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ARMY MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

REPORT NO. 2

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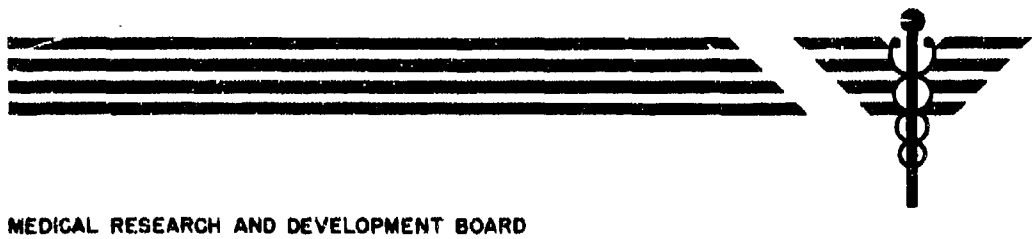
EFFICIENCY OF SIGNAL CORPS OPERATORS IN EXTREME COLD[1]

[1]Sub-project under Studies of Physiological and Psychological Problems of Military Personnel in Relation to Equipment, Environment and Military Tasks (AMRL-57) approved by CG, ASF, 31 May 1946.



MEDICAL RESEARCH AND DEVELOPMENT BOARD
OFFICE OF THE SURGEON GENERAL
DEPARTMENT OF THE ARMY

REPORT NO. 2

EFFICIENCY OF SIGNAL CORPS OPERATORS IN EXTREME COLD[1]

by

Dr. E. A. Blair, Chief Physiologist, and Carl W. Gottschalk,
1st Lt., MC

from

Armored Medical Research Laboratory
Fort Knox, Kentucky, January 22, 1947

[1]Sub-project under Studies of Physiological and Psychological Problems of Military Personnel in Relation to Equipment, Environment and Military Tasks (AMRL-57) approved by Commanding General, ASF, 31 May 1946.

Project No. 57-2 22 January 1947
MEDEA

ABSTRACT

EFFICIENCY OF SIGNAL CORPS OPERATORS IN EXTREME COLD

OBJECT:

At the request of the Signal Corps, experiments were designed to test the effect of wearing issue arctic clothing and of exposure to extreme cold while wearing arctic clothing on the efficiency of Signal Corps men operating representative Signal Corps equipment.

PROCEDURE:

Four Signal Corps operators were detailed to the AMRL and their performance tested on the following equipment:

Radar Trainer BC-968-A - Error in tracking integrated over a three-minute period.

Radio SCR-694-C-Time required to change frequency and resume voice transmission.

Switchboard BD-72 - Time required for the manual operations in completing a call through the switchboard.

After a three week period of training, a routine was established in which each subject operated each of the three sets of equipment for fifteen-minute periods during each hour of testing. During the mornings normal values were obtained at 23°C with fatigue uniform and then with the same conditions except that a mitten assembly was worn. In the afternoons the subjects wore complete arctic clothing including the mitten assembly and worked for three hours at ambient temperatures that were lowered from -25°C to -41°C on successive days.

RESULTS AND CONCLUSIONS:

(1) Radar Trainer BC-968-A and switchboard BD-72, without modification can be operated while wearing mittens, arctic, with two woolinserts and, overwhites, outside. It is necessary to first remove the protective grill of Radio SCR-694-C before it can be operated with mittens.

(2) The radar trainer can be operated as efficiently with mittens as barehanded. Radio and switchboard operators are less efficient when wearing mittens although considerable improvement was gained by training with mittens at comfortable temperatures.

(3) Efficiency with each instrument is still lower when arctic clothing is worn and men are exposed to low temperatures in the cold room. The immediate loss of efficiency is at least partly due to the cumbersome arctic clothing, but there are probably other unidentified factors.

(4) Efficiency with the radio and switchboard showed only negligible change during any three-hour exposure period. When, on successive days, ambient temperature was lowered from -25°C to -41°C no associated change in efficiency could be demonstrated.

(5) Efficiency with the radar trainer was generally lowest during the second hour of exposure. Performance on different days was poorer with lower ambient temperature. Part of the effect of cold on efficiency is related to the discomfort produced, even through mittens, by contact with the cold metal control handle.

(6) With ambient temperatures of -40°C and a wind velocity of 3-5 mph, men protected by arctic clothing as now issued and allowed to exercise become uncomfortably cold after one and one-half hours and after two and one-half hours may have dangerously cold hands and feet. Usually, by taking as much exercise as their duties would permit, they were able to withstand an exposure of three hours without injury.

(7) Arctic clothing as now designed affords least adequate protection for hands and feet of Signal Corps men while operating their equipment at extremely cold ambient temperatures.

RECOMMENDATIONS:

(1) That Signal Corps operators be taught to work wearing mittens whenever practicable.

(2) That Signal Corps equipment be winterized so as to permit:

(a) Operation while wearing mittens (e.g., the protective grill of radio SCR-694-C should be removed or modified).

(b) Considerable freedom of the operators so that they can exercise during operations (e.g., lengthen head-phone extension cords for radio and switchboards).

(3) That consideration be given to the modification of metal control handles in order to reduce operator discomfort during continuous cold-weather operations.

(4) That the problem of more adequate protection of the hands and feet from extreme cold be actively investigated.

Submitted by:
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(REPRINTED)

EFFICIENCY OF SIGNAL CORPS OPERATORS IN EXTREME COLD

I. OBJECT: The objects of these experiments were to test (1) the effect of arctic clothing and (2) the effect of extreme cold while wearing arctic clothing, on the efficiency of representative Signal Corps men while operating representative Signal Corps equipment.

II. EXPERIMENTAL:

A. Materials and Equipment.

(1) Signal Corps Equipment. The following equipment was selected, winterized and sent to the AMRL by the Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey, as representative types of Signal Corps equipment.

(a) Radar Trainer BC-968-A. An instrument designed to train future radar operators. As in actual radar tracking, the operator observes two pulses on the screen of an oscilloscope. Course cams supplied with the machine maneuver the pulses in a pattern similar to radar tracking under service conditions. Difference in height of pulses indicates an off-target position and this can be corrected by properly rotating a hand wheel attached to the trainer. Off-target deviations are recorded in the form of an ink line on a strip chart in which deviation of the recorded line from the center of the chart is proportional to the degree to which the operator is off-course. (Figure 4.) A counter serves as an integrator and records a numerical score which corresponds to the total tracking error. The machine is adjusted so that each tracking run lasts three minutes. The most difficult course cam, number 6, was used. The machine was set for azimuth operations only and attachments for interference, noise and fading were not used. The trainer was calibrated at the beginning and end of each morning and afternoon experiment. For details, see Appendix I, paragraph A.

(b) Radio Set SCR-694-C, a portable receiver-transmitter. Microphone T-17 was used. Electrical power was furnished by Vibrator Power Supply PE-237 connected to a 12 volt storage battery kept outside of the cold room. An electrical time clock was used to measure

the time required for the operator to change to a new frequency and notify the observer by voice transmission on that new frequency that he had completed the prescribed operations including manipulating dials and switches sixteen times and zero beating three times. In order to operate the radio while wearing mittens it was found necessary to first remove the protective grill. For details of radio operations, see Appendix I, paragraph B.

(c) Switchboard BD-72, a lightweight, twelve-line, field telephone switchboard. Telephone EE-8-A was used. By means of a selector switch and either of two telephones, the observer could signal any of the twelve lines of the operator's switchboard. Lines from the two halves of the switchboard were paired at random by means of six colors. The operator was required to complete the call through his switchboard by connecting the signaled line with the other line designated by the same color. This method of signaling the operator was devised in order to leave out the undesirable complication of voice instruction, as "Dexter, three". The interval required for the manual operations entailed in completing the call through the switchboard was timed by an electric time clock in a thyratron activated relay circuit (see Appendix I, paragraph C).

(2) Special Equipment.

(a) Standard Electric Time Clock, Model S1, manufactured by Standard Electric Time Company, Springfield, Massachusetts. Accurate to within 0.01 seconds.

(b) Thyratron activated relay circuit for time clock control. See Appendix I, paragraph C, for wiring diagram.

(c) Potentiometer, galvanometer and constantan-copper thermocouples.

(d) Cold room, 12,000 cubic feet capacity, cooled by a two-stage ammonia compressor.

(3) Clothing

Three different combinations of issue clothing were worn.

(1) Herringbone-twill fatigue clothing.

(2) Fatigues plus a mitten assembly consisting of mittens, arctic, with insert, mittens, wool insert, trigger finger, and mittens, overwhite. Nylon inserts were not worn.

(3) Full arctic clothing including the mitten assembly.

See Appendix II, for detailed list of arctic clothing.

Clothing outfits 1 and 2 were worn while obtaining controls at comfortable laboratory temperatures and outfit 3 was worn during all cold room work.

B. SUBJECTS:

Four healthy young men, all 19 years of age, were selected by the Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey, as representative Signal Corps operators and were detailed for one month to the AMRL to be used as test subjects. Their individual Signal Corps training is enumerated in Appendix III. AMRL personnel served as recorders.

C. PROCEDURE:

The subjects gained proficiency in the operation of the equipment during the first three weeks. During the fourth week the data presented in Table I was obtained. During this last week a routine was established in which each subject operated each of the three sets of equipment during each hour of testing. This procedure enabled each man to complete each hour about thirty calls through the switchboard, to change frequency on the radio ten to fifteen times and to make three or four tracking runs with the radar trainer.

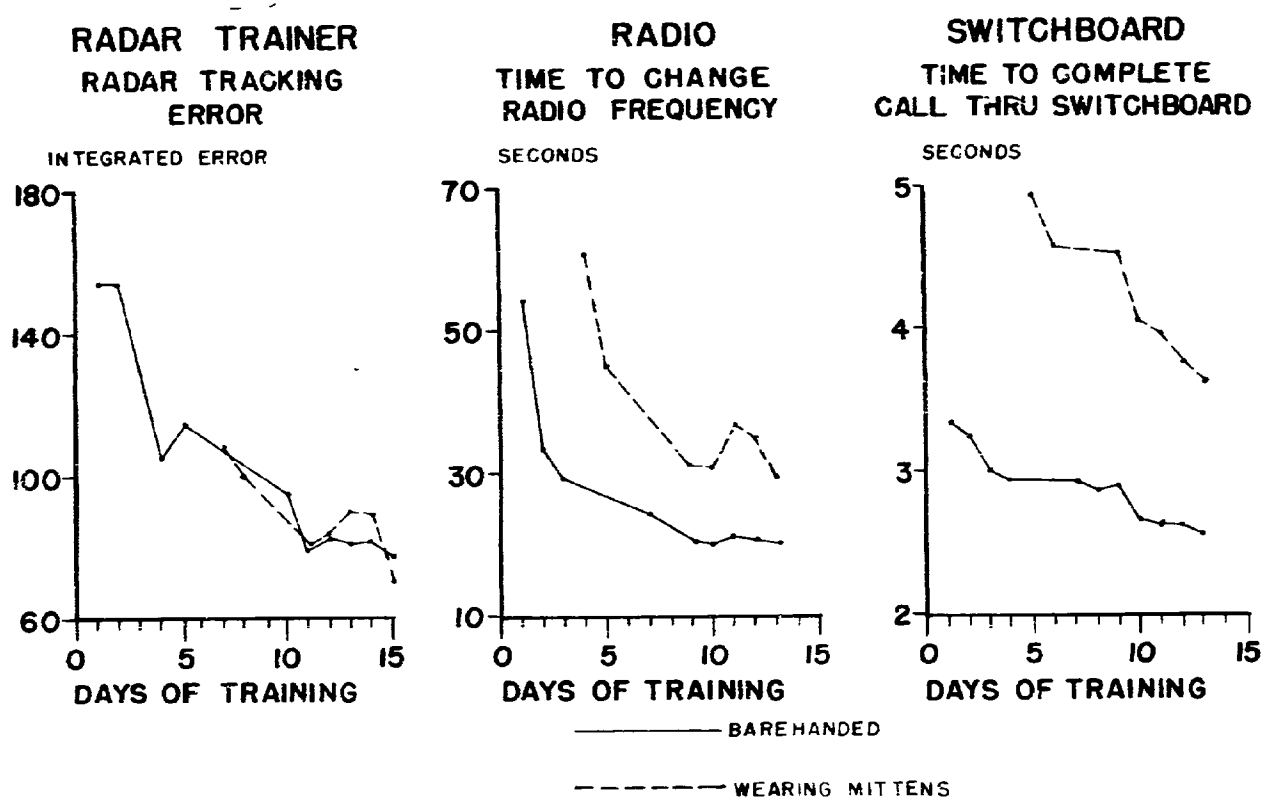
Each day included five hours of testing. The first two hours the men wore fatigues and during one of the hours operated the equipment barehanded and during the other hour operated the equipment while wearing the mitten assembly. The data obtained during these two hours, at the laboratory temperature of 23°C, were used as controls.

FIGURE 1

AVERAGE LEARNING CURVES

FOUR SUBJECTS

FATIGUE UNIFORM, AMBIENT TEMPERATURE 23°C



The third, fourth and fifth hours, in the afternoon, were spent in the cold room. The subjects wore complete arctic clothing including the mitten assembly (See Appendix II). Cold room temperature was lowered on successive days from -25°C to -41°C with a mean deviation of no more than ± 2°C on any day. Wind velocity ranged between 3-5 miles/hour.

As a safeguard against the possibility of frost bite during cold room work, skin temperatures of the right thumb and left great toe of some of the subjects were checked by means of thermocouples.

D. RESULTS:

Although the four test subjects had attended various Signal Corps schools, it was soon apparent that additional practice would greatly improve their performance. This is illustrated for radar trainer BC-968-A in Figure 1. As shown, improvement at first was rapid, but after the tenth day showed little change. It will be noted that the mitten assembly produced no change in performance even when first worn.

Figure 1 also illustrates the improvement in radio operation that came with continued practice, and here too, there was but little improvement after the tenth day. When mittens were first worn they constituted a marked handicap which was quickly reduced by further practice with mittens at laboratory temperatures.

Switchboard performance showed less improvement with practice (Figure 1) than did radar trainer and radio operation. Mittens, however, resulted in a considerable increase in time required to complete each call. Performance while wearing mittens continually improved with practice.

In Table 1 are tabulated the average scores made on each machine during the last five days of the experiment. These scores show that at comfortable laboratory temperatures the integrated error on the radar trainer was the same whether the operator worked barehanded or with mittens. Whenever the trainer was operated in the cold room the error was always significantly greater.

On the radio, mittens increased by one-half the time required for a frequency change. An additional increase occurred when the subjects entered the cold room and this value remained constant throughout the exposure period.

TABLE 1

TEST SCORES
SIGNAL CORPS EQUIPMENT

CONTROLS TEMPERATURE 23°C FATIGUE UNIFORM			COLD ROOM EXPOSURE TEMPERATURE -25° TO -41°C FULL ARCTIC CLOTHING		
SUBJ	HANDS BARE	MITTEN ASSEMBLY	FIRST HOUR	SECOND HOUR	THIRD HOUR
	RADAR TRAINER -- INTEGRATED ERROR				
JJR	63	63	90	101	99
BAC	97	102	123	173	145
RAS	77	77	114	124	122
LJL	95	94	140	165	131
Avg	83	84	117	141	124
	RADIO SECONDS TO CHANGE FREQUENCY				
JJR	25	38	50	56	45
BAC	23	35	50	52	43
RAS	21	30	37	41	38
LJL	17	28	32	34	37
Avg	22	33	42	46	41
	SWITCHBOARD SECONDS TO COMPLETE CALL				
JJR	2.99	4.07	5.15	4.89	5.25
BAC	2.53	3.44	4.22	4.50	4.45
RAS	2.81	4.02	4.85	4.89	4.76
LJL	2.65	4.58	5.47	5.62	5.85
Avg	2.75	4.03	4.92	4.98	5.08

A table of the average scores made on Signal Corps equipment by each of the four subjects during the final five days of the experiment. Controls were run in the mornings and cold room scores were made during a three-hour exposure each afternoon.

Switchboard operation time was also significantly increased by mittens and further increased by cold room exposure. As with the radio, switchboard scores varied negligibly throughout the three hours of cold room exposure.

No constant change in radio and switchboard scores occurred when the ambient temperature was lowered on successive days. (Figure 3). The integrated error on the radar trainer, however, was generally higher at lower ambient temperature. This trend was apparent even during the first hour of cold room exposure.

Subjective reactions of the operators during their daily three-hour cold room exposure periods were rather constant from day to day. The first hour of exposure the subjects were comfortable but from the early part of the second hour complained of cold hands and feet and throughout the third hour these parts were uncomfortably cold. Thumb and toe skin temperatures as low as 1°, 1.5° and 3°C were registered. On two occasions, subjects' hands and feet became so painfully cold that they were ordered out of the cold room at the end of two and one-half hours. Shivering was never observed. After the first hour, operation of the radar trainer always chilled the operator's thumb that was grasping the metal handle of the control wheel and at times this thumb became so painfully cold and stiff that it prevented effective operation of the trainer. The subjects discovered that muscular activity helped them stay warm and throughout the last hour and one-half of cold room exposure voluntarily exercised whenever their duties would permit.

III. DISCUSSION:

From the above scores it is apparent that mittens interfered with operation of Signal Corps equipment (except the radar trainer) and that full arctic clothing interfered even more. In order to best compare the effect of mittens, arctic clothing and cold room exposure on the operation of the three different pieces of equipment, it was found convenient to first convert the absolute scores into "Per Cent Efficiency of Normal Performance". This was done according to the following formula:

$$\text{Average Efficiency Per Cent of Normal} = \frac{\text{Average score standard conditions}}{\text{Average score wearing mittens, etc.}} \times 100$$

Thus, the subjects, when wearing fatigues and mittens at comfortable laboratory temperatures, operated the radar trainer at 100% efficiency, the radio at 65% efficiency and the switchboard at 69% efficiency. These are average efficiencies for the last five days of the experiment only, as the radio and switchboard efficiencies were much less when mittens were first

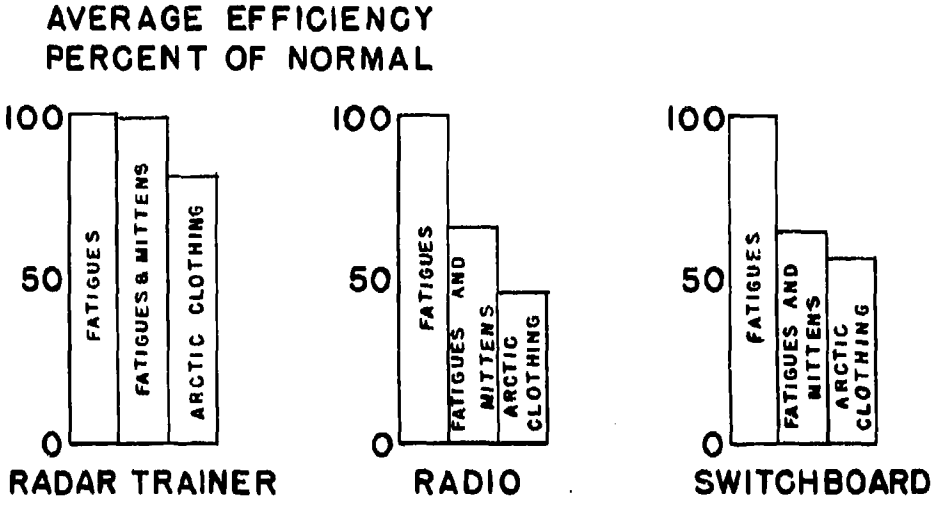
worn. (See Figure 2 for a representative day). Training with mittens on these two latter machines at comfortable laboratory temperatures produced marked improvement in performance in a few days and improvement with the switchboard was continuing even at the end of the experiment. At no point did wearing mittens reduce efficiency of radar trainer operations. (Figure 1). Training schedules for such equipment as the radio and switchboard should include periods of operation at mild temperatures while wearing mittens.

As the operators had no subjective feelings of coldness during the first hour of their cold room exposure, the decrease in efficiency this hour is believed to principally reflect the cumbersomeness of arctic clothing. (See Figure 2). During the second and third hours the operators always complained of cold hands and feet, complaints substantiated by skin temperature measurement, and results for these two hours include any effect of cold in addition to the necessity for wearing bulky clothing.

During the first hour of cold room exposure, the radio was operated at an average of 51% efficiency and the switchboard at an average of 57% efficiency. Efficiency with these two machines did not vary significantly during the second and third hour of any exposure period nor with the lowering of ambient temperatures on successive days. (See Figure 3). The reason that cold extremities did not lower efficiency is thought to be that the mittens were so cumbersome that they completely masked tactile sensation and prevented fine finger motions, permitting only grasping between the thumb and fingers. Thus little change in performance occurred when fingers became cold and stiff, as most of the required motions were made from the wrist, elbow and shoulder joints and tactile sensation had already been masked. Extreme chilling of the hands, as occasionally happened when operating the radar trainer, prevented effectual grasping of objects.

Radar trainer performance differed from that with the radio and switchboard, as efficiency the first hour of cold room exposure on successive days decreased from 81% to 60% with a drop in ambient temperature from -25° to -41°C. On any particular day efficiency was usually lowest the second hour. (See Figure 3). Although other factors were probably involved, such as the increase from one to two pounds in maximum handwheel tension and a slowing of response by the commutator variable contact which was not reflected in calibration values, part of this decrease in efficiency was due to the marked chilling of the operator's thumb by the metal control wheel handle. Thumb chilling was most painful the second hour of exposure and at times resulted in the operator temporarily losing control of the hand wheel. (See Figure 4). It was generally during the second hour that radar trainer efficiency was lowest.

FIGURE 2
EFFFCT OF MITTENS AND ARCTIC CLOTHING ON EFFICIENCY OF OPERATION OF SIGNAL CORPS EQUIPMENT

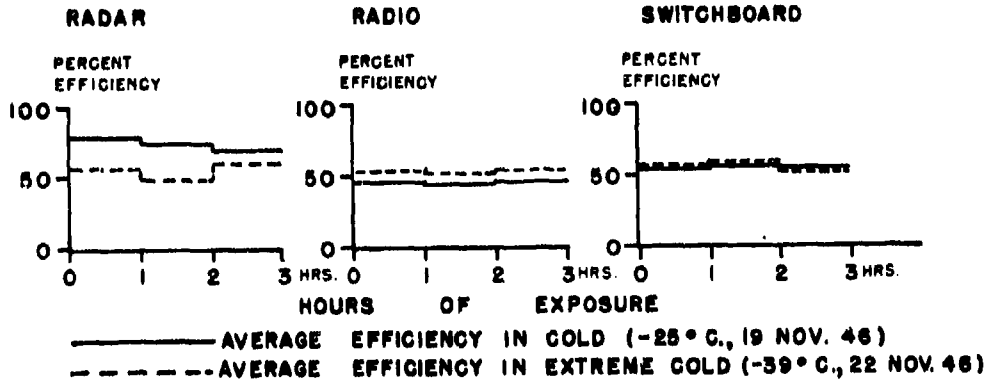


Average efficiency, per cent of normal, of the four subjects on a representative day while working in fatigues at 23°C with and without mittens and for the first hour of work at -15°C while wearing full arctic clothing (no subjective feelings of coldness).

Electrical heating or an insulating covering of any metal control handle requiring prolonged contact at cold temperatures seems desirable in order to maintain the operator's hands at a safe temperature.

FIGURE 3

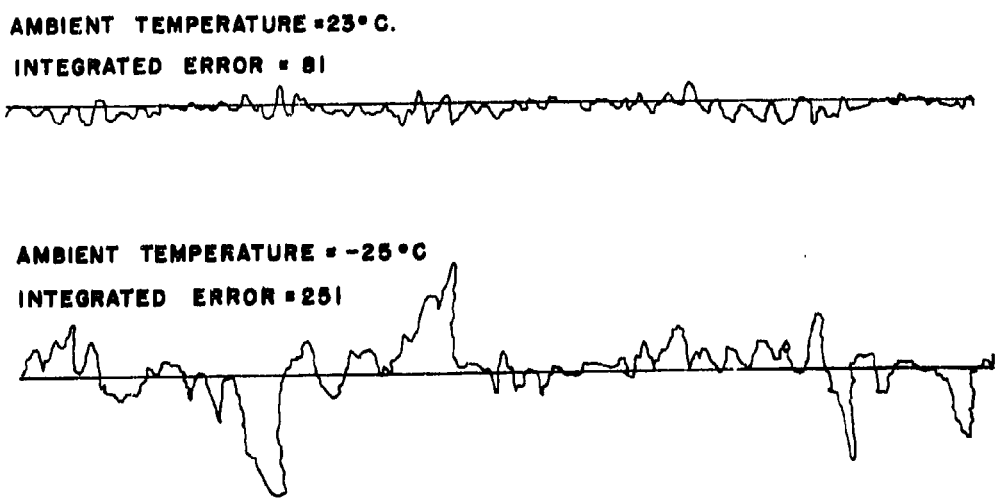
EFFECT OF AMBIENT TEMPERATURE ON EFFICIENCY



Average efficiency of four subjects on two representative days illustrating that radio and switchboard performances were identical in cold and very cold environments, while radar trainer efficiency was lower at lower ambient temperatures. As on these two days, radio and switchboard performance varied negligibly throughout the three hours of any exposure period. Radar trainer efficiency was usually lowest the second hour.

FIGURE 4

EFFECT OF THUMB CHILLING ON RADAR TRAINER OPERATION



A reproduction of the strip charts from two tracking runs by subject LJL on 19 November 1946. (Deviation from center is proportional to the tracking error). The top graph is from a control run with the subject dressed in fatigues and working at an ambient temperature of 23°C. Integrated error = 81. The bottom graph represents the subject's third tracking run during the second hour of exposure to an ambient temperature of -25°C. Integrated error = 251. Previous contact with the cold metal control wheel had left the operator's thumb so stiff that he could no longer effectually grasp the control wheel and a large tracking error resulted.

IV. CONCLUSIONS:

(1) Radar Trainer BC-968-A and switchboard BD-72 without modification, can be operated while wearing mittens, arctic with two wool inserts and, overwhites, outside. It is necessary to first remove the protective grill of Radio SCR-694-C before it can be operated with mittens.

(2) The radar trainer can be operated as efficiently with mittens as bare handed. Radio and switchboard operators are less efficient when wearing mittens although considerable improvement was gained by training with mittens at comfortable temperatures.

(3) Efficiency is still lower when arctic clothing is worn and men are exposed to low temperatures in the cold room. The immediate loss of efficiency is at least partly due to the cumbersome arctic clothing, but there are probably other unidentified factors.

(4) Efficiency with the radio and switchboard showed only negligible change during any three-hour exposure period. When, on successive days, ambient temperature was lowered from -25°C to -41°C no associated change in efficiency could be demonstrated.

(5) Efficiency with the radar trainer was generally lowest during the second hour of exposure. Performance on different days was poorer with lower ambient temperature. Part of the effect of cold on efficiency is related to the discomfort produced, even through mittens, by contact with the cold metal control handle.

(6) With ambient temperatures of -40°C and a wind velocity of 3-5 mph, men protected by arctic clothing as now issued and allowed to exercise become uncomfortably cold after one and one-half hours and after two and one-half hours may have dangerously cold hands and feet. Usually, by taking as much exercise as their duties would permit, they were able to withstand an exposure of three hours without injury.

(7) Arctic clothing as now designed afford least adequate protection for hands and feet of Signal Corps men while operating their equipment at extremely cold temperatures.

V. RECOMMENDATIONS:

(1) That Signal Corps operators be taught to work wearing mittens whenever practicable.

(2) That Signal Corps equipment be winterized so as to permit:

(a) Operation while wearing mittens (e.g., the protective grill of radio SCR-694-C should be removed or modified).

(b) Considerable freedom of the operators so that they can exercise during operations (e.g., lengthen headphone extension cords for radio and switchboards).

(3) That consideration be given to the modification of metal control handles in order to reduce operator discomfort during continuous cold-weather operations.

(4) That the problem of more adequate protection of the hands and feet from extreme cold be actively investigated.

APPENDIX I

A. Calibration of Trainer BC-968-A.

At the beginning and end of each morning and afternoon series, the radar trainer was calibrated by removing the course cam and fixing the cam follower to the frame with a cap screw, so that movement of the commutator variable contact was controlled entirely by the hand wheel. The "zero position" of the hand wheel was then determined. The "zero position" was that position of the control wheel at which no error was registered during the course of a three-minute run, indicating that the variable contact was in exactly the midline of the commutator cylinder. At this point the pulses on the cathode ray screen were balanced. The variable contact was then moved by one revolution of the handwheel to the right and then to the left of the commutator midline and the score of a three-minute run in each position was recorded. The "zero position" and one-revolution deviations were always approached from a clockwise direction in order to keep inaccuracies due to play at a minimum.

Although the "zero position" of the hand wheel varied considerably at each calibration (due to a sector gear in the hand drive unit), the sum of the integrated error produced by the two one-revolution deflections was remarkedly constant and averaged 1596 with an average deviation of only ± 19.

B. Radio Frequency Change Protocol.

In order for a series of frequency change times to contain comparable scores, each frequency change was one of 200 KC. By an appropriate motion of his hand the observer signaled to the operator whether the change would be an increase or decrease of 200 KC from the previous setting. The subject then performed the following operations on his receiver-transmitter (all switches and dials were returned to their original position following each frequency change except the frequency control):

Receiver:

PHONE-CW-NET-CAL Switch, PHONE to CAL
SENSITIVITY Switch, LOW to HIGH
Volume Control, LOW to HIGH
Tune 200 KC up or down as directed and
Zero Beat receiver to calibration
PHONE-CW-NET-CAL Switch, CAL to NET

Transmitter:

SEND-STANDBY-OFF Switch, STANDBY TO SEND
Turn CRYSTAL Switch from Crystal A to MO
POWER Switch, LOW to HIGH
Frequency Control Switch to new calibration
Zero Beat by Tuning transmitter to receiver by ear
Adjust Indicator to maximum glow by aligning the two dots
CW-MCW-PHONE Switch, MCW to CW
Depress Microphone Button and
Adjust Antenna Tuning knob to maximum light
Readjust Frequency Tuning Control to Zero Beat by ear
CW-MCW-PHONE Switch, CW to PHONE

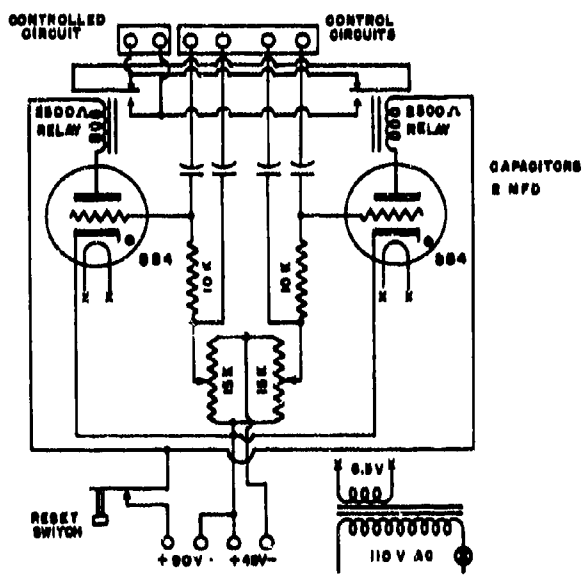
Receiver:

PHONE-CW-NET-CAL Switch,
NET to PHONE

Transmitter:

Depress Microphone
Switch and send
"Stop Clock"

C. Wiring diagram for Thyratron Relay Circuit



APPENDIX II

The following is a list of the arctic clothing worn during all work in the cold room. All items are standard Army Issue.

1. Undershirt, wool O.D. (turtle neck)
2. Drawers, wool, O.D., long
3. Shirt, flannel, O.D., coat style
4. Trousers, field, wool, serge 18 oz. special
5. Sweater, high neck
6. Muffler, wool, O.D.
7. Trousers, field, cotton, O.D. (ankle closure)
8. Parka, field, pile, O.D.
9. Parka, field, cotton, O.D., (fits legs)
10. Parka, field, overwhite
11. Trousers, field, overwhite
12. Mask, face, cold weather
13. Socks, cushion sole, 1 pair
14. Socks, Ski, white, 2 pairs
15. Socks, felt, 1 pair
16. Boots, mukluk, with 2 pair felt or jute insoles
17. Mittens, arctic, with insert
18. Mittens, wool insert, trigger finger
19. Mittens, overwhite

APPENDIX III

Qualification of Subjects

A. BAC, Pfc. - RA 38775697. Age 19 years. Height, 5 ft. 9 in., weight, 155 lbs., healthy.

Signal Corps Training: Central Signal Corps School, Camp Crowder, Mo., for three weeks. Eastern Signal Corps School, Fort Monmouth, New Jersey, for six months course in telephone and telegraph installation and repair. Signal Corps Engineering Laboratories, Development Detachment, Fort Monmouth, New Jersey, one month.

B. JJR, Pvt., - RA 12234441. Age 19 years. Height, 6 ft. 1/2 in., weight, 163 lbs., healthy.

Signal Corps Training: Central Signal Corps School, Camp Crowder, Mo., for 3 weeks. Eastern Signal Corps School, Fort Monmouth, New Jersey, qualifying as Central Office Technician with MOS 095. Signal Corps Engineering Laboratories, Development Detachment, Fort Monmouth, New Jersey, one month.

C. RAS, Cpl., - 44126243. Age 19 years. Height, 5 ft. 7 in., weight, 130 lbs., healthy.

Signal Corps Training: Central Signal Corps School, Camp Crowder, Mo., for four months. Eastern Signal Corps School, Fort Monmouth, New Jersey, for a four and one-half months course in telephone cable splicing. Signal Corps Engineering Laboratories, Development Detachment, Fort Monmouth, New Jersey, one month.

D. LJL, Pvt., - 43044154. Age, 19 years. Height 6 ft. 1 in., weight, 160 lbs., one eye astigmatic.

Signal Corps Training: Eight months in Radio Operators School and two months at Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey.