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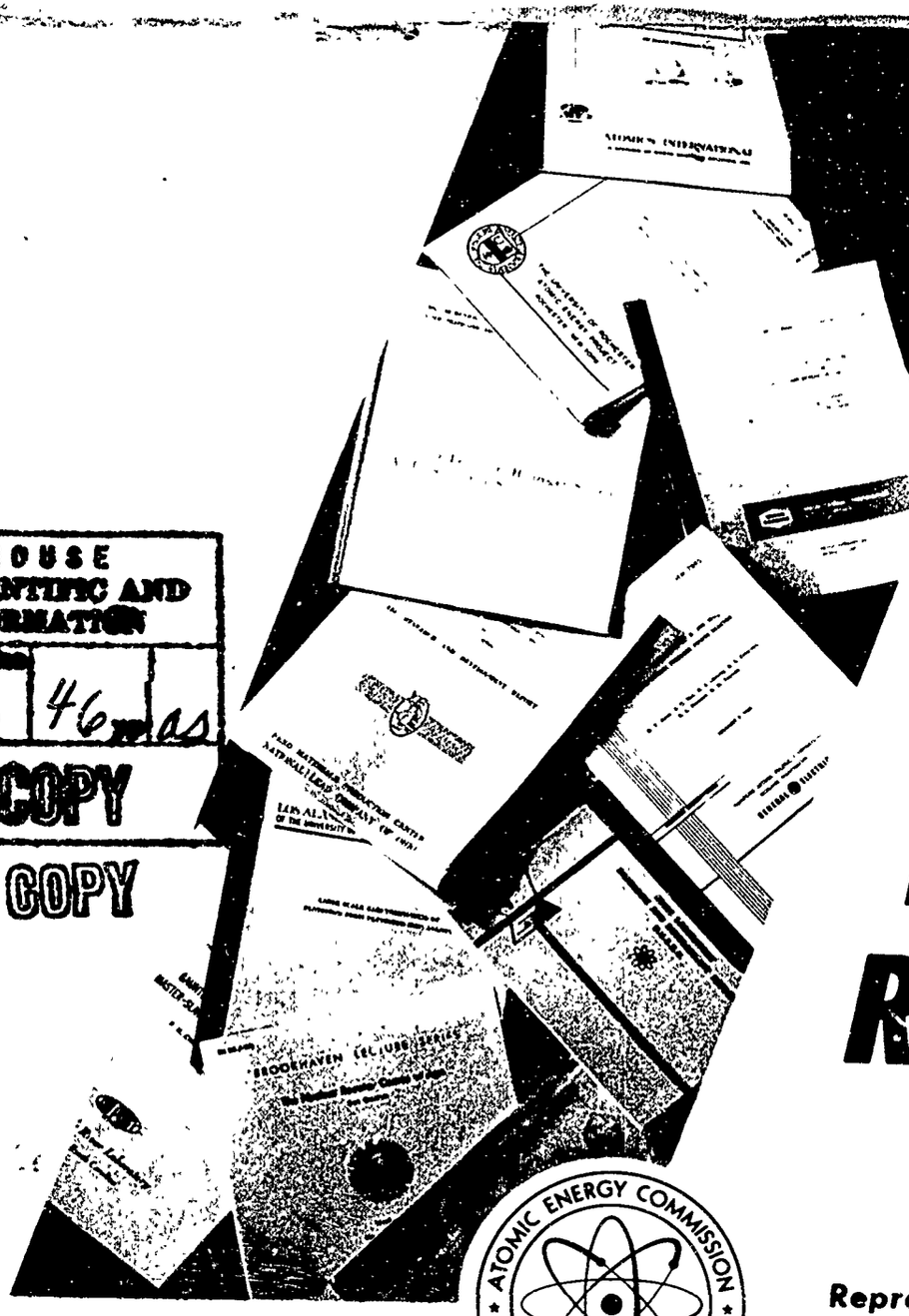

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OPERATION JANGLE

PROJECT 6.3-1

EVALUATION OF MILITARY INDIVIDUAL AND COLLECTIVE PROTECTION DEVICES AND CLOTHING

by

JOHN R. HENDRICKSON

July 1952

CLASSIFICATION CANCELLED
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For The Atomic Energy Commission
Chief, Declassification Branch

CHEMICAL CORPS CHEMICAL AND RADIOLOGICAL LABORATORIES
ARMY CHEMICAL CENTER, MARYLAND

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PREFACE

The purpose of Project 6.3-1 was to determine the adequacy of items of protective equipment for use in radioactively contaminated areas. The work at the test site was performed under the direction of the author, who was Project Officer.

The report is a compilation of four individual reports covering separate items of equipment.

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The assistance of Lt. Col. Charles Robbins and Lt. Robert L. Hansel in the planning and conduct of this project is gratefully acknowledged.

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ABSTRACT

Under conditions resulting from surface and underground detonations of atomic bombs, tests were conducted on Chemical Corps impregnated and unimpregnated protective clothing, Individual Protective Mask M9A1 with M11 Canister, Tank Collective Protector E26 and E22, and Protective Ointment M5. Both impregnated and unimpregnated clothing were capable of preventing contact between the skin and radioactive dusts. Unimpregnated clothing demonstrated better contamination-decontamination characteristics, but the secondary radiation from all clothing was negligible. The protective cover was effective in preventing contamination of clothing. The M9A1 mask with M11 canister furnished complete protection against inhalation of radioactive dust. The filtering efficiencies of the E26 tank collective protectors were found to be very high, and no deficiencies were found in the unit. The filtering efficiencies of the E22 tank collective protectors were also high. Panels coated with M5 ointment were found to be much more highly contaminated than bare panels.

CHAPTER 1

PROTECTIVE CLOTHING[9]

1.1 INTRODUCTION

1.1.1 Objective

The object of this phase of Project 6.3 was to determine the adequacy of Chemical Corps protective clothing to prevent radioactive dust produced by atomic bomb detonations (surface and underground) from contacting the skin of the wearer.

1.1.2 Historical

During the period between World War I and World War II, Chemical and Radiological Laboratories developed an impregnation process for clothing to protect the wearer against war gases. A mixture of nine parts of N,N'bis (2,4,6 Trichlorophenyl) dichlorourea and one part of zinc oxide was developed to neutralize mustard gas. This compound, known as $XZCC_2$, is used as an impregnate in standard items of clothing issue to produce Chemical Corps protective clothing. The class I protective uniform consists of standard helmet and gas mask and the following items impregnated with $XZCC_2$: underclothing, socks, boots, gloves and coveralls. Class II protective uniform is the same as Class I except an unimpregnated undershirt may be worn. Class III uniform is composed of the same items, but none are impregnated.

The individual protective cover, Fig. 1.1, was designed to provide protection against chemical warfare agents sprayed from aircraft. It is constructed of .002 inch flame and moisture resistant cellophane. For cold climate use, the cover is lined with scrim to increase resistance to cracking. The soldier is instructed to dispose of the cover after it becomes contaminated. The cellophane cover was recently de-standardized in favor of a cover, now under development, which is more easily donned.

1.1.3 Properties of Protective Clothing

The protective uniform should prevent radioactive dust from contacting the skin, should be difficult to contaminate and easy to decontaminate by simple laundering procedures. Another desirable property in the protective clothing, not tested under this project, is protection against the thermal effects of atomic bomb detonations. It is obvious

that one protective uniform be used in chemical, bacteriological, and radiological warfare.

1.2 EXPERIMENTAL PROCEDURE

1.2.1 Clothing on Racks (Fig. 1.2)

At 2,000 feet downwind (40° north of east) from Ground Zero, ten racks were set up for exposure of protective clothing to the surface detonation. The following items of clothing were mounted on the racks:

1. Individual protective cover
2. Individual protective cover
3. Impregnated herringbone twill coverall
4. Impregnated herringbone twill coverall
5. Unimpregnated cotton sateen coverall
6. Unimpregnated cotton sateen coverall
7. Unimpregnated herringbone twill coverall
8. Impregnated herringbone twill coverall encased in an individual protective cover
9. Impregnated cotton sateen coverall encased in an individual protective cover
10. Impregnated cotton sateen coverall

All impregnated clothing contained 7 to 15% by weight of $XKCC_3$.

Six hours after the detonation, the clothing was collected and removed to the Control Point at the test site, where each item was monitored with a side-window PR-3 Beta-Gamma survey meter from a distance of six inches, as the level of activity was above the range of the Chemical Corps clothing monitor.

1.2.2 Clothing in M26 Tanks

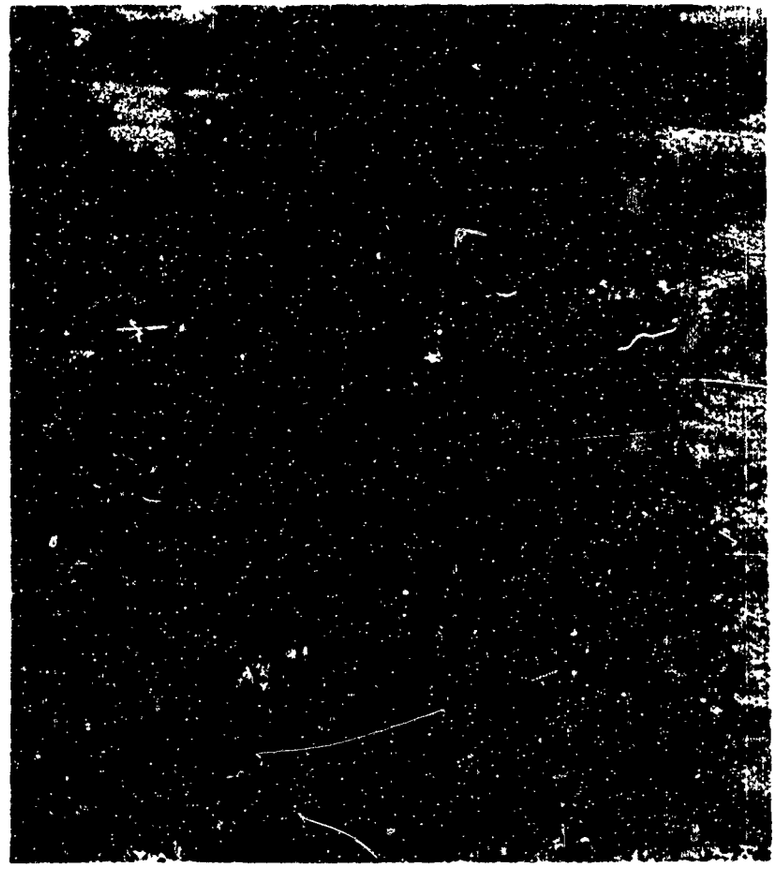

Fig. 1.1 Individual Protective Cover

1.2.2 Clothing in M26 Tanks

During the surface detonation, clothing was exposed at the five crewmen's positions within each of two M26 tanks. The tanks were located 2,000 feet downwind, 15° east of south, from Ground Zero. The

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Fig. 1.1 Individual Protective Cover

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Fig. 1.2 Ten Clothing Racks with Protective Clothing and Individual Protective Covers Located 2,000 feet and 3,000 feet NE of Ground Zero During Surface Detonation

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front of one tank and the side of the other faced the blast. All crew hatches were open.

Six hours after the detonation, the clothing was collected and monitored according to the procedure used on the clothing from the racks.

1.2.3 QMC Controlled Contaminator[12] (Fig. 1.3)

Five types of coveralls (see Table 1.5) were contaminated uniformly in the QMC controlled contaminator, using dust collected near the surface crater. Each batch was run for 10 minutes with 1/4 pound radioactive dirt. The "shake-off" dirt was removed by an air blast and collected in a bag filter. The laundering and drying of the coveralls was accomplished in the QMC portable laundry unit, employing the standard QMC laundering formula with General Aniline detergent. The same laundering procedure was used for each batch. Monitoring of the coveralls was done before and after laundering at nine points.

1.2.4 Clothing Worn by Men (Fig. 1.4)

Men walking, crawling, and riding in armored vehicles passed through the contaminated areas produced by both the surface and underground detonations. The clothing worn included coveralls, drawers, undershirts, socks, gloves and boots; either impregnated or plain.

Four hours after the surface detonation, eight teams of men worked for a period of one hour in the contaminated areas (Fig. 1.5). Five days after the underground detonation, one team walked and one team walked and crawled through the 10 to 500 milliroentgen per hour area (Fig. 1.6), downwind from Ground Zero. The walking team traveled approximately 1/2 mile in 1/2 hour. The walking and crawling team crawled ten yards in the 300 milliroentgen per hour zone.

At 25-1/2 hours after the surface detonation, crewmen wearing Class I protective clothing entered the two M26 tanks and drove through the contaminated area.

1.3 TEST RESULTS

1.3.1 Clothing on Racks (Tables 1.1 and 1.2)

The results of the contamination of rack-mounted protective clothing 2,000 feet from the surface detonation were as follows: The average contamination, measured at six inches approximately eight hours after the detonation, was 0.025 mr/hr. The range of readings on clothing items was 0.01 to 0.04 mr/hr. The helmet was the most highly contaminated item, having a reading 0.37 mr/hr. The average permissible level of contamination for clothing, presupposing use throughout lifetime of wearer and a large safety factor, is 7 mr/hr[8].

Fig. 1.3 Bag Filter Attached to QMC Contaminator for Collecting "Shake-off" Dirt from Protective Clothing

Fig. 1.4 Typical Chemical Corps Uniform Worn by Men in Contaminated Areas after Surface and Underground Nuclear Detonations. (Note: M9A1 Protective Mask)

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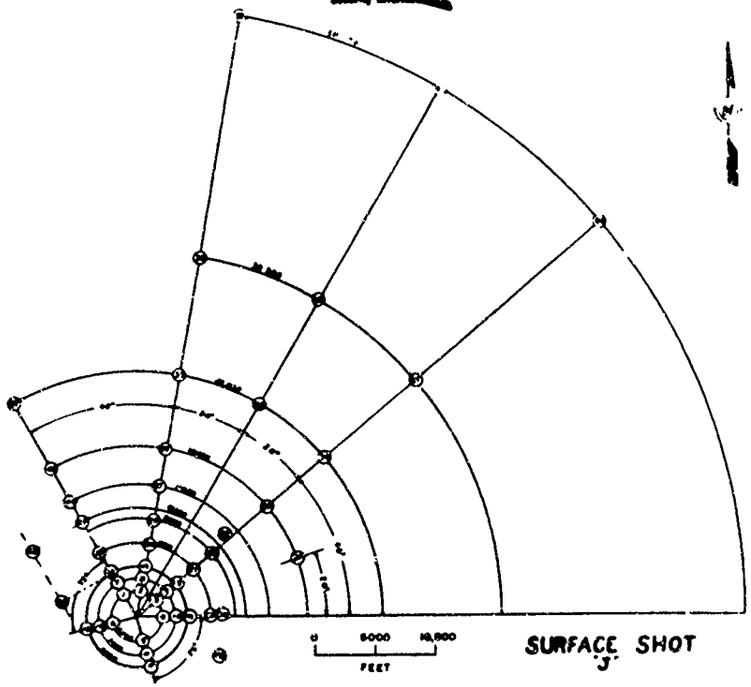

Fig. 1.5 Areas in which various teams of men wearing protective clothing walked for one hour after H+4 hours, and area of M26 Tank operations. Direction of wind: Northerly during detonation.

Walking Area 1	Stations	2, 8, 14, 20, 23, 27
2		1, 7, 13, 19, 25, 44
3		3, 9, 15, 21, 24, 28
4		29, 33, 36, 39
5		5, 11, 17, 4, 10, 16, 22, 26, 46, 31
6		30, 34, 37, 40
7		6, 12, 18, 42, 43, 45, 32
8		35, 38, 41

M26 Stationary Tanks exposed during detonation at Station 5.
M26 Tanks Itinerary after detonation: Station 5 north to point 800 feet east of ground zero, thence west to within 200 feet of the crater and returning southward.

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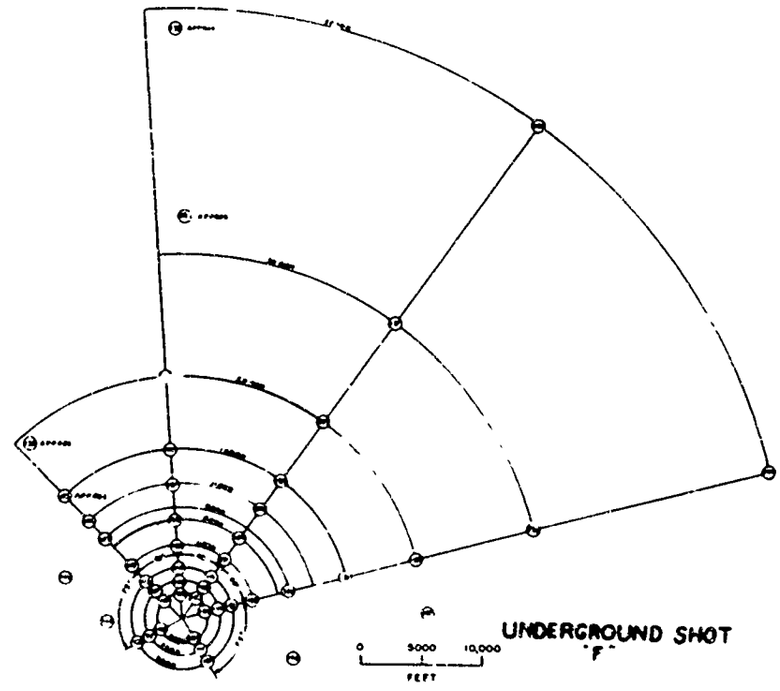

Fig. 1.6 Area in which teams of men wearing protective clothing walked and crawled for ½ hour, on H+5 days; and itinerary of M26 tanks and personnel carrier, T18E1. Direction of Wind: Northerly during detonation.

Area in which protective clothing was worn: Men walked from 10 mr/hr zone near Station 107 to 500 mr/hr zone near Station 101. Some crawled for 10 yards in 300 mr/hr zone between Stations 101 and 107. Stationary armored vehicles exposed during detonation at Station 101. Itinerary of armored vehicles after detonation: Station 106 north to Station 101, thence to tip of crater, thence to Station 104 and return via same route.

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Table 1.1

Results of Contamination of Protective Clothing on Racks at 2000 Feet from Ground Zero on the NE Leg of the Surface Shot - (Exposed from H to H + 6 hrs)

Number Assigned to Articles	Clothing Outergarment Coverall and/or Cover	Date of Measurement @ H + 8 hrs	Ave. Contamination in mr/hr @ 6" corrected for Background
* 1	Impregnated Cotton-Sateen w/cover	19 Nov 51	0.03
* 2	Laundered, Impregnated HBT w/cover	19 Nov 51	0.03
3	Cotton-Sateen, Impregnated	19 Nov 51	0.04
4	HBT, Impregnated	19 Nov 51	0.03
5	Individual Protective Cover #1	19 Nov 51	0.03
6	Individual Protective Cover #2	19 Nov 51	0.03
7	Laundered HBT	19 Nov 51	0.01
8	Laundered Cotton-Sateen	19 Nov 51	0.03
9	Laundered, Impregnated HBT	19 Nov 51	0.01
10	Cotton-Sateen	19 Nov 51	0.01
11	Tee-Shirt, Cotton	19 Nov 51	0.03
12	Boots	19 Nov 51	0.04
13	Helmet	19 Nov 51	0.37

* The clothing underneath the covers was uncontaminated.

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TABLE 1.2

Results of Contamination of Protective Clothing on Racks at 3000 Feet from Ground Zero on the NE Leg of the Surface Shot - (Exposed from H to H + 6 hours)

Number Assigned to Articles	Clothing Outergarment and/or Cover	Date of Measurement @ H + 8 hours	Ave. Contamination in mr/hr @ 6" corrected for background
1	Laundered, Impregnated HBT	19 Nov 51	0.06
2	Impregnated HBT	19 Nov 51	0.10
3	Laundered Cotton-Sateen	19 Nov 51	0.06
4	Cotton-Sateen	19 Nov 51	0.05
5	Impregnated Cotton-Sateen	19 Nov 51	0.05
* 6	Laundered, Impregnated HBT w/cover	19 Nov 51	0.05
* 7	Impregnated Cotton-Sateen w/cover	19 Nov 51	0.06
8	Individual Protective Cover #1	19 Nov 51	0.05
9	Individual Protective Cover #2	19 Nov 51	0.05
10	Laundered HBT	19 Nov 51	0.07
11	Combat boots	19 Nov 51	0.07
12	Tee-Shirt, Cotton	19 Nov 51	0.03
13	Helmet	19 Nov 51	4.7

* The clothing underneath the covers was uncontaminated.

below which no contamination is required even when presupposing a continuing lifetime exposure and a large safety factor, is 7 mr/hr.

The results of contamination at 3,000 feet downwind from Ground Zero show that the average contamination measured at six inches eight hours after the detonation, was 0.06 mr/hr, or slightly higher than the average at 2,000 feet. The range of activities was 0.03 to 0.10 mr/hr on clothing. Again the helmet was the most highly contaminated giving a reading of 4.7 mr/hr.

The protective cover proved very effective but became brittle from the heat. However, the fact that the covers were manufactured in 1942 may have been responsible for the brittleness.

1.3.2 Clothing in M26 Tanks (Tables 1.3 and 1.4)

The activities on the clothing in the two M26 stationary tanks were lower than the activities of clothing exposed on racks. The average contamination was 0.01 mr/hr at six inches eight hours after the detonation.

Contamination of clothing on men in mobile tanks was greater than on coveralls in same unmanned stationary tanks.

1.3.3 Clothing from GMC Contaminator (Tables A.1 and A.2)

The correction curve, Fig. 1.7, was used to correct the activities of the clothing from the contaminator to one hour after the detonation. The resulting contamination levels are shown in Table 1.5. The impregnated clothing was more highly contaminated than the corresponding unimpregnated. The laundering efficiency for unimpregnated clothing was higher than for impregnated.

1.3.4 Clothing Worn by Men (Tables 1.6, 1.7, 1.8, A.3, A.4)

Of protective clothing worn by men after the surface detonation, gloves and boots worn into areas near Ground Zero were the most highly contaminated, giving readings ranging from .01 to 9 mr/hr at six inches when monitored 26 hours after the detonation. Contamination of underclothing was negligible.

Of the clothing worn into the contaminated area produced by the underground detonation, the maximum reading was 3.7 mr/hr. The men who crawled received only 2 to 4 mr from their clothing while receiving a total dosage of 1 to 2 roentgens, as measured by film badges which recorded radiation from both the clothing and the ground.

The contamination of clothing worn by men riding through the area contaminated by the surface shot was also negligible.

TABLE 1.3

Contamination of Coveralls Placed in Two Stationary M-26 Tanks During the Surface Detonation (Clothing Exposed from H to H + 6 hours)

No.	Type of Coverall	Seat	Comp't	Tank No.	PR-3 Meter Reading in mr/hr @ 6" at H + 8 hrs corrected for background
1	Laundered, Impregnated HBT	Commander	Upper	418 head-on	0.02
2	Laundered HBT	Gunner	Upper	418 head-on	0.01
3	Laundered, Impregnated HBT	Loader	Upper	418 head-on	0.02
4	Laundered HBT	Driver	Lower	418 head-on	0.01
5	Laundered, Impregnated HBT	Ass't. Driver	Lower	418 head-on	0.02
6	Laundered, Cotton-Sateen	Commander	Upper	424 side-on	0.01
7	Impregnated Cotton-Sateen	Gunner	Upper	424 side-on	0.01
8	Impregnated Cotton-Sateen	Loader	Upper	424 side-on	0.00
9	Cotton-Sateen	Driver	Lower	424 side-on	0.01
10	Cotton-Sateen Impregnated	Ass't. Driver	Lower	424 side-on	0.00

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TABLE 1.4

Contamination of Coveralls Worn by Crewmen in Two Mobile Tanks After the Surface Detonation

No.	Type of Coverall	Seat	Compt	Tank No.	Ave. Reading on PR-3 Survey Meter in mr/hr at 6" at H + 26 hrs corrected for background
1	Unimpregnated Cotton-Sateen	Ass't. Driver	Lower	418	0.03
2	Impregnated Cotton-Sateen	Driver	Lower	418	0.03
3	Impregnated Cotton-Sateen	Commander	Upper	418	0.05
4	Unimpregnated Cotton-Sateen	Gunner	Upper	418	0.03
5	Laundered, Unimpregnated HBT	Ass't. Driver	Lower	424	0.03
6	Laundered, Impregnated HBT	Driver	Lower	424	0.03
7	Laundered, Impregnated HBT	Commander	Upper	424	0.01
8	Gloves (1,4, &5)				0.02
9	Gloves, Impregnated (2,3,6, &7)				0.03
10	Undershirts (1,4, &5)				0.00
11	Undershirts, Impregnated (2,3,6, &7)				0.01
12	Drawers (1,4, &5)				0.01
13	Drawers, Impregnated (2,3,6, &7)				0.01
14	Socks (1,4, &5)				0.00
15	Socks, Impregnated (2,3,6, &7)				0.00

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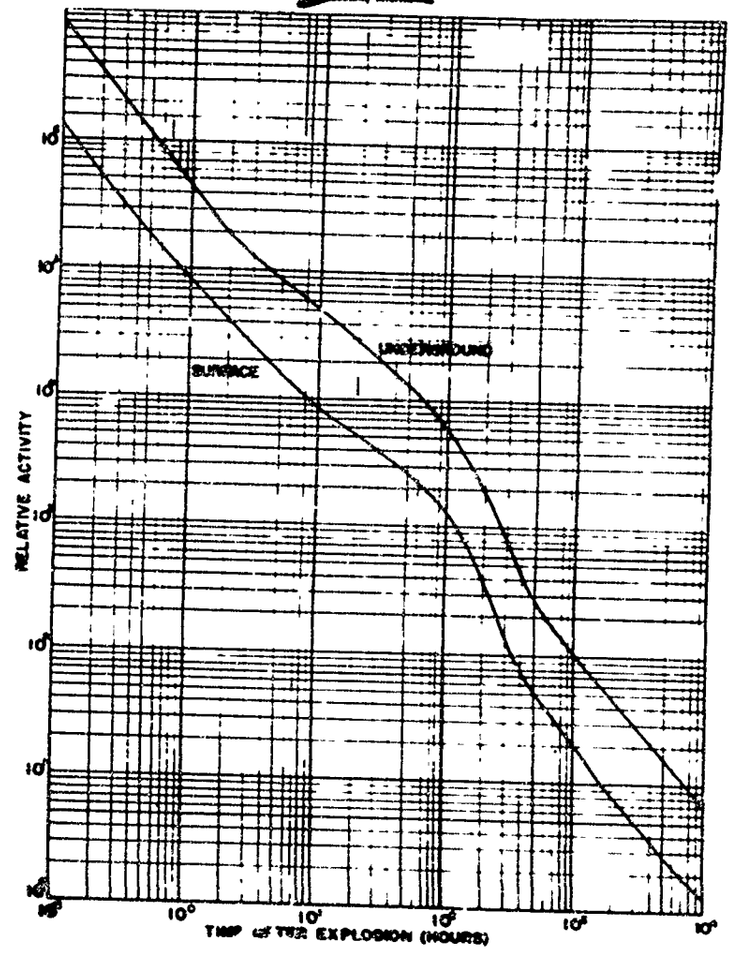

Fig. 1.7 Decay Factors for Correcting Activities to H Hour plus 1 Hour

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TABLE 1.5

Contamination of Coveralls Placed in QMC Controlled Contaminator and Laundered at Indian Springs, Nevada

Batch	No. Coveralls	Coveralls	Batch	Average PR-3 Readings in mr/hr at 6" at H + 1 hours corrected for background		% Retention of Contamination	% Removal of Contamination
				After Contamination	After Laundering		
1	5	Laundered HBT	1	356	49	13.8	86.2
2	5	Impregnated HBT	2	840	283	33.7	66.3
3	5	Laundered, Impregnated HBT	3	888	375	42.2	57.8
4	5	Cotton-Sateen	4	366	33	9.0	91.0
5	4	Impregnated Cotton-Sateen	5	796	261	32.8	67.2

TABLE 1.6

Contaminated Areas in Which Various Teams Walked for One Hour While Wearing Protective Clothing after Surface Detonation (See Fig. 1.5)

Team No.	Distance Downwind from Ground Zero	Direction
1	2-11,000 ft	N
2	11-20,000 ft	NW
3	2-9,000 ft	NE
4	14-50,000 ft	N
5	2-14,000 ft	E & SE
6	14-50,000 ft	[illegible]
7	2-8,000 ft	NW & SW
8	20-50,000 ft	NNE

TABLE 1.7

Protective Clothing Worn After Surface Detonation by Men Walking in Contaminated Areas (See Fig. 1.5 and Table 1.6)

Total Number Suits	Coveralls *	Team Numbers
7	Laundered HBT	1, 3, 4, 5, 6, 7, & 8
8	Impregnated HBT	1, 2, 3, 4, 5, 6, 7 & 8
7	Laundered and Impregnated HBT	2, 3, 4, 5, 6, 7 & 8
3	Cotton-Sateen	1, 3, & 6

* Underneath the coveralls, drawers and undershirts were worn. The underclothing was either impregnated or unimpregnated to match the corresponding coveralls. In addition, uniforms with impregnated clothing included impregnated socks, boots and glover. Uniforms with unimpregnated clothing were matched with unimpregnated socks, boots and gloves.

TABLE 1.8

Protective Clothing Worn After Underground Detonation (See Fig. 1.6)

Number	Coveralls	Team **
2	Laundered Herringbone Twill	1
6	Impregnated Herringbone Twill	1 and 2
2	Laundered, Impregnated HBT	1
2	Cotton Sateen	1 and 2
8	Cotton Sateen, Impregnated	1 and 2

* Team 1 crawled and walked

** Team 2 walked only

1.4 DISCUSSION OF RESULTS

The level of contamination of the clothing under the test conditions was very low, indicating no hazard to the wearer. The fact that underclothing worn by the men crawling after the underground detonation was still uncontaminated indicates that the clothing is adequate to prevent contact between radioactive dust and the skin of the wearer. The impregnated clothing, in general, retained more radioactive dust than did the unimpregnated items. It is significant, however, that the level of radiation due to dust on clothing throughout the tests was negligible.

1.5 CONCLUSIONS

1. Impregnated herringbone twill clothing is more easily contaminated than impregnated cotton sateen clothing. However, the difference is slight.

2. Class I and Class III protective clothing furnish adequate protection against the penetration of radioactive dust under the soil conditions encountered in the test.

3. Cotton-sateen clothing has contamination-decontamination characteristics superior to those of herringbone twill.

4. Under the soil and weather conditions encountered at the Nevada Test Site, contamination of clothing worn by personnel in the area contaminated by an atomic detonation would not constitute a military hazard.

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CHAPTER 2

EVALUATION OF M9A1 INDIVIDUAL PROTECTIVE MASKS[4]

2.1 INTRODUCTION

2.1.1 Objective

The objective of this phase of Project 6.3 was to determine the adequacy of the Chemical Corps Individual Protective Mask M9A1 to protect the wearer from inhalation of radioactive dust resulting from an atomic bomb detonation.

2.1.2 Historical

The M9A1 Protective Mask, Fig. 1.4, developed by Chemical and Radiological Laboratories during the latter part of World War II, was designed to protect the wearer against all known war gases and toxic aerosols. As standardized in May 1951, the mask consists of a medium weight rubber face-form with M11 canister[5] attached to the face-piece. The M11 canister contains a paper particulate filter and an activated charcoal (ASC) filter in series. The mask is held tightly against the face by a head harness. Previous to this test, the M9A1 mask had been found suitable for protection against chemical and bacteriological agents.

2.2 EXPERIMENTAL PROCEDURE

The apparatus for determining the overall radiometric efficiency of the mask consisted of a molded rubber nose-piece with a cotton-wad filter (Fig. 2.1). The periphery of the nose-piece was sealed to the volunteer wearer's face with adhesive tape. The mask was worn in the usual manner over the nose-piece. The volunteers who wore the mask test units were members of the teams walking and riding through the contaminated area after the surface detonation for the clothing tests described in Chapter 1. After the wearers returned from the tests, the cotton wads were counted to determine their radioactivity.

2.3 TEST RESULTS

No radioactivity was found on the cotton wads returned from the surface shot when counted 25 hours after the detonation. Five M11 canisters from masks worn by personnel who entered the contaminated area for a period of 1/2 hour approximately 3-1/2 hours after the underground

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Fig. 2.1 Nosepiece and Cotton Filter Worn Under Protective Mask M9A1 by Men Walking in Areas.

A. Rubber Nosepiece. B. Cotton Filter (fits into the nosepiece).

detonation, were disassembled and counted for evaluation of the radiation hazard. The activities, corrected to one hour after the detonation, ranged from 1.12 mc to 5.20 mc.

2.4 DISCUSSION OF RESULTS

Since no measurable amount of radioactivity reached the cotton wad of the test nose-piece, it may be assumed that the filtering efficiency of the mask unit approached 100% under the low-contamination conditions of the surface shot.

The radiation from the M11 canisters (Table 2.1), used by men working in the contaminated area after the underground detonation, was not dangerous and would not constitute a hazard (1 to 5 mc at H + 1 hr).

2.5 CONCLUSIONS

1. The M9A1 Protective Mask was adequate to prevent inhalation of radioactive particles under the conditions of the test.

2. The accumulation of radioactivity in the M11 Canister, under the test conditions, was not sufficient to produce a radiation hazard.

2.6 RECOMMENDATIONS

None, as work is continuing on the development of individual protective devices.

TABLE 2.1

Radioactivity Collected in M11 Canisters by Men Walking in Contaminated Area While Wearing M9A1 Protective Masks, for One-Half Hour (3½-4 Hours After the Underground Detonation)

Canister Number	Sample Number	Radioactivity mc @ H + 1 hr for 2" diameter samples	Radioactivity mc @ H + 1 hr for M11 Canister
18	1	4.38×10^{-2}	
18	2	3.60×10^{-2}	
18	3	5.68×10^{-2}	
18	Average	4.55×10^{-2}	1.12
41	1	6.94×10^{-2}	
41	2	9.95×10^{-2}	
41	3	8.69×10^{-2}	
41	Average	8.53×10^{-2}	2.10
46	1	15.2×10^{-2}	
46	2	16.1×10^{-2}	
46	3	9.91×10^{-2}	
46	Average	13.7×10^{-2}	3.37
50	1	24.4×10^{-2}	
50	2	14.1×10^{-2}	
50	3	24.8×10^{-2}	
50	Average	21.1×10^{-2}	5.20
52	1	13.2×10^{-2}	
52	2	5.95×10^{-2}	
52	3	21.4×10^{-2}	
52	Average	13.5×10^{-2}	3.33

CHAPTER 3

EVALUATION OF TANK COLLECTIVE PROTECTORS E26[1] AND E22[2,11]

3.1 INTRODUCTION

3.1.1 Objective

The object of this phase of Project 6.3 was to determine the adequacy of the Tank Collective Protector E26 to protect a tank crew from the inhalation of radioactive particles while operating in an area contaminated by detonation of an atomic bomb.

3.1.2 Historical

During the late stages of World War II, the Chemical and Radiological Laboratories developed a device, the Tank Collective Protector E22, for the protection of tank crews against chemical warfare agents. Further developmental work has produced the Model E26. This three man protector consists of one Air Purifier E2 and a Tank Mask E56-M10A1-E20 for each man.

The principal parts of the air purifier are a blower, a centrifugal separator, and replaceable paper and charcoal filter units. The purifier operates on 24 volt direct current and delivers approximately 12 cubic feet of air per minute.

The Tank Mask E56 consists of a fully molded rubber face blank with a full-face vinylite eye shield. The face-piece is equipped with a lip microphone connected to the tank communication system. Wire reinforced rubber tubing connects the mask and the air purifier through a M10A1 canister in a carrier worn by the crew member. The system is designed so that the crewman can quickly disconnect the tubing and use the mask and canister as an individual protector when emergency abandonment of the tank is necessary.

The Tank Collective Protector E22, predecessor to the E26, is similar to the E26 in basic design. The E22 is larger in overall dimensions and is not equipped with the individual M10A1 canisters for separate use in evacuation. During the planning stage of Project 6.3, the E26 was not available. Before the E26 was made available, detailed plans for the E22 tests were advanced enough that the test could be completed at no additional cost and but little additional effort; therefore, the E22 investigation was conducted.

3.2 EXPERIMENTAL PROCEDURE

3.2.1 Tank Collective Protectors E26 in Armored Vehicles (Figures 3.1 and 3.2)

During the surface and underground detonations, two M26 tanks, in which E26 collective protectors were installed, were exposed. At the underground detonation, a T18E1 personnel carrier equipped with an E26 protector was exposed.

During the detonations the vehicles were stationary and not manned. At the surface detonation, the two tanks were located 2,000 feet upwind (southeast) of Ground Zero, with all crew hatches open. One tank faced the blast with engines running; the other tank was parked with one side exposed to the blast and with engines not operating.

During the underground detonation, the two tanks and the personnel carrier were situated 2,000 feet downwind (northwest) of Ground Zero. One tank and the personnel carrier faced toward Ground Zero, with engines running and hatches open. One tank was parked with a side toward the blast, with engines off and hatches closed.

Shortly after each detonation, the effluent air filter samples were removed to the laboratory on the test site for counting of radioactivity. The influent particulate filters from the air purifier and the M10A1 canisters were transported to the Army Chemical Center, Maryland, where radioactivities were determined and calculations were made.

3.2.2 Tank Collective Protector E22

One type of apparatus (Fig. 3.3), used in determining filter efficiencies of the E22 tank collective protectors consisted of an adapter, a filter pack made up of one layer of Chemical Corps Type 6 paper and two layers of Chemical Corps Type 5 paper, and a blower to draw the sample through the filter. The rate of flow through the filter unit was 3 cfm, while the capacity of the collective protector was 18 - 19 cfm. The excess air passed through the vents in the adapter. Three collective protectors were tested with this type apparatus at 4,000 feet from Ground Zero.

The second type of apparatus is diagrammatically illustrated in Fig. 3.4. The apparatus consisted of a shielded Geiger-Mueller tube and an electronic circuit to measure and record instantaneously the level of radioactivity in the effluent of the collective protector. A filter sampler similar to the first apparatus was included in this type sampler. A separate Geiger-Mueller tube and electronic circuit were

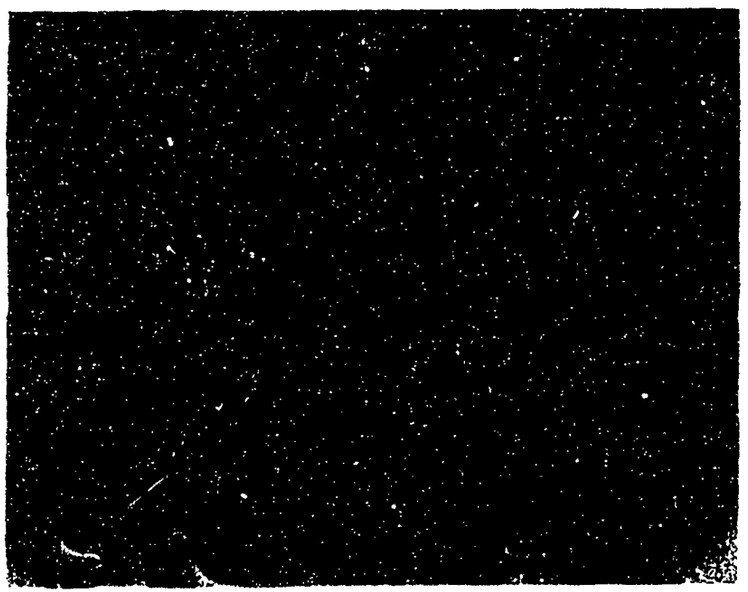


Fig. 3.1 Three Man, E26 Tank Collective Protector (Air Purifier) Evaluated in Stationary and Mobile M26 Tanks and T18E1 Personnel Carrier During the Surface and Underground Detonations. A. Carrier for Protective Mask. B. Tank Protective Mask, E39. C. M10 Canister. D. E26 Tank Collective Protector. E. Test Filter, Chemical Corps Type 6.

Fig. 3.2 Turret Compartment Crew wearing Tank Masks connected by Hoses to a Three-Man, E26 Tank Collective Protector mounted inside an M26 Tank.

A. M10A1 Canister connected in series between Tank Mask and Tank Collective Protector Filter; B. Tank Mask Holder; C. Tank Mask

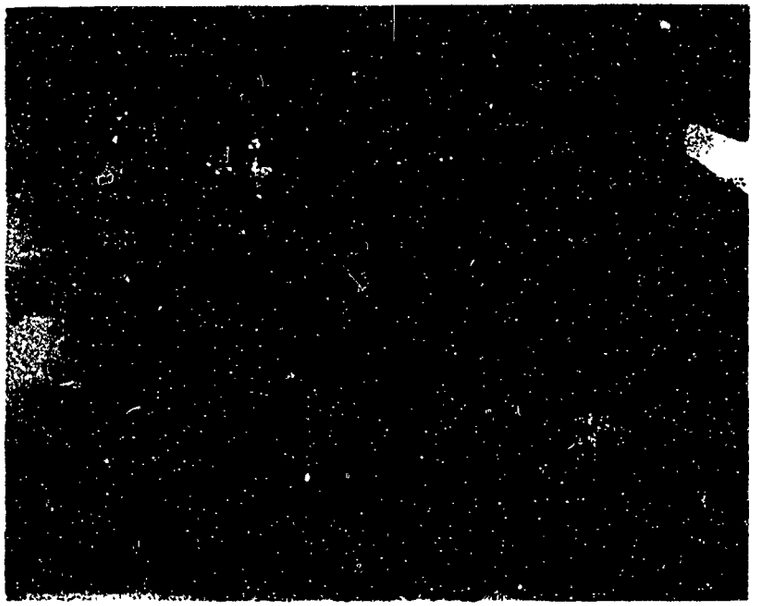
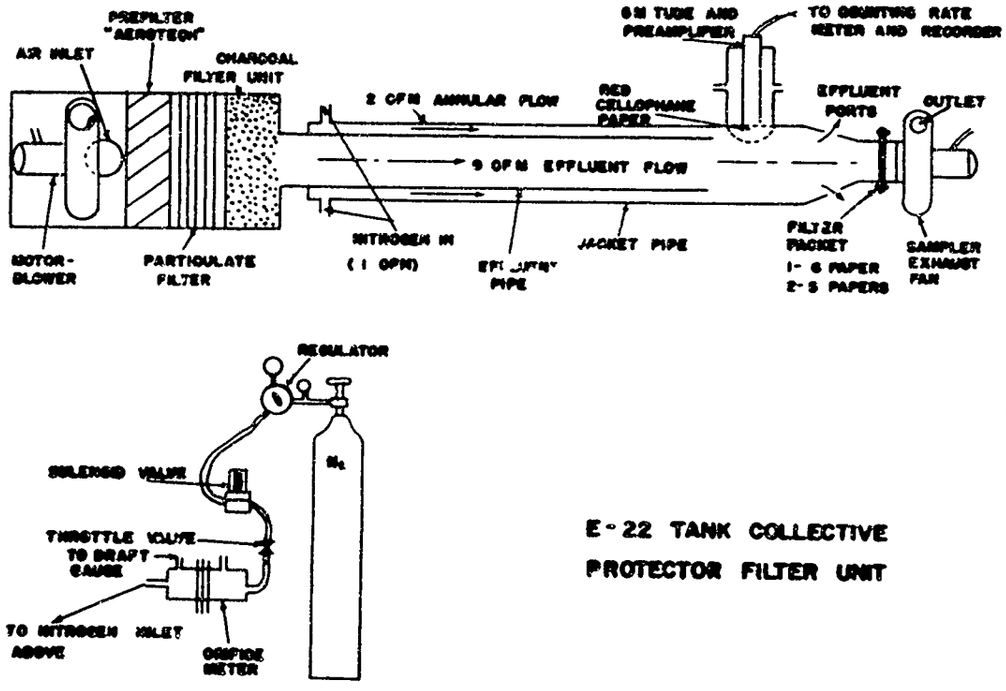


Fig. 3.3 E22 Tank Collective Protector Filter Efficiency Evaluation Unit Mounted on Platforms at Stations 13, 14 and 15, respectively, 4,000 feet from Ground Zero and Operating during Surface Detonation

A. E22 Tank Collective Protector Filter unit, consisting of electrically-operated blower, centrifugal separator for large particles, pleated Chemical Corps Type 6 Paper Filter, and Charcoal Filter connected in Series. B. Filter Packet, composed of one layer of Type 6 and two layers of Type 5 Chemical Corps Filter Paper mounted in series. C. Exhaust Fan and Motor for drawing air sample aliquot through above filter packet. D. 24 volt Air Force Batteries used to operate above exhaust fan and Tank Collective Protector Filter Unit. E. Platform. F. Ports to release excess air from Tank Collective Protector Unit.



E-22 TANK COLLECTIVE PROTECTOR FILTER UNIT

Fig. 3.4 Diagram of Apparatus for Measuring the Filter Efficiency of an E22 Tank Collective Protector

used to measure and record the instantaneous background at each station. Three of the instantaneous recording units were used at 20,000 feet from Ground Zero.

Five minutes before the surface detonation, the six test units were started by a timing signal and relay system. After two hours, the units were stopped by a preset timing device. The filter paper samples were collected approximately four to six hours after the detonation and were transported in individual plastic bags for counting at the laboratory operated by the National Institute of Health at the test site.

3.3 TEST RESULTS

3.3.1 Tank Collective Protectors E26 in Armored Vehicles

During the surface detonation, the level of radioactivity near the tanks was too low to permit determination of radiometric filter efficiencies of the E26 protectors. Radiation from the protectors was negligible.

After the underground detonation the radiometric filtering efficiencies of the particulate filters in the E2 air purifier were calculated from the following formula:

$$\text{Efficiency} = 100 \frac{d/m_1}{d/m_1 + d/m_2 + d/m_3 \ldots + d/m_n} \qquad (3.1)$$

where d/m is the counting rate of activity collected corrected to identical geometry conditions. This formula holds true only in the event that the penetration of the last layer is negligible. The efficiency of the M10A1 canister, as previously evaluated, is high enough that this assumption is reasonable[7]. The amount of dust retained between the particulate filter and the canister is negligible also. Therefore, formula 3.1 above can be simplified to:

$$\text{Efficiency} = 100 \frac{A}{A + B} \qquad (3.2)$$

where A = total corrected activity on particulate filter

where B = total corrected activity on M10A1 canister

The values of total corrected activity on the influent particulate filter are given in Table B.2. The total corrected activities of the M10A1 canisters are given in Table B.3. The efficiencies, given

in Table B.1 are well over 99.9%. The radiations, as measured by a Tracerlab laboratory monitor, from the components of the three collective protectors are given in Tables B.4, B.5, and B.6.

3.3.2 Tank Collective Protector E22, Platform Mounted

The filter efficiencies of the E22 tank protectors 4,000 feet downwind from the surface detonation are given in Table B.7. The influent concentration at one station was not determined because the sampler, a part of the Project 2.5a apparatus, jammed the counter. The radiometric filter efficiencies of the other two were 89.8 and 98.9% respectively.

The instantaneous radiometric readings from one of the test units at 20,000 feet from Ground Zero are given in Table B.8. The efficiency calculations are given in Table 3.1. Data were not obtained from the other two units. In one case, the background was so high that the electronic recorders went off scale, and at the other station, the paper on the electronic recorder slipped, causing unreliable readings.

3.4 DISCUSSION OF RESULTS

The indicated high radiometric filtering efficiency of the particulate filter in the E26 Collective Protector, coupled with the high efficiency of the M10A1 Canister, indicates that the E26 Protector is quite satisfactory for protection of vehicle crews against the inhalation and ingestion of radioactive dust. The tanks were not located in the area of greatest contamination, but the contamination was great enough to make the test conclusive.

The filter efficiencies for the E22 tank collective protectors served to verify the results of the tests on the E26 models, giving efficiencies of the same magnitude. The results of the tests indicate that both the instantaneous recording and filter pack apparatus provide adequate means of determining the filtering efficiencies of devices similar to the tank collective protector.

3.5 CONCLUSIONS

1. The E26 Tank Collective Protector furnishes adequate protection against the inhalation of radioactive dust resulting from the detonation of an atomic bomb.

2. The instantaneous recording method and the filter pack method are both satisfactory means of determining filtering efficiencies of devices similar to the tank collective protector.

TABLE 3.1

Calculation of Filter Efficiency of E22 Tank Collective Protector at Station 35, 20,000 ft NNE and Downwind from Surface Detonation

1. Average Reading* of Instantaneous Effluent (H+1 hr)	24 CPM
2. Time that Particulate Cloud was Over Station 35	13 minutes
3. Volume of Effluent Air Seen by GM Tube	0.5 cuft.
4. Geometry of GM Tube	50 %
5. Rate of Flow of Air Past GM Tube	9.0 CFM
6. Activity of Influent Filter Paper Corrected for Time, Geometry, Flow and Background	14.13×10^5 CPM

$$\% \text{ Filter Efficiency} = 100 \left[\frac{14.13 \times 10^5}{14.13 \times 10^5 + \frac{(24)(9)(13)}{(.50)(0.5)}} \right]$$

$$= 99.09\%$$

* See Table B.6, Appendix B

CHAPTER 4

CONTAMINATION OF M5 INDIVIDUAL PROTECTIVE OINTMENT[10]

4.1 INTRODUCTION

4.1.1 Objective

The object of this phase of Project 6.3 was to compare the contaminability of aluminum panels coated with M5 Protective Ointment with the contaminability of bare panels when exposed to the surface and underground detonations of atomic bombs, in order to obtain information relative to the contaminability of skin coated with M5 ointment.

4.1.2 Historical

The M5 Protective Ointment, a chloramide, was developed as an aid in the protection and decontamination of skin exposed to vesicant chemical warfare agents, particularly the mustard gases.

4.2 EXPERIMENTAL PROCEDURE

The samples for this test consisted of 2-1/2" x 3" plates of 18 gage aluminum. At each station, one horizontal and one vertical plate were coated with ointment, and an uncoated control plate was mounted beside each sample. Forty-six stations were located at distances from 2,000 to 50,000 feet from Ground Zero. Additional panels were mounted on two M26 tanks and a T18E1 Personnel Carrier. During both shots, the armored vehicles were stationary, but after the underground detonation new panels were mounted and the vehicles were driven past the surface crater.

The panels were removed approximately four hours after each detonation and were flown to the Army Chemical Center, Maryland, where radioactivity was measured by a Geiger-Mueller tube and scaler. The activities were calculated to H + 1 hour, using the decay factors of Figure 1.1.

4.3 TEST RESULTS

The results of radioactivity measurements on the panels mounted on the armored vehicles show that in every case, the corrected activity of the corresponding uncoated control panel.

The greatest contamination was found at 30,000 feet downwind from Ground Zero, in the path of the greatest radioactive fall-out. This contamination was 60 microcuries per square centimeter at H + 1 hour on the horizontal panel. The lightest contamination was found on the upwind panels.

4.4 DISCUSSION OF RESULTS

As the ointment on the aluminum panels was quite viscous due to low temperature at the time of the shots, the number of radioactive particles retained on the samples was probably smaller than would be retained by ointment on a warm surface such as human skin.

4.5 CONCLUSIONS

1. Ointment-coated aluminum panels definitely collect and retain more radioactivity than do bare aluminum panels.

2. It can be concluded from the results of the panel tests that radiological contaminability of human skin exposed to atomic detonation would be increased by use of M5 Protective Ointment.

APPENDIX A

TABLE A.1

Decontamination Data Sheet

Pounds 51

Date 24 Nov 51 Water B. G. 1045 cpm Type Load Cml C Impregnated

Step	Operation	Water Level (in.)	Temp. °F.	Time	Supplies	pH	Solution Activity - CPM		
						Lab.	Raw	True	Adjusted 8" Water
1	Suds	5	90 100	5	General Aniline Det. 6 oz.	7.9	55,106	54,061	35,680
2	Suds	5	130	5	General Aniline Det. 3 oz.	8.5	25,654	24,607	16,242
3	Suds	5	140	5	General Aniline Det. 2 oz.	8.5	13,508	12,463	8,226
4	Rinse	8	140	3	---	8.2	7,450	6,405	6,405
5	Rinse	8	120	3	---	8.1	5,150	4,105	4,105
6	Rinse	8	100	3	---	8.1	4,338	3,293	3,293
									73,951

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APPENDIX A

TABLE A.2

Decontamination Data Sheet

Pounds 31

Date 24 Nov 51 Water B. G. 1034 GPM Type Load Cal C Unimpregnated

Step	Operation	Water Level (in.)	Temp. °F	Time	Supplies	pH	Solution Activity - CPM		
						Lab.	Raw	True	Adjusted 8" Water
1	Suds	5	90 100	5	General Aniline Det. 6 oz.		25,596	24,292	16,033
2	Suds	5	130	5	General Aniline Det. 3 oz.		10,070	8,766	4,786
3	Suds	5	140	5	General Aniline Det. 2 oz.		5,374	5,070	3,346
4	Rinse	8	140	3	---		2,320	1,016	1,016
5	Rinse	8	120	3	---		1,890	586	586
6	Rinse	8	100	3	---		1,828	524	524

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APPENDIX A

Table A.3 (See Fig. 1.5)

Contamination of Protective Clothing Worn by Men Walking One Hour in Contaminated Areas of Surface Shot at H + 6 Hours

Man	Clothing of Team #1 (See Fig. B.1.11)	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
#1	Laundered HBT Coverall	0.16 mr/hr
	Gloves, Cotton	1.36
	Undershirt, Cotton	0.01
	Drawers, Cotton	0.01
	Socks, Cotton	0.04
	Boots	1.09
	Helmet, Steel	0.18
	Gas Mask, M9A1	0.25
#2	Impregnated HBT Coverall	0.30
	Gloves, Cotton, Impregnated	0.88
	Undershirt, Cotton, Impregnated	0.04
	Drawers, Cotton, Impregnated	0.00
	Socks, Cotton, Impregnated	0.33
	Boots, Impregnated	0.02
	Helmet	0.17
	Gas Mask, M9A1	0.32

APPENDIX A

Table A.3 (Cont'd)

Man	Clothing of Team #1 (See Fig. B.1.11)	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
#6	Cotton-Sateen Coverall	0.16
	Gloves, Cotton	0.47
	Undershirt, Cotton	0.01
	Drawers, Cotton	0.01
	Socks, Cotton	0.00
	Boots	0.50
	Helmet	0.17
	Gas Mask, M9A1	0.22
	Clothing of Team #2	
#1	Impregnated HBT Coverall	0.29
	Impregnated Gloves, Cotton	0.02
	Impregnated Cotton Undershirt	0.03
	Impregnated Cotton Drawers	0.02
	Impregnated Socks, Cotton	0.00
	Impregnated Boots	0.04
	Helmet	0.17
	Gas Mask, M9A1	0.07
#2	Laundered, Impregnated HBT Coverall	0.22
	Cotton, Impregnated Gloves	0.02

APPENDIX A

Table A.3

Man	Clothing of Team #2 (See Fig. B.1.11)	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
Cont'd #2	Cotton, Impregnated Undershirt	0.03
	Cotton, Impregnated Drawers	0.03
	Cotton, Impregnated Socks	0.03
	Boots, Impregnated	0.04
	Helmet	0.17
	Gas Mask (not worn)	-
	Clothing of Team #3	
#1	Laundered, HBT	0.01
	Cotton Gloves	0.06
	Cotton Undershirt	0.00
	Cotton Drawers	0.00
	Cotton Socks	0.00
	Boots	0.04
	Helmet	0.04
	Gas Mask, M9A1	0.05
#2	Impregnated HBT Coverall	0.01
	Impregnated Cotton Gloves	0.08
	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.00
	Impregnated Cotton Socks	0.00

APPENDIX A

Table A.3 (Cont'd)

Man	Clothing of Team #5	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
Cont'd #2	Impregnated Boots	0.07
	Helmet	0.05
	Gas Mask, M9A1	0.05
#3	Laundered, Impregnated HBT Coverall	0.00
	Impregnated Cotton Gloves	0.04
	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.00
	Impregnated Cotton Socks	0.01
	Impregnated Boots	0.05
	Helmet	0.01
	Gas Mask, M9A1	0.04
#4	Cotton-Sateen Coverall	0.02
	Cotton Gloves	0.04
	Cotton Undershirt	0.01
	Cotton Drawers	0.00
	Cotton Socks	0.01
	Boots	0.04
	Helmet	0.05
	Gas Mask, M9A1	0.06

APPENDIX A

Table A.3 (Cont'd)

Man	Clothing of Team #6	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
#1	Laundered HBT Coverall	0.08
	Cotton Gloves	0.36
	Cotton Undershirt	0.01
	Cotton Drawers	0.01
	Cotton Socks	0.01
	Boots	2.31
	Helmet	0.08
	Gas Mask	0.11
#2	Impregnated HBT Coverall	0.07
	Impregnated Cotton Gloves	0.98
	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.00
	Impregnated Cotton Socks	0.01
	Impregnated Boots	8.65
	Helmet	0.14
	Gas Mask, M9A1	0.13
#3	Laundered, Impregnated HBT Coverall	0.25
	Impregnated Cotton Gloves	0.88
	Impregnated Cotton Undershirt	0.01

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Table A.3 (Cont'd)

Man	Clothing of Team #4	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
Cont'd #5	Impregnated Cotton Drawers	0.01
	Impregnated Cotton Socks	0.01
	Impregnated Boots	1.80
	Helmet	0.38
	Gas Masks, M9A1	0.38
	Clothing of Team #6	
#1	Laundered HBT Coverall	0.00
	Cotton Gloves	0.02
	Cotton Undershirt	0.01
	Cotton Drawers	0.00
	Cotton Socks	0.00
	Boots	0.00
	Helmet	0.00
	Gas Mask, M9A1 (not measured)	-
#2	Impregnated HBT Coverall	0.00
	Impregnated Cotton Gloves	0.03
	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.00
	Impregnated Cotton Socks	0.00
	Impregnated Boots	0.04

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Table A.3 (Cont'd)

Man	Clothing of Team #6	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
Cont'd #2	Helmet	0.02
	Gas Mask	0.04
#3	Laundered Impregnated HBT Coverall	0.01
	Impregnated Cotton Gloves	0.04
	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.01
	Impregnated Cotton Socks	0.00
	Impregnated Boots	0.04
	Helmets	0.02
	Gas Mask, M9A1	0.05
	Clothing of Team #6	
#1	Laundered HBT Coverall	0.00
	Cotton Gloves	0.01
	Cotton Undershirt	0.00
	Cotton Drawers	0.01
	Cotton Socks	0.00
	Boots	0.01
	Helmet	0.03
	Gas Mask, M9A1	0.03
#2	Impregnated HBT Coverall	0.00
	Impregnated Cotton Gloves	0.00

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Table A.3 (Cont'd)

Man	Clothing of Team #6	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
Cont'd #4	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.01
	Impregnated Cotton Socks	0.05
	Impregnated Boots	0.04
	Helmet	0.05
	Gas Mask, M9A1	0.05
#5	Laundered Impregnated HBT Coverall	0.02
	Impregnated Cotton Gloves	0.03
	Impregnated Cotton Undershirt	0.01
	Impregnated Cotton Drawers	0.01
	Impregnated Cotton Socks	0.02
	Impregnated Boots	0.06
	Helmet	0.03
	Gas Mask, M9A1	0.04
#6	Cotton-Sateen Coverall	0.05
	Cotton Gloves	0.01
	Cotton Undershirt	0.00
	Cotton Drawers	0.00
	Cotton Socks	0.00
	Boots	0.02

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APPENDIX A

Table A.3 (Cont'd)

Man	Clothing of Team #6	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
Cont'd #4	Helmet	0.02
	Gas Mask, M9A1	0.04
	Clothing of Team #7	
#1	Laundered HBT Coverall	0.03
	Cotton Gloves	0.01
	Cotton Undershirt	0.01
	Cotton Drawers	0.00
	Cotton Socks	0.00
	Boots (not measured)	-
	Helmet (not measured)	-
	Gas Mask, M9A1 (not measured)	-
#2	Impregnated HBT Coverall	0.00
	Impregnated Cotton Gloves	0.01
	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.00
	Impregnated Cotton Socks	0.00
	Impregnated Boots	0.00
	Helmet	0.00
	Gas Mask, M9A1	0.03
#3	Laundered Impregnated HBT Coverall	0.00
	Cotton Gloves	0.00

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Table A.3 (Cont'd)

Man	Clothing of Team #7	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
Cont'd #6	Cotton Undershirt	0.01
	Cotton Drawers	0.00
	Cotton Socks	0.00
	Boots	0.00
	Helmet	0.00
	Gas Mask, M9A1	0.03
	Clothing of Team #8	
#1	Laundered HBT Coverall	0.00
	Cotton Gloves	0.00
	Cotton Undershirt	0.01
	Cotton Drawers	0.01
	Cotton Socks	0.02
	Boots	0.09
	Helmet	0.07
	Gas Mask, M9A1	0.04
#2	Impregnated HBT Coverall	0.00
	Impregnated Cotton Gloves	0.08
	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.00
	Impregnated Cotton Socks	0.00
	Impregnated Boots	0.21

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APPENDIX A

Table A.3 (Cont'd)

Man	Clothing of Team #8	Ave. Readings on PR-3 Survey Meter at 6" @ H + 26 hours
Cont'd #2	Helmet	0.08
	Gas Mask, M9A1	0.04
#3	Laundered Impregnated HBT Coverall	0.00
	Impregnated Cotton Gloves	0.07
	Impregnated Cotton Undershirt	0.00
	Impregnated Cotton Drawers	0.00
	Impregnated Cotton Socks	0.04
	Impregnated Boots	0.14
	Helmet	0.06
	Gas Mask, M9A1	0.01

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APPENDIX A

TABLE A.4 (See Fig. 1.6)

Contamination of Protective Clothing Worn by Men Walking in Contaminated Area of Underground Shot

No. Men	Performance	Article of Clothing	Ave. Reading PR-3 Survey Meter at 6" @ H + 124 hrs corrected for background
3	Walked, Crawled	Impregnated Cotton-Sateen Coverall	2.60 mr/hr
	" "	Impregnated Cotton Gloves	3.70
	" "	Impregnated Cotton Undershirts	0.00
	" "	Impregnated Cotton Drawers	0.00
	" "	Impregnated Cotton Socks	0.12
	" "	Impregnated Boots	2.50
	" "	Helmet	0.23
	" "	Gas Mask, M9A1	0.37
1	" "	Unimpregnated Cotton Sateen	0.60
	" "	Cotton Gloves	0.70
	" "	Cotton Undershirt	0.04
	" "	Cotton Drawers	0.10
	" "	Cotton Socks	0.17
	" "	Boots	0.70
	" "	Helmet	0.20
	" "	Gas Mask, M9A1	0.25
4	" "	Impregnated HBT Coveralls	2.94
	" "	Impregnated Cotton Gloves	2.90
	" "	Impregnated Cotton Undershirts	0.00

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APPENDIX A

TABLE A.4 (Cont'd)

Contamination of Protective Clothing Worn by Men Walking in Contaminated Area of Underground Shot

No. Men	Performance	Article of Clothing	Ave. Reading PR-3 Survey Meter at 6" @ H + 124 hrs corrected for background
4	Walked, Crawled	Impregnated Cotton Drawers	0.00 mr/hr
	" "	Impregnated Socks	0.00
	" "	Impregnated Boots	2.00
	" "	Helmets	0.20
	" "	Gas Mask, M9A1	0.45
1	" "	Laundered HBT Coverall	0.60
	" "	Cotton Gloves	0.80
	" "	Cotton Undershirts	0.00
	" "	Cotton Drawers	0.00
	" "	Cotton Socks	0.00
	" "	Boots	1.00
	" "	Helmets	0.30
	" "	Gas Mask, M9A1	0.20
5	" "	Impregnated Cotton-Sateen Coveralls	0.28
	" "	Impregnated Cotton Gloves	0.56
	" "	Impregnated Cotton Undershirts	0.00
	" "	Impregnated Cotton Drawers	0.00
	" "	Impregnated Cotton Socks	0.05
	" "	Impregnated Boots	0.53

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APPENDIX A

TABLE A.4 (Cont'd)

Contamination of Protective Clothing Worn by Men Walking in Contaminated Area of Underground Shot

No. Men	Performance	Article of Clothing	Ave. Reading PR-3 Survey Meter at 6" @ H + 124 hrs corrected for background
5	Walked, Crawled	Helmets	0.12 mr/hr
	" "	Gas Masks, M9A1	0.09
1	" "	Cotton-Sateen Coverall	0.23
	" "	Cotton Gloves	0.80
	" "	Cotton Undershirts	0.00
	" "	Cotton Drawers	0.00
	" "	Cotton Socks	0.00
	" "	Boots	0.50
	" "	Helmet	0.10
	" "	Gas Mask, M9A1	0.00
4	Walking	Impregnated HBT Coveralls	0.43
	"	Impregnated Cotton Gloves	0.62
	"	Impregnated Cotton Undershirts	0.00
	"	Impregnated Cotton Drawers	0.00
	"	Impregnated Cotton Socks	0.01
	"	Impregnated Boots	0.65
	"	Helmets	0.17
	"	Gas Masks, M9A1	0.17
1	"	HBT Coverall, Laundered	0.30

PROJECT 6.3-1

APPENDIX A

TABLE A.4 (Cont'd)

Contamination of Protective Clothing Worn by Men Walking in Contaminated Area of Underground Shot

No. Men	Performance	Article of Clothing	Ave. Reading PR-3 Survey Meter at 6" @ H + 124 hrs corrected for background
1	Walking	Cotton Gloves	0.20 mr/hr
	"	Cotton Undershirt	0.00
	"	Cotton Drawers	0.00
	"	Cotton Socks	0.00
	"	Boots	0.77
	"	Helmets	0.10
	"	Gas Mask, M9A1	0.30

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APPENDIX B

TABLE B.1

Radiometric Filter Efficiencies of E26 Tank Collective Protectors in Underground Detonation

		(A) *Total Corrected Activity on Part. Filt. @ H + 2200 hours	(B) **Total Corrected Activity on M-10 Canister @ H + 2200 hours	$100(\frac{A}{A+B})$ Filter Efficiency in Per Cent (Radiometric)
VEHICLE NO.	POSITION			
M-26 Tank 418S	In Hull	429 uc	4×10^{-2} uc	99.991
M-26 Tank 418S	In Turret	440	16×10^{-2}	99.964
M-26 Tank 424S	In Hull	231	2×10^{-2}	99.989
M-26 Tank 424S	In Turret	298	3×10^{-2}	99.990
T-18E1 Personnel Carrier	Inside	434	11×10^{-2}	99.975
			Average	99.982

* See Table B.2 for source of above figures

** See Table B.3 for source of above figures

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APPENDIX B

TABLE B.2

Activities of Particulate Filters in Influent Stream of E-26 Tank Collective Protectors from Underground Detonation

Vehicle Number	Position	(A) CPM of 2" dia. circles at H+2200 hrs corrected for geom. & background	Time of Measurement	(B) (A x 183) CPM of Total Area of Filter Corrected	(C) *$\frac{B}{(3.70 \times 10^4)}$ Activity of filter in uc @ H + 2200 hrs
M-26 418S	In Hull	96,734	H+2200 hrs	1.587×10^7	429
M-26 418S	In Turret	88,655	H+2200 hrs	1.621×10^7	440
M-26 424S	In Hull	46,803	H+2200 hrs	8.57×10^6	231
M-26 424S	In Turret	60,225	H+2200 hrs	1.102×10^7	298
T18E1 Personnel Carrier	Inside	87,657	H+2200 hrs	1.603×10^7	434

* See Table 3.1 for calculation of filter efficiencies of E-26 tank collective protectors

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APPENDIX B

**TABLE B.3

Activities of M-10 Canisters in Effluent Streams of M-26 Tank Collective Protectors in Underground Detonation

Vehicle Number	Position	(A) Ave. CPM on 2" dia. circle corrected for background	(B) (A) (10) CPM corrected for geometry	(C) (51.3) (B) CPM corrected for geom. and area	Time	*(D) Decay Factor correct to H+2200 hrs	(E) (C) (D) 3.7×10^4 Total Activity in uc at H+2200 hrs
M-26 Tank 4185	In Hull	6	60	3,100	H + 1128 hrs	.45	4×10^{-2}
M-26 Tank 4188	In Turret	36	360	18,500	H + 864 hrs	.32	1.6×10^{-1}
M-26 Tank 4248	In Hull	4	40	2,000	H + 1130 hrs	.45	2×10^{-2}
M-26 Tank 4249	In Turret	6	60	3,100	H + 960 hrs	.37	3×10^{-2}
T18E1 Personnel Carrier	Inside	19	190	9,800	H + 1056 hrs	.41	1.1×10^{-1}

* Decay factors obtained from curve in Fig. 1.5

** See Table B.1 for calculation of filter efficiency of M-26 tank collective protectors

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APPENDIX B

TABLE B.4

Radiation Hazard Results of E-26 Tank Collective Protectors in #18, M-26 Tank During Underground Detonation

Point of Measurement Tank No. 18	Radioactivity** in counts per minute 3 H + 1 hour			
	Turret #44		Hull #49	
	Surface	6" Away	Surface	6" Away
Aerotech End	746×10^6	280×10^6	652×10^6	326×10^6
Aerotech End w/o Baffle Plate	3110	562	3110	777
Intake side (4 slots)	1201	209	1470	244
Side opposite intake	592	179.8	735	204
Wide sides	812	219	940	244
End w/3-hose connections	484	123.3	735	204
Particulate Filter Inlet	11,400	2,860	13,100	3,260
Particulate Filter Effluent	8,280	2,070	9,320	2,330
Charcoal Filter Inlet *	37.5	28.0	11.43	6.44
Charcoal Filter Effluent *	95.3	60.8	155	73.5

* After radioactive dust was wiped from charcoal holder, readings on charcoal filter were the same as background.

** As measured by Tracerlab Laboratory Monitor.

APPENDIX B

TABLE B.5

Radiation Hazard Results of E-26 Tank Collective Protectors in #24, M-26 Tank During Underground Detonation

Point of Measurement Tank No. 24	Radioactivity** in counts per minute @ H + 1 hour			
	Turret #46		Hull #47	
	Surface	6" Away	Surface	6" Away
Aerotech End	406×10^6	207×10^6	278×10^6	251×10^6
Aerotech End w/o Baffle Plate	3,910	577	2,140	371
Intake side (4 slots)	748	137.5	577	139.5
Side opposite intake	530	119.0	371	111.6
Wide sides	640	145.1	464	139.5
3-Hose Connection End	437	211	186.0	111.5
Particulate Filter Inlet	10,630	2,660	4,170	1,118
Particulate Filter Effluent	7,170	3,490	7,440	1,470
Charcoal Filter Inlet *	28.2	---	9.3	---
Charcoal Filter Effluent *	162.6	---	27.8	---

* After radioactive dust was removed from charcoal holder, readings on charcoal filter were the same as background.

** As measured by Tracerlab Laboratory Monitor.

APPENDIX B

TABLE B.6

Radiation Hazard Results of E-26 Tank Collective Protector in T18E1 Personnel Carrier During Underground Detonation

Point of Measurement	Radioactivity** counts per minute @ H+1 hour - #50 Troop Compartment	
	Surface	6" Away
Aerotech End	884×10^6	178.7×10^6
Aerotech End w/o Baffle Plate	4220	422
Intake Side (4 slots)	1420	249
Side opposite intake	615	130.7
Wide Sides	1173	219
3-Hose connection end	442	159.5
Particulate Filter Inlet	10,960	2,760
Particulate Filter Effluent	7,680	1,825
Charcoal Filter Inlet *	50.0	36.4
Charcoal Filter Effluent *	863	50.0

* After radioactive dust was wiped from Charcoal holder, readings on Charcoal were the same as background.

** As measured with Tracerlab Laboratory Monitor.

APPENDIX B

TABLE B.7

Filter Efficiencies of E-22 Tank Collective Protectors at 4,000 Feet Downwind from the Surface Detonation

Station Number	Direction from Ground Zero	Counts per Minute @ H + 24 hours Influent A	Effluent B	Filter Efficiency in Per Cent $100\left(\frac{A}{A+B}\right)$
13	NW	Jammed	541,800	---
14	N	106,630	12,153	89.77
15	NE	48,530	551	98.88

TABLE B.8

Instantaneous Radiometric Effluent Readings of E-22 Tank Collective Protector at Station 35, 20,000 Feet NNE and Downwind from Surface Detonation

Time that Particulate Cloud was Over Station #35 was 13 Minutes

Time of Reading	Counts per Minute Effluent	Background	Difference
H + 90 minutes	470	444	26
H + 91 minutes	340	330	10
H + 93 minutes	315	288	27
H + 94 minutes	264	240	24
H + 95 minutes	445	420	35
		Ave.	24 C.P.M.

See Table 3.1

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