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TESTING OF THE COCOON-4 SLEEPING SHELTER

Michel B. Ducharme

Defence and Civil Institute of Environmental Medicine
1133 Sheppard Avenue West
P.O. Box 2000
North York, Ontario
M3M 3B9

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EXECUTIVE SUMMARY

The Cocoon-4 by Envirogear Ltd. entails a new concept of sleeping shelter recently introduced on the market. This is a four-season, air-inflated, waterproof, down-filled sleeping shelter incorporating an inflatable mattress and a waterproof detachable canopy, and rated to be thermally comfortable between -43 to 21°C. The aim of the present study was to evaluate the performance of the Cocoon-4, in the field and in the laboratory, over a range of temperatures and humidities that could be encountered by the Canadian Forces during operations.

In general it was found that the concept of adding air to an airtight down sleeping shelter to vary the insulation while keeping the down dry works well. Serious problems with the quality of construction and the design of some critical components such as the valves were observed. It was concluded that the Cocoon-4 could be a valuable emergency shelter for the Canadian Forces providing the manufacturer could improve on the quality of his product and could add some modifications to the shelter, such as an automatic inflation system, to make it more suitable for an injured person.

ABSTRACT

The objective of the present study was to evaluate the performance of a new concept of sleeping shelter, the Cocoon-4, in the field and in the laboratory, and under different temperature and humidity conditions that could be encountered by the Canadian Forces. It was found that the concept of adding air to an airtight down sleeping shelter to vary the insulation while keeping the down dry works well. Some problems with the quality of construction and the design of some critical components such as the valves were observed which made the performance of the Cocoon-4 less impressive than expected from the claims made by the manufacturer. It was concluded that the Cocoon-4 could be useful for the Canadian Forces as emergency shelter providing the manufacturer could improve on the quality of his product, and could add some modifications to the design.

INTRODUCTION

The Medical Life Support Division (MLSD) is currently looking for new technology to improve military survival equipment. Lately, an interesting new concept of sleeping shelter, the Cocoon-4, (Envirogear Ltd., 127 Elm St., Cortland, NY 13045, U.S.A.) came on the market and MLSD suggested that it could be a potential alternative to the current emergency sleeping bag used in military aircraft and SKAD kit (Survival Kit Air Droppable).

The Cocoon-4 is an air-inflated, waterproof, down filled (650+ goose down) sleeping shelter incorporating an inflatable mattress and a waterproof detachable canopy (see Fig. 1). The shelter is rated to be thermally comfortable between -43 to 21°C depending on the air pressure inside the bag which controls the loft of the down. According to Envirogear Ltd., the most attractive advantage of the Cocoon-4 over competitive products is that it can retain its insulative properties even in wet conditions, and the body sweat or perspiration can not get into the down, keeping the shelter dry, thermally comfortable and light.

The purpose of the present study was to test the Cocoon-4 sleeping shelter in the field and in the laboratory to evaluate its performance under different ambient temperatures and humidities that could be encountered by the Canadian military personal during operations.

METHODS

The Cocoon-4 sleeping shelter was tested at different ambient temperatures (from -38 to 10°C) and humidities (from dry arctic air to wet temperate air), in the field (Baffin Island, NWT, and Algonquin Park, Ontario) and in the laboratory (cold chamber, DCIEM). The field trial in the Arctic was performed between 10 - 21 March 1992, and the ambient temperature during the nights ranged between -38 and -24°C (dry air). Two field trials were performed in Algonquin Park: one during winter time (9-10 February 1992) when the temperature during the night reached -21°C, and one during spring time (29 May to 1 June 1992) when the temperature during the nights ranged between 4 and 13 °C and the humidity from normal to wet (rainy). The test in the cold chamber

was performed at -35°C, 10% relative humidity, and 2.5 $km \cdot h^{-1}$ wind velocity. These conditions were chosen to verify the claims made by the company that the Cocoon 4 is a four-season waterproofed sleeping shelter (adjustable from 21 to -43°C by manually adding air to the down sleeping shelter).

The temperatures during the different field tests were recorded with 3 thermistors (YSI 44004, Yellow Springs Instrument Co., Yellow Springs, Ohio, U.S.A.) and read with a hand ohmmeter (Fluke 27 multimeter, John Fluke MFG Co., Everett, WA, U.S.A.) to a resolution of 0.1°C. One thermistor read the ambient air temperature at the chest level, 10 cm above the shelter; and the other thermistors read the shelter's inside wall temperatures at the chest and the feet levels. The temperatures were recorded in the morning between 6:00-7:00 h after 8-10 hours of shelter occupancy.

During the test in the cold chamber, in addition to the previous temperatures, the skin temperature at six sites on the subject's body (chest, forearm, hand, calf, foot, and toe) and the rectal temperature were recorded continuously during the night with thermistors (YSI 44004, Yellow Springs Instrument Co., Yellow Springs, Ohio, U.S.A.) using a computer-controlled data acquisition system (model HP-3052A, computer model HP-85, Hewlett-Packard). The rectal temperature was measured with a thermistor probe inserted 150 mm beyond the anus. Mean values over 1-min periods were calculated for all measured variables.

RESULTS

Strengths of the Cocoon-4

The concept of adding air to an airtight down sleeping shelter to vary the insulation while keeping the down dry works well. After two weeks of arctic camping, no significant increase of the weight of the sleeping shelter through accumulation of moisture and ice in the down could be detected. The down kept its insulative properties, which is a major improvement over other down sleeping bags on the market. By varying the quantity of air inside the sleeping shelter, it was possible to stay thermally comfortable (excepting the feet at the coldest temperatures) despite a

wide range of ambient temperatures (-38 to 13°C). The temperature inside the sleeping shelter at the chest level varied between 15 and 28°C. It took some experience, however, to find the right amount of air needed for a specific ambient temperature. Too much insulation induced sweating and because the shelter is waterproof even from the inside, the sweat accumulated inside the sleeping shelter and caused some discomfort.

The concept of a combined sleeping bag and shelter also works well. The detachable canopy keeps wind, snow, rain and bugs (the majority) out of the sleeping bag.

The Cocoon 4 is waterproof and can be used in the rain.

The comfort of the Cocoon 4 is very good, superior to the comfort achievable with conventional sleeping bags.

The sleeping shelter is easy to maintain.

Weaknesses of the Cocoon-4

There were three general areas of weakness:

1) Quality of construction

• The down insulation was not evenly distributed inside the tested sleeping shelter, causing serious problems during the coldest nights. Even when the bag was fully inflated light was visible through the bottom of the sleeping shelter (at the foot level). This lack of insulation caused the temperature of the inner wall of the shelter at the level of the feet to drop to -1°C during the coldest night in the field (-38°C) even when the temperature of the inner wall of the shelter at chest level was a comfortable 23°C. This low temperature caused a build-up of frost which wetted the socks and induced intolerably cold feet. To avoid this problem, part way through the arctic field trial an arctic sleeping bag was added inside the shelter to cover the feet and lower legs.

Figure 2 shows the progressive decrease of the skin temperature of the foot (from 33.1 to 19.9°C; a decrease of 13.2°C) and the toe (from 33.7 to 10.9°C; a decrease of 22.8°C) during the night in the cold chamber at -35°C, despite the relatively constant skin temperatures for the four

other body sites (chest, forearm, hand, and calf). The decrease of the skin temperature of the foot and toe are directly related to the marked decrease (from 18.8 to 2.3°C) of the inner wall temperature of the shelter at the foot level. During the night, the rectal temperature of the subject decreased by 1.1°C, which was partly attributed to the beginning of a light hypothermia, but also to the normal circadian cycle of the body temperature.

At higher ambient temperatures, the temperature inside the bag at the foot level was more comfortable, but never reached the temperature observed at chest level. For example, at ambient temperatures of 4 and 13°C, the temperatures at foot level were 18 and 23°C respectively, while the temperature at the chest level was around 28°C.

- Some of the air valves leaked and the sleeping shelter had to be reinflated several times during the field trials (sometimes even in the middle of the night).
- One of the unidirectional air valves was difficult to operate under cold conditions: it was difficult to push air into the sleeping shelter with the manual pump bag.
- The rubber of the foot pump cracked during use in the cold.
- The manual pump bags lost their seals around the valves, making inflation of the sleeping shelter laborious.

2) Design and components

- The threads of the valves are prone to damage.
- The valves were leaky: poor seal in cold conditions.
- The valves were difficult to unscrew in the cold.
- The external zippers could not be fully closed when the sleeping bag was fully inflated due to the tension between the upper and lower half of the sleeping shelter.
- The foot pump was too stiff to operate in the cold.
- The pegs provided with the canopy were too weak and too short to be used in the snow or on hard ground.
- The neck seal was not tight enough, causing heat leakage from the sleeping shelter.
- The segments of the canopy's poles should be attached together with an elastic cord.
- The sleeping shelter was slippery on snow.

• It was laborious to expel all the air out of the shelter during deflation, making the Cocoon-4 quite bulky for storage or transportation.

3) Basic concepts

• If the Cocoon-4 has to be used as an emergency shelter, it should be inflated with a CO_2 cartridge since an injured person will not be able to inflate it alone (it takes a minimum of 15 minutes to fully inflate the bag with both hands after some practice).

• The gas used to inflate the shelter should be dry to optimise the thermal insulation of the down.

• A change in ambient temperature will affect the volume of air inside the shelter because of the law of gas expansion. Ideally a pressure regulator should be used to keep the insulation optimal.

DISCUSSION AND CONCLUSIONS

In general, the concept of the Cocoon 4 sleeping shelter is good and worked well. The shelter stayed dry during rainy conditions and no build-up of ice was observed in the down during the Arctic trial. The thermal comfort, however, was compromised during the coldest nights by an uneven distribution of down insulation at the level of the feet. At ambient temperatures colder than -20°C, cold feet were a serious problem, accentuated by frost formation on the inner side of the bottom section of the shelter.

The quality of the construction and the design of some critical components such as the valves, the neck seal, the external zippers, and the system of down distribution need improvements. The valves are the weakest parts of the Cocoon-4. They are leaky, difficult to unscrew and to screw in the cold, and the threads are damaged easily.

The main function of the Cocoon-4 in the Canadian Forces could be as an emergency shelter. To use the Cocoon 4 for this function it is advisable to add an automatic inflating system to the sleeping shelter so that an injured person can use it without any help.

In conclusion, the Cocoon-4 could be a valuable emergency shelter for the Canadian Forces providing the manufacturer could improve on the quality of his product and could add the above modifications to the shelter to make it more suitable for an injured person.

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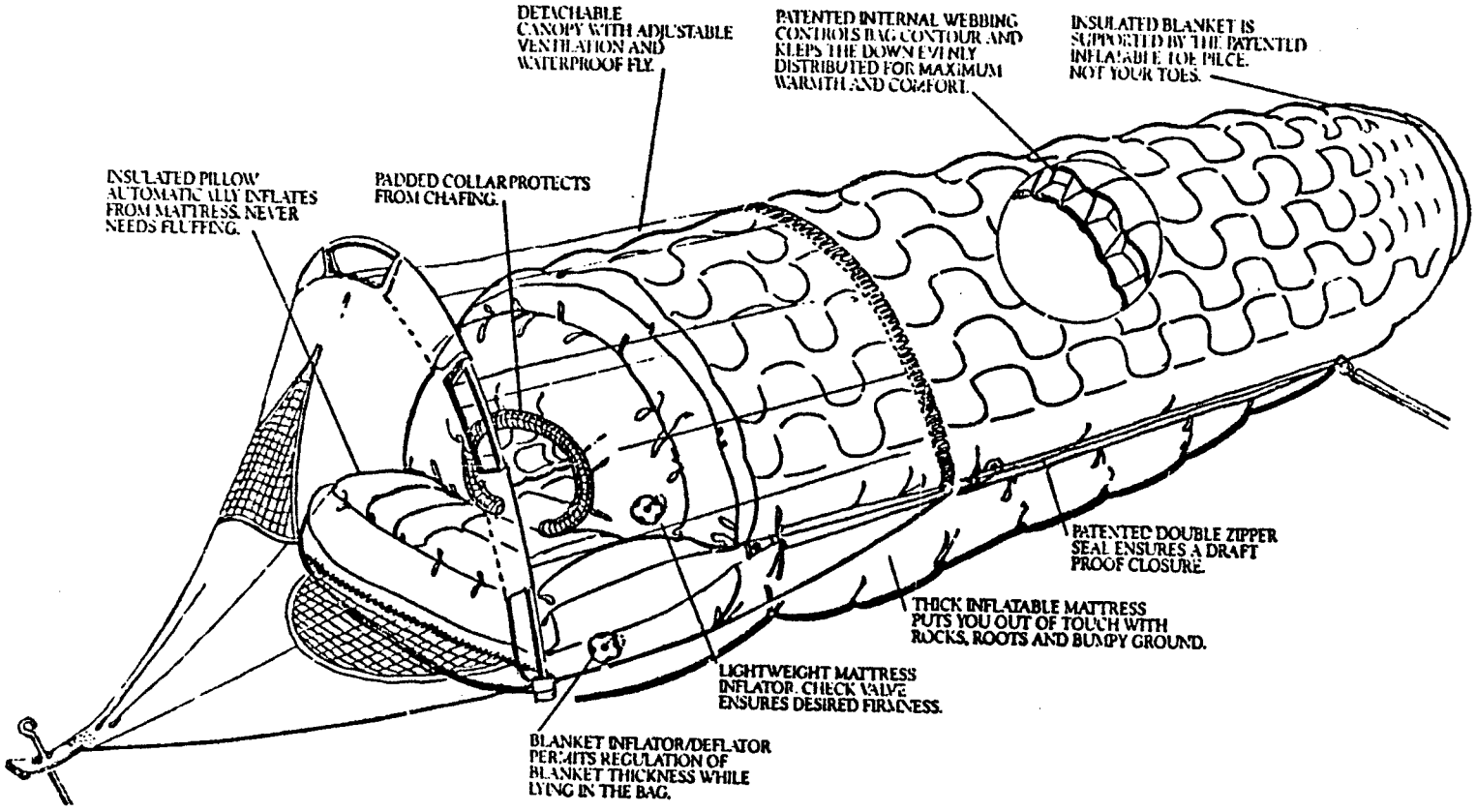

Figure 1. The Cocoon-4 sleeping shelter (reproduced from the publicity pamphlet of the Cocoon-4).

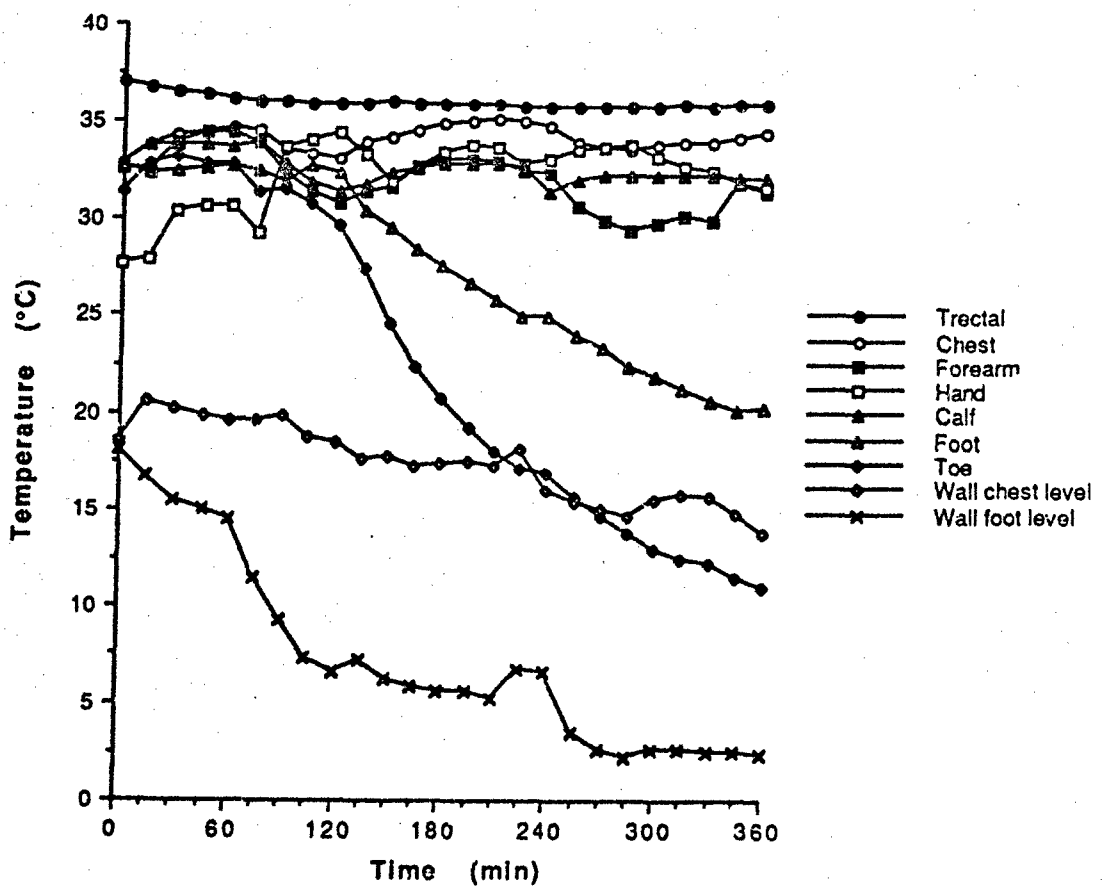

Figure 2. Temporal evolution of the skin temperature at 6 body sites, and the rectal temperature of a subject sleeping in a Cocoon-4 sleeping shelter during a 6 hours' night in the climatic chamber at -35°C, 10% relative humidity, and 2.5 $km \cdot h^{-1}$ wind velocity. The temperature of the wall at two locations inside the shelter are also presented.

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