.
2. D.J. Hidson, "Thermal Imaging for Clothing Research - A Review of the Literature", DREO TN 76-13, May 1976.

ACKNOWLEDGEMENTS

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Appendix "A"

Item Names and Numbers of Clothing Worn

8420-21-116-2266
Undershirt Pullover Style OG 107 V Neck

8420-21-116-2272
Drawers Men's Thigh Length Cotton Broadcloth OG 107

8415-21-866-1550
Trousers Combat Lightweight OG 107

8440-21-104-2859
Socks Men's Wool/Nylon Grey

8415-21-866-1538
Coat Combat Cotton/Nylon Lightweight OG 107

8430-21-857-9098
Boot Combat GS MK II Black

8405-21-103-3768
Beret Man's Knit Wool

8405-21-857-7418
Trousers Wet Weather Field Type OG 107

8405-21-857-7405
Jacket Wet Weather Field Type OG 107

8405-21-857-7417
Hood Wet Weather Field Type OG 107

8430-21-857-7195
Overboot, Boots Combat

8415-21-860-7985
Coverall CW Protective

4240-21-860-1714
Mask CML B10

Appendix "A"

8430-21-860-7391

Overboots, NBC

Developmental Item

Gloves, NBC

8470-21-872-3179

Helmet Assembly Soldier's Steel

8415-00-261-6833

Cover Helmet Camouflage Reversible

8415-21-866-1502

Coat Combat Men's OG 107 GS MK II

8415-21-840-8552

Trousers Combat Men's OG 107 GS MK II*

8415-21-866-1514

Liner Men's Coat Combat OG 107 GS MK II

8415-21-857-7791

Gloves Combat

8415-21-857-7758

Liner Gloves Combat

8430-21-857-7195

Overboot Boots Combat

* The Trousers, Combat Men's worn by the subject are no longer standard issue, but are still in field use. The item name and number listed here are for the current standard issue item.



Figure 1 - Undershirt; Drawers.



Figure 2 - PLUS Trousers, Combat Lightweight; Socks.

A



B



C



D



Figure 3 - PLUS Coat, Combat Lightweight; Boot, Combat; Beret. (Basic Combat).

A



B



C



D



Figure 4 - Basic Combat PLUS Webbing and Rifle.

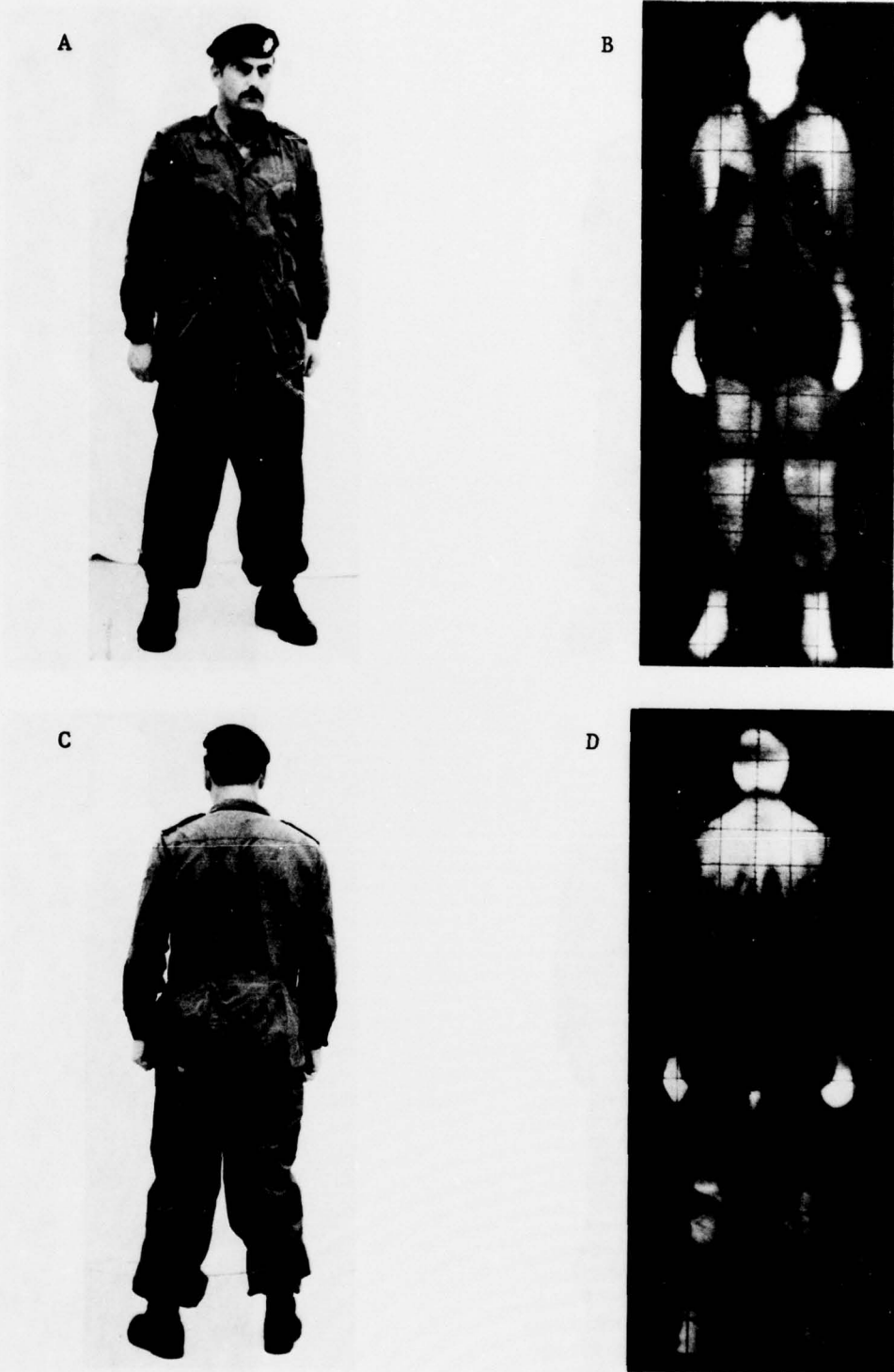


Figure 5 - Basic Combat PLUS Trousers Wet Weather.

A



B



C



D



Figure 6 - PLUS Jacket and Hood, Wet Weather; Overboot, Combat.



Figure 7 - Basic Combat PLUS Coverall, CW Protective; Mask; Overboots, NBC; Gloves, NBC.

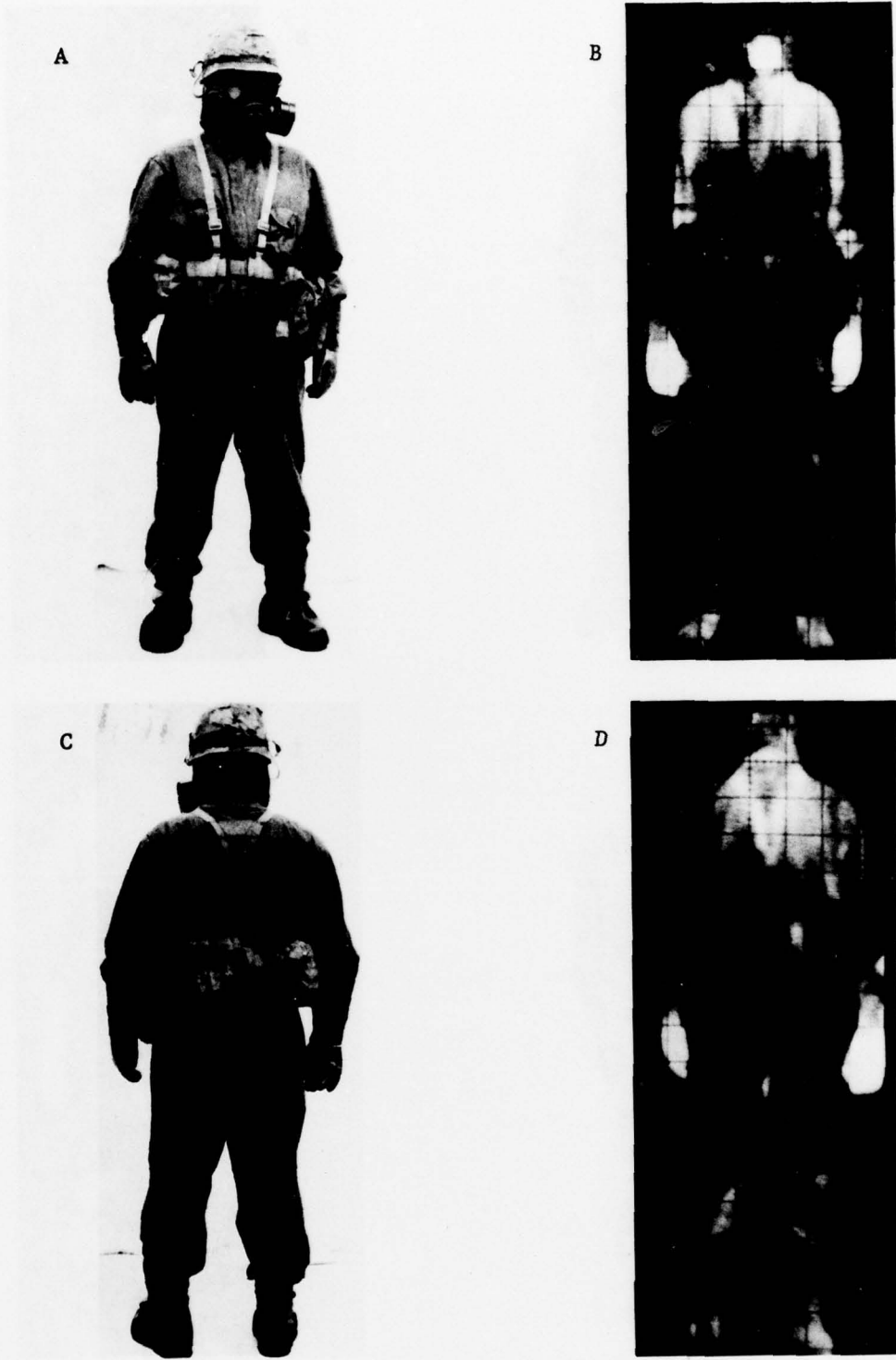


Figure 8 - PLUS Webbing and Helmet

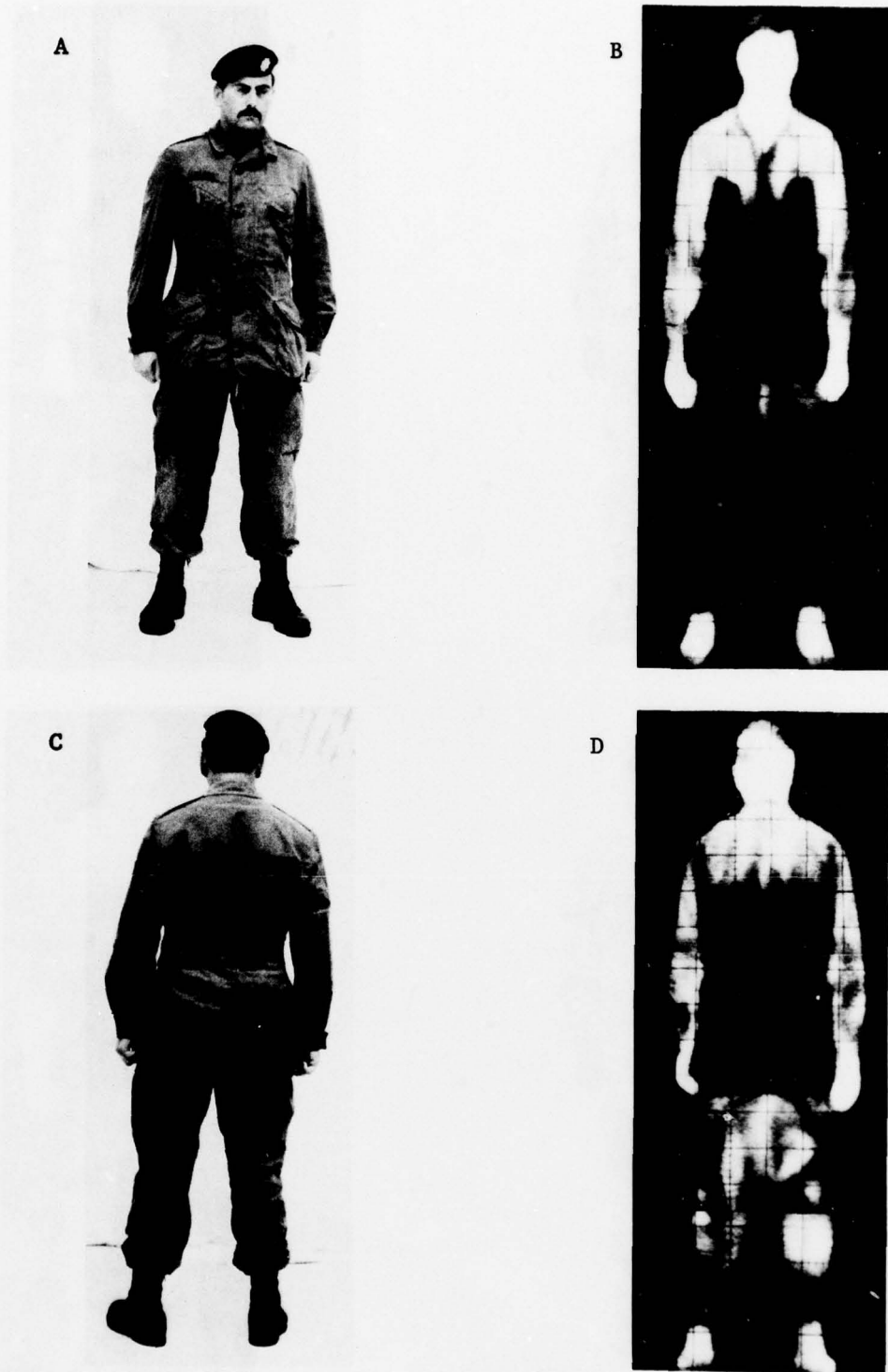


Figure 9 - Basic Combat MINUS Trousers, Combat Lightweight PLUS Coat, Combat; Trousers Combat.



Figure 10 - PLUS Liner, Coat Combat; Gloves, Combat; Liner, Gloves Combat; Overboot, Combat.

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