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COLD REGIONS ENVIRONMENTAL PROTECTION TEST OF CLOTHING.(U)
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This TOP prescribes methods for evaluating the protective qualities of clothing developed for cold regions use. It contains procedures for evaluating wind, cold, and snow protection characteristics. It describes the necessary facilities and instrumentation requirements for test accomplishment.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-109
Test Operation Procedure 10-2-510
AD No.

1 May 1978

COLD REGIONS ENVIRONMENTAL PROTECTION TEST OF CLOTHING

1. SCOPE. This Test Operations Procedure (TOP) details test procedures for evaluating the envrionmental protective capability of clothing developed for cold regions use. A series of procedures are presented, each designed to produce data to support an evaluation of the environmental protection qualities of cold weather clothing.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

2.1.1 A heated inclosure that is suitable for placing temperature measuring elements on personnel participating in the test.

2.1.2 A 100-meter course on relatively flat, smooth, and open terrain. The course will be sufficient width to allow 12 test participants to traverse the course at the same time. The course will have a heated shelter at one end to house the temperature monitoring and recording instrumentation.

2.1.3 An area that can be used to fire the standard military rifle or simulated firing of the rifle. This area must be in a location that precludes snow from being blown off.

2.2 Instrumentation. All instrumentation requiring calibration will be within their calibration period to assure the minimum accuracies can be obtained.

Item	Range	Minimum Accuracy
Meteorological Instr Thermometer	25°C to -55°C (77°F to -67°F)	±1°C (±1.8°F)
Hygrometer	0 to 95%	±5%
Wind Velocity	0 to 64 knots (40 mph)	±3 kph (±2 mph)
Wind Direction	0 to 360°	±5°
Timer	6 hour	±30 sec

Item	Range	Minimum Accuracy
Thermocouple or thermistor with monitor and recorder (portable)	0°C to 40°C (32°F to 104°F)	+1°C (±1.8°F)
Scale (weight)	2 kg (4.9 lbs)	+1 gm (±0.05 oz)
IR Scanner with photographic attachment	2°C (1.8°F) discrimination	+1°C (±1.8°F)
Generator	1 kw	NA

2.3 Equipment. A truck with a platform on the front, capable of accommodating three men abreast.

3. PREPARATION FOR TEST.

3.1 Facilities. Assure that the warm shelter is available at one end of the test course to house the temperature monitor and recorder, and that 60-cycle power is available in the shelter.

3.2 Equipment. Insure that equipment is available for use and a power source is available at the test site if applicable.

3.3 Clothing. All items of clothing including the test item will be examined before the tests to insure they are dry.

3.4 Instrumentation. Place thermocouples on the outside of the big toe, on the left foot, the center of the throat, and at the tip of the smallest finger of the right hand of all test participants. Place other thermocouple on test participants according to the item to be tested as indicated by the following chart.

Head Protective Equipment
- Back of Neck
- Middle of the Forehead
- The Tip of the Nose
- Left Cheek

Upper Torso
- Center of Chest
- Center of Back, 3 inches below Shoulder Level
- Center of Stomach

Trousers
Front of Thigh (right)
Directly behind Left Knee

3.5 Data Required.

3.5.1 Meteorological Information. Temperature, relative humidity, wind velocity, wind direction, and overall weather observations.

3.5.2 Instrumenation. Type, nomenclature, accuracy, description, and serial number of each item of instrumentation.

3.5.3 Personnel Data. Test participant's name, results of physical examination, and anthropometric measurements. All items of clothing being worn by each test participant (same for all test participants).

3.5.4 Test Item. Type, size, and general description and physical condition of each test item; and total number of items to be tested.

3.6 Personnel.

3.6.1 Test participants will be oriented in all aspects of application and use of the test item.

3.6.2 Test participant will be briefed on the objective of the test, the procedures to be followed in accomplishment of the objective, the responsibility of the test participant during test conduct, and the approximate time required to complete the test.

3.6.3 All test participation will be voluntary, if required, and willing to sign privacy statements, if required.

4. TEST CONTROLS.

4.1 Before conduct of test, each prospective participant will be examined by qualified medical personnel to verify they are in acceptable physical condition for performing intended test activities. Those individuals with physical conditions that would bias the test results or endanger their health will not be used as test participants. Results of the medical examination will be a part of the privacy act release (AR 70-25).

4.2 If during testing, test participants are removed from testing for medical reasons, they will undergo an immediate physical examination by a physician. The physician's report of the results of the examination, insofar as it reflects upon the ability of the individual to participate in the test, will be included in the test data. Results of the medical examination will be a part of the privacy act release (AR 70-25).

4.3 During conduct of test, all participants will be dressed with identical type and amount of standard issue clothing and the test item. The type and amount of clothing worn shall be appropriate to the prevailing weather condition.

4.4 The temperature range for which the item is designed will be determined from the requirements documents or the test directive. All tests will be conducted within this temperature range. This temperature range will be divided into three equal divisions. At least one test will be conducted within the lower one-third of the lowest temperature range and the upper one-third of the highest temperature.

4.5 A minimum of 12 test items will be used during each test. These 12 items shall encompass the size range of the personnel performing the tests.

4.6 During conduct of the test when the temperature of the extremities (finger, toe) drops to 10°C (50°F), the test participant will be removed from testing immediately and allowed to warmup in a heated shelter.

4.7 Test participants shall have a minimum rest period of 10 hours between tests.

4.8 Throughout testing, test participants will be observed for symptoms of frostbite. At the first symptoms, a test participant will be removed from testing and examined by medical personnel.

4.9 At any phase of testing, if a test participant indicates unusual discomfort, he will be removed from the testing and the cause of the discomfort will be investigated.

5. PERFORMANCE.

5.1 Cold Protection. The cold protection qualities of the test item will be evaluated during the 6-hour tests. Two of these 6-hour tests will be conducted in the lower temperature range and two 6-hour tests will be conducted in the upper temperature range for which the item was designed. Items that fail the cold protection test at the lower temperature range will be tested in the lower one-third of the mid-temperature range as calculated in paragraph 4.4. All testing will be conducted during wind velocities of less than 5 kph (3 mph).

5.1.1 Method.

5.1.1.1 Active. Test participants will spend 6 continuous hours outside performing test. Test participants will make two round trips of a

100-meter course at an average pace which will require 10 minutes time. The temperature indicated by the thermocouples mounted on the test participants will be monitored and recorded every 20 minutes. Test participants experiencing cold discomfort or the temperature of the extremities go below 16°C (60°F), will have the temperature of their thermocouples recorded at 10-minute intervals until removed from testing. Testing will begin when the outside temperature enters and is predicted to remain for the test period within the range that the test is to be conducted. Continual recording of meteorological data will be accomplished throughout the conduct of the test.

5.1.1.1.1 In a warm shelter (21°C, ±3°C), each test participant will don the test item and the additional standard issue clothing appropriate to the prevailing conditions. The temperature of the thermocouples of each test participant shall be recorded.

5.1.1.1.2 The test participants will go outside and walk two round trips of the test course every 10 minutes. The temperature of the thermocouples shall be monitored and recorded every 20 minutes or at the conclusion of the 4th, 8th, 12th, and 16th round trip.

5.1.1.1.3 At the end of 80 minutes or the conclusion of the 16th round trip, each test participant will be allowed a 10-minute break. This 10-minute break shall be spent in the environment in which the test is being conducted. During this break, test participants may drink hot or cold liquids; however, the amount and type of liquid consumed by each test participant will be recorded.

5.1.1.1.4 At the conclusion of the 10-minute break, the test participants will resume walking the test course. The temperature of the thermocouples will be recorded at the conclusion of the 18th, 22th, 26th, and the 30th round trip of the test course. At the conclusion of the 30th round trip of the test course, the test participant will take a 10-minute break. The amount and type of liquid consumed by each test participant shall be recorded.

5.1.1.1.5 At the conclusion of the second 10-minute break, the temperatures of the thermocouples shall be monitored and recorded.

5.1.1.1.6 After the break, the test participants shall resume walking the test course. The temperature of the thermocouples shall be monitored and recorded at the conclusion of the 36th, 40th, 44th, and 48th round trip of the test course.

5.1.1.1.7 At the conclusion of the 48th round trip of the test course, the test participants shall take a 10-minute break. The type and amount of liquid consumed by each test participant shall be recorded.

5.1.1.1.8 At the conclusion of the 10-minute break, the test participants shall resume walking of the test course. At the conclusion of the 50th, 54th, 58th, and 62nd round trip of the test course, the temperature of the thermocouple shall be monitored and recorded.

5.1.1.1.9 At the conclusion of the 62nd round trip of the test course, the test participants shall be given a 10-minute break. The type and amount of liquid consumed by each test participant shall be recorded.

5.1.1.1.10 At the conclusion of the 10-minute break, the temperature of the thermocouples shall be monitored and recorded. The test participants shall then move to a warm shelter with a temperature of 21°C, ±3°C. The temperature of the thermocouples shall be monitored and recorded after an elapsed time of 10 minutes and 20 minutes in the warm shelter.

5.1.1.1.11 At the conclusion of 20 minutes in the warm shelter, test participants shall remove the test items and all instrumentation.

5.1.1.1.12 Each test participant will then be interviewed (appendix C) to obtain an individual evaluation of the test item thermal qualities.

5.1.1.2 Inactive. Test participants shall spend 2 hours outside simulating a standing guard duty performing a minimum of physical activity. The temperature indicated by the temperature sensing device attached to data will be recorded continuously throughout the test.

5.1.1.2.1 In a warm shelter (21°C, ±3°C) each test participant will don the test item and the standard issue clothing appropriate to the prevailing weather conditions. The temperature of the temperature sensing element will be recorded. The test participants shall then go outside and start the test insuring that all temperature sensing elements are connected to a recording device.

5.1.1.2.2 At the conclusion of 30 minutes testing, each test participant shall be scanned on four sides with the IR Scanner to locate areas of high heat loss. If significant high heat loss areas are located, the sensitivity of the IR Scanner shall be adjusted to obtain maximum temperature detail on the display unit. Photographs will be taken of the scanner display indicating the high temperature areas.

5.1.1.2.3 At the conclusion of 1 hour of testing repeat the test procedures of paragraph 5.1.1.2.2.

5.1.1.2.4 At the conclusion of 90 minutes of testing repeat the test procedures of paragraph 5.1.1.2.2.

5.1.1.2.5 At the conclusion of 2 hours of testing repeat the test procedures of paragraph 5.1.1.2.2. Test participants will then disconnect the temperature sensing elements from the recorders and enter the warm shelter. The test item shall be worn for 20 minutes after entering the warm shelter. The temperature of the sensing elements shall be recorded at the conclusion of 10 minutes and 20 minutes in the warm shelter.

5.1.1.2.6 At the conclusion of 20 minutes in the warm shelter, the test item and all temperature sensing elements shall be removed. Each test participant shall then be interviewed to obtain an individual evaluation of the test item thermal qualities.

5.1.2 Data Required.

Meteorological data
Thermocouple temperature and time of each measurement
Results of interview
Test participant's comments
Discontinued test (environmental related) attributable to problems in test item
Recorded observation of the test officer
IR Scanner photographs (if applicable)

5.2 Wind Protection. The wind protective qualities of the test item shall be evaluated in two 1-hour tests. The wind protection capabilities of the test item shall be evaluated at windchill temperatures of between -55°C (-67°F) and -70°C (-94°F). If the test items are unsatisfactory at windchill temperatures between -55°C and -70°C, it will be retested at windchill temperatures between -40°C and -50°C (-58°F). Windchill temperatures will be determined from the charts contained in appendix B.

5.2.1 Method. Test participants will spend 1 continuous hour in windchill temperatures between -55°C and -70°C. The minimum wind velocities used to derive these windchill temperatures will be 32km/hr (20 mph). The windchill factors may be artificially induced by travel in an open in an conveyance without wind shielding. The temperature on the temperature sensors on each test participant will be monitored continuously.

5.2.1.1 In a warm shelter (21°C, ±3°C), each test participant will don the test item and the additional standard issue clothing appropriate to the prevailing conditions. The temperature of the temperature sensors on each test participant shall be recorded.

5.2.1.2 Immediately after leaving the warm shelter, test participants shall proceed to the test area and connect the temperature sensors to the recorders and begin testing.

5.2.1.3 After 1 hour of the test described in paragraph 5.2.1, the test participants shall disconnect the recording instrumentation and return to the warm shelter.

5.2.1.4 After returning to the warm shelter, test participants shall continue to wear the outside clothing ensemble for 20 minutes. The temperature of the thermocouples shall be recorded at the conclusion of 10-minute and 20-minute intervals.

5.2.1.5 After 20 minutes, test participants may remove the test item. Each test participant shall then be interviewed to obtain an individual evaluation of wind protective characteristics.

5.2.2 Data Required

Meteorological information
Windchill temperature factors
Thermocouple temperature
Number of tests discontinued because of cold and narrative description of cause
Recorded observations of the test officer

5.3 Snow Protection. The protective capabilities of the test item shall be evaluated from two 3-hour tests. One test shall be conducted within 15°C of the lowest temperature at which the test item is designed to be worn and one test will be conducted at temperatures between -3.9°C (25°F) and 4.5°C (40°F). Testing shall be performed in a minimum snow depth of 6 inches.

5.3.1 Method. Test participants will start at a staging area and march for approximately 30 minutes to a rifle range. Test participants will then perform a firing or simulated firing exercise and advance by crawling to a new position.

5.3.1.1 Prior to starting the test, all test items will be thoroughly dried and the weight of each item recorded. In a warm shelter (21°C, ±3°C) test participants will don the test item and the additional standard issue clothing appropriate to the prevailing weather conditions. The temperature of each thermocouple on each test participant shall be recorded prior to leaving the warm shelter and at 20-minute intervals thereafter during the test.

5.3.1.2 Test participants shall assemble in a rifle squad and march to the rifle range. The march shall be through existing snow a minimum of 6 inches deep.

5.3.1.3 Upon arrival at the rifle range, each test participant shall either fire or simulate the firing of 50 rounds of ammunition through the standard military rifle from the prone position. They will then crawl 50 meters to a new firing position and either fire or simulate the firing of 50 additional rounds from the prone position.

5.3.1.4 Test participants will then crawl 100 meters to a new firing position and either fire or simulate firing of 50 additional rounds from the prone position.

5.3.1.5 After completion of the firing, test participants will assemble into a squad and march for 30 minutes back to the staging area.

5.3.1.6 After reaching the staging area the temperature of each thermocouple should be recorded (regardless of time since last temperature recording) and the test participants shall enter a heated shelter. The test items will be removed, weighed, and the weights recorded.

5.3.1.7 Test participants will then be interviewed (appendix C) to obtain an individual evaluation of the test items resistance to snow penetration.

5.3.2 Data Required.

Meteorological condition
Weight of test items
Thermocouple temperature
Total time
Snow classification data (CRTC Memo 70-5)

5.4 Perspiration Absorption

5.4.1 Method The moisture absorption characteristics of the test item shall be evaluated during four 2-hour tests. Two test shall be conducted within 15°C of the lowest temperature the test item is to be worn, and two test will be conducted between -3.9°C and 4.5°C. One test in each temperature range will be conducted with test participants marching at an average pace of 2 1/2 miles an hour and one test will be conducted with test participants marching at an average pace of 4 1/2 miles an hour. The test item shall be weighed before the test begans and immediately after the conclusion of the exercise to determine moisture uptake. Ventilation techiques used during the exercise shall be consistant for all test participants.

5.4.1.1 All test items shall be thoroughly dried and the item weighed and the weight recorded. Test participants will don the test item, and the additional clothing appropriate to the prevailing weather condition in a warm shelter (21°C, ±3°C).

5.4.1.2 The test participants shall assemble at the test site free from snow and perform the applicable marching exercise described in paragraph 5.4.1.

5.4.1.3 At the conclusion of the 2-hour test period, test participants shall enter the warm shelter and remove the test items. The test item shall be weighed immediately and the weight recorded.

5.4.1.4 Data Required

Weight of test item (start)
Weight of test item (conclusion)
Type test and length
Meteorological conditions

6. DATA REDUCTION AND PRESENTATION.

6.1 Tabulate all data.

6.2 Cold Protection. Examine tabulated data at individual points in time. Average values from individuals for each thermocouple location. If comparing experimental to standard clothing, compare the average values and dispersions. Subjective comments from test participants, test supervisory personnel observations and interview data will be summarized. IR Scanner temperature data shall be correlated with the temperature data accumulated in the inactive phase of the test.

6.3 Wind Protection. Plot thermocouple temperature versus time for each thermocouple location. Values from different individuals will be plotted on a scatter diagram with a least squares curve fit for each thermocouple location (see sample, appendix A). Subjective comments, as in para 6.2, will be summarized.

6.4 Snow Protection Data reduction performed as in para 6.2. Snow classification data will be recorded. Net weight gains of clothing will be calculated.

6.5 Perspiration Absorption. Moisture uptake of the test items shall be calculated and presented in tabular form and correlated to the use of the test item. Comparation data for standard or comparison clothing will be listed.

6.6 The data sheets along with the opinion interview accomplish the content of a checklist.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, MD 21005. Technical information may be obtained from the preparing activity: Commander, US Army Cold Regions Test Center, ATTN: STECR-TD-EE, APO Seattle, WA 98733. Additional copies are available from the Defense Documentation Center, Cameron Station, Alexandria, VA 22314. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A
SAMPLE DATA SHEETS

TEST DATE _____ TIME STARTED _____

TEST ITEM (NAME) _____ TEST PARTICIPANT

TEST ITEM SN _____ (NAME) _____

TEST TIME	TEMPERATURE (°C)								WIND SPEED		
	AMBIENT	THERMOCOUPLE LOCATION									
MINUTES	OUTSIDE	1	2	3	4	5	6	7	MIN	MAX	AVE
0											
20											
40											
60											
80											
100											
120											
140											
160											
180											
200											
220											
240											
260											
280											
300											

THERMOCOUPLE LOCATION CHART

POSITION	LOCATION
1	_____
2	_____
3	_____
4	_____
5	_____
6	_____
7	_____

SAMPLE THERMOCOUPLE DATA PLOTS

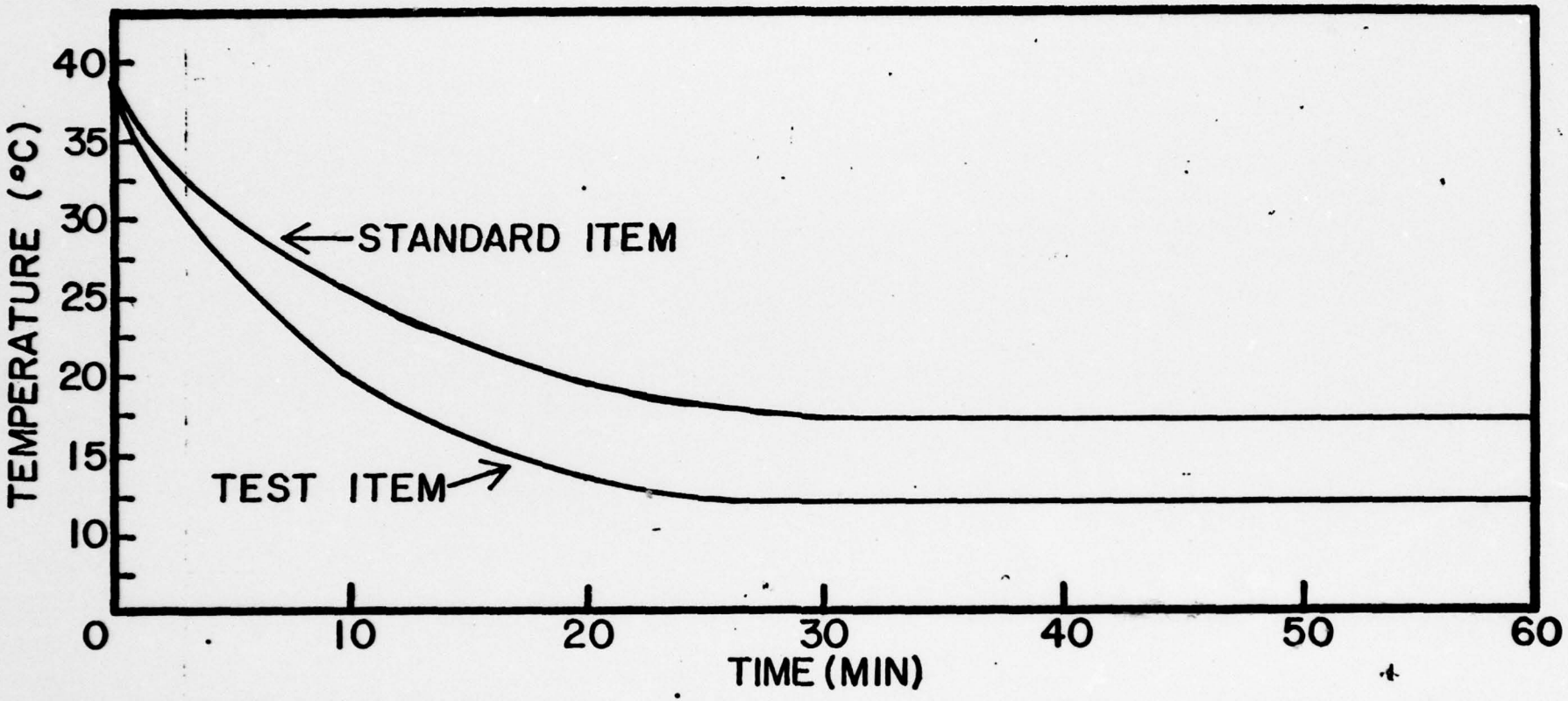

FIGURE XX - MEAN TEMPERATURE AT CHEST VERSUS TIME FOR TEST ITEM COMPARED TO STANDARD (WIND CHILL - 65°C)

WIND SPEED		COOLING POWER OF WIND EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE"																				
KNOTS	MPH	TEMPERATURE (°F)																				
CALM	CALM	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
		EQUIVALENT CHILL TEMPERATURE																				
3 - 6	5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60	-70
7 - 10	10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
11 - 15	15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
16 - 19	20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150

WINDS ABOVE 40 HAVE LITTLE ADDITIONAL EFFECT	LITTLE DANGER	INCREASING DANGER (Flesh may freeze within 1 minute)
		GREAT DANGER (Flesh may freeze within 30 secs)

Degrees Fahrenheit	1	2	3	4	5	6	7	8	9
Degrees Celsius	0.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00

APPENDIX C
OPINION INTERVIEW *

1. a. How do you rate the fit of the clothing that you have worn?

_____6. Excellent

_____5. Very Good

_____4. Adequate

_____3. Not Quite Adequate

_____2. Poor

_____1. Extremely Poor

b. Comments: _____

_____

_____

2. a. How do you rate the freedom of movement afforded by the clothing?

_____6. Excellent

_____5. Very Good

_____4. Adequate

_____3. Not Quite Adequate

_____2. Poor

_____1. Extremely Poor

b. Comments: _____

_____

_____

* To be used in testing both the test and comparison items.

3. a. How do you rate the ability of the clothing you have worn to keep you warm on a windy day?

_____6. Excellent

_____5. Very Good

_____4. Adequate

_____3. Not Quite Adequate

_____2. Poor

_____1. Extremely Poor

b. Comments: _____

_____

_____

4. a. How do you rate the ability of the clothing you have worn to keep you warm on a calm day?

_____6. Excellent

_____5. Very Good

_____4. Adequate

_____3. Not Quite Adequate

_____2. Poor

_____1. Extremely Poor

b. Comments: _____

_____

_____

5. a. How do you rate the ventilaiton characteristics of the clothing that you have worn?

_____6. Excellent

_____5. Very Good

_____4. Adequate

_____3. Not Quite Adequate

_____2. Poor

_____1. Extremely Poor

b. Comments: _____

_____

_____

6. a. How do you rate the clothing you have worn for use by the Army?

_____6. Excellent

_____5. Very Good

_____4. Adequate

_____3. Not Quite Adequate

_____2. Poor

_____1. Extremely Poor

b. Comments: _____

_____

_____

7. a. How do you rate the fasteners, snaps, and zipper provided on the clothing that you have worn?

_____6. Excellent

_____5. Very Good

_____4. Adequate

_____3. Not Quite Adequate

_____2. Poor

_____1. Extremely Poor

b. Comments: _____

_____

_____

8. a. How do you rate the ease with which you were able to don the clothing?

_____6. Extremely Easy

_____5. Easy

_____4. Could be Easier

_____3. Difficult at Times

_____2. Difficult

_____1. Extremely Difficult

b. Comments: _____

_____

_____

9. a. How do you rate the ease with which you were able to doff the clothing?

_____6. Extremely Easy

_____5. Easy

_____4. Could be Easier

_____3. Difficult at Times

_____2. Difficult

_____1. Extremely Difficult

b. Comments: _____

_____

_____

10. a. Did you sweat excessively while wearing the clothing during outdoor exercises? YES _____ NO _____.

b. If yes, please explain: _____

_____

_____

11. a. Did you experience any cold spots, numbness or shivering while wearing the clothing during outdoor exercises? YES _____ NO _____.

b. If yes, please explain: _____

_____

_____

12. a. While you were wearing the clothing, did snow or other foreign material get inside the clothing? YES _____ NO _____.

b. If yes, please explain: _____

_____

_____

13. a. Were you bothered by any of the following while you were wearing the clothing?

YES	NO	
_____	_____	Fabric Noise
_____	_____	Static Electricity
_____	_____	Loose Flaps
_____	_____	Loose Cords

b. If yes to any of the above, please explain: _____

_____

_____