12 APR 1963

AMXND-NT

SUBJECT: Beta Hazard Experiment Using Volunteer Military Personnel

TO: The Surgeon General
Department of the Army
Attn: MEDDH-NE
Washington 25, D. C.

1. Reference: AR 70-25, Use of Volunteer as Subjects of Research, dated 26 March 1962.

2. Approval is requested for subject tests to be conducted at the U. S. Army Nuclear Defense Laboratory's Field Facility, Camp McCoy, Wisconsin, beginning 22 April 1963, in accordance with paragraph 6 of above reference.

3. The proposed experiment, described in detail in Inclosure 1, "Military Significance of Beta Hazard under Radioactivity Contaminated Field Clothing", will involve 12 volunteer military enlisted personnel who will be subjected to whole body radiation dose not to exceed 3 rem during a test period of 5 days. The project officer in charge will be Mr. John L. Meredith of this Laboratory, and the attending physician will be Colonel Louis E. Browning, Office of the Surgeon General.

4. All applicable regulations contained in AR 70-25 and in Code of Federal Regulations, Title 10, Chapter 20, Standards for Protection Against Ionizing Radiation, will be complied with. The Federal regulations allow personnel to receive 3 rem/calendar quarter and have been used in numerous past nuclear tests and experiments.

1 Incl (dup)
as

GORDON L. JACKS
Lt Col, CmlC
Commanding

1303-11

JDG/mb/63017

MEDDH-NE (12 Apr 63) 1st Ind
SUBJECT: Beta Hazard Experiment Using Volunteer Military Personnel

DA, OTSG, Washington 25, D.C.,

TO: Chief of Research and Development, Department of the Army,
ATTN: CRD/N, Washington 25, D.C.

Recommend approval of use of volunteers as outlined in Inclosure 1, basic communication, provided these volunteers are at least 20 years of age and that their individual previous and contemplated exposures will not total 5(N-18), where N is the individuals age in years at his last birthday.

FOR THE SURGEON GENERAL:

1 Incl
(dup w/d)

LAURENCE A. POTTER
Colonel, MC
Executive Officer

JOSEPH D. GOLDSTEIN
Colonel, MC
Consultant, Nuclear Medicine

CONCURRENCE:

Chief, Occupational Health Branch
Preventive Medicine Division
Directorate of Professional Svcs

JOHN A. HILCKEN
Lt. Colonel, MSC
Nuclear Energy Division
USA Med R&D Command

for Colin F. Vorder Bruegge, Col, M.C
U.S. ARMY MEDICAL R&D COMMAND

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1. <u>Title</u>: Military Significance of Beta Hazard under Radioactively Contaminated Field Clothing

2. <u>Background</u>:

a. The radioactive component of the fallout field resulting from a surface or near-surface burst of a nuclear weapon consists predominately of the fission products produced by the nuclear reaction. These fission products emit beta particles and gamma rays in the process of radiative decay. When deposited upon bare skin or clothing in intimate contact with the body surface the beta particles emitted by the fission products can produce a lesion characterized as a beta burn.

b. The occurrence of beta burns on skin surfaces contaminated with fission products has been a matter of historical fact since the TRINITY detonation when cattle situated downwind from the burst point developed skin lesions as a consequence of the deposition of fallout. This experience has been repeated upon at least three other occasions at weapons tests, in 1951, 1953 and 1955, when cattle and horses were involved.[15]

c. Beta burns occurred in humans at Operation SANDSTONE where four individuals were injured and again at Operation CASTLE when 100 persons were burned to greater or lesser degree.[9, 11, 18]

d. On the basis of experimental work on animals and limited studies in humans, it appears that on the order of 2,500 rep of beta, of intermediate energies, delivered to the skin is the threshold for wet desquamation.[1, 14, 17, 18, 29] There are major differences in the surface dose required to produce transepidermal injury depending upon the energy of the beta particles. The lower the energy the greater the surface dose required. It appears that for energies comparable to the average maximum of the fallout field, which varies from 3 MEV to 1 MEV with time after fission, from 1,500 to 3,000 rep will produce wet desquamation in 2 to 3 weeks following exposure.[19]

e. There have been numerous theoretical studies which considered the relative contribution to dose within the fallout field of the beta and gamma emitting components of the fission product material. The theoretical calculations of Condit et al [10] and Dale et al [12,13] have shown that these ratios can be very high, favoring the beta component, in some cases approaching 130:1 beta to gamma. Where Condit based his calculations upon the assumption that the average energy of the betas was on the order of 4 MEV in arriving at a ratio of 130:1, Dale has considered the changing energy of the beta component and shown that the ratio varies with time ranging from 15:1 at 2 hrs after detonation to a low of 4:1 at 10 days rising again to 40:1 at the end of 3 years. The Condit calculations determined the ratio in air while Dale based his ratios upon the dose to surfaces under typical field clothing. In all cases the calculations were based upon purely theoretical considerations of beta-gamm energies and considered the contaminated surface as an idealized perfect plane of infinite area uniformly contaminated with fission products.

f. In Nevada, and the same might be said for comparable areas of the world, such as the coral beaches of the Pacific test sites, the movement of the surface under the impetus of prevailing winds tends to mobilize and cover the discrete contaminated particles which typically make up the fallout. The beta emitters are attached to dirt and debris and are not separate entities as such. For each particle contaminated by radioactivity there are undoubtedly hundreds of other such particles which are not so contaminated. The earth's surface therefore does not accurately represent the flat homogeneously contaminated infinite plane which has been used in all calculations of beta gamma ratio and dose rate in the fallout field. The dirt particles contaminated with beta emitters become mixed, inhomogeneously, with the individual particles making up the surface, masking and shielding by surface irregularities then enters the picture and self absorption must be considered. (6)

g. Actual measurements of beta dose rate and the beta gamma ratio in the field, at nuclear test series if they have been made at all, are buried within reports of other projects from weapons tests which were primarily concerned with related aspects of instrumentation. In the absence of better data it has been assumed by many investigators that the ratio of 10:1 betas to gammas probably reflects a realistic view of the situation within the fallout contaminated area. In actuality the application of beta gamma ratios to the solution of this problem represents a case of reductio ad absurdum since the ratio may vary widely within broad limits depending upon the selection of appropriate conditions. In the case of the infinite, inhomogeneous plane the ratio may even approach unity whereas a very small contaminated object when removed to an uncontaminated area may show a ratio of many hundreds of betas for each gamma. As the human injuries have shown, where beta emitting material is concentrated burns can occur even though the beta gamma ratio of the surrounding field may be assumed to be within such limits that beta lesions should not be anticipated.

h. Since the range of beta particles in air is limited in comparison with that of gamma radiation, survey meters and personnel monitoring instruments employed in a fallout contaminated area measure only those beta particles within a few feet of the instrument while the gamma contribution to measured dose or dose rate comes from an area several hundreds of feet in diameter. As a consequence it has been postulated that the beta dose is at all times negligible in comparison with the gamma exposure. Assuming that the beta to gamma ratio of 10:1 is a reasonable representation of the field situation personnel would receive a whole body exposure of 250 RAD while the dose to exposed skin would approximate 2,500 RAD (rep) beta. This beta dose is at the threshold for desquamation and could result in the appearance of some lesions at the end of 2 or 3 weeks. The gamma dose, however, would result in almost 100% morbidity in personnel so exposed and is expected to require hospitalization of all individuals in this exposure range. The beta dose to clothed surfaces would be attenuated by field clothing and would probably not result in the appearance of a significant number of lesions. On this basis the position has been taken that the gamma component is dominant and gamma exposure would control duration of occupancy as well as determining the maximum permissible exposure.

i. There are several factors over and above the physical accidents of inhomogeneous distribution, shielding by surface irregularities and the like, which have contributed to the virtual absence of beta burns at the Nevada Test Site. Among these are the fact that personnel by and large do not engage in activities at the NTS which require them to remain in close apposition to the surface for periods of time. Highly contaminated areas are avoided or are entered only after donning of suitable clothing. The dry nature of the contaminant mitigates against retention by clothing and simple decontaminating measures have sufficed to remove the majority of such material from clothing.

j. Where animals, and some individuals, have received adequate fallout upon exposed skin to cause beta burns the burns have for the most part been discrete in nature, circumscribed and separate, reflecting the nature of the individual particles causing the physiological damage. The major exception to this general statement is represented by the SANDSTONE Operation where a group of individuals handled highly contaminated objects with their bare hands. The objects involved were in general uniformly contaminated and did represent a homogeneously contaminated plane. In this case the individuals received whole surface beta burns with the entire area in contact being burned evenly over the presenting aspect. (18)

k. The problem presented to personnel by surface contamination of field clothing would appear to encompass more elements of the "beta bath" situation than of the discrete hot particle condition. The soldier crawling over a contaminated area would tend to distribute dust and mud with some uniformity over the surface of the clothing in contact with the ground. There would be concentrations of material at the elbows and knees but for the purposes of this discussion the point to be made is that the single hot particle condition would not be expected to exist. Since the radioactive material is essentially separated from the body surface by the intervening thicknesses of clothing and direct contact would be anticipated only where abrasion and pressure might ensure passage of the material through the uniform, or in the case of the ungloved hands, the condition presented to the absorbing layers of the body is essentially that of the uniformly contaminated plane. If the threshold for desquamation is exceeded one might anticipate a reasonably even burn over the skin area subjected to such a dose.

l. The early theoretical calculations by Condit indicated that field clothing attentuated beta radiation by only approximately 9%. Transmissivity was determined by calculating beta absorption by material of mass ratio equivalent to field clothing based upon a 4 MEV source.[9] Actual field measurements by Brennan[6] and calculations by Dale et al[13] show that this type clothing actually can be expected to attentuate beta exposure by approximately 50 %. Black in his study has measured the same degree of attenuation by fatigues.[3,4]

m. It would appear then that the lower limit of contamination of the surface of clothing which might be expected to cause incapacitating burns lies in the area of 5,000 rad. Lower contaminated soil loading would permit longer exposure before burns were anticipated while greater degree of loading would result in burns following shorter exposures.

n. Experience with the Marshallese in 1954 indicates that the position held by many individuals as to the secondary role of betas in casualty production is still correct, at least under the circumstances of that event. These individuals received both beta burns and significant doses of whole body external gamma radiation. The whole body dose of approximately 175 rad received by the group at Rongelap was on the border of what is considered an incapacitating exposure in the sense that the addition of some 30 to 50 rad would be expected to result in hospital admission for many in the group. Beta burns in the group, while severe in some instances, did not result in incapacitation nor occasion any serious medical concern as to the outcome of the affected individuals. The scanty clothing worn by these people, and lack of shoes, coupled with lack of knowledge as to preventive measures contributed to the extensive incidence of these lesions.[9,11] Under ordinary circumstances in disciplined populations the incidence of beta lesions should be expected to be significantly less than was the experience in the Marshall Islands. The whole body exposure from penetrating gamma radiation would in that case be the controlling factor for duration of occupancy of the fallout area and determine the extent of injury and incapacitation of exposed personnel.

o. This position, however, ignores the special, although not unusual, condition of individuals who leave the fallout field after their clothing is contaminated. This condition does not necessarily depend upon physical removal to an uncontaminated location outside the fallout area, it could be attained by entrance into a shelter or other protected environment where the whole body gamma exposure would be essentially terminated, or at least minimized. In this situation beta contamination on the surface of clothing, if not removed, would continue to expose the skin to radiation. Such exposure would exist until the clothing was adequately decontaminated.

p. Recent theoretical and field studies by Black[3,4] show that the uniforms of troops crawling through contaminated areas collect radioactive material and that adequate soil loading can occur to result in the production of significant beta burns. An individual receiving a whole body gamma dose of some 95 RAD who then leaves the contaminated area can accumulate sufficient beta emitters on clothing while in the area to give a beta dose of some [illegible],000 RAD to skin under the clothing if the material is not removed over a period of 48 hours.

q. The experiment conducted by Black involved the use of dry simulant (La^{140}) spread over sun baked bare ground and grassy areas. This work indicated that even dry material is taken up by clothing to such an extent as to constitute a hazard if early removal is not effected. His experiment did not address itself to the problem of expedient decontamination or the probable effectiveness of decontamination in lessening the severity of skin burns.

r. The problem of contamination of clothing with mud or liquid material has not been studied nor do the accidental exposures previously recorded contribute to an understanding of this condition.

s. The Army Medical Service position at this time holds that under most conditions within the fallout field the gamma component is the controlling factor limiting duration of occupancy and determining the degree of injury of exposed personnel. It is postulated, further, that beta contamination of clothing is not a hazard since contamination on the surface of clothing may be readily removed by simple field expedients such as shaking or brushing.

t. The United Kingdom has taken the position that while this may be the case with dry contaminant the presence of wet fallout material upon clothing would result in a significant hazard due to greater uptake by clothing and increased transport of the wet material through the clothing. UK experience at their nuclear tests indicates that their position may prove to have experimental validity.

u. The continued and persistent lack of data on the subject of the beta hazard under contaminated clothing has been an onerous and vexing problem for a period of time, now approaching 10 years, and one which requires early study in order to develop valid guidance for combat units.

v. It is considered that the conduct of any experiment designed to evaluate the contamination of clothing in a fallout field and the extent of the beta dosage to skin under this clothing must involve the use of personnel actually maneuvering through a radioactive area. Prior studies on the uptake of radioactive contamination by clothing, with the exception of Black's work which involved human volunteers, have been done in a most unrealistic fashion. Radioactive material has been spread upon clothing stretched upon the ground with analyses of uptake and residual activity after decontamination being made on this material. Uniformly the authors of these studies conclude that clothing uptake under these conditions does not approximate the situation existing after personnel crawl through contaminated areas and grind radioactive material into clothing.

3. Hypotheses:

a. When personnel crawl or maneuver through a fallout field where fission products have become mixed with mud and water, retention of the wet material by field clothing, after personnel have left the radioactive area, may result in the development of severe beta burns on clothed skin.

b. Expedient field decontamination methods available to the soldier in the combat situation will not significantly reduce the hazard of beta burns under clothing.

4. Objectives:

a. To evaluate uptake by clothing of wet material, mud and dirt, in a simulated fallout field.

b. To compare uptake of wet and dry fallout simulant by field clothing in terms of the relative hazard from beta burns to clothed skin.

c. To evaluate effectiveness of simple decontamination methods which can be performed by personnel in the field where clothing has been contaminated by either wet or dry fallout material.

5. Materials and Methods:

a. Experimental subjects and materials.

(1) Experimental subjects:

A total of 12 volunteers will be obtained either from personnel presently stationed at Camp McCoy, Wisconsin, or from the Volunteer Detachment of the Chemical-Biological-Radiological Agency, Army Chemical Center, Maryland. The provisions of AR 70-25, 26 March 1962, relative to voluntary participation in experimentation, briefing of participants and medical supervision will be complied with in obtaining volunteers for this study.

(2) Materials:

See Inclosure 1, List of Materials and Equipment.

b. Technical Methods.

(1) Duration of exposure of volunteers both in the simulated fallout field and while wearing contaminated clothing will be strictly limited in time such that the whole body gamma exposure of 3 rad authorized by the Surgeon General, U.S. Army, for the conduct of this experiment will not be exceeded.

(2) The surface activity density of the simulated field will be based upon the time over which the experiment will be conducted, the activity of the field being determined by the time required to perform the required maneuvers. The dose (exposure versus time) received by volunteers can be regulated by altering either the intensity of the field or the time of exposure.

(3) Based upon the experimental design (subpar 5 c) detailed below, it is calculated that each volunteer will receive a whole body gamma dose of approximately 0.8 rad during the course of the study. This calculation assumes

a surface activity density for the test area of 500 $\mu c/ft^2$, and is based upon each volunteer making two passages through the field. It is further assumed that each volunteer will wear the contaminated clothing for a period of 1 hour after crawling through the simulated fallout field. Exposure during the 1 hour waiting period will be due entirely to the activity which has been taken up by the clothing and skin in maneuvering through the radioactive field. It is estimated that the total activity deposited on clothing and skin will not exceed 1 millicurie.

c. Experimental design.

(1) A simulated fallout field will be prepared at the Camp McCoy Field Facility, U.S. Army Nuclear Defense Laboratory, Camp McCoy, Wisconsin. Experimental techniques and methods for the preparation and distribution of radioactive materials previously developed by and for the Nuclear Defense Laboratory will be employed.

(2) The simulated fallout field will be prepared by distributing $Lanthanum^{140}$ over an area of 48 feet by 120 feet. Two such fields will be required. Surface activity will be approximately 500 microcuries per square foot (approx. 115 mr/hr at 3 feet). It would be desirable to use sand ranging from 32.5 microns to 100 microns in size as the carrier for the radioactive tracer in order to encompass the range of particle sizes of interest in the fallout field. This size range embraces 58% of total activity from a land surface burst nuclear weapon reaching the ground by H + 18 hours, or less, following detonation, from a cloud top height of 60,000 feet (approx. 200 KT). If standard procedures now established for the production of simulants do not permit of particle sizes within this range more restricted ranges may be used. The smaller particles may be of more interest under the conditions suggested since skin deposition under clothing with the wet simulant may depend upon particle size if there is indeed a relationship between transport through clothing and particle size. One might anticipate that larger particles would not pass through clothing as readily as smaller particles.

(3) There will be 3 tests: A "practice test" over dry soil, involving no radioactive material; a "dry test" during which personnel will be moved across a dry hard-packed field over which the fallout simulant has been spread; and "a wet test", where the personnel will move through a wet field of mud and puddles of water, over which the simulant has been spread.

(4) During each run 6 men attired in fatigues, and 6 men in field trousers and field jackets, each with combat boots, mock rifles (of expendable material) and gas masks will be required to crawl a distance of approximately 120 feet. Each man will have attached to his body at six selected locations, 12 beta-gamma discriminating film badges enclosed in plastic bags. Personnel will be required to crawl through the field in a lane approximately 4 feet wide and generally in the center of the field so as best to enhance the dosage contribution of the environment.

(5) As each man completes the crawl through the field he will be required to partially remove his clothing. Six film badges will then be removed from each man. The 12 men will then be divided into 4 groups of 3 men each. The first two groups of 3 will be directed to replace their clothing and move to a waiting area away from the simulated fallout field. The second two groups of 3 will be required to perform simple decontamination of their clothing such as brushing with their hands, shaking, and, in the case of the "wet test", by attempting to wring out the clothing and to scrape the soil from it with a bayonet. These second two groups of 3 will then be directed to join the first group at the waiting area.

(6) All personnel will occupy the waiting area for a period of one hour (approximately 10 minutes has been allowed for addition of films and simple decontamination following their entry from the fallout field). Smoking and eating will not be permitted while in the waiting area. Personnel will be required to minimize all movements while in the waiting area in order to minimize the loss of radioactivity from their clothing.

(7) After one hour in the waiting area all personnel will be monitored at the surface of their clothing and over the site of their film badges. They will then be required to carefully remove their clothing and each will be monitored again over the site of their film badges. In addition, monitoring instrument readings will be taken at 6-10 pre-selected locations on each man where the deposited skin contamination is the highest. At this time the remaining 6 films will be removed from each man, removed from their plastic containers, and prepared for processing.

(8) At this time several skin casts will be made by spraying or attaching adhesive film on selected body sites in order to determine the distribution on the skin of the radioactive contamination under the conditions of the dry and wet tests.

(9) Approximately 10 square cm. samples will then be cut from each man's fatigues at the sites of the greatest skin contamination. These samples will be counted to determine the resulting activity density from the soil uptake by the clothing.

(10) Personnel will then be immediately taken to a suitable facility for shower, thorough decontamination and issue of fresh clothing. Uniform procedures for personal decontamination will be established in order to evaluate effectiveness of decontamination and ensure that permissible exposure levels are not exceeded.

(11) While participating in the test volunteers will wear gas masks. If, on the basis of preliminary practice tests, it is found that injury to the knees and elbows is possible due to abrasion, elastic knee and elbow guards will be worn during the actual test. If excessive material is found to collect in the genital region swim trunks of tightly woven material will be worn.

(12) Urine samples will be analyzed for radioactivity pre and post operationally. Nasal swipes will be made at the end of each test run to indicate possible presence of radioactivity in respiratory passages. Total body burdens for radioactivity will be determined pre and post operatively in the whole body counter.

6. Collection Reduction and Analysis of Data:

a. Data Collection (for each of 2 tests). A sample data collection sheet is at Inclosure 2.

(1) 72 β-γ films off upon completion of crawl (t_1).

(2) 72 β-γ films off upon completion of test (t_3).

(3) 48 skin casts collected upon completion of test.

(4) 72 - 2"x2" clothing samples collected upon completion of test, and from the areas of highest contamination.

(5) 72 monitoring instrument readings taken after each test over film badge sites.

(6) 72 monitoring instrument readings taken after each test over areas of highest contamination ("hot spots").

(7) 72 monitoring instrument readings taken upon completion of test of undersurface of clothing over the "hot spots".

(8) 72 monitoring instrument readings taken upon completion of test of undersurface of the clothing over the β-γ film sites.

b. Total Beta Dose to Selected Body Sites ("Hot Spots").

(1) The beta dose as a function of time to selected body sites, where the skin and clothing contamination is the greatest, will be estimated from the expression:

$$D(t) = D_\beta t \,(R_s/R_f + R^1_s/R^1_f)$$

where

D_β= Net β-γ film reading for the one hour waiting period following each crawl, and is obtained from $D_\beta = D_\beta(t_3) - D_\beta(t_1)$

R_f= monitor reading over skin at film site.

R_s= monitor reading over skin at "hot spot"

R^1_f= monitor reading over the film site and of the inner surface of the clothing

R^1_s= monitor reading over "hot spot" and of the inner surface of the clothing

t= exposure time in hours

(2) The beta dose will be plotted as a function of time under the following four test conditions:

(a) Dry test - fatigue clothing - simple decontamination and no decontamination.

(b) Dry test - field clothing - simple decontamination and no decontamination.

(c) Wet test - fatigue clothing - simple decontamination and no decontamination.

(d) Wet test - field clothing - simple decontamination and no decontamination.

c. The Beta Dose to Selected Sites.

Beta dosages to selected body sites ("hot spots") will be determined from the expression given in b above and will be plotted as a function of the body site as follows:

(1) Dry test - fatigue clothing - simple decontamination and no decontamination.

(2) Dry test - field clothing - simple decontamination and no decontamination.

(3) Wet test - fatigue clothing - simple decontamination and no decontamination.

(4) Wet test - field clothing - simple decontamination and no decontamination.

d. Distribution of Radioactive Contamination on the Skin.

Radiographs will be prepared from the skin casts in order to compare, under the four conditions tested, the qualitative distribution of radioactivity on the skin. Representative radiographs will be chosen to demonstrate the differences, if any, in the distribution pattern under the following conditions:

(1) Dry test - fatigue clothing

(2) Dry test - field clothing

(3) Wet test - fatigue clothing

(4) Wet test - field clothing

e. Penetration of Radioactivity Through Clothing.

The ratio of the beta activity on the inner surface of the clothing to that on the outer surface will be determined by proportional counting of the 2"x2" clothing samples. This ratio, represented by $A_{\beta}(Int)/A_{\beta}(Ext)$, will be plotted as a function of the body "hot spot", and for the following conditions:

(1) Dry test - four curves, per graph.

(2) Wet test - four curves, per graph.

f. Maximum Radioactivity Concentrations Taken Up by Clothing.

(1) From well-type scintillation crystal assay of 2"x2" cloth samples the activity density ($\mu c/cm^2$) over the "hot spots" will be determined and displayed, as a function of body site, as follows:

(a) Dry test - four curves per graph.

(b) Wet test - four curves per graph.

(2) From the graphs of (1) above, which is a measure of clothing uptake for a simulated fallout field of 500 - 1000 $\mu c/ft^2$, the clothing uptake may be estimated for fallout fields of higher surface contamination. The maximum activity density in the clothing will be plotted as a function of the surface activity density of actual fallout fields resulting from nuclear weapon detonations.

g. Estimate of Beta Hazard to Troops.

From the results of subparagraphs a through f above, and what is known concerning the relation of the total beta skin dose to the various degrees of injury, an estimate can be made of the beta hazard to combat troops under the following four conditions:

(1) Fallout over dry terrain - fatigue clothing - no decontamination performed by soldier.

(2) Fallout over dry terrain - fatigue clothing - simple decontamination performed by the soldier.

(3) Fallout over dry terrain - field clothing - simple decontamination.

(4) Fallout over dry terrain - field clothing - no decontamination.

(5) Fallout over wet terrain - fatigue clothing - simple decontamination.

(6) Fallout over wet terrain - fatigue clothing - no decontamination.

(7) Wet terrain - field clothing - simple decontamination.

(8) Wet terrain - field clothing - no decontamination.

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MATERIALS AND EQUIPMENT

Fallout Simulant (La-140 tracer spread over 5770 ft^2 at surface activities of 500 - 1000 mc/ft^2. Assuming 30% processing loss and one-half-life decay in processing.)	16 1/2-33 curies
Gas Masks	16 ea
Fatigue Jackets	16 ea
Fatigue Trousers	16 pr
Field Jackets	16 ea
Field Trousers	16 pr
Helmet Liners	12 ea
Combat Boots	14 pr
Drawers	30 ea
Undershirts	30 ea
Wool Socks	30 pr
Web belts	24 ea
Bayonets	6 ea
Plastic gloves (or rubber)	50 pr
β-γ film packets	300 ea
"Plastic bags (about 4" x 4")	400 ea
Scotch Tape (4" wide)	100 ft
Cotton (6-12" wide)	1 roll
Cotton swabs	1 box
Mock rifles (or 2"x2"x3' wood pieces)	12 ea
Detergent ("Radiac Wash")	5 gal
Detergent ("Alconax")	6 cans
Collodion Spray	5 cans

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Low level gamma counting system (wide-type crystal, scaler, etc.)	2 ea
Monitoring Instruments, intermediate range (AN/PDR-39, AN/PDR-T1B, AN/PDR-43)	2 ea
Monitoring Instruments, low range (AN/PDR-27(A-J), AN/PDR-46, Victoreen "Scintillac" w/Beta Probe., or equivalents)	4 ea
Elastic knee pads	28 ea
Elastic elbow pads	28 ea
Nylon tank trunks	24 ea

DATA SHEET

VOLUNTEER NO. ____________
DECON/NO DECON
FATIGUES/FIELD CLOTHING

	DRY TEST									WET TEST								
FILM SITE	R_f	R_f^1	$D_T(t_1)$	$D_\gamma(t_1)$	$D_\beta(t_1)$	$D_T(t_3)$	$D_\gamma(t_3)$	$D_\beta(t_3)$	$D_\beta(t_3)$ $-D_\beta(t_1)$	R_f	R_f^1	$D_T(t_1)$	$D_\gamma(t_1)$	$D_\beta(t_1)$	$D_T(t_3)$	$D_\gamma(t_3)$	$D_\beta(t_3)$	$D_\beta(t_3)$ $-D_\beta(t_1)$
1																		
2																		
3																		
4																		
5																		
6																		

HOT SPOT	R_s	R_s^1	CASTS TAKEN	$A_\beta(Int)/A_\beta(Ext)$	$\mu c/cm^2$		R_s	R_s^1	CASTS TAKEN	$A_\beta(Int)/A_\beta(Ext)$	$\mu c/cm^2$	
1 ( )												
2 ( )												
3 ( )												
4 ( )												
5 ( )												
6 ( )												

Incl 2