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FIELD TESTING OF FACIAL PROTECTIVE DEVICE IN ANTARCTICA

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Principal Investigators:

Arne G. Nielsen
CAPT DC USN

Max J. Perlitsh
LT DC USN

Coordinator of Test Program:

Thomas M. Allensworth
LCDR DC USN
(Dental Officer at McMurdo Sound, DF '60-'61)

APPROVED BY:

Walter R. Miles, Ph.D.
SCIENTIFIC DIRECTOR

RELEASED BY:

George F. Bond
CAPT MC USN

SUMMARY PAGE

THE PROBLEM

To conduct field tests of a facial protective device, designed in the Dental Research Branch, intended for use in extremely cold environments.

FINDINGS

The mask was considered successful in the protection of face a eyes and the oral structures, even in temperatures of -75°F and 17 kn of wind. There were no reports of frostbite. The non-fogging lenses were considered satisfactory. The chief complaint was the inability wear glasses under the mask. Resistance to breathing was encountered in some instances--due sometimes to increased altitude of the working area, in other instances to ice accumulation or condensation.

APPLICATION

This prototype mask should lead to the development of a more p fect device for providing facial protection in extremely cold weather --one that may be worn with comfort and adequate protection at 0°F as well as -100°F and at all intermediate temperatures.

ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Bureau of Medici and Surgery Research Project MR005.12-5220, under Subtask (2), Study Oral Health in the Antarctic. The present report is No. 14 on this S task and was approved for publication on 24 April -963.

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SUMMARY OF FIELD TESTS OF COLD WEATHER FACIAL PROTECTIVE DEVICE CONDUCTED IN ANTARCTICA DURING DEEP FREEZE '60-'61*

INTRODUCTION

NMRL Memorandum Report 61-6 of 14 July 1961 presented a review of protection problems among Naval personnel stationed in Antarctica and described a prototype face mask designed in our Dental Branch to enable the wearer to be comfortable in the extremely low temperatures encountered in such cold areas. In laboratory tests in a cold chamber at -70°F., the subject was entirely comfortable for periods of one hour, in contrast to the extreme discomfort experienced after three minutes under identical conditions, but without the mask.

The mask is described as "lightweight and provides protection for the face, eyes, oral structures, and the respiratory tree". It has no external source of power, but relies entirely on re-cycling of natural body energy (heat and moisture). With the mask in place, the temperature of the inhaled air measured on the labial surface of the central incisors was 60°F. Without mask protection, temperatures under identical conditions were as low as 32°F. The eye protective feature remained fog-free for the one hour period of the test. Ice accumulation within the mask was not a problem during the test period.

The present report gives the results of the field testing of this facial protective device on location in the Antarctic Naval Stations.

PROCEDURE

Four prototypes of the facial protective device were sent to Antarctica for field testing, one to each of the U. S. Antarctic wintering-over stations, i.e., Pole Station, McMurdo Naval Air Station, Hallett Station, and Byrd Station. The medical officers at each of the above stations were responsible for the conduction of test programs. Field test data were obtained from questionnaires answered by the test subjects after each test. A sample of this questionnaire appears as Appendix A.

* Report made to ONR

Test conditions varied at each of the stations, as follows:

(a) Pole Station:

Elevation	9184 feet
Wind	18 to 20 knots common
Temperature range	-10°F to -120°F
Number of tests	Five

(b) McMurdo Naval Air Station:

Elevation	102 feet
Wind	20 to 30 knots common, peak gusts as high as 35 knots
Temperature range	+30°F to -75°F
Number of tests	Three

(c) Hallett Station:

Elevation	16 feet
Wind	Peak gusts of over 100 knots
Temperature	Average 10° to 15°F warmer than McMurdo
Number of tests	Two

(d) Byrd Station:

Elevation	5000 feet
Wind	15 to 30 knots common
Temperature	-35°F to -75°F
Number of tests	Four

RESULTS

The test data obtained from each station is summarized as follows:

POLE STATION

Questions	Number of Trials 1	2	3	4	5
1. Weather conditions:					
Temperature	-26.6 F	-26°F	-26°F	-52°F	-75°F
Wind	8 knots	12 knots	12 knots	11 knots	17 knots
Light	Sun	Sun	Sun	Sun	Night
2. Work	cargo handling	cargo handling	cargo handling	cargo handling	equipment handling
3. Length of time worn	45-60 min	30-45 min	30-45 min	45-60 min	15-30 min

4.	Worn continuously	yes	yes, except to adjust	yes	no, ice clearing breaks	yes
5.	Eye Protection:					
	Clear	yes	yes	yes	no (blurred)	no (fogged)
	Glare with lenses	yes	yes	yes	yes	DNA*
	Glare with visor	no	no	no	no	DNA*
6.	Worn before	no	no	no	no	yes (1)
7.	Beard worn	yes	yes	yes	yes	yes
	Reduce effectiveness	yes	yes	yes	yes	yes
8.	Interference with work. Explain	limits vision	limits vision	limits vision	limits vision	limits vision, moisture
9.	Resistance to breathing	no	yes	yes	no	yes
10.	Face warm	yes	yes	yes	yes	yes
11.	Face comfortable	yes	no**	no**	no, excess condensation	no, excess condensation

* Does Not Apply
** Pressure at bridge of nose

McMURDO NAVAL AIR STATION

Questions	Number of Trials 1	2	3
1. Weather conditions:			
Temperature	-11°F	-20°F	app -15°F
Wind	25 knots	10 knots	30-50 knots
Light	Sun	Cloudy	Cloudy
2. Work	walking uphill	walking uphill	shoveling snow

3.	Length of time worn	15-30 min	10 min	15-30 min
4.	Worn continuously	yes	yes	yes
5.	Eye Protection:			
	Clear	yes	yes	yes
	Glare with lenses	yes	no	no
	Glare with visor	no	---	---
6.	Worn before	no	yes (1)	yes (2)
7.	Beard worn	no	no	no
	Reduce effectiveness	---	---	---
8.	Interference with work. Explain	yes, vision	yes, vision	yes, visior
9.	Resistance to breathing	yes	yes	yes
10.	Face warm	yes	yes	yes
11.	Face comfortable	no*	no*	no*

* Pressure at bridge of nose

HALLETT STATION

	Questions	Number of Trials 1	2
1.	Weather conditions:		
	Temperature	$+3^{o}F$	$+4^{o}F$
	Wind	50 knots	30 knots
	Light	Daylight Sun-cloudy	Cloudy
2.	Work	Walking, storm conditions	Heavy labor
3.	Length of time worn	over 1 hour	one nour
4.	Worn continuously	no	no, cumbersome
5.	Eye protection:		
	Clear	yes	yes
	Glare with lenses	no	no
	Glare with visor	no	---

6.	Worn before	no	yes (1)
7.	Beard worn	yes	yes
	Reduce effectiveness	no	no
8.	Interference with work. Explain	no	yes, excess water poor adj.
9.	Resistance to breathing	yes	yes
10.	Face warm	yes	yes
11.	Face comfortable	yes	no, keep re-adjusting

BYRD STATION

Questions		Number of Trials 1	2	3	4
1.	Weather conditions:				
	Temperature	---	-54°F	-56°F	-54°F
	Wind	---	14 knots	---	30 knots
	Light	night	night	night	night
2.	Work	shoveling snow	shoveling snow	walking	various outside work
3.	Length of time worn	15 min	30-45 min	less than 15 min	15-30 min
4.	Worn continuously	yes	yes	yes	yes
5.	Eye protection:				
	Clear	yes	yes	no	no
	Glare with lenses	DNA*	DNA*	no	no
	Glare with visor	DNA*	DNA*	DNA*	DNA*
6.	Worn before	once	twice	no	no
7.	Beard worn	no	yes	no	no
	Reduce effectiveness	---	no	---	---

8.	Interference with work. Explain	yes, hard to breathe	yes, limits vision	yes, fogged eyepiece limits vision	yes, lim: vision
9.	Resistance to breathing	yes	no	yes	yes
10.	Face warm	yes	yes	yes	yes
11.	Face comfortable	yes	yes	no	yes

* Does Not Apply

Discussion of test data - The device was tested 14 times during the entire 1960-61 Deep Freeze Operation. This small number of tests suggests limited acceptance of it or natural resistance to the use of a new "gadget."

The most satisfactory tests were done at Pole Station, and the following comments pertain to these tests. The eye protective feature seemed satisfactory except in tests 4 and 5 in which the test temperatures were -52°F and -75°F respectively. The visor apparently provided satisfactory glare protection. The device provided satisfactory cold protection even at the extreme test temperatures, but it was not comfortable to wear because of the accumulation of condensate within the respiratory portion of the mask covering the mouth and nose. Also, the subjects reported uncomfortable pressure on the bridge of the nose. The reported disadvantages of the device included resistance to breathing in tests #2, #3, and #5. The field test factors that probably contributed to this problem, which was not encountered in the cold chamber tests, were the subjects' increased respiratory demand because of his physical activity and different environment as compared to conditions in the cold chamber tests. The other reported disadvantage was the reduced working effectiveness of the subject because of the limited visual field provided by the protective lenses.

The test data obtained from the other three stations more or less substantiate the results reported from Pole Station.

Dr. Allensworth's notes record subject comments and opinions regarding the protective device.

The device was sent to Antarctica to test, primarily, its usefulness for the conservation of energy; protection of the oral structures,

face, eyes, and the respiratory tree. The complaints noted in regard to fit of the device and problems related to communication were anticipated. If the device tested satisfactorily in regard to the basic requirements, as noted above, it was planned to seek solutions to the additional problems related to its use.

DISCUSSION

The face mask was designed to provide protection for the face and eyes as well as the oral structure and to minimize respiratory energy loss.

In the first of these two respects, the mask was a success as the face was kept warm in the Antarctic with a low trial temperature of -75°F and 17 knots of wind, and there were no reports of frostbite of the face of any of the observers while wearing the mask. The non-fogging lenses were considered satisfactory in that they remained clear for the user and generally a set of lenses would last two to three weeks. (Byrd Station found the lens to last only about 1 hour wearing time). An exception to this was two observers reporting fogging; as these were the only reports of fogging, it is felt that this resulted from poor fit of the mask which enabled exhaled air to enter the area between the eyes and the lens. The single sun visor was sufficient to reduce the sun glare to a comfortable level.

The chief complaint was limited field of vision due to the eyepiece size, which created a safety hazard when working around machinery. When wearing headgear for warmth, hearing acuity is considerably reduced and it is necessary to use the eyes much more than the ears to avoid hazards. Another visual complaint was the inability to wear glasses under the mask. In Operation Deep Freeze, some of the vision requirements are being waived and there are men who must wear glasses while working, which precludes them from wearing a mask of the present design.

Resistance to breathing was considered by the subjects to be a disadvantage of the mask and two reasons were given for this:

1. Resistance due to increased dead air space was the most frequent comment. With Pole Station and Byrd Station having a high altitude, it is an effort to breathe on exertion and the increase of the dead air space necessitates an increased effort. The observer at McMurdo, after each of three trials, experienced substernal discomfort for approximately 24 hours.

2. Resistance due to ice accumulation or condensation inside of the tube and in the rubber nose and mouth cover. This condensation necessitated the removal of the mask for clearing.

The wearing of a beard was reported to reduce effectiveness of the mask by Pole people in temperatures -26°F to -52°F, but in a temperature of -75°F with approximately the same wind velocity, this was found to not reduce the effectiveness of the mask. In Doctor Walk's report from Byrd, he commented that having a beard did not interfere with the fit too much.

Two observers commented that the mask did not extend to cover the lower part of the mandible, one said the "jawbone" got cold, and another the chin. Neither man had a beard, so this would be a very susceptible area to frostbite.

The mask was deemed uncomfortable by all observers, even those who reported the face being comfortable, and commented on aspects of the mask which did bother the observer. The main objection was the collection of condensation from exhaled air which would leak out from the lower edge of the mask and freeze the mask to the face or beard. Rhinorrhea presented a problem, as the mask had to be removed to remove the mucus with a tissue or the mucus would collect with the condensation. Due to anatomical differences of the face, some of the observers had difficulty in adjusting the mask to a comfortable fit, especially in the area across the bridge of the nose.

SUMMARY

Face masks were tested under field conditions at Pole Station, McMurdo, Byrd Station, and Hallett Station. Weather conditions varied from temperatures of +4°F, 30 knots wind, daylight but cloudy to -75°F, 17 knots wind and night. The face mask will keep the wearer's face warm and will provide protection to the eyes from cold and glare. The observers comments are listed below:

1. Limited field of vision.
2. Inability to wear glasses with mask.
3. Excessive resistance to breathing.
4. Collection of condensation and/or mucus on face side of mask with the subsequent leakage of these fluids from lower edge of mask and freezing or running down neck.
5. Mask makes communication (speaking or hearing) difficult.
6. Proper and comfortable fit of mask to all wearers is difficul
7. Having a beard reduces the efficiency of the mask, but two of

observers that had no beards reported lower part of the mandible getting cold.

8. Inability to wear some types of issue hats/caps with the mask.

CONCLUSION

There is a definite need for a facial protective device against cold weather. Due to the range in temperature between U. S. Antarctic stations, the design of a cold weather facial protective device should be versatile so that it may be worn at $0^{\circ}F$ as well as at $-100^{\circ}F$ with adequate protection at all intermediate temperatures.

The mask in its present design, and as used in these field trials, was not acceptable by those men who wore it. This does not mean that the mask will not protect the face of the wearer from the cold; it gives excellent protection from the cold and would probably be more acceptable for use in temperatures ranging far below those encountered in Antarctica.

APPENDIX A

EVALUATION QUESTIONNAIRE FOR COLD WEATHER FACIAL PROTECTIVE DEVICE
(To be completed after each trial)

NAME _____
Last First Middle

RATE/RANK/TITLE _____

DATE _____

DUTY STATION _____

1. Weather Conditions: Temperature _____
Wind Velocity _____
Light Condition
Sunny _____
Cloudy _____
Night _____

2. Describe type of work engaged in during test _____

3. Worn for: 0-15 minutes _____
15-30 minutes _____
30-45 minutes _____
45-60 minutes _____
Over 1 hour _____

(Circle one)

4. Was the device worn continuously for the above period? Yes No

5. Eye protection: Were eye pieces clear___? Fogged___?
Was there a glare problem with
lenses only? Yes No
With lenses and single sun visor Yes No
With lenses and double sun visor? Yes No

6. How many times have you worn this device before? _____

7. Did you have a beard? Yes No
If yes, did it reduce the effectiveness of the device? Yes No

8. Did device interfere with your ability to work? Yes No
If yes, describe _____

9. Was there any resistance to breathing? Yes No

10. Was your face warm while wearing the device? Yes No

11. Was your face comfortable while wearing the device? Yes No

PLEASE RECORD COMMENTS, RECOMMENDATIONS FOR IMPROVEMENTS, ETC ON THE REVERSE SIDE OF PAGE