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7 September, 1945

CHAMBER TESTS WITH HUMAN SUBJECTS
X. PROTECTION AFFORDED BY CC-2
IMPREGNATED CLOTHING UNDER VARIOUS
CONDITIONS OF EXPOSURE

By
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Report No. P-2590

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ABSTRACT

This report describes the results of an investigation to evaluate, by means of chamber tests, the effect of (a) variation in temperature and relative humidity, (b) variation in wind velocity, and (c) activity during exposure on the protection afforded by 1-1/2 layer CC-2 impregnated clothing.

As a result of this investigation, it has been concluded that:

(a) With regard to temperature and relative humidity, maximum protection is afforded at low temperature and high relative humidity, whereas minimum protection is provided at high temperature and low relative humidity.

(b) Increased wind velocity during exposure results in a decrease in the protection afforded by CC-2 impregnated clothing.

(c) Slightly greater protection is provided by CC-2 clothing when worn by men engaged in vigorous activity as compared with inactive men.

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INTRODUCTION

A. Authorization.

1. This work was authorized under Project 547/41, "Maintenance, Bureau of Ships", dated 16 December 1940. The problems which were proposed for study were given in Bureau of Ships letter S-S77-2(Dz), Serial 811 of 17 December 1940.

B. Statement of Problem.

2. The purpose of this investigation was to determine the effect of (a) variation in temperature and relative humidity, (b) variation in wind velocity, and (c) activity during exposure on the protection afforded by 1-1/2 layer CC-2 impregnated clothing.

C. Known Facts Bearing on Problem and Theoretical Considerations.

3. It has long been a recognized fact that the vesicant action of H vapor on unprotected men is most pronounced under conditions of high temperature and high relative humidity. For this reason H vapor has been considered as presenting a more serious threat in the tropics than in temperate climates, and chamber tests for the evaluation of the protection afforded by CC-2 impregnated clothing have usually been conducted at high temperatures and relative humidities.

4. Whereas chamber tests have been conducted at this Laboratory and by the UCTL, and British and Australian investigators to study quantitatively the effect of variation in temperature and relative humidity on exposure of unprotected men to H vapor*, as far as is known, no previous work has been reported on the effect of these variables on exposure of men protected with CC-2 impregnated clothing.

5. The results reported in NRL Report No. P-2579 have shown that in exposure of unprotected men to

*NRL Report No. P-2579, Chamber Tests with Human Subjects. IX. Basic Tests with H Vapor.

H vapor, the increased physiological activity of H vapor at high temperature was closely associated with inception of perspiration and resulting formation of a liquid film on the surface of the skin. On the basis of these results, it would be expected that less protection would be afforded by CC-2 impregnated clothing at high temperatures than at low temperatures if the leakage of H vapor through the clothing was comparable. However, it has been established as the result of both chemical tests and chamber tests at this Laboratory (unpublished data) that the leakage of H vapor through moist or wet CC-2 clothing is considerably less than the leakage through dry clothing. Therefore, since both perspiration and high relative humidity tend to wet the clothing, lesser leakage would be expected at high temperature and relative humidity.

6. From the above considerations it is indicated that the effects to be expected from variation in temperature and relative humidity on the protection afforded by CC-2 impregnated clothing would be dependent on the relative magnitudes of these inverse effects, i.e., increased activity of H at high temperature and decreased leakage through wet clothing.

7. In chamber tests at this Laboratory and at UCTL, appreciable wind velocity is attained by the use of large circulating fans. In most of the tests conducted at Edgewood Arsenal and by Australian investigators the wind velocity is negligible.

8. Chamber tests at Edgewood Arsenal have indicated that wind velocity has little or no effect upon the results obtained in the exposure of unprotected men to vesicant vapors. However, it is considered possible that an appreciable effect would be observed in the case of men wearing CC-2 protective clothing, due possibly to an increase in leakage of vapor at high velocities.

9. In most chamber tests at this Laboratory

up to the present time, the exposures have been carried out with only limited activity of the subjects during exposure. In standard tests at this Laboratory the men are for the most part inactive, the only movement being a change of position every five minutes. At Edgewood Arsenal, the subjects are kept in constant motion during the exposure, and in Australian chamber tests the subjects are required to lift and carry ammunition boxes periodically during the exposure.

10. Any effects to be observed as the result of variation in the activity of the subjects during chamber exposure would be a function of several factors such as:

(a) Increased activity would tend to cause increased perspiration and consequent increased wetting of the skin and the clothing. The effect of this factor would thus be comparable to the effect of increased temperature.

(b) Increased activity, especially of the arms and legs, would cause a "pumping" action or "bellows" effect which might be expected to produce an effect comparable to that resulting from increased wind velocity.

(c) Vigorous activity might cause loosening of the drawstring fastenings of the clothing and thus result in vapor leakage at these points.

D. Previous Work Done at this Laboratory.

11. No previous chamber tests have been conducted at this Laboratory with the purpose of evaluating the effects studied in this series of tests. This report is the tenth of a series on "Chamber Tests with Human Subjects" in which the results obtained in the evaluation of various protective equipment against the vesicant effects of persistent chemical warfare agents are reported,

EXPERIMENTAL

A. Procedure for Chamber Tests.

12. The operation of the NRL chamber is

described in detail in NRL Report No. P-2208, dated 22 December 1943. The general procedure for conducting chamber tests is also described in that report,

13. The tests described in this report were conducted as "man break" tests. Each man exposed in the chamber was supplied with the following protective equipment:

- (a) Navy diaphragm mask, Mark III or IV.
- (b) Standard Navy Issue Arzen suit impregnated with CC-2 by the water suspension process.
- (c) CC-2 impregnated rib-knit shorts.
- (d) Standard Navy undershirt (skivvy shirt - unimpregnated).
- (e) CC-2 impregnated cotton socks (2 pair).
- (f) CC-2 impregnated elbow-length wool gloves.
- (g) Overshoes (Arctics).
- (h) Protective Ointment (S-330-NCIII) for face and neck.

14. The subjects were given successive daily exposures to H vapor in the chamber at CT 1200 (60 minutes) under various conditions of temperature, relative humidity, wind velocity, and activity as described later for each series of tests. The clothing was worn by the subjects for 4 hours after the chamber exposure. The men were examined and read by the Medical Officer before each exposure and each subject was withdrawn from the test when he had incurred a reading of E (intense erythema) or greater on any part of his body. The successive daily exposures were continued until all the men had "broken", i.e., reached a reading of E or greater. The average number of exposures tolerated was used as the basis for evaluating the protective capacity of the clothing under the conditions of the test.

B. The Effect of Variation in Temperature and Relative Humidity.

15. In this series of tests, groups of 7 - 9 men dressed in the protective equipment described above were subjected to "man-break" tests at CT 1200 (60 minutes) under the following conditions of temperature and relative humidity during exposure:

Group 1 - 70°F, 55% RH
 Group 2 - 70°F, 90% RH
 Group 3 - 90°F, 35% RH
 Group 4 - 90°F, 65% RH (Standard Conditions)
 Group 5 - 90°F, 90% RH

The wind velocity during the exposures was the standard 2-2.5 m.p.h. and there was no activity of the subjects other than a change of position every 5 minutes.

16. The results obtained are summarized in Table I. The detailed individual data for these tests are given in Tables VI through XI, Appendix II.

Table I

Effect of Variation in Temperature and Relative Humidity

1-1/2 layer CC-2 clothing; CT 1200 (60 minutes).

<u>Date Started</u>	<u>No. of Men</u>	<u>Temp. (°F)</u>	<u>RH %</u>	<u>No. of Exposures Tolerated</u>	
4/30/45	7	70	55	8.9+	(6/7 men "broken")
4/30/45	9	70	90	12++	(0/9 men "broken")
4/30/45	9	90	35	4.8	(9/9 men "broken")
4/30/45	8	90	65	8.1	(8/8 men "broken")
4/30/45	9	90	90	7.3+	(8/9 men "broken")

17. It may be observed from the data in Table I, that; (a) the maximum protection is afforded by CC-2 impregnated clothing under conditions of low temperature, (70°F) and high relative humidity (90%), and (b) the minimum protection is afforded under conditions of high temperature (90°F) and low relative humidity (35%). These results are in agreement with theoretical predictions since high temperature produces greater physiological activity of H vapor and high relative humidity causes greater wetting of the clothing and thus less leakage of H vapor. The results at 70°F-90% RH are worthy of special notice since in this test none of the subjects had "broken" after 12 exposures.

18. The number of exposures tolerated at the three other conditions tested are all of the same order of magnitude and do not indicate any greatly significant

differences. The fact that of the three, high temperature (90°F) and high humidity (90%) gave the least protection, whereas low temperature (70°F) and low humidity (55%) gave the most, indicates that the increased activity of H at high temperatures is of somewhat greater significance than the reduced leakage of H vapor through wet clothing.

19. The results of this test show that the prevailing standard conditions for chamber tests of protective clothing (high temperature and high relative humidity) do not represent the most adverse conditions under which use of the clothing might be necessary. It is indicated that the use of H under desert conditions (i.e., high temperature and low relative humidity) would represent a more serious threat with regard to "breaking" CC-2 impregnated clothing.

C. The Effect of Variation in Wind Velocity.

20. For the determination of the effect of variation in wind velocity on the protection afforded by CC-2 impregnated clothing, three standard "man break" tests were conducted in which the wind velocities were 1, 2, and 5 miles per hour. The exposures were made at CT 1200 (60 min.) and 90°F and 65% R.H. with no activity of the subjects except a change of position every 5 minutes.

21. The data obtained in this series of tests are presented in summarized form in Table II. Physiological data are given in Appendix III, (Tables XII through XV).

Table II

Effect of Variation in Wind Velocity

1-1/2 layer CC-2 clothing; CT 1200 (60 min.); 90°F, 65% RH.

<u>Date Started</u>	<u>No. of Men</u>	<u>Wind Velocity (m.p.h.)</u>	<u>No. of Exposures Tolerated</u>
5/30/45	5	1	9.2+ (4/5 men "broken")
5/30/45	8	2 (standard)	8.8 (8/8 men "broken")
5/30/45	7	(at 5 m.p.h.)	6.3+ (6/7 men "broken")

22. The results of this test show that an increase in wind velocity during exposure causes a decrease in the protection afforded by CC-2 impregnated clothing. The difference in average number of exposures tolerated for 1 and 2 m.p.h. velocities is not considered of great significance, but the value for 5 m.p.h. velocity is significantly lower. From these data it can be concluded that, as wind velocity is increased, leakage of H vapor through CC-2 impregnated clothing increases and the clothing thus affords less protection.

23. It is recognized that the range of wind velocities studied in this series of tests was not extensive. However, the range was limited to the conditions which could be obtained readily in the NRL chamber. It is believed that a more quantitative relationship between exposures tolerated and velocity would be obtained if studied over a wider range of wind velocity.

D. The Effect of Activity during Exposure.

24. The effect of activity during chamber exposure was evaluated in the following manner. Two groups of subjects were subjected to "man break" tests at CT 1200 (60 min.). The temperature was 90°F, the relative humidity 65% and the wind velocity 2-2.5 m.p.h. One group of men exercised during exposure by going through a series of vigorous calisthenics 5 minutes out of every 10. These calisthenics included stationary running, deep knee bends, squat thrusts, etc. The other group was inactive except for a change of position in the chamber every 5 minutes.

25. Summarized results are given in Table III. Physiological data are shown in Appendix IV, (Tables XVI through XVIII).

Table III

Effect of Activity during Exposure

1-1/2 layer CC-2 clothing; CT 1200 (60 min.); 90°F, 60% RH

<u>Date Started</u>	<u>No. of Men</u>	<u>Activity</u>	<u>No. of Exposures Tolerated</u>
3/27/45	4	None	4.3 (4/4 men "broken")
3/27/45	7	Vigorous Exercise	5.0+ (6/7 men "brcken")

26. The results shown in Table III indicate that slightly greater protection is afforded by CC-2 impregnated clothing under conditions of vigorous activity. It was observed during these tests that the clothing of the active men was much wetter from perspiration than that of the inactive men at the conclusion of each chamber exposure. Thus, it appears that the effect of increased wetness of the clothing in reducing H vapor leakage was of greater significance than any increase in leakage due to a possible "pumping" or "bellows" action produced by the exercise or an increase in the physiological activity of H vapor.

27. No evidence was obtained in this test indicating a leakage of vapor due to loosening of the drawstring fastenings of the clothing worn by the active men. Thus, with reasonable care in dressing, vigorous exercise should not be expected to present any difficulties with regard to the fit of the clothing.

SUMMARY AND CONCLUSIONS

1. Standard "man-break" tests have been conducted to determine the effect of (a) variation in temperature and relative humidity, (b) variation in wind velocity, and (c) activity during exposure, on the protection afforded by 1-1/2 layer CC-2 impregnated clothing.

2. In studying the effect of variation in temperature and relative humidity, it was demonstrated that: (a) the maximum protection is afforded by CC-2 impregnated clothing at low temperature and high relative humidity and (b) the minimum protection is afforded at high temperature and low relative humidity. These results correlate with predictions based on previous tests which showed that high temperature produces greater physiological activity of H vapor and that wet clothing (produced in this case by high humidity) does not permit as great a leakage of H vapor as dry clothing.

3. The tests on the effect of variation in wind velocity showed that an increase in wind velocity during exposure results in decreased protection afforded by CC-2 impregnated clothing.

4. It was found that slightly greater protection is provided by CC-2 clothing when worn by men engaged in vigorous activity as compared with inactive men. It is believed that this increased protection results from increased wetness of the suits from perspiration.

RECOMMENDATIONS

1. It is recommended that the effects of variations in conditions studied in this investigation be considered carefully in evaluating results obtained in chamber testing of CC-2 impregnated clothing.

2. This report completes a series of studies on the effect of exposure conditions on the protection given by CC-2 impregnated clothing. No recommendations for changes in Service use of the clothing are indicated.

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H. W. Fox - " "
M. J. Curry, CSp(X) " "
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The subjects participating in these tests were volunteer personnel from NTC, Bainbridge, Maryland.

APPENDIX I

Table IV

Physiological Readings - Legend

<u>Symbol</u>	<u>Reaction</u>
E•	Moderate Erythema
E	Intense Erythema
E+	Papular Erythema
NPV	Numerous Pin-point Vesicles
NV	Numerous Vesicles
V	Vesicle

Readings of mild and questionable erythema are not included since they are not considered significant in tests of this nature.

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Table V

Body Areas - Legend

<u>Abbreviation</u>	<u>Area</u>	<u>Abbreviation</u>	<u>Area</u>
aaf	anterior axillary folds	kn	knees
aar	anterior arms	le	legs
ab	abdomen	lth	lateral thorax
ale	anterior legs	lum	lumbar
ar	arms	paf	posterior axillary folds
ash	anterior shoulders	par	posterior arms
ath1	anterior thighs	pen	penis
ax	axillae	ple	posterior legs
bt	buttocks	pop	popliteal spaces
C ₇	7th cervical	psh	posterior shoulders
cf	cubital fossae	pthi	posterior thighs
cl	clavicles	sc	scapulae
dh	dorsum of hands	scr	scrotum
dth	dorsal thorax	uab	upper abdomen
el	elbows	ulth	upper lateral thorax
fa	forearms	umar	upper medial arms
igf	intergluteal folds	umthi	upper medial thighs
il	iliac crest	vth	ventral thorax
ing	inguinal	wr	wrist

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Appendix II

Detailed Physiological Data for Tests on
Effect of Temperature and Relative
Humidity

Table VI

Test No. 1 - Temperature 70°F; Relative Humidity 55%

Date Started: 4/30/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
11	' E ax ' E° aar,cf,athi,kn, ' ale,pop	' E cf ' E° ax,kn,psh,sc,pop
8	' E ax	' E ax ' E° kn,ale,psh,sc,dth, ' pop
5	' E ax,ulth ' E° kn	' E ax ' E° cf,pop
9	' E umthi,pop ' E° athi,kn,ale,psh, ' pthi,ple	' E umthi ' E° athi,kn,ale,pthi, ' ple,pop
11*	' E° umar,pop	' E pop
9	' E umthi,kn,pop ' E° ax,athi,ale, ' pthi,ple	' E pop ' E° ax,athi,kn,ale, ' pthi,ple
9	' E cf,ax,umthi,athi, ' kn,pop ' E° ale,pthi,ple	' E ax,athi,kn,pop ' E° aar,cf,pthi

Av. 8.9+

*In this and subsequent tables, signifies man withdrawn from test for reasons other than a "break".

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Table VII

Test No. 2 - Temperature 70°F; Relative Humidity 90%

Date Started: 4/30/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
12*	E° C ₇	No Readings, E° or greater
12*	E° cf	No readings, E° or greater
12*	E° cf, psh, sc, dth	E° cf, fa, psh, sc
12*	E° cf, kn	E° cf, kn
12*	E° cf	E° cf
12*	E° cf, fa	E° el
12*	E° kn, psh, el	E° kn, psh
12*	E° cf, kn, C ₇	E° cf, kn
12*	No readings E° or greater	E° kn

Av. 12++

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Table VIII

Test No. 3 - Temperature 90°F, Relative Humidity 35%

Date Started: 4/30/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
6	' E pop ' E° ash,umar,aar,cf, ' athi,kn,ale,paf, ' pthi	' E ash,cf,kn,ale,pop ' E° umar,athi,psh,el, ' sc,dth,pthi,ple
5	' E cl,umar,ax,ulth, ' paf,psh,sc,dth, ' pop ' E° ash,cf,aaf,lth, ' uab,athi,kn,ale, ' el,pthi,ple	' E cl,cf,aaf,ax,ulth, ' uab,paf ' E° ash,aar,lth,abd, ' athi,kn,ale,psh,el, ' sc,dth,pop
4	' E umar,ax,ulth,athi, ' kn,psh,sc,dth ' E° ash,aar,cf,lth, ' pthi,pop,ple	' E umar,aaf,ax,ulth,paf, ' psh,sc,dth,igf ' E° cl,cf,athi,kn,ale, ' pthi,pop,ple,lth
3	' E psh ' E° ash,umar,cf,lth, ' kn,sc,dth	' E paf,psh,sc,dth ' E° cl,ash,umar,aar,cf, ' ax,lth,athi,kn,ale, ' pthi,pop
4	' E ax ' E° ulth,athi,kn, ' ale,paf	' E ax,ulth ' E° kn
5	' E pop ' E° umar,cf,ax,ulth, ' kn,psh,sc,dth, ' pthi	' E umar,ulth,pop ' E° ax,lth,athi,kn,ale, ' paf,psh,sc,dth,pthi, ' ple
4	' E ax,ulth,paf ' E° cf,aaf,kn,psh, ' sc,dth	' E ax,ulth,paf ' E° cf,aaf,athi,kn,ale, ' psh,sc,dth
6	' E ax ' E° cf,psh,sc,dth, ' pop	' E ax,pop ' E° umar,cf,athi,kn,paf, ' psh,sc,dth,pthi,ple
6	' E pop ' E° ash,umar,cf,aaf, ' athi,kn,ale,psh, ' sc,dth,pthi	' E ash,kn,ale,paf,sc, ' dth,pthi,pop ' E° umar,cf,athi,psh,ple

Av. 4.8

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Table IX

Test No. 4 - Temperature 90°F; Relative Humidity 65%

Date Started: 4/30/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
6	E ash, ax, psh, sc E° umar, aaf, lth, dth, pop, cf	E cl, ash, umar, ax, ulth, psh, sc, dth E° aaf, paf, pop
12	E ash, umar, cf, athi, kn, ale, psh, par, el, C7, sc, dth, lum, pthi, pop, ple	E ash, aar, umar, vth, ueb, cf, athi, kn, ale, pthi, ple, pop, bt E° psh, sc, dth, par, el
	No readings (Sick Bay)	E aar, cf, athi, kn,) ale, paf, pop) 72 E° umar, fa, dh, wr,) psh, par, el, sc,)hours dth, pthi, ple)
10	E pop, ple E° aar, cf, athi, kn, ale, psh, sc, dth	E cf, pop E° aar, athi, kn, ale, paf, sc, dth, ple
8	E ax E° athi, kn, ale, pop	E ax, pop E° athi, kn, ale, paf, psh, C7, sc, pthi, ple
8	E pop E° umar, cf, kn, paf, psh, el, sc, pthi, ple	E pop E° umar, aar, cf, athi, kn, ale, paf, psh, el, sc, dth, pthi, ple
4	E ash, umar, aar, cf, ax, lth, vth, athi, kn, ale, paf, psh, el, sc, dth, pthi, pop, ple E° par	E ash, umar, aar, cf, ax, lth, ath, kn, ale, paf, psh, par, el, sc, dth, pthi, pop, ple
8	E pop E° athi, kn, ale, paf, psh, sc, dth, pthi, ple	E kn, pop E° umar, cf, ax, ulth, athi, ale, paf, psh, el, sc, dth, pthi, ple

av. 8.1

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Table X

Test No. 5 - Temperature 90°F; Relative Humidity 90%

Date Started: 4/30/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
6	E psh,sc E° ash,aar	'NV psh 'E ash,psh,sc,dth 'E° aar,cf,athi,kn,ale, par,el,pthi,pop,ple
10	E cf E° aar,kn,el	'E aar,cf 'E° kn,paf,psh,el,sc,dth
10	E pop E° ash,cf,athi,kn, psh,sc,dth, pthi	'E kn,pop 'E° cf,athi,ale,paf,psh, el,sc,dth,pthi
10*	E° cf,kn	'E° cf,kn,psh,sc,dth,pop
7	E psh,sc,dth,pop E° athi,kn,ale, pthi,ple	'E athi,kn,ale,paf,psh,sc, dth,pop 'E° ash,pthi,ple
6	E athi E° kn	'E athi,kn 'E° ale,el,pthi,pop,ple
5	V psh E° ash,kn,psh, sc,dth	'V psh 'E° athi,kn,psh,sc,dth
6	NPV ash E ash,vth E° athi,kn,psh, sc,dth,pthi, pop,ple	'NV aar 'NPV psh 'E cf,vth,psh 'E° athi,kn,ale,sc,pthi, pop
6	NPV sc	'NPV sc 'E° sc,pthi,pop

Av. 7.3+

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Table XI

Effect of Temperature and Relative Humidity

Date Started	No. of Men	Temp. ("F)	RH (%)	No. of Men Broken on Day No.												No. of Breaks Tolerated.	Av. Exp. Tolerated.
				1	2	3	4	5	6	7	8	9	10	11	12		
4/30/45	7	70	55				1		1	3		1,1*				6	8.9 +
4/30/45	9	70	90										9*			None	12. + +
4/30/45	9	90	35			1	3	2	3							9	4.8
4/30/45	8	90	65			1	1	1	3	1	1		1			8	8.1
4/30/45	9	90	90				1	4	1			2,1*				8	7.3 +

* Not "Broken"

Appendix III

Detailed Physiological Data for Tests on
Effect of Variation in Wind Velocity

Table XII

Test No. 6 - Wind Velocity 1 m. p. h.

Date Started: 5/30/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
9	E pop E° athi, kn, ale, pthi, ple	E pop E° cf, athi, kn, ale, pthi, ple
11*	E° kn, psh	No Readings E° or Greater
11	NPV aar E psh, pop, sc E° ash, cf, athi, kn, ale, par, el, dth, pthi, ple	NPV aar E° ash, cf, athi, kn, ale, psh, par, el, sc, pop
6	E sc, dth E° kn, paf, psh	E umthi, ale, psh, sc, dth, pop E° ash, cf, aaf, kn, paf, el, pthi, ple
9	E kn, pop E° aar, athi, ale, pthi	E kn, pop E° aar, athi, ale, pthi, ple

Av. 9.2+

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Table XIII

Test No. 7 - Wind Velocity 2 m.p.h.

Date Started: 5/30/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
10	E aaf,ax,paf,sc E° cf,psh,dth, pthi,pop,ple	E paf,sc E° cf,aaf,ax,psh,el. dth,pthi,pop
10	E kn,el,pop E° athi,ale,psh, sc,dth,pthi, ple	E kn,el,pop E° athi,ale,pthi,ple
8	E cf,pop E° kn	E cf,pop E° kn,el
8	E pop E° umar,ax,kn,ale	E umar,ax,athi,kn, ale,pop E° aar,cf,paf,psh, par,el,sc,pthi, ple
8	E cf,kn,pop E° ale,psh,el, C ₇ ,sc,dth	E cf,kn,pop E° aar,ale,psh,el. sc,dth,ple
9	E cf,kn,pop E° ash,vth,athi, ale,el	E cf,kn,pop E° umar,athi,ale,el
10	E kn E° umar,aar,cf, athi,el,pthi, pop,ple	E° umar,aar,kn,paf, psh,el,sc,dth, pthi,pop
7	E pop E° cf,kn	E cf,pop E° kn,psh,el,sc

Av. 8.8

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Table XIV

Test No. 8 - Wind Velocity - 5 m.p.h.

Date Started: 5/30/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
6	E cl, ash, umar, aaf, lth, paf, psh, sc, dth E° cf, ax, athi, kn, ale, el, pthi, pop	E ash, aaf, lth, kn, paf, psh, sc, dth E° aar, cf, ax, athi, ale, el, pop
8*	E° kn, paf, el, pop	E pop E° athi, kn, ale, paf, pthi, ple
4	E kn E° aar, cf, dh, wr, lth, athi, ale, paf, psh, sc, dth, pthi, pop, ple	E cl, vth, kn, pop E° umar, cf, aaf, lth, athi, paf, psh, el, sc, dth, pthi, ple
6	E kn, pop E° ale, el	E kn, pop E° umar, ale, ple
5	E psh, sc E° umar, cf, ax, lth, kn, par, el, dth, ash, cl	E psh, sc, dth, pop E° cl, ash, umar, cf, ax, lth, athi, kn, ale, paf, par, el, C ₇
7	E umthi, kn, psh, sc, pop E° ash, cf, ax, athi, ale, paf, el, dth	E ash, umthi, kn, ale, psh, sc, pop E° aar, cf, paf, dth, pthi, ple
8	E ax, kn, pop E° umar, psh, el, sc, dth	E ax, kn, pop E° cf, athi, ale, psh, sc, dth, pthi, ple

Av. 6.3+

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Table XV
Effect of Variation in Wind Velocity

Date Started	No. of Men	Wind Velocity (m.p.h.)	No. of Men Broken on Day No. -----											No. of Breaks	Av. Exp. Tolerated
			1	2	3	4	5	6	7	8	9	10	11		
5/30/45	5	1					1		2				1,1*	4	9.2 +
5/30/45	8	2					1	3	1	3				8	8.8
5/30/45	7	5				1	1	2	1	1,1*				6	6.3 +

* Not "Broken"

Appendix IV

Detailed Physiological Data for Tests on
Effect of Activity during Chamber
Exposure

Table XVI

Test No. 9 - Activity during Exposure

Date Started: 3/27/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
6	' E athi, kn, ale, psh, ' sc, dth, pthi, pop ' E° umar, aaf, lth, ' ple	' E+ athi, kn, ale ' E° cl, cf, lth, psh, sc, ' dth, pthi, pop, ple ' E° ash, aar, ax, vth, ' paf
8	' E athi, kn, psh, sc, ' dth ' E° pthi, pop, ple	' E paf, psh, sc ' E° athi, kn, ale, dth, ' pthi, pop, ple
4	' E athi, kn, ale, pop ' E° cf, psh, dth, pthi, ' ple	' E pop ' E° athi, kn, ale, pthi, ple
3	' E psh, sc, dth ' E° ash, umar, aaf, ' cf, ax, lth, vth, ' uab, par, el	' E ash, umar, paf, psh, sc, ' dt ' E° aar, cf, ax, par, el
5	' E ax ' E° cf, aaf, psh, sc, ' dth, pthi, pop	' E cf, ax, athi, kn, ale, ' paf, psh, sc, dth ' E° lth, pop
4	' E ax, psh, sc, dth ' E° ash, aar, cf, lth, ' vth, athi, kn, ale, ' paf	' E ash, umar, cf, aaf, ax, ' lth, paf, psh, sc, dth ' E° vth, athi, kn, ale, par, ' el
5*	' E° psh, sc, dth, ' pthi, pop, ple	' E psh, sc, dth, pthi, pop, ' ple ' E° ash, aaf, athi, kn, ale

Av. 5.0+

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Table XVII

Test No. 10 - No Activity during Exposure

Date Started: 3/27/45

No. of Exposures Tolerated	Readings (Hours after Last Exposure)	
	24	48
4	' E+ athi ' E ash,cf,aaf,ax, ' lth,kn,paf,psh, ' sc,dth,pthi, ' pop,ple ' E° ale,par	' E ash,aaf,ax,lth,vth,athi, ' kn,psh,paf,sc,dth ' E° aar,cf,ale,par,el, ' pthi,pop,ple
5	' E umar,paf ' E° ash,aaf,ax, ' athi,kn,psh, ' sc,dth,pthi, ' pop,ple	' E umar,ax,paf,psh,sc,dth ' E° ash,athi,kn,ale,pthi, ' pop,ple
4	' E umar,psh,sc,dth ' E° ash,aar,cf,aaf, ' ax,lth,athi,kn, ' ale,pthi,pop, ' ple	' E umar,paf,psh,pop ' E° ulth,athi,kn,ale,sc, ' dth,lum,pthi,ple
4	' E cl,ash,psh,sc, ' dth ' E° umar,aar,cf, ' lth,athi,kn, ' ale,pthi,pop, ' ple	' E ash,paf,psh,sc,dth ' E° cf,umar,lth,athi,kn, ' ale,ax

Av. 4.3

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Table XVIII

Effect of Activity during Chamber Exposure

Date Started	No. of Men	Activity	No. of Men Broken on Day No.---								Av. Exposures Tolcrated
			1	2	3	4	5	6	7	8	
3/27/45	7	Vigorous Exercise	1	2	1	1	*	1	1	6	5.0
3/27/45	4	None				3	1			4	4.3

*Not "Broken"

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