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ANNUAL REPORT

1 APRIL 90 TO 31 MARCH 91

ENVIRONMENTAL PROTECTION SECTION

PROTECTIVE SCIENCES DIVISION

DEFENCE RESEARCH ESTABLISHMENT OTTAWA

PCN 051LC

JUNE 1991  
OTTAWA

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**PROTECTIVE SCIENCES DIVISION**  
**ENVIRONMENTAL PROTECTION SECTION**

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**HEAD - Dr. R.M. Crow**

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**DEFENCE RESEARCH ESTABLISHMENT OTTAWA**

**PROTECTIVE SCIENCES DIVISION**

**ENVIRONMENTAL PROTECTION SECTION**

**ANNUAL PROGRESS REPORT**

**1 APRIL 1990 TO 31 MARCH 1991**

INTRODUCTION

(U) The Protective Sciences Division is made up of the Environmental Protection Section and the Chemical Protection Section. The Environmental Protection Section carries out research on heat and moisture transport and physiology to develop improved clothing, sleeping bags, equipment, tents and procedures to protect Canadian Forces (CF) personnel from harsh environments, particularly the land element in the cold. The Chemical Protection Section is responsible for carrying out research and development of NBC clothing and equipment. A particular duty is to ensure that current and future equipment are not vulnerable to new threat agents.

(U) Over the past year, the two Sections have worked closely together on formulating plans for the Integrated Protective Clothing and Equipment Project. We are still waiting for its final approval and funding. The time spent on this endeavour is not reflected in this Memorandum.

(U) The war in the Middle East gave us an opportunity to quickly apply the knowledge and experience gained over the years of working for the Department of National Defence. Most of January and February was spent doing this work and this is reported at the end of the Memorandum under "Operation Friction". It was most satisfying to do so and rewarding to see how contractors, both in industry and university, went well beyond the call of duty to help us. It was most appreciated.

(U) Because some of the work carried out by the Chemical Protection Section is classified and carried out under agreements with the United States and the United Kingdom, the Annual Progress Report of the Division has had a limited distribution. Last year, the Environmental Protection Section published its own unclassified Technical memorandum so that its work be given a wider distribution and is continuing this practice this year.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY 2B	
PROJECT TITLE: MULTI-ENVIRONMENTAL - HUMAN PERFORMANCE AND LIFE SUPPORT (U)	
SUB-PROJECT TITLE: Environmental Protection (U)	
RESPONSIBLE DIRECTOR:  Dr. B. Harrison	PRINCIPLE INVESTIGATOR:  Dr. R.M. Crow
PY ASSIGNED: PROF 4.9 TECH 3.4 MIL 2.0	

**OBJECTIVE**

(U) The development of improved clothing, equipment and procedures for the protection of CF personnel from harsh environments, particularly the Land Element in the arctic winter.

**APPROACH**

(U) Basic experimental and theoretical investigations are carried out to increase understanding of the human thermoregulatory system, of the physics of heat and moisture transport in clothing, of the physical properties of textiles and of the mechanics of structures such as tents. The knowledge gained is applied to the development and evaluation of experimental, prototype clothing and equipment.

**CURRENT OBJECTIVES**

1. (U) To study the environmental, ergonomic and design factors which determine the effectiveness of protective clothing and develop prototypes with improved protection.
2. (U) To develop prototype equipment and operating procedures for the protection of CF personnel in harsh environments.
3. (U) To investigate thermal and mechanical aspects of temporary shelters and establish a technology base for the development of more effective shelters for use by the Canadian Forces.
4. (U) To investigate the effect of clothing and protective equipment on human physiological thermoregulation.
5. (U) To understand the mechanisms of the transport of heat, air, liquids and vapour through textiles and similar materials and through clothing or equipment systems.

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**CONSULTATION AND ASSISTANCE**

(U) The Environmental Protection Section provides advice on clothing and equipment to various CF units, particularly Directorate of Clothing General Engineering Maintenance (DCGEM), Directorate of Land Requirements (DLR) and the Surgeon General and to outside agencies such as the Royal Canadian Mounted Police, Ontario Ministry of Labour and the Coast Guard.

**SUB-PROJECT ELEMENTS**

051LC-101 (U) Clothing  
051LC-201 (U) Equipment  
051LC-301 (U) Structures  
051LC-401 (U) Physiology  
051LC-501 (U) Heat and Mass Transport of Agents  
051LC-502 (U) Heat Loss from the Face  
051LC-503 (U) Heat and Mass Transport from Footwear  
051LC-504 (U) Transport of Liquid  
051LC-505 (U) Wind Penetration

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC	
PROJECT TITLE: Environmental Protection (U)		RESPONSIBLE INVESTIGATOR(S) 1. B. Cain 2. W. Dyck 3. R.M. Crow 4. R. Oszcewski	
WORK UNIT TITLE: Clothing (U)			
TASK: EPS-101		PY ASSIGNED: PROF 0.1 TECH	

**OBJECTIVE**

(U) To study the environmental, ergonomic and design factors which determine the effectiveness of protective clothing and develop prototypes with improved protection.

**OVERALL GOALS**

1. (U) To develop cold and cold-wet clothing. (Completed)
2. (U) To develop a prototype boot for cold-wet conditions (See TASK 051LC-503).
3. (U) To develop novel concepts for integrating CW protection into the cold weather clothing and the combat clothing. (Unknown)

**PREVIOUS HIGHLIGHTS**

(U) Requirements for arctic clothing for the infantry have been analyzed, prototypes of a new cold-wet/extreme-cold weather clothing system produced, successfully field trialled, reports written and responsibility for this project passed to DCGEM. An analysis of weather data to determine the extent and character of cold-wet weather likely to be encountered by the CF was completed and a report written. The principle factors determining the heat stress in chemical warfare (CW) ensembles have been identified and a solution of skin-tight clothing proposed. Trial quantities of waterproof, vapour-permeable stretch fabric, from which such clothing could be made has been successfully produced under contract. A project has been set up at Defence Research Establishment Suffield (DRES) with DREO cooperation for the production of waterproof, water-vapour permeable films or coatings incorporating chemicals capable of destroying CW agents.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) A field study of the effect of low-angle sunshine on thermal comfort carried out in the High Arctic summer was reported.

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TASK: EPS-101 (CONT'D)

**GOALS AND PROGRESS FOR REPORTING PERIOD (CONT'D)**

2. (U) DRES has obtained samples of agent-destroying films.

**NEXT PERIOD'S GOALS**

1. (U) To commence work on projects to NBC harden the cold-weather clothing and the combat clothing when funding through the Integrated Protective Clothing and Equipment Project is in place.
2. (U) To complete the development contract on receipt of three prototype waterproof, water-vapour permeable stretch fabrics.
3. (U) To write up the field study of the effect of low-angle sunshine on thermal comfort.
4. (U) To assist DRES with the project on agent-destroying films by measuring the films' water-vapour permeability.
5. (U) To assist DCGEM as required in the development phase of the cold weather clothing.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC	
PROJECT TITLE: Environmental Protection (U)		RESPONSIBLE INVESTIGATOR(S) 1. R. Osczevski 2. B. Cain	
WORK UNIT TITLE: Equipment (U)			
TASK: 051LC-201		PY ASSIGNED: PROF 0.4 TECH 0.1	

**OBJECTIVE**

(U) To develop prototype equipment, clothing and operating procedures for the protection of CF personnel in harsh environments.

**OVERALL GOALS**

1. (U) To develop a series of sleeping bags for various CF applications. (Completed)
2. (U) To develop trial methodologies in anticipation of CF requirements. (Terminated)

**PREVIOUS HIGHLIGHTS**

(U) Prototype arctic sleeping bags have been developed at DREO. DREO prototype equipment has been combined with existing CF and commercial items to form life support systems for arctic use and trialled by DREO staff. In order to trial prototype items adequately, new methods of trialling were proposed and tried on several Arctic exercises. Heated boxes (for electronics or medical supplies) and heated eye protection were developed under contract. The catalytic methanol burner in the heated box did not operate satisfactorily at low temperatures. Further development of this burner configuration was not recommended. The first prototype heated eye-protector was evaluated and considerable more work would be required to make it practical.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) Further work on sleeping bag systems will be carried out when stated military requirements are received.
2. (U) Due to the departure of the principal investigator, the development of trial methodologies is terminated.

**NEXT PERIOD'S GOALS**

1. (U) This task is in abeyance.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC	
PROJECT TITLE: Environmental Protection (U)		RESPONSIBLE INVESTIGATOR(S) 1. B. Cain	
WORK UNIT TITLE: Structures (U)			
TASK: 051LC-301		PY ASSIGNED: PROF 0.7 TECH 0.?	

**OBJECTIVE**

(U) To investigate thermal and mechanical aspects of temporary shelters and establish a technology base for the development of more effective shelters for use by the Canadian Forces.

**OVERALL GOALS**

1. (U) To better understand the temperature distribution and air circulation in tents. (April 93 - Revised)
2. (U) To build prototype insulated tents. (Completed)

**PREVIOUS HIGHLIGHTS**

(U) The majority of this work has been reported under DCGEM 36 and 37. A contract study of wind loading on scale models of tents has established wind-loading coefficients for various shapes of structures. A further contract study established the validity of the model data on one shape of full-sized tent. This study also determined the stresses in tent fabric. Fleet Technology, Kanata provided a data base of temperature distributions and air velocities in two typical tents as a function of heater power and forced ventilation rate. Fellfab Industries, Hamilton constructed and delivered two styles of insulated tents.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) A study has been initiated to study both theoretically and experimentally the heat and mass transport within a tent when the tent wall is in motion. This is in partial fulfilment of requirements for a PhD from Carleton University by the responsible investigator.
2. (U) The oxygen permeability of several "breathable" coated fabrics was measured. Many "breathable" fabrics were found to be effectively impermeable to oxygen. A simple model was used to predict oxygen levels in tents made of these and other fabrics. Use of tents made from these materials at moderate altitudes could be hazardous.

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TASK: EPS-301 (CONT'D)

**NEXT PERIOD'S GOALS**

1. (U) To continue with the study to determine the effect of a moving tent wall on the heat and mass transport within the tent.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC	
PROJECT TITLE: Environmental Protection (U)		RESPONSIBLE INVESTIGATOR(S) 1. Dr. S.D. Livingstone 2. Mr. R.W. Nolan 3. Mr. A.A. Keefe	
WORK UNIT TITLE: Physiology (U)			
TASK: 051LC-401		PY ASSIGNED: PROF 1.0 TECH 2.0	

**OBJECTIVE**

(U) To investigate the effect of clothing and protective equipment on human physiological thermoregulation.

**OVERALL GOALS**

1. (U) To study the effects of warming and cooling people using arterio-venous anastomosis (AVA). ( March 1991)
2. (U) To study the influence of CO<sub>2</sub> on thermoregulation. (March 1992)
3. (U) To study respiratory heat loss in warm environments. (August 1991)
4. (U) To develop a new, safe and simple evaluation procedure for heat stress caused by various clothing ensembles. (June 1992)

**PREVIOUS HIGHLIGHTS**

(U) Cooperative experiments with DCIEM have been shown that normal methods of measuring skin temperatures are suspect and better methods have been proposed. A new study on cooling and heating using AVAs has indicated that this may be an simple and easy way of changing body temperature. The use of water cooled socks for heat stressed pilots has been found to be feasible in the laboratory. The composition of air in a sleeping bag was found to contain high levels of CO<sub>2</sub>. The results of this study have been accepted for publication. Respiratory heat loss in the cold has been measured.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) A study of the effects of breathing CO<sub>2</sub> on subjects exposed to the cold in sleeping bags has been completed and the results are being analyzed. This work is in partial fulfilment of the requirements for a MSc from the University of Ottawa by Mr. Keefe.

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TASK: EPS-401 (CONT'D)

**GOALS AND PROGRESS FOR REPORTING PERIOD (CONT'D)**

2. (U) A study of the immersion of the feet in cold water has shown it to be as effective a method of alleviating heat stress as cooling the hand and a prototype cooling sock has been shown to be effective.
3. (U) A new, safe and simple evaluation procedure for the heat stress caused by various clothing ensembles is still being examined.
4. (U) Respiratory heat exchange in warm environments is being studied.
5. (U) Experiments were done to examine the effect of wearing the prototype CW on work tolerance at 40°C. (Operation Friction)

**NEXT PERIOD'S GOALS**

1. (U) To analyse and publish the results of the experiments on the influence of CO<sub>2</sub> on thermoregulation.
2. (U) To write a report on the effectiveness of cooling socks.
3. (U) To complete the development of the procedure for heat stress.
4. (U) To continue the study on respiratory heat loss in a warm environment and write a report.
5. (U) To determine the heat loss from prototype clothing.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC
PROJECT TITLE: Environmental Protection (U)		RESPONSIBLE INVESTIGATOR(S) 1. B. Cain
WORK UNIT TITLE: Heat and Mass Transport of Agents (U)		
TASK: 051LC-501	PY ASSIGNED: PROF 0.1 TECH	

**OBJECTIVE**

(U) To understand the mechanisms of the transport of heat, air, liquids and vapour through textiles and similar materials and through clothing or equipment systems.

**OVERALL GOALS**

1. (U) To model agent penetration in clothing. (Uncompleted)
2. (U) To model the flow properties of the chemical-agent clothing test-cell. (September 1991 - Revised)

**PREVIOUS HIGHLIGHTS**

(U) Some simple modelling of chemical agent diffusion through clothing and skin has been done but has not been completed due to the departure of the investigator. The flow properties of the test-cell used to measure agent penetration of clothing materials are unknown. Theoretical modelling of transport and flow properties in the clothing test-cell and other geometries have been initiated.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) Modelling of the transport properties from a drop in low speed flow was completed and a report on it started.

**NEXT PERIOD'S GOALS**

1. (U) To complete writing the report.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC	
PROJECT TITLE: Environmental Protection (U)		RESPONSIBLE INVESTIGATOR(S) 1. R. Osczevski	
WORK UNIT TITLE: Heat Loss from the Face (U)			
TASK: 051LC-502		PY ASSIGNED: PROF 0.3 TECH	

**OBJECTIVE**

(U) To understand the mechanisms of the transport of heat, air, liquids and vapour through textiles and similar materials and through clothing or equipment systems.

**OVERALL GOALS**

1. (U) To understand heat loss from the face. (December 1991)

**PREVIOUS HIGHLIGHTS**

(U) Preliminary measurements of heat loss from a model face was carried out under various environmental conditions and with various parka hood configurations. A suitable fan for a wind tunnel was identified. Temporary lack of laboratory space prevented further progress.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) To find suitable laboratory space.

**NEXT PERIOD'S GOALS**

1. (U) None. Further work will be carried out when space permits. This task is in abeyance.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC	
PROJECT TITLE: Environmental Protection (U)		RESPONSIBLE INVESTIGATOR(S) 1. W. Dyck 3. R.M. Crow 4. R.J. Oszcewski	
WORK UNIT TITLE: Cold-Wet Footwear (U)			
TASK: 051LC-503		PY ASSIGNED: PROF 0.6 TECH 0.5	

**OBJECTIVE**

(U) To study the environmental, ergonomic and design factors which determine the effectiveness of footwear and develop prototypes with improved protection.

**OVERALL GOALS**

1. (U) To identify knowledge gaps in the development of footwear for cold-wet climates to establish a research and development program. (September 1991)

**PREVIOUS HIGHLIGHTS**

(U) A prototype clothing system had been developed for cold-wet conditions (+10° to -10°C). There is no CF boot specifically for this temperature region where water and slush exist. A selection of boots and socks incorporating new materials were obtained and preliminary field studies carried out under contract. Sweating hot plate studies in several simulated sock/boot combinations were initiated and a report on preliminary findings was produced. The simulations of heat and moisture transport on the sweating hot plate were continued to determine the influence of liquid water transport and absorption. Preliminary results were obtained for permeability of a hydrophillic film at temperatures between -10° and +40°C.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) Due to the departure of one of the responsible investigators, progress has been slow. Now that there is a new scientist on the project, another preliminary field trial has been carried out under contract and a comprehensive review has been initiated to establish a wider ranging way-ahead.
2. (U) Pending delivery of new equipment, physical simulations of heat and moisture transport in footwear materials has been suspended.
3. (U) Experiments to investigate the temperature dependence of permeation of water vapour through hydrophilic films have continued.

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TASK: EPS-503 (CONT'D)

**NEXT PERIOD'S GOALS**

1. (U) To identify knowledge gaps and re-define the way-ahead.
2. (U) Continue experiments with hydrophillic films.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC
PROJECT TITLE: Environmental Protection (U)	RESPONSIBLE INVESTIGATOR(S) 1. R.M. Crow	
WORK UNIT TITLE: Transport of Liquid (U)		
TASK: 051LC-504	PY ASSIGNED: PROF 0.1 TECH 0.5	

**OBJECTIVE**

(U) To understand the mechanisms of the transport of heat, air, liquids and vapour through textiles and similar materials and through clothing or equipment systems.

**OVERALL GOALS**

1. (U) To understand the movement of liquids into and within textiles, i.e. wicking. (March 1992)

**PREVIOUS HIGHLIGHTS**

(U) A literature review was written. Experiments on layer-to-layer wicking and drop spreading showed that layer-to-layer wicking is an emptying-filling phenomenon. When a drop is placed on a fabric, it spreads out due partially to capillary pressure. Two reports were written. A test method for determining the maximum amount of water a fabric will freely hold was established.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) The water absorption test method was compared to two ASTM test methods and inter-person trials conducted for the three methods. A paper on the subject was written and accepted for publication and presentation.

**NEXT PERIOD'S GOALS**

1. (U) To explain vertical wicking.
2. (U) To conduct experiments to determine how liquid water affects the thermal insulation of knitted wool and polypropylene.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY: 2B		FINANCE CODE: 051LC
PROJECT TITLE: Environmental Protection (U)	RESPONSIBLE INVESTIGATOR(S) 1. B. Cain 2. R.M. Crow 3. R. Oszewski	
WORK UNIT TITLE: Wind Penetration (U)		
TASK: 051LC-505	PY ASSIGNED: PROF 0.1 TECH	

**OBJECTIVE**

(U) To understand the mechanisms of the transport of heat, air, liquids and vapour through textiles and similar materials and through clothing or equipment systems.

**OVERALL GOALS**

1. (U) To understand wind flow over and penetration into and through clothing. (April 1994).

**PREVIOUS HIGHLIGHTS**

(U) Modelling studies of heat and mass transport have omitted transport by convection because of the complexity of the subject, and thus work has been lacking in this area. A preliminary studies of wind penetration from a cylinder and through clothing have been completed under contracts to Carleton University and CORD respectively. In windy conditions, the prototype clothing (see EPS 051LC-101) has about twice the insulation of the current system.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. The principal investigator of this project has left DREO and will not be replaced. Follow-up contracts were let to Carleton University and CORD.

**NEXT PERIOD'S GOALS**

1. (U) To complete the Carleton contract and examine the results.
2. (U) To analyze the CORD results.

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01 APRIL 1990 - 31 MARCH 1991

CATEGORY 1B	
PROJECT TITLE: SPONSORED TASKING - ENVIRONMENTAL PROTECTION SECTION (U)	
RESPONSIBLE DIRECTOR:  Dr. B. Harrison	PRINCIPLE INVESTIGATOR:  Dr. R.M. Crow
PY ASSIGNED: PROF 1.1 TECH 0.6 MIL 0.5	

(U) The following sponsored tasks were active in the Environmental Protection Section during the reporting period:

Task DCGEM 080 (EPS-006) (U) Insulated Tarpaulins for Vehicles  
Task DCGEM 081 (EPS-007) (U) Tents for Use in Warm Climates  
Task DCGEM 082 (EPS-008) (U) Analysis of Several Tentage Problems

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01 APRIL 1990 - 31 MARCH 1991

SPONSOR/TASK # DCGEM 080		CATEGORY: 1B	FINANCE CODE: 051LC
PROJECT TITLE: Insulated Tarpaulins for Vehicles (U)		RESPONSIBLE INVESTIGATOR(S) 1. Mr. B. Cain	
DSP #		TASK: EPS-006	
FUNDS ALLOCATED: \$19K		PY ASSIGNED: PROF 0.1 TECH 0	

**OBJECTIVE**

(U) To establish guidelines which will optimize fuel and insulation requirements with regard to comfort and to minimize the thermal IR signature of vehicle tarpaulins.

**OVERALL GOALS**

1. (U) To establish the heating, cooling, ventilation and insulation requirements for a soft-covered troop carrier, based on theoretical calculations. Thermal infra-red detection requirements will be included in the analysis. (Completed).
2. (U) To recommend tarpaulin materials and construction details based on Goal 1 and material properties of fabrics currently available. (Completed).
3. (U) To construct and test a prototype tarpaulin to experimentally verify theories and assumptions of Goals 1 and 2. (December 1991- Revised).

**PREVIOUS HIGHLIGHTS**

(U) The heating, cooling, ventilation and insulation requirements for a soft-covered troop carrier based on theoretical calculations was put out to contract. Thermal infra-red detection requirements will be included in the analysis.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) A theoretical study done under contract indicated that a double walled tarpaulin with controlled ventilation should provide a comfortable temperature in a truck and, at the same time, provide substantial thermal camouflage. The double wall construction was predicted to be of greater importance than the actual tarpaulin material in providing thermal camouflage and so it was recommended that the selection of tarpaulin materials not be dominated by the thermal camouflage requirements. In short, no change of materials is required.

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TASK: DCGEM 080 (CONT'D)

**NEXT PERIOD'S GOALS**

1. (U) To raise a contract to make such a prototype tarpaulin for the 2.5 Ton Truck and analyze the tarpaulin for its ability to control heat loss, IR radiation and infiltration over a range of outdoor conditions.

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01 APRIL 1990 - 31 MARCH 1991

SPONSOR/TASK # DCGEM 081		CATEGORY: 1B		FINANCE CODE: 051LC	
PROJECT TITLE: Tents for Use in Warm Climates (U)			RESPONSIBLE INVESTIGATOR(S) 1. Mr. B. Cain		
DSP #			TASK: EPS-007		
FUNDS ALLOCATED:			PY ASSIGNED: PROF 0.1 TECH 0.0		

**OBJECTIVE**

(U) To maximize tentage design for passive and active climate control.

**OVERALL GOALS**

1. (U) To establish desirable thermal characteristics for tentage in warm weather. (Complete).
2. (U) To examine specific shelter configurations to establish the design requirements to met the results of Goal 1. (November 1989).
3. (U) To test full scale prototype models to verify the conclusions of Goal 2. (December 1989).

**PREVIOUS HIGHLIGHTS**

(U) The desirable thermal characteristics for tentage in warm weather have been established using ASHRAE's comfort range and a report sent to DCGEM.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) The future of this tasking was discussed with DCGEM and it was decided that work should continue in this area. Unfortunately, there is no current user requirement for tentage for warm weather and hence no funding is available. Work in this area is not planned for the next period.

**NEXT PERIOD'S GOALS**

1. (U) None.

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01 APRIL 1990 - 31 MARCH 1991

SPONSOR/TASK # DCGEM 082		CATEGORY: 1B FINANCE CODE: 051LC	
PROJECT TITLE: Analysis of Several Tentage Problems (U)		RESPONSIBLE INVESTIGATOR(S) 1. Mr. B. Cain	
DSP #		TASK: EPS-008	
FUNDS ALLOCATED:		PY ASSIGNED: PROF 0.2 TECH 0.4	

**OBJECTIVE**

(U) To perform initial research in areas of NBC and thermal IR protection to establish ground work for the future R&D on use of insulated shelters.

**OVERALL GOALS**

1. (U) To establish tent bulk and weight as a function of usable space and fuel use in cold/cold-wet environments. (Completed)
2. (U) To establish materials selection criteria for NBC requirements versus general environments for current materials. (Uncompleted)
3. (U) To study energy absorption in visual and thermal infra-red to determine guidelines for material selection for minimal thermal infra-red detection. (Completed)

**PREVIOUS HIGHLIGHTS**

1. (U) The energy absorption in visual and thermal infra-red was studied to determine guidelines for material selection for minimal thermal infra-red detection. A study of the IR properties of fabrics in the 3 to 5  $\mu$ m range was completed and a report written for the open literature. Tent bulk and weight as a function of useable space and fuel use in cold/cold wet conditions was completed under contract.

**GOALS AND PROGRESS FOR REPORTING PERIOD**

1. (U) No work was carried out to establish materials selection criteria for NBC requirements versus general environments for current materials due to other commitments.
2. (U) A study on the water vapour transport through wet materials as would occur in a tent which has condensation on its walls was completed and a report written.

**NEXT PERIOD'S GOALS**

1. (U) None. After discussions with the sponsor, this Task has been terminated.

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**OPERATION FRICTION**

For Operation Friction, EPS personnel participated in several projects.

1. They provided expertise for the "interim" CW skin-tight clothing project by: assisting with the construction of the garments, altering the current CW suit, designing and making prototype garments, measuring the water vapour permeability of component fabrics and by comparing the "interim" CW skin-tight clothing with other garment systems for heat stress, both theoretically on a manikin and on test subjects. Observations during this last study led to experiments to re-evaluation of the wearability of the C4 mask in hot environments. A contract was placed to the University of Ottawa to study this in detail. They found that the more physically fit the subject, the longer the mask could be worn.

2. They assisted in the modification of the CW casualty bag, the theoretical modelling and prediction of heat and moisture exchange in the bag, determining the carbon dioxide permeability of the bag and by setting up and teaching other scientists the protocol for its evaluation in hot environments.

3. Reports of the above work will be written.

4. During the latter stages of Operation Friction, assistance was provided to the Surgeon-General in developing non-invasive vital signs monitoring devices to support the Canadian Forces Medical Services in preparing to treat casualties within a nonconventional scenario. Three concepts were developed to meet the requirements. Although the need for such specialized monitoring devices remain, more recent events have changed the urgency to one of a more routine nature. The work has temporarily stopped, pending the development of a new timetable.

**PUBLICATIONS**

B. Cain. Use of Water Vapour Permeable Fabrics in Tents (U). DREO Technical Note 90-27. 1990.

R.J. Osczevski. A High Arctic Summer Expedition (U). DREO Report 1068. 1991.

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**PRESENTATIONS**

A.A. Keefe. Effect of Breathing CO<sub>2</sub> on Sleep and Thermoregulation (U). Presented to the Kinesiology Students Symposium, University of Waterloo, Feb. 1991.

S.D. Livingstone, R.W. Nolan and A.A. Keefe. Effect of a 100 day Polar Ski Expedition on Cold Acclimatization (U). Presented to the Eighth International Congress on Circumpolar Health, Whitehorse, Yukon, May 1990.

**VISITORS TO THE SECTION**

CRAD, Associate CRAD, CF NBC School, Dr. Farnworth, Mr. B. Askew and Mr. B. Sutherland of META Research, Capt. C. Pederson of Denmark, Dr. Burczyk of DRES, Ms. Rothwell, DCIEM, staff of DLR, DAR, DCGEM, DRDL, DRDA, DRD (HP), DNBCC, RMCP.

**ATTENDANCE AT CONFERENCES/MEETINGS**

Dr. R.M. Crow, as Custodian, chaired meeting to revise NATO Allied Publication, Heat Transfer and Physiological Effects of Clothing, Hohenstein Institute, Bonnigheim, Germany, April 1990.

W. Dyck and A.A. Keefe to USARIEM and US Army R&D Labs, Nov. 90.

J.B. Cain, W. Dyck, S.D. Livingstone to DCIEM re IPCE, Dec 90.

Dr. R.M. Crow to meetings of the Institute of Textile Science in Montreal and Toronto.

Mrs. P.A. Dolhan to meetings of the Canadian General Standards Board in Montreal and Toronto.

**COMINGS**

Mr. W. Dyck joined the Section, having worked at CRAD Headquarters for 3 1/2 years in DRD (Human Performance). Previous to that, he was at DRES.

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