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ENVIRONMENTAL PROTECTION RESEARCH DIVISION

Research Study Report

PB-30

A QUESTIONNAIRE EVALUATION OF CIC COLD WET CLOTHING BY MEN STATIONED IN U.S. ANTARCTIC

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1. Introduction

An important aspect of QMC responsibility is to furnish the soldier with clothing and equipment which will afford adequate protection and enable him to function effectively in extremely cold weather. The QM R&E Command is continually conducting research to design and develop such clothing and equipment. For this reason there is a continuing need for information concerning the performance of clothing in the field, as partial guidance for the modification of old, and for the design and development of new items.

This report is based on a ~~printed~~ questionnaire which was designed to secure information concerning the performance of QMC cold weather clothing under Antarctic conditions.* Copies of the questionnaire were completed during the 1957-1958 International Geophysical Year by 30 men who were stationed in the Antarctic.** In addition to answering the questions asked, many of the men made additional comments concerning the clothing and its functioning at low temperatures. Since the conditions experienced (i.e., temperature, wind-speed, hours of continuous exposure, clothing worn, type of activity, etc.,) varied considerably from respondent, to respondent, the data are not readily quantifiable. However, where appropriate some frequencies, means, and medians have been presented. Despite the limitations it is believed that the information contained in this report will provide useful information for the future design and development of cold weather clothing.

2. Conditions

Almost all of the men were engaged in active outdoor work involving meteorological and glaciological studies. In addition, the bulk of the men shoveled snow, hauled supplies, dug pits, etc. However, they were

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* A copy of the questionnaire appears in the Appendix. This questionnaire was prepared at this Command, and copies were distributed by the Antarctic Clothing Study Group of the United States National Committee, of the International Geophysical Year 1957-1958.

**Only 28 questionnaires are discussed as one man wore civilian clothing almost exclusively, and the other wore the QMC clothing, only under relatively warm conditions (+ 20°F).

usually not continuously exposed to the more severe conditions for long periods of time. The most severe temperatures under which the respondents wore the arctic ensemble ranged form -10° to -102°F., with a mean of -55°F. The most severe wind-speeds ranged from 0 mph to 60 mph, the mean being 22 mph. During the severest temperature and wind conditions indicated, the majority of men experienced wind from virtually all directions. The longest continuous exposure to the conditions noted, ranged from 1/2 to 8 hours, with a mean of approximately 2 1/2 hours.

3. Protection Afforded by the Arctic Ensemble Worn

In response to the question, "How well did the total ensemble worn protect you under the most severe conditions experienced?", there were 25 "Excellent" or "Good" ratings, one "Fair", one "Fair to Poor" rating and one man did not respond. Two of the seven "Excellent" and one of the 18 "Good" ratings were qualified with "when moving."

Each man rated how cold or warm he felt under the most severe conditions on each of three ten point scales (see question 5 in Appendix). The median rating on the general scale was 6.5, which corresponds to a point on the scale between "Cool, but fairly comfortable," and "Comfortable." The median rating for the hands was 6, "Cool, but fairly comfortable," and the median for the feet was 7, "Comfortable."

To the question, "Did the Arctic ensemble keep your body warm during the coldest conditions you experienced?", there were 23 "Yes" and four "no" responses. One "Yes" response applied only to non-QMC down-filled outer clothing.

In another question the men were asked to rate the arctic ensemble on the basis of their "total wearing experience" with it. This resulted in three "Excellent," 19 "Good," three "Fair," and one "Poor" rating. (One man rated non-QMC down-filled outer clothing "Good to Excellent," and one man did not answer.)

It should be noted that the men were permitted to wear whatever clothing suited their needs. Thus many men wore combinations of standard and non-standard QMC clothing, personal clothing and in some cases, Navy and Air Force clothing. As a result, the clothing worn varied appreciably from man to man, and consequently the meaning of "arctic ensemble" was undoubtedly interpreted somewhat differently by each man.

However, from the above information, it seems that the arctic ensembles actually worn furnished adequate protection and warmth for the various sub-zero conditions encountered by the respondents.

Effect of Clothing on Job Performance

Twenty men indicated that they were able to perform their "tasks with ease while wearing the Arctic Ensemble." Of these 20, four qualified their responses by adding that they could not perform their tasks easily when arctic mittens were worn and dexterity was required. Another man stated that he could "usually" perform his tasks easily while wearing the ensemble. The remaining seven men noted that they could not perform their tasks easily when the arctic ensemble was worn, and two of them gave as the reason that work could not be done with mittens. The other reasons given referred generally to cumbersomeness.

5. Comments Concerning Individual Clothing Items

a. Headgear

Twelve of the 23 comments concerning headgear referred to the pile cap. Favorable and unfavorable comments about this cap were equally divided. The favorable comments were general and of far less value for design guidance, than the more specific negative comments which follow: "awkward," "not needed," "completely unsuitable," "warmer than necessary when the hood is used," "binds when the flaps are down," "should have a cape at the back to protect the neck," and "too heavy - chin strap is complicated."

All but one of the five comments concerning the Balaclava cap were very favorable, such as "most useful piece of headgear." The one unfavorable comment was that it "did not reach below the neck when pulled down over the face."

The six comments concerning the parka hood all referred to specific undesirable characteristics: "needs to be larger," "wire in the hood broke," and several comments that the hood restricts the field of vision.

The question, "Did the headgear adequately protect your head, neck, and face ... under the most severe conditions experienced?" resulted in 14 "Yes" and 12 "No" responses. One man failed to answer the question and another used a parka which "made headgear unnecessary." Nine of the 12 "No" responses referred to inadequate protection for the face.

All but two of the comments regarding the face masks used were unfavorable and four of the five comments pertaining to protective eye glasses were also unfavorable.

b. Upper body clothing

Of the 16 comments made concerning the OG wool shirt, nine were favorable, three were partially favorable, and the remaining four were unfavorable. Three of the latter indicated that the shirt tail was too short.

Ten of the 13 comments pertaining to the field jacket were favorable, but general in nature. Two of the three remaining comments indicated that the pockets were useful, but the jacket was heavy.

All but two of the 11 comments concerning the field jacket liner were favorable. It was regarded as "very good" and "warm yet light," but one man considered it "too bulky" and another though it "wore out quickly."

The majority of the 14 comments pertaining to the parka were favorable but varied considerably and did not permit generalization.

A number of the men wore down-filled clothing and the comments regarding it were very favorable. In general, it seems that warmth was the feature that made this clothing popular.

c. Lower body clothing

The eight comments concerning the wind resistant cotton trousers (trousers, shell, field) varied greatly, and cannot be generalized.

Three of the four comments pertaining to the OG cotton trousers (trousers, shell, field, arctic) were favorable, but one wearer commented that they "shrunk considerably with washing."

Seven of the nine comments concerning the arctic field trouser liner were very favorable. The two negative comments were: "not comfortable" and "reduce mobility."

The arctic mohair trouser liner was referred to as "very good" and "excellent," but was also considered unnecessary, bulky and uncomfortable.

One man wore the Air Force cold weather zip-on trousers. He commented that "since these pants could be zipped on in about half a minute they were very good for my use." Navy insulated trousers were worn by another man, who stated that these trousers, being waterproof, "get damp inside with continuous use and the rubberized material becomes brittle at -67°." Wool trousers were considered to be "OK to -75°" by one man.

d. Handgear

Of the 18 comments made concerning the arctic mittens, favorable and unfavorable comments were about equally divided. In general, the mittens were considered warm but clumsy.

Eight of the ten comments regarding the mitten trigger-finger inserts were favorable. Typical favorable comments were "give fingers good dexterity," and "best and warmest - excellent when used inside large mitten."

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The two unfavorable comments were: "interfered with work" and "thumb wears out quickly."

To the question "If you wore the Army Arctic Handwear Assembly under the most severe conditions experienced, did it keep your hands warm?", there were 20 "Yes," and four "No" responses, with four men not answering. In response to the question "If your hands became cold because it was necessary to work barehanded, were you able to rewarm your hands satisfactorily by putting them back in your mittens?", there were 16 "Yes's," four "No's," and five men left the question blank. Four of the "Yes" responses were qualified with: "generally," "most of the time," "if exercising," and "if frostbite was not severe." The remaining three responses were: "usually," "sometimes," and "only sometimes." Another question, "could you perform tasks requiring a high degree of hand dexterity, while wearing arctic handgear?", resulted in three "Yes" responses, 20 "No" responses and four blanks. One man indicated that it "depended on how cold his hands were." The reasons given by the 20 men who answered "No," were related to the lack of dexterity when the arctic handgear was worn.

e. Footgear

(1) Data from question 3

Judging by the number of comments to question 3, the felt and the white dry cold rubber insulated boots were the boots worn by most of the men.

A number of favorable and partially favorable comments regarding the felt boot were made, several of which referred to warmth and comfort. Two common complaints concerning the felt boot were bonding failure and poor traction.

Ten of the 28 comments made regarding the white dry cold rubber insulated boots were favorable. Typical favorable comments were: "liked them very much," and "excellent for extreme cold." The remaining comments were either partially favorable or unfavorable. A number of the unfavorable statements referred to the accumulation of sweat, and cold feet when inactive.

Six comments were made regarding the black insulated boot, however, the diversity of these comments makes generalization difficult.

Most of the ten comments pertaining to the ski boot were either unfavorable or partially unfavorable. Three of these comments noted that the boots were heavy.

The nine comments concerning the mukluks were about equally divided between those that were favorable and those that were unfavorable. Here again, the comments were somewhat diverse.

Canvas packs were worn by one man who stated that these boots were "poor on ice and not satisfactory for use with crampons." One respondent wore Air Force flight boots and his comment was that these boots were warm with felt insoles and ski socks for indoor and short period outdoor use.

All but one of the 11 comments pertaining to the felt insoles were favorable. The one unfavorable comment was that the insoles were not needed.

Almost all of the 15 comments concerning the cushion sole socks indicated approval. The remaining comments all noted that the socks wear out rapidly, particularly at the heels.

Seven of the ten responses referring to the wool socks (natural) were favorable. The other comments were: "too heavy," "socks should be 1/2 size larger than inner felt socks - too much bundling in toes."

The felt socks were noted as being "OK," "good," "too warm," and "not needed." One man stated that "sheep lined slippers were better" than the latter socks.

(2) Data based on questions 8 and 9

In response to the question "what type of footgear including socks did you wear?"* many of the men listed more than one type of boot and several types of socks without specifying how these items were combined. Some men did not indicate the socks worn, and others were vague about the type of socks being referred to. As a result for many of the respondents the reference for the "Yes" and "No" answers to the following questions cannot be determined.** Such uninterpretable responses are not included in this report. As a result the data on footgear from this section of the questionnaire are based on only nine respondents and are limited to the cold dry insulated boot. However, where the answers to the questions were specific, i.e., where there was a definite reference, the data are presented below.

Nine men listed the dry cold boot as the footgear worn with different men wearing different types of socks (e.g., cushion sole socks and wool socks). All but one of the nine men reported that this footgear kept

* See Appendix - question 8
**See Appendix - questions 9a - k

their feet warm. The remaining man indicated that the dry cold boots and socks did not keep him warm "when standing too long." Five men stated that their feet got too warm while wearing the dry cold footgear, three stated that they did not, and one man failed to respond. Two of the men who noted that their feet did get too warm qualified their responses - one with "when working hard" and the other with "above + 10° with heavy exertion ." To the question "Was there any accumulation of sweat within your footgear that could be considered objectionable?", there were five "Yes" and four "No" responses, one of the latter being qualified with "except for warmer temperatures 0° to + 30°F." The five men who responded in the affirmative to the latter question, indicated that they "changed socks" when perspiration accumulated within their footgear. Only one man answered "Yes" to the question "Was there any accumulation of frost or ice?" He indicated that "frost accumulated around his ankle." Two men failed to answer this question. All nine respondents reported that the dry cold boot provided good traction over varied surfaces and terrain. Seven of the nine men stated that the boot did not stiffen at low temperatures, while the remaining two men indicated that it did at -40° F and at -100° F. Two men reported bonding failures, one of which was"at the toe," and the other, the "ski binding attachments." (One man did not respond.) None of the respondents indicated that the dry cold boot failed to the extent that replacement was necessary. Here again, there was one failure to respond. Only one man noted that the footgear impeded progress, the reason stated being that "above 0° F the dry cold boot overprotected." (Two men did not comment on this question.) Foot discomfort thought to be caused by the dry cold boot was reported by four of the nine men. The comments made were: "excessive sweating - feet became tender - aggravated athletes foot," "excessive sweating caused tender feet," and "had rash once when I failed to change wet socks after a 12-hour work period. Believe rash due to over perspiration and rubbing of boots."

From the comments and responses made concerning the dry cold boot, in general, but with several important exceptions, it seems to have been considered satisfactory at lower temperatures, but less satisfactory under conditions which caused the feet to perspire excessively.

f. Underwear

Eleven of the 13 comments concerning the undershirt and the ankle length drawers were very favorable, such as "good in all respects" and "warm - good fit." The critical comments were that the underwear was "too" scratchy," the undershirt was "good, but should button into drawers in the back so that it won't pull out" and the drawers should have "extra padding at the knees."

g. Suspenders

Ten comments were made regarding the suspenders. Six of the favorable comments were general in nature. The specific comments were:

"good item - not too rugged," "excellent but don't last long," "never saw need for suspenders," "preferred regular type suspenders."

6. Reports of Extreme Cold and of Frostbite

In answer to the question "Did any part or parts of your body ever become extremely cold?"; 19 of the men responded in the affirmative and some mentioned several parts of the body. The face and feet were the body parts noted most frequently, with eight and nine mentions respectively. Hands were mentioned six times, finger three times, and wrists once. The nose and neck were only noted once. Eight of the men did not report that they became extremely cold, and one man failed to respond to the question.

A total of 32 cases of frostbite were reported by 17 of the 28 respondents. The body part most frequently involved was the nose, which was reported frostbitten 11 times. Second in frequency was the face, with eight mentions of frostbite. The hands and feet were each reported as having been frostbitten four times, and the fingers and ears were reported three times. Frostbitten wrists were mentioned twice.

Only a few men indicated the circumstances under which frostbite had occurred. Three men who reported frostbite of the nose and face indicated that this had occurred when "facing the wind." One man's hand and one man's fingers were frostbitten while "working barehanded," and another man's fingers were frostbitten while "nailing and wiring." Frostbitten feet were claimed by a man who was "standing still" in cold dry boots, and another was frost bitten while "surveying." One respondent who reported frostbitten ears stated that he had been "out too long with no cap." A case of frostbitten wrists was attributed to "windy conditions."

7. Additional Comments and Suggestions Concerning the Ensemble and its Components.

The two final questions called for additional comments and suggestions concerning the arctic ensemble and its components. The responses made in reply to these two questions were too diverse to permit generalization.

8. Summary

This report presented the results of a questionnaire on QMC cold dry clothing submitted to 28 men stationed in the Antarctic. In general, the arctic ensembles worn furnished adequate protection and warmth for the various sub-zero conditions encountered. However, most of the men reported parts of their body were extremely cold and/or frostbitten at one time or another. The body parts most frequently mentioned were the nose, face, hands and feet. The majority of men responded that they were able

to perform their jobs with ease while wearing the arctic ensemble, although many men indicated that they could not perform tasks requiring dexterity when the arctic mittens were worn. Favorable and unfavorable reactions to individual clothing items were summarized in the text.

Appendix

QUESTIONNAIRE

Performance of Quartermaster Cold-Weather Clothing
Under Antarctic Conditions

The Quartermaster Reseach & Development Command, which developed and furnished the cold weather clothing which you have been using, desires to secure as much information as possible concerning its performance. For this reason, you are being asked the following questions. Your answers are expected to furnish information of value to Quartermaster designers and developers of cold weather clothing. Please answer as accurately and completely as you can. In addition to answering the questions, you are encouraged to make additional comments concerning the clothing and its functioning in the margins or at the end of the questionnaire.

1. The following information is desired as background for interpreting your answers to the questions.

NAME: _____

Briefly describe the work which you do outdoors: _____

_____

_____

2. What were the most severe conditions under which you have worn the Arctic Ensemble?

(a) Temperature: _____ °F., with (b) a wind speed of __ miles per hr.

(c) Orientation with respect to wind: Facing directly into the wind ___
Quartering into the wind ___
Wind coming from the side ___
Wind coming from behind ___

(d) Longest number of hours of continuous exposure to the conditions described: _____

(e) Amount and type of physical activity during this exposure period: _____

_____

_____

3. Opposite each item of clothing listed in Column I, check in Column II to indicate the items you have in your possession, and in Column III to indicate which items you have worn. In Column IV, check all items worn together at the same time to form an ensemble used under the most severe conditions experienced.

Print in the blank spaces in Column I, the names of any additional items of cold weather outdoor clothing which are in your possession but are not printed in Column I. Make check marks opposite these items in Columns II, III & IV in the same manner that you do for the printed items. Use Column V for comments

I NAME OF ITEM	II HAVE ITEM	III HAVE WORN ITEM	IV COMPLETE ENSEMBLE WORN UNDER COLDEST CONDITIONS	V COMMENTS CONCERNING INDIVIDUAL ITEMS (Protection, warmth, fit, dexterity, mobility, ruggedness, convenience, quality, appearance, effectiveness, ease of maintenance, interference with activities, design, weight, etc.)
Undershirt, Full Length Sleeve.				
Drawers, Ankle Length				
Shirt, Wool, OG 108				
Coat, w/o Hood				
Liner, Coat Mohair Frieze				
Trousers, Cotton WR				
Trousers, Cotton, OG m07-M1951				
Liner, Trousers Arctic Field				
Liner, Trousers Arctic Mohair				
Parka, Cotton Nylon Oxford				
Suspenders, Scissors Back Type				
Cap, Cotton Pile				
Mittens, Insert				
Mittens, Arctic				
Boots, Felt				
Boots, Ski Mtn				
Socks, Wool, Natural				

I NAME OF ITEM	II HAVE ITEM	III HAVE WORN ITEM	IV COMPLETE ENSEMBLE WORN UNDER COLDEST CONDITIONS	V COMMENTS CONCERNING INDIVIDUAL ITEM (Protection, warmth, fit, dexterity, mobility, ruggedness, convenience, quality, appearance, effectiveness, ease of maintenance, interference with activities, design, weight, etc.)
Socks, Wool, Cushion Sole				
Socks, Felt				
Insoles, Felt				
Boots, Rubber Insulated Cold Dry White				
Boots, Rubber Insulated Black (Std)				
Boot, Rubber Insulated Black, Experimental (This item does not have auxiliary eyelet tabs at base of eyelet stays)				

4. How well did the total ensemble worn protect you under the most severe conditions experienced: (Underline one answer)

1) Excellent protection

2) Good protection

3) Fair protection

4) Poor protection

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III C...

1) So c...

2) Numb...

3) Very ...

4) Cold ...

5) Uncom...

6) Cool, ... comf...

7) Comfor...

8) Warm, ... comf...

9) Uncomfo...

10) Hot

6. Di... conditions ...

If No, ... were not kep...

7. Were ... Arctic Ensemb...

If No, p...

8. What ...

5. How warm or cold were you while wearing the total ensemble under the most severe conditions experienced. Answer by underlining the statement in each column which best describes the most extreme subjective cold experienced? Make additional comments in the margin if you wish to do so.

	IN GENERAL I WAS		MY HANDS WERE		MY FEET WERE
1)	So cold I was helpless	1)	Frost-bitten	1)	Frost-bitten
2)	Numb with cold	2)	Numb with cold	2)	Numb with cold
3)	Very cold	3)	Very cold	3)	Very cold
4)	Cold	4)	Cold	4)	Cold
5)	Uncomfortably cool	5)	Uncomfortably cool	5)	Uncomfortably cool
6)	Cool, but fairly comfortable	6)	Cool, but fairly comfortable	6)	Cool, but fairly comfortable
7)	Comfortable	7)	Comfortable	7)	Comfortable
8)	Warm, but fairly comfortable	8)	Warm, but fairly comfortable	8)	Warm, but fairly comfortable
9)	Uncomfortably warm	9)	Uncomfortably warm	9)	Uncomfortably warm
10)	Hot	10)	Hot	10)	Hot

6. Did the Arctic ensemble keep your body warm during the coldest conditions you experienced?

Yes____ No____

If No, please explain what areas of your upper and/or lower body were not kept warm.

7. Were you able to perform your tasks with ease while wearing the Arctic Ensemble?

Yes____ No____

If No, please explain.

8. What type of footgear including socks did you wear?_____

9. While wearing such footgear under the most severe conditions experienced:

a. Were your feet warm? Yes____ No____

If No, under what circumstances did your feet become cold?

b. Did your feet ever get too warm? Yes____ No____

If Yes, under what circumstances did your feet get too warm?

c. Was there any accumulation of sweat within your footgear that could be considered objectionable?

Yes____ No____

If your answer to c and/or d was Yes, please explain and indicate footgear worn and the conditions existing when this happened.

d. Was there any accumulation of frost or ice?

Yes____ No____

If your answer to c and/or d was Yes, please explain and indicate footgear worn and the conditions existing when this happened.

e. If sweat, frost or ice accumulated within your footwear, what did you do about it?

f. Did your footgear provide good traction over varied surfaces and terrain?

Yes____ No____

If No, please explain and if you fell, please so state.

g. Did your footgear stiffen up at low temperatures?

Yes____ No____

If the answer is Yes, was the stiffening sufficient to make your feet uncomfortable?

Yes____ No____

If the answer to g. is Yes, did the stiffening interfere with walking?

Yes____ No____

h. Did any bonding failures occur? That is, did any of the seams or parts of the footgear separate from each other?

Yes____ No____

If bonding failures occurred, please explain in what areas of your footgear bonding failures occurred?

i. Did your footgear fail to the extent that a replacement had to be made?

Yes____ No____

If Yes, describe the type of failure and explain what you think caused such failures.

j. Did your footwear impede your progress in any way while traveling on foot, on skis or other types of oversnow equipment for foot travel?

Yes____ No____

If Yes, please explain.

k. Did you experience any foot discomfort or suffer any foot disability which you think was caused by your footgear?

Yes____ No____

If Yes, explain the nature of the foot discomfort and/or foot disability.

10. If you wore the Army Arctic Handwear Assembly under the most severe conditions experienced,

a. Did it keep your hands warm?

Yes____ No____

b. If your hands became cold because it was necessary to work barehanded, were you able to rewarm your hands satisfactorily by putting them back in your mittens?

Yes____ No____ Never had to work barehanded____.

c. Could you perform tasks requiring a high degree of hand dexterity, while wearing arctic handgear?

Yes____ No____

If No, please explain.

11. Did the headgear components of the Arctic Ensemble adequately protect your head, neck, and face against the environmental hazards to which you were exposed under the most severe conditions experienced?

Yes____ No____

If No, describe the areas of inadequate protection and the circumstances.

a. Did the headgear interfere with your vision or hearing to an objectionable degree?

Yes____ No____

If Yes, please explain.

12. Based on your total wearing experience with the Arctic ensemble, would you rate it

Excellent_____
Good _____
Fair _____
Poor _____

13. Were you frostbitten?

Yes____ No____

If your answer is Yes, what part of your body was frost-bitten? What were the circumstances?

14. Did any part or parts of your body ever become extremely cold?

Yes____ No____

If your answer was yes, list the part or parts of your body which were extremely cold?

Make additional comments concerning the Arctic Ensemble or its components.

Make suggestions for improvement of the Arctic Ensemble or its components.

_____
(SIGNATURE)