Part I. The Monitoring and Decontamination of Personnel - J. Austin

1. Introduction

The RH Group control system was devised to enable staff to make sorties into the radio-active areas following the Totem detonations. The part under RH5 control comprised the issue of protective clothing, provision of charging facilities and assistance with dressing, and the monitoring, undressing and decontamination of personnel on their return from active areas.

2. Layout of the System

The basic arrangement of the system was fixed at an early stage in the trials preparation, but there were considerable deviations from the original layout. The actual layout of tents and their contents is best shown by reference to the drawings appended to the report. (Figures 1 to 3).

3. Preparations

During the initial stages of the operations, in addition to the assembly of stores, preparations were made to prevent spread of radio-active material. The tent floors were covered with bitumenised paper, which, if contaminated, could be removed. All table and bench tops were covered with P.V.C. sheeting, to facilitate decontamination. Even with the low contamination encountered, the latter measure proved useful, though the former turned out to be unnecessary.

4. Operation of Each Stage in the System (Reference in Brackets are to Sites in Figure 1)

4.1 Clothing Issue (A 17)

A party proceeding to the active area entered RH5 at the clothing store. They had already been briefed by the Health Controller and issued with the necessary dosimeters and instruments. The controller had also broadcast the list of names to RH5. At the clothing store* each man passed along the counters and was issued with the following items:- an aertex undersuit, rubber gloves, a hood, sweat-rag, combination oversuit, respirator with filter and anti-dim outfit, socks and short rubber boots already fitted with white cotton overboots. The storeman, after training, was found capable of estimating quickly the correct sizes and took roughly 30 seconds to complete each issue. When a very large party such as that for rocket recovery was expected, the storemen was assisted by two other RH5 personnel and issue was very rapid. This speed of issue was possible only by carefully preparing the stocks in a convenient position, for instance, by previously fitting the cotton over and placing socks ready inside the boots.

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*See Part III

4.2 Dressing (A 18)

The parties changed into protective clothing in this tent. The dressing was done under RH5 supervision whenever necessary, most persons requiring some guidance and assistance, at least on their first sortie. When ready, the party were checked to ensure that they were correctly dressed and then they moved out across the barrier to their vehicle.

4.3 Reception and Preliminary Monitoring (A 21)

On returning, a party left their vehicle at the car-park, deposited equipment at the store tent and entered health control at A21. Firstly dosimeters and film badges were handed to an RH5 attendant, who recorded the arrival of each man on a prepared list. The respirator filters were removed, marked and sent to RH4 who wished to investigate the quantity of radio-activity drawn into the filter. Each man was very briefly monitored by a second attendant and the highest level on head, body and feet recorded, the hood, suit and overshoes being marked if active, with either red or green chalk to indicate the level of the activity.

4.4 Undressing Procedure(A22)

Two undressers carried out this operation in accordance with a special technique designed to prevent activity being transferred from the outside of the clothing to the mens' skin or underclothing. As they were removed, the garments were sorted according to the chalk marks into bins for highly active items, items of low activity or inactive items. This sorting was required before clothing could be despatched for laundering, since the inactive clothes went to the normal Woomera laundry while the low activity batch was sent to a special radio-active laundry. If too active, the garments were stored pending final disposal. Tolerance levels for clothes sorting were varied with time after each detonation, and calculated so that by the time articles were unpacked at Woomera they would have decayed to a level considered safe for handling under the existing condition*.

4.5 Pre-shower monitoring (A23)

This stage was designed to record the extent to which activity penetrated the protective clothing and to make possible an assessment of the efficiency of a number of decontamination mixtures which were available in the showers. It would have enabled personnel to be told of any high-spots which would require special attention in the showers. However, no significant activity penetrated the clothes and the only activity detected at this stage was in the hair of some who had not worn hoods. Bins were provided for underclothes and socks removed before entering the showers.

4.6 Showers (A27)

These were of raw, cold, highly saline water. Soap was used with difficulty and most people preferred the anionic detergent "Teepol". No more drastic reagents were required during the trial, though special creams, pastes and solutions for potassium permanganate treatment had been prepared

4.7 Final Monitoring (A28)

After drying, attendants monitored each person using a monitor type 1021 and as the final stage, the hand and foot monitor type 1027 was used. Operations were watched by an RH5 attendant who authorised those who were free of radio-activity to return to the clean change tent,

where drinking water was supplied. In a few cases hair remained active and such personnel were sent back to re-shower until clear. The 1027 monitor proved to be influenced by the high background which was occasionally found at the site generally. At most times it proved quite reliable, and by exercise of rigid control on personnel, sources, and active equipment, this high background could be avoided.

5. RH5 Staff

RH5 was staffed by ten Australian servicemen, who were available for training on R day and then again on D1-1. One man, a Sapper, proved much superior to the others in keenness and intelligence and was made supervisor in the final monitoring stage while the only N.C.O. took charge of A21. On the whole the men carried out well the more routine procedures but required much supervision, most of them being unused to undertaking tasks on their own initiative.

The N.C.O. and one man in A21, in addition to receiving and monitoring the sorties, opened up the film-badge outer wrappings for RH3, sorted gloves for re-issue, removed used overboots from boots and monitored the boots.

The two undressers were, in addition, responsible for returning non-active clothing to the storeman, disposing of very active items and packing slightly active clothing in sealed bags for transport to the active laundry.

The two staff in A23 acted as dressers in A18 when possible, as did the three men from A28. They also assisted the storeman in packing non-active laundry.

6. Number and Activity Levels of Personnel

During the period D1 to D1+11, 336 persons made sorties into the forward area, the highest total in one day being 55 on D1. From D2 to D2+9, 246 persons passed through the organisation.

On the outgoing side it has been mentioned that clothing issue was quick; while dressing, of course, rather depended on the persons concerned, but could be easily achieved in 10 minutes if the person dressing was familiar with the clothing. The time to come through RH5 from the car-park back to the clean-change tent varied considerably but two persons were known to have completed this in 8 minutes, on the other hand one man, being the last of about 24 who all arrived back together, took 25 minutes. On the whole, no obvious bottleneck held up progress, for two persons at a time could pass each stage except initial reception, while provision was made for four showering at one time, this being the longest process in the organisation. The levels of activity found on the head, body and feet of returning personnel were analysed and are presented below, both in tables and in the form of cumulative distribution graphs, plotted logarithmically. The figures presented are those actually measured on return by a 1021 $\beta\gamma$ probe with open window held 1 in. from the surface, not being referred to any particular time after the detonation. The levels picked up did not fall off appreciably as the decay occurred, because parties were limiting their exposure to a certain level of radiation at all stages and as decay occurred, proceeded nearer to the most active areas.

The following table shows the activity level of personnel returning from sorties. The cumulative figures are also shown plotted in Figure 4.

Activity Range (c.p.s.1021)	T.1 (Total 336) Per Cent Men in Range			T.2 (Total 246) Per cent Men in Range		
	Head	Feet	Body	Head	Feet	Body
0-15	93.7	54	91	96.5	42	95.7
15-50	5.4	16	5	1.2	20	3
50-100	.6	8	1.5	1.5	7.5	3
100-500	.3	14	1.7	0	17	1.0
500-2000	0	5	.4	0	9.5	0
> 2000	0	5	.4	0	4.0	0
	Cumulative Per Cent.			Cumulative Per Cent.		
below 15	93.7	54	91	96.5	42	95.7
" 50	99.1	70	96	98.5	62	98.7
" 100	99.7	78	97.5	100	69.5	99
" 500	100	92	99.2		86.5	100
" 2000		97	99.6		96	
" ∞		100	100		100	

It has been discovered from the analysis of these figures, that the distribution between personnel of activity picked up can be predicted by use of Poisson's Series. The order of contamination, i.e. up to 10 counts/sec., 10-100 cts., 100-1000 cts., occurs almost exactly in accordance with a Poisson Distribution, the correlation being remarably close in the case of the feet. If in the Poisson series $e^{-m}(1 + \frac{m}{1!} + \frac{m^2}{2!})$ the first term is taken to represent the fraction of persons with less than 10 cts./sec., the series then predicts the number between 10 and 100 cts./sec., as its second term and between 100 and 1,000 as its third term. The values of m for the four cases plotted in the graph of Figure 4 are:-

Totem 1 (Feet 0.73
(Head 0.14
(Body 0.165

Totem 2 Feet 1.08

The exact significance of this relationship is difficult to assess but it may enable more quantitative predictions to be made of contamination levels likely to arise among, say, rescue workers in Civil Defence. In order to test further that a Poisson type logarithmic distribution is associated with contamination, the results of the survey of rubber boots from the Hurricane Trial (1) were similarly analysed. Again the distribution was found, this time with a maximum in the curve between 10 and 100 cts./sec.

The quantity of raw water consumed was not recorded but it is estimated that about 400 gallons were used on D1 day, mainly in the showers. This corresponds to about 8 gallons per person showering. Probably with hot water more would be used.

7. Conclusion

The organisation achieved its purpose of protecting personnel against radio-active contamination. It appears that it did this without too much inconvenience and discomfort to the persons concerned; there were no complaints on this score. The task of decontamination was no real problem owing to the low order of contamination and the fact that nothing penetrated the clothing. In the case of an underground burst the problem would probably have been greater. This low contamination of personnel was mainly due to the large average size of fallout particles and to measures taken to reduce dust while travelling in open vehicles*. The use of tents caused many difficulties especially in the high winds frequently encountered. Their use also lead to the spreading of the organisation over a wide area, making supervision very difficult. The stage of pre-shower monitoring turned out to be unnecessary and would be omitted on any future occasion, while much simplification of the whole routine would be possible in a system more ideally arranged for the purpose.

Part II. Protective Clothing. - D. G. Stevenson

8. Introduction

The RH5 team was responsible for the provision, storage and issuing of clothing to all who were required to work in the active areas, both in the field and in the normal areas adjacent to Health Control.

The main stocks of clothing were for the provision of protective suiting for personnel proceeding on sorties into the forward areas. The basic issue included the following:

Aertex combination underclothing.
Protective combination suits.
Hoods.
Half wellington boots.
Overshoes.
Socks.
Sweat rags.
Respirators and anti-dim-outfits.
Gloves.

Full details of each item, and of the other items such as overalls, laboratory coats, hats, etc. are given in Appendix I and in a series of photographs, illustrating techniques used in donning protective clothing and undressing.(Figures 5 and 6).

9. Commentary and Recommendations

9.1 Aertex Combination Underclothing

These proved completely satisfactory and their continued use is recommended.

A heavier garment might be considered for work at cooler times of day or if cooler conditions are anticipated in future trials. A garment of fine knitted cotton type would be suitable.

It would be preferable from the decontamination standpoint to use thicker underclothes rather than thicker outer suits.

9.2 Protective Combination Suits

These suits had been modified since operation Hurricane by the addition of a denim reinforcement at the elbows and knees. The effect of this addition cannot be judged since very little contamination was experienced. In view of the fact that the additions make the garment significantly heavier, it is recommended that the reinforcement be omitted for land trials.

In other respects the design of the suit was satisfactory, although the provision of "an instep" tape on the inner leg, similar to that on the inner cuff, would be advantageous.

The material used in the present suits is open to criticism. While the type and weight was quite satisfactory it is recommended, in the light of experience of the decontamination of suits used on Hurricane, that an undyed plain gaberdine (cotton) be used. A suitable fabric, (used in experimental suits made up for RH5) is a close woven bleached gaberdine. A fabric of this type would probably be somewhat cooler when used on hot sunny days. The weather proofing of material 3170 was not effective although the test, a thunderstorm of tropical intensity,

was somewhat severe. This material is vat dyed and there are indications that the dye may aid the retention of activity.

The use of mordanted dyes should be avoided as decontamination by sequestering solutions would be hindered by the presence of metals which will exhaust the chelating agent.

The use of nylon or terylene would be suggested but may have to be excluded on economic grounds. The retention of activity by these fabrics is much lower than by cotton, although figures for penetration are not yet available.

The size distribution of the suits was rather inadequate, as will be seen in the Appendix, only sizes up to 5 ft. 10 in. were provided. In actual fact there were a fair number of personnel in excess of 6 ft.

9.3 Hood

Hoods were introduced in the present trial as a result of experience gained in operation Hurricane, where very little protection about the heads of personnel was provided.

The hoods were fairly satisfactory although the facial aperture and skirt were a little small. Although, of course, the hoods were not called upon to exclude high levels of activity, they were completely successful in excluding what activity there was.

Recommendations regarding fabrics in Section 9.2 apply here also.

9.4 Half Wellington Boots

These were completely satisfactory, very little contamination was found, although those used on the Kitten trials were written off.

9.5 Overshoes

Overshoes were introduced with a view to reducing contamination of the rubber boots and in this respect were remarkably effective. The overshoes themselves were often fairly highly contaminated, but they were not durable and wore through rapidly. Approximately 50 per cent failed to survive one sortie. If, however, such overshoes are regarded as expendable the situation is fairly satisfactory.

Providing such a step was economical, soles of overshoes might in future be of nylon or terylene or some similar material. Better wear would be expected, although the overshoes would cost slightly more. An alternative would be to impregnate the soles with polythene or a similar material.

9.6 Socks

No comments.

9.7 Sweat Rags

The sweat rags were of cotton scrim and of a rather inferior quality. Something rather better such as a light cotton terry cloth, is recommended for the future, with possibly a prior laundering treatment and impregnation with a wetting agent to improve its absorbancy.

9.8 Respirators

No general comments can be made here. The advisability or otherwise of wearing respirators may be ascertained from the analysis of filter activities as measured by RH4 team.

The anti-dim outfits were of variable efficiency, probably depending on the technique of use.

9.9 Gloves

Most complaints regarding the protective clothing were associated with the rubber gloves. These were of black rubber with fairly narrow gauntlet. Hands of personnel invariably sweated considerably and difficulty in removal was experienced. In some cases the gloves became torn, but owing to the low external contamination, no contamination of hands resulted.

While impervious gloves are necessary for handling highly contaminated objects, and such gloves will necessarily cause heavy sweating of the hands, it is recommended that personnel likely to handle only low levels of activity wear woven fabric gloves. Such gloves might be worn by survey teams, drivers, etc.

In cases where a completely impervious glove is required, fabric lined P.V.C. gloves might prove easier to manipulate, although they would reduce the sensitivity of touch.

9.10 Other Clothing

A small range of additional clothing was issued by RH5 team. All items such as laboratory coats, hats, berets, etc. were satisfactory Full length overalls, buttoned at the neck were issued to RH5 personnel in A21 and A22 active tents.

this purpose the only equipment obtainable sufficiently quickly were two household type washing machines and a number of "Sawyer" wood burning stoves for water heating. Since capacity was limited by lack of hot water these were added to later by borrowing a mobile soup-kitchen which included an oil-fired boiler. These items were collected together in a suitable place in the open, which was declared an "active area" and made out of bounds to unauthorised personnel.

The clothing to be washed was often partly soaked in oil and the cotton gloves and overshoes invariably so. Various methods were tried using the limited facilities available and eventually the following method was evolved for oily articles.

(i) Agitate in 25 gallons solvent petrol and squeeze out. (Operator wearing gloves).

(ii) Soak and agitate in further 25 gallons solvent petrol for at least 15 minutes. Squeeze out.

(iii) Wash in hot solution containing 1 lb. sodium metasilicate and 400 ml. of detergent (Comprox A.) (about 10 gallons).

(iv) If still above 50 cts./sec. soak in 20 gallons solution containing.

$2\frac{1}{2}$ lb. Ammonium Citrate.

20 g. Cellofas.

$1\frac{1}{2}$ lb. Comprox.

$1\frac{1}{2}$ lb. Versene.

adjust to pH 5.

(v) Rinse, squeese out and hang out to dry.

13.2 Typical results with this process obtained on D1 + 19, with very oily gloves are given below.

Process	Level - Counts per Second	
	Before	After
Standard soap-alkali laundry wash	1500	800
(i) Above	1000	300
(ii) "	300	200
(iii) "	200	100
(iv) + (v) above	100	50

By using this process it was found possible to go on re-using the gloves and overalls without the level building up dangerously, as it would have done otherwise, for in a half days wear, areas giving over 1000 cts./sec. were quite frequent.

The drainage from these machines was also improvised and a small depression in the ground used as a soak-away. This area was marked off and its activity level watched but the ground took up the liquor

quite well and very heavy storms assisted in washing the active material into the earth so that very little was recorded on the surface. It was recommended that this area should be cordoned off for at least six months after operations ceased if a survey showed any signs of activity.

14. Conclusions

Only about 200 lb. of low-activity clothing were sent from Emu to the radio-active laundry at Woomera and no difficulty was experienced in cleaning this. However, samples of higher level were retained for experiments and the results showed that high decontamination efficiency was difficult to attain(3).

Clothing rendered oily and radio-active from contact with aircraft proved difficult to clean, but by using a combined solvent and complexing wash process, sufficient success was achieved to enable work to continue on the contaminated aircraft.

Part IV. Monitoring and Decontamination of Instruments and Equipment - D. G. Stevenson

15. Introduction

Considerable preparations were made for the decontamination of equipment associated with the Totem trial. Goods to be handled fell into two categories:-

(a) Equipment and instruments exposed near the explosion, and subsequently retrieved.

(b) Equipment, especially survey instruments, taken into the active area after the explosion.

In the latter category vehicles used by re-entry parties may also be included.

16. Facilities (See Figure 1.)

A concrete hard standing - A20.A, provided with water stand-pipes and an elevated ramp for servicing and decontaminating vehicles was available. In the laboratory, A20, sinks and a fume cupboard were installed for the decontamination of smaller items of equipment. An active storage tent, A19. was provided for the storage of equipment etc., pending monitoring and decontamination. This latter was intended to have been at least 100 yards from A20,and A20.A, but was, in fact, fairly close, thus being useless for the storage of highly active samples.

17. Preparations to Facilitate Decontamination

17.1 Records

A method of transferring data obtained in the active area to the clean area was required by RH4 team. It was visualised that data sheets brought back by returning personnel would be well above tolerance and would require decontamination.

A solution to the problem, suggested by RH5 team, was to enclose a blank data sheet with a carbon paper in an envelope, inscriptions on the outside being transferred to the protected inner sheet which later could be removed from the active envelope. This principle, using a polythene envelope, was actually used, although the clarity of the carbon copy at times left something to be desired. An improvement could probably have been made by the use of a ball point pen in place of a pencil.

17.2 Vehicles

Three land Rovers were allocated for use by parties re-entering active areas, such vehicles being used for preparations prior to D1. On the basis of experience gained in rehearsal when the vehicles were driven through some very dusty areas, the hoods, wind-screens and side screens were completely removed. These measures were found to reduce the entry of dust though with a following wind there was a tendency to travel in one's own dust cloud. The removal of the above parts also aided cleaning and the maintenance of a relatively low level of activity on the vehicles.

An additional step was the sealing of the canvas covered seats in P.V.C. sheet. The seat backs were of leathercloth and were not considered to require covering.

18. Nature of Ground Activity and Fallout

Close in to the crater area the terrain was very dusty and on windy days columns of dust extended several hundred feet into the air. However, the activity of such dust does not appear to have been very high and the proportion of fission product material was probably quite low.

For one or two days after D1, some very high winds were encountered and much equipment was slightly contaminated by the active dust blown up from the tower area. On the other hand shortly after D2, very severe rain storms laid the dust and similar equipment was of very low activity.

In all cases ground contamination by fission products appeared to be very small indeed apart from the relatively narrow corridor of fallout activity downwind of the tower sites. By far the greatest contribution to radiation in all but the fallout areas was that due to induced activity. Though formerly considered to be only a minor factor, in the present trials it proved to be a major consideration. All equipment retrieved from the field after exposure was active from induced radiation and the presence or absence of removable activity had to be ascertained by the taking of smears. This greatly hindered the clearing of recovered instruments and equipment.

The actual fallout downwind of the tower proved to be different from expectations. By far the greatest proportion of the activity at one mile was in the form of 0.2 to 1 mm. spheres, the size tending to fall off with distance. The particles were not readily picked up by passing vehicles, nor blown about by the high winds. There was a little fine dust which was adherent to surfaces of samples in the fallout area, but this was negligible.

19. Decontamination of Equipment

19.1 Equipment Re-Entering the Active Area after the Explosions

19.1.1 Survey Instruments

Most of the instruments used were type 1313 radiation monitors, originally carried in heavy canvas haversacks. These were often stood on active ground, or left on the floors of vehicles where a certain amount of activity had been trodden in. Although contamination was only slightly above tolerance, the canvas bags were not easy to decontaminate and some were eventually discarded. One or two survey instruments were slightly contaminated but were easily cleaned.

The gamma dose rate recording meters erected after D 1 became slightly contaminated due to wind blown dust but these were easily cleaned; adhesive tape on one of the units had collected a moderate amount of activity.

19.1.2 Vehicles

The Land Rovers used for active work were driven through some highly active areas, including the craters, yet in spite of this the general level of activity was low. Frequently on return from a sortie single particles of 0.2 to 1 mm. diameter had been carried into the vehicle on boots or on equipment, but a careful vacuum cleaning removed the sand and active particles. Occasionally large active particles were thrown up by the wheels and lodged under the wings; careful searching with a crevice nozzle on a vacuum cleaner was usually effective. Fine dust contamination was apparent only on the lower parts of the vehicle, especially on oily engine surfaces,

where up to 500 c/s (1021) were detectable. A certain amount of activity also collected on the wheel rims where a thick coating of fine dust was regularly deposited.

No decontamination of these vehicles was attempted as they were later assigned to the Australian Peace Officer organisation for patrolling the active areas.

19.2 Equipment Exposed to the Explosion

All equipment retrieved from the active areas had to be cleared by RH5 team.

The following outstanding items were surveyed and eventually passed as fit for moving to clean areas:-

Centurion Tank	- A.E. Group
Radar Aerials	- N.S.2. Team
Blast Gauges	- M.E. Group
Cameras	- P.O. Group

19.2.1 Centurion Tank

This item was brought from its site to a position near Health Control where it could be monitored with greater ease. A survey made with a type 1021 monitor on D1 + 11 indicated a general γ level of 50 c/s close to the Tank, but with high spots at any brasswork. Since most of the radiation was neutron induced and not decontaminable, extensive smear tests were made. The results are given in the Appendix II. Although loose contamination, probably wind blown, was slight, the induced activity would constitute a serious hazard. Although the general level if assumed to be due to Fe - 59 would not have decayed much, the radiator would have been extremely active nearer D1 as Cu-64 has a half-life of 12.9 hours.

It was recommended that the more active parts of the Tank should be washed down, which being done, the vehicle was removed to the clean areas.

19.2.2 Radar Aerials

The N.S.2 Radar Aerials erected for Totem 1, had been exposed to sand storms for some ten days before being recovered. As the figures given in Appendix II show, smears were moderately active. Again a general level of about 50 c/s on a 1021 instrument prevented direct monitoring. After cleaning, as indicated, the final level was considered low enough for the equipment to be crated for return to the United Kingdom.

The aerials exposed to Totem 2,also to a heavy thunderstorm (D2 + 2) showed low smearable activity. After routine washing the equipment was passed as clean enough for shipment.

19.2.3 Blast Gauges

On the afternoons of D1 and D2 the M.E. Group returned from the tower areas with a number of blast and other gauges. Some of these registered up to 1 R/hour (H + 8 hours) close to the gauge. The activity was not smearable and appeared to be induced in the brasswork. 2B.A. nuts removed from some of the gauges, and counted under an end-window Geiger showed a half-life of about 12 hours. The gauges themselves appeared to decay at a similar rate. The induced activity would appear to be almost

entirely due to Cu-64. Very little activity was detected by smear tests and after a few days when the gauges had decayed to below tolerance, they were released.

19.2.4 Cameras

Of a number of cameras which were exposed to fallout about half were cleared immediately. All had been protected by P.V.C. bags and on removing these, most of the rest were cleared. One or two lens and filter heads were carefully examined and decontaminated. Decontamination was mainly a matter of locating small visible particles of fallout.

20. Reagents and Techniques

Although the level of contamination was low, some decontamination had to be effected. The usual reagent was Teepol used in normal brackish water. Sequestering agents would be useless in such water, unless an uneconomically large amount were added.

20.1 S.D.G. Solution and Southend Paste

A general purpose decontaminating solution, S.D.G., was made up but was used only in the decontamination of aircraft(4).

In addition a mild abrasive paste was prepared. The composition was:-

Pumice Powder	400 g.
Teepol	40 ml.
Glycerine	60 ml.
Water	40 ml.
Sequestrol M.	20 g.

The ingredients are ground up well together until a thick paste is obtained. This composition is similar to the household cleaner "Gumption", with the addition of the complexing agent.

20.2 Vacuum Cleaners

By far the most useful method of decontamination on the Totem trial was vacuum cleaning. Hoover domestic type cylinder models were available and although they were not completely satisfactory, they were of great assistance. In particular, low levels were maintained inside vehicles, where fallout particles were inclined to accumulate, having entered on boots of personnel and on exposed equipment. In addition stray samples of active sand could be removed without hazard.

The fallout, being relatively coarse, was particularly amenable to vacuum cleaning treatment. In one particular instance a small piece of carpet, experimentally exposed in the fallout area gave 1 to 2,000 c/s, but after a thorough treatment with the cleaner, the level was reduced to the background figure of 2 to 3 c/s.

The above remarks should perhaps be conditioned to consideration of the climatic conditions. In more humid conditions it may well be that the vacuum cleaner is far less effective, as indeed, loose dust would probably be less.

The main disadvantages of the present type of machine were, firstly that the filter bag was often clogged up by the finer particles of sand and dust, and secondly, that the filter bag was not removable. As a result of the latter, the bag had to be emptied by the rather cumbersome method

of shaking the whole machine. When clogged, the inner filter fabric was beaten with a stick. (This is, of course, somewhat hazardous when the machine is active).

21. Tolerance Levels

In the present trial a nominal figure of 15 c/s on a type 1021 instrument ($\beta\gamma$ probe one inch from surface; open window) was used as a general tolerance to distinguish between clean and dirty goods. In general this was satisfactory and most goods were well below this figure. Considerable care had to be exercised to ensure that highly active samples were stored well away from the monitoring positions; on one or two occasions when samples were dumped near the A20.A hardstanding, backgrounds rose to well above the tolerance figure.

In the monitoring of suits worn by personnel returning from forward areas on D-day to about D + 7, elevated tolerance levels were used. These levels were calculated, assuming a $t^{-1.2}$ decay, so that the activity of the suits on reaching the laundry on the following day would be at the tolerance level.

In smear tests on exposed equipment a tolerance of the order of a few disintegrations per minute per square inch of surface was used. Cleared goods had smear counts of up to 25 d./min./sq. in. of surface but usually more of the order of 10 or less at D + 10.

A tolerance figure for β radiation due to neutron irradiation had to be introduced. The figure of 15 c/s on 1021 is based on lifetime contact, thus for the purpose of packaging and return to the United Kingdom a figure of 1000 c/s on an open window 1021 probe was deamed reasonable. The usual γ radiation tolerance was adhered to.

22. General Conclusions

It may be said that in the present trial no major decontamination problem associated with ground equipment was encountered. The only real hazard was that due to induced radiation, and in all cases this rapidly decayed to below the tolerance levels.

Although a large number of instruments were taken into the active area, contamination was only slight, and readily removable, the operation being more tedious than difficult.

The greatest contamination was on the vehicles used by re-entry parties, up to 500 c/s (1021) being registered on the engine casing. It is fortunate that decontamination of these vehicles was not required, as the engines were somewhat inaccessible; if cleaning had been required, similar techniques to those used in the decontamination of aircraft would probably prove most satisfactory.

23. Operation and Layout

Reference should be made to the layout plan of Health Control shown in Figure 1.

The operation of the system as far as equipment and vehicles were concerned was as follows:-

Equipment taken into the field after the explosion was carried by the personnel concerned to the waiting vehicles and taken away.

The plan was that on return all records, instruments, etc., should be left in Tent A19 by the personnel concerned, before proceeding to

A21 for entry into the decontamination system. In addition, A19 should have been at least 100 yards from the remainder of the site. In actual fact the site was not laid out according to plan. A19 was rendered semi useless as an active store and highly active goods had to be stored elsewhere.

It was intended that returning sorties should stop at A19 on the way in to leave all samples, instruments, records, etc., move on to the park A20.A and then proceed on foot to A21. After personnel had been passed as clean, or at a convenient time they were to don white protective clothing and re-enter the active area to collect samples, monitor and if necessary, decontaminate equipment and instruments under RH5 supervision.

In actual practice there was a tendency to dump goods on the A20.A park, including at times very active and badly packed samples, with the result that the background at A20.A was unduly high. On one or two occasions highly active samples had to be removed into the Bush. Although in general other teams decontaminated their own equipment, the survey meters had usually to be dealt with by RH5 team.

One serious omission in the original plan was the provision of a normal barrier system for the entry of RH5 staff and others into the Health Control active area for recovery of records, equipment, etc., for servicing vehicles and work in the active laboratory A20. A barrier had to be improvised near the active exit from A18, and a system of laboratory coats and overshoes, similar to the Aldermaston system introduced. The disadvantage of the improvised system was that the monitoring facilities were at a distance.

The use of tents on the Totem trial proved very inconvenient; the active store A19 had collapsed by the end of the trial. Criticism may be made in respect of the unsatisfactory method of erection, necessitatin frequent repairs in windy weather. Buildings, either of the Nissen or other types are essential to the smooth running of a Health control syst

From the research aspect the operation of a counting room in an ope indswept tent was almost impossible and time wasted on this account may e measured in days. Any large-scale decontamination would have been ve ifficult in water such as was available on Totem.

The facilities for handling vehicles were adequate, although the r ovided for the servicing and decontamination of vehicles was of a poo ign. A lower ramp would have sufficed, and clear access between th cks is required. The area for decontamination of vehicles was ade ough on windy days the hardstanding was swamped with sand and the ies choked. The hardstanding was provided with electricity and much general decontamination was done at

and re... decontaminate equipm... the A20.A

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From the research aspect the operation of a counting room in an open windswept tent was almost impossible and time wasted on this account may be measured in days. Any large-scale decontamination would have been very difficult in water such as was available on Totem.

The facilities for handling vehicles were adequate, although the ramp provided for the servicing and decontamination of vehicles was of a poor design. A lower ramp would have sufficed, and clear access between the tracks is required. The area for decontamination of vehicles was adequate although on windy days the hardstanding was swamped with sand and the gullies choked. The hardstanding was provided with electricity and water and much general decontamination was done at tables placed there.

24. Kitten Trials

Although RH5 team was prepared for decontamination of personnel and equipment associated with the Kitten Trials, their services were not required. It is understood that the level of contamination was very low and readily removable. Duckhams' Jelly was said to be a very effectiv dry decontaminant, the jelly being rubbed on and wiped off on rags and tissues.

25. Recommendations

Several recommendations are worth making in connection with the handling of equipment and instruments.

25.1 Monitors for Field Use

There would appear to be little point in the use of a thick canvas haversack when taking type 1313 γ monitors into active areas. Activity adheres to these cases and they are difficult to decontaminate. An alternative would be a P.V.C. or polythene impregnated fabric, with a smooth surface. However, even more satisfactory would be the attachment of a carrying strap to the instrument itself, which is designed for every decontamination, having a stove enamelled finish.

25.2 Vacuum Cleaners

The requirements for a vacuum cleaner are as follows:-

(a) High suction.
(b) Non-clogging filter.
(c) Disposal of active dirt without exposure to atmosphere.
(d) Safe disposal of effluent air.
(e) Decontaminable hose and nozzles.

In the present trials the main failures were in respect of (b) and (c). Means are required for filtering a fair amount of fine dust without clogging the filter bag. The use of a removable and replaceable bag would improve matters very considerably.

References

1. Austin, J. and Stevenson, D.G. "The Decontamination of Radioactive Clothing. Part I. Preliminary Survey." A.W.R.E. Report No. T14/54.

2. Austin, J. and White P.A. "Development of Plant and Process for a Radioactive Laundry". High Explosives Research Report No. A30, (1953)

3. Stevenson, D. G. "The Decontamination of Radioactive Clothing." A.W.R.E. Report No. T108/54.

4. Austin, J. "The Prevention and Removal of Radioactive Contamination. Part VI. Decontamination of Aircraft at Woomera and Amberley." A.W.R.E. Report No. T106/54.

Item	Type	Origin	Sizes	Numbers	Value	Present Status of Items not written off	Remarks
Outer Protective Combination Suits	Suits, Combination Design D/50/14A	Weinbergs Weatherproofs Ltd., Manchester (thro' C.D.E.E. Porton)	Chest 1. 34"-38", Height 5'3"-5'6" 2. 34"-38", 5'7"-5'10" 3. 40"-46", 5'3"-5'6" 4. 40"-46", 5'7"-5'10"	400 400 100 100	(£4. 10. 0. each) £4,500	200 at Emu 50 to Amberley 550 at Woomera	Material Gaberdine 3170 Olive Drab W.P. Denim No. 3 Drab Suits written off - mainly those used on Kitten Trials or in the Monte Bello s
Hoods	Design D/29/9	Ex. Op. Hurricane	3. 4.	}312	(£4. 0. 0. each		
Combination Underclothing	Standard	As Design D/50/14A	Standard	1,000	(14/-each) £700	As above	Material Gaberdine 3170
		The Cellular Clothing Co. Ltd.	38" Chest 40" " 42" " 44" " 46" "	13 doz. 18 doz. 10 doz. 6 doz. 3 doz.	£466	200 at Emu 25 to Amberley 225 to Woomera	
Half Wellington Boots	Boots Rubber Warwick, Half Wellington	Dunlop Rubber Co. Ltd.,	6 11 7 12 8 9 10	50 20 100 10 200 150 70	(17/6 pair) £525	200 at Emu 200 at Woomera	
Overshoes	White Elastic tops	J.& A.Hillman Ltd., Dudley (A.W.R.E.Stock)	Ex large Large Medium Small	200 400 400 200	£325	}200 at Emu }100 at Amberley }200 at Woomera	Expendable items
Socks	W.D. Pattern Grey Woollen	M.O.S. R.O.F. Chorley	1 2 3 4	100) 200) only 200)500 received 100)		100 at Emu	
Sweat Rags	Cotton Scrim	Aldermaston Stores	30 in. sq.	3,000	£25	All written off	Some used as packing for delicate instruments on return to U.K.
Respirators	Facepieces Respirator Anti gas light Mk.VI	via. C.D.E.E. Porton Government Stocks	Large PR 9A Normal PR 10A Small PR 11A	150 300 150		200 at Emu 240 at Woomera	
	Containers Respirators Anti R/A Dust No. 1 Mk. I		PR 22A	1,000		200 at Emu	Expendable items
	Cloths, outfits Anti dim. Mk. VI.			2,000		1,000 at Woomera	Expendable items

Gloves	Gloves, Rubber Post Mortem latex, 16 in. with gauntlet and roughened palms	Veedip Ltd., St. Helens Works, Slough	8 8½ 9 9½ 10	100 pairs 250 pairs 200 pairs 100 pairs 50 pairs	(8/- pair) £280	All written off	These were insufficient and although normally expendable, many salvaged for re-use
Towels	Turkish, bath	Aldermaston stores		700	£730	300 at Emu	For use after decontamination in RH5 showers

Other items held in RH5 Clothing Store

Wellington Boots	Boots Rubber Knee Gents Warwick.	Dunlop Rubber Co. Ltd.	7 - 10	100 pairs		All at Woomera	
Hats	Hats Jungle Green	J. Compton Sons Ltd., Webb London, E.3.	7 7⅛ 7¼ 7⅜ 7½	50 50 40 40 20	£89	All issued to Totem Staff (Written off)	
Towelling	Terry Towelling White Medium Grade	Local Purchase (Reading)	18 in. wide	200 yards	£49	100 yd. at Woomera	Used for face flannels in showers
Micro filter Dust Respirators	Siebe Gorman	Home Office	Normal & Large	50		30 at Woomera	Expendable
Lab. Coats	White	Local Stores	Sizes 1 - 4	100	£125	Distributed between Emu and Amberley	
Overalls	White - Atomic Energy	Local Stores	Sizes 1 - 4	140		as above	
Berets	Black	Home Office	Large	50	£4. 4. 0. doz.	All issued (Totem Staff)	
Gloves	Leather Heavy	Home Office		50 pairs	12/- pair	Mostly at Woomera	(Few used)
	Surgical	Local Store	9	50 pairs	2/9 pair		Expendable
Eyeshields	Anti gas G.S.	W.D. Stores		700	9d. each	300 at Woomera	

Appendix II

Smear Tests

I. Centurion Tank

No.	Location	D1 + 11 d./min./sq.in.
1.	Rear Armour	4.7
2.	L.H. Radiator	0
3.	R.H. "	1.0
4.	L.H. Fan	0
5.	R.H. Fan	3.0
6.	Oil filter case on starter engine	6.0
7.	Top of Turret	0
8.	Front of Turret	5.0
9.	Gun Muzzle	2.5
10.	Front Armour (upper)	3.5
11.	R.H. Shock-Absorber Housing	20.5
12.	L.H. " " "	12.4
13.	Underside-Front	5.0
14.	" Rear	0
15.	Floor of Turret	9.8
16.	Pedal base in Cab	3.2
17.	Top of Gun Barrel in Turret	26.5
18.	Inside Exhaust Fishtails	0

Location 6, 11, 12 and 17 were washed and the tank passed as "clean"

II. Blast Gauges

Nine smears taken at random on Gauges retrieved from R/T_2 lane

1.	30	d./min./sq.in. D2 + 1
2.	40	
3.	37	
4.	43	For comparison, the decay factor
5.	53	from D2 + 1 to D2 + 11 would be 13: 1
6.	25	
7.	100	
8.	0	
9.	2.5	

After washing down these gauges were passed as "clean".

III. ii...2. Radar Aerials

D.1 Aerials. D1 + 11

		Before cleaning d./min./sq.in.	After cleaning d./min./sq.in.
1. 293 Q.	Transmitter unit cover	7,000	11
2. "	Front half sealing ring	4,300	16
3. "	Roller bearing cage	780	
4. "	Blackened portion of bearing casting	62	
5. "	Sand from waveguide casting	18,500	0
6. "	Sand off front of transmitter cover and main casting	22,000	
7. "	Front portion of motor body	140	
8. 275	Perspex bezel	52	
9. "	Blackened portion of reflector	16	4.4
10. "	Top of body on opposide side to dial thermometer	14	3.7
11. "	Glass of dial thermometer	90	
12. "	Side of body	29	0.7
13. "	Back cover	40	
14. "	Front of waveguide	30	
15. 293 Q.	Washed down with paraffin		
16. 275	Washed just with Teepol then with paraffin		

FIGURE 1.

BLOCK LAYOUT OF R.H. CONTROL AT A

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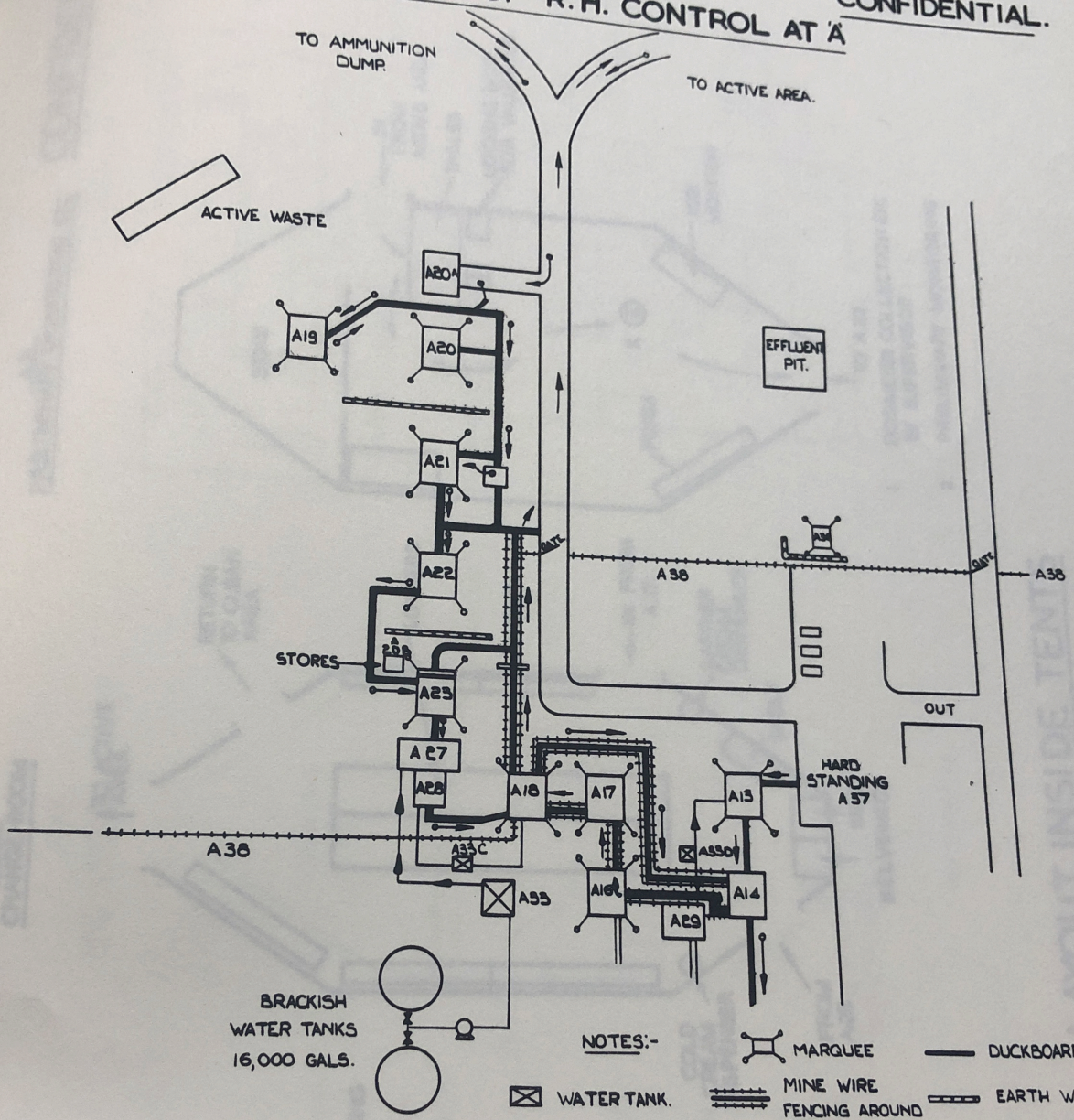

A13	CLEAN WAITING R.H.I.
A14	BRIEFING & OPS R.H.I.
A16	INSTRUMENT STORE. R.H.2.
A17	CLOTHING STORE.
A18	CLEAN CHANGE
A19	ACTIVE STORE
A20	ACTIVE DECONTAMINATION
A20A	HARD STAND VEHS. CONCRETE.
A21	DOSIMETER COLLECTION & PRELIMINARY MONITORING.
A22	ACTIVE CHANGE
A23	PRE MONITOR AND COUNTING.
A27	SHOWERS.
A28	MONITOR
A29	DENSITOMETRY.

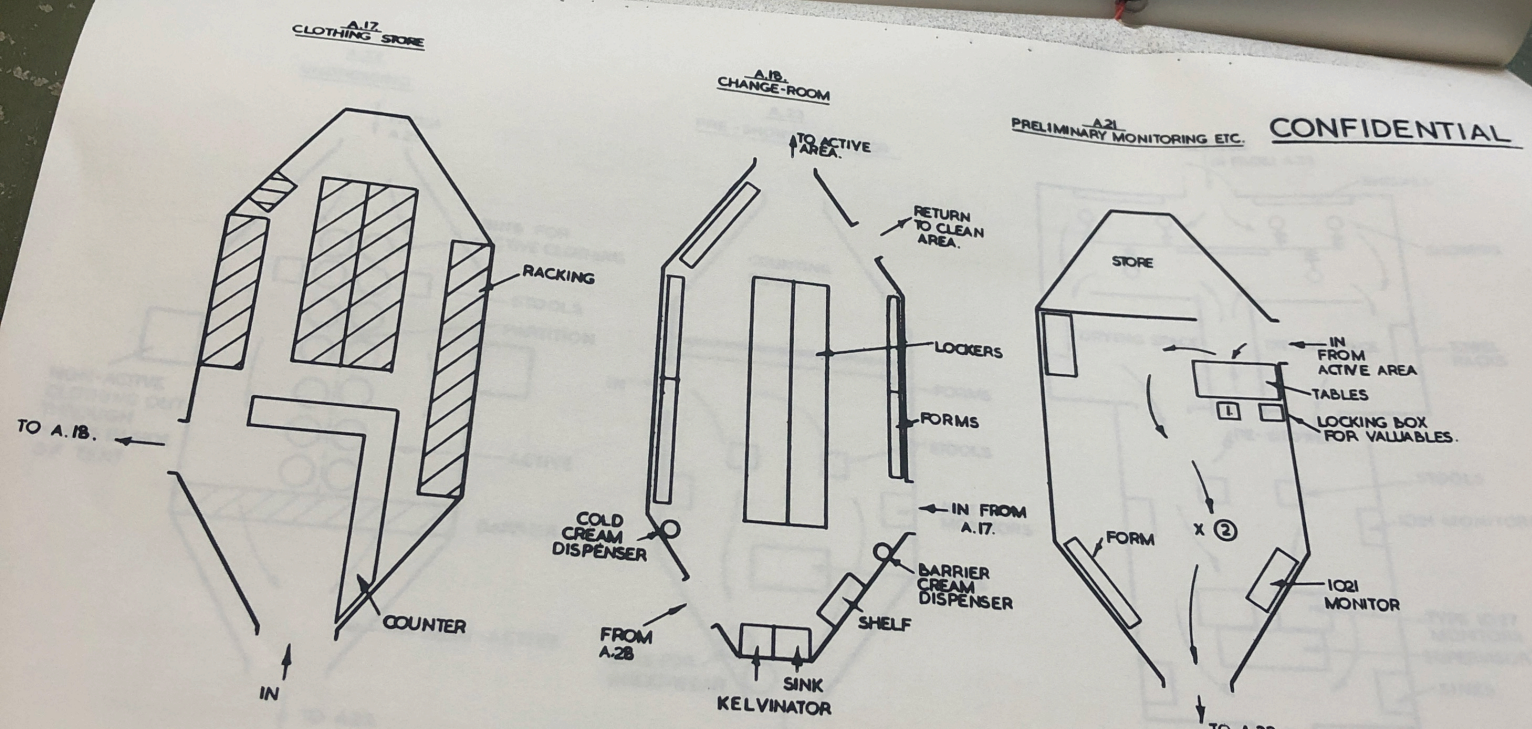

FIGURE 2. LAYOUT INSIDE TENTS

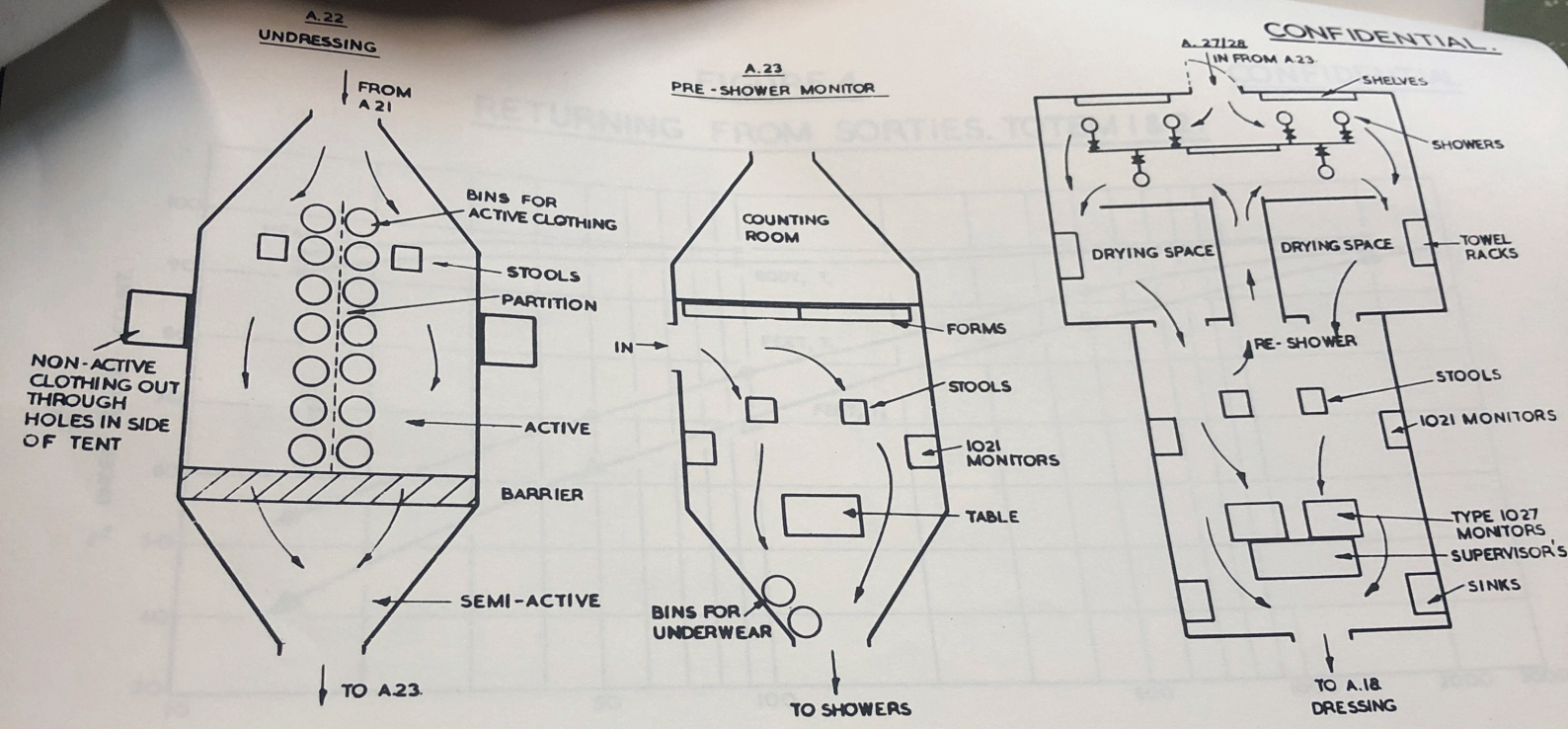

FIGURE 3. LAYOUT INSIDE BUILDINGS.

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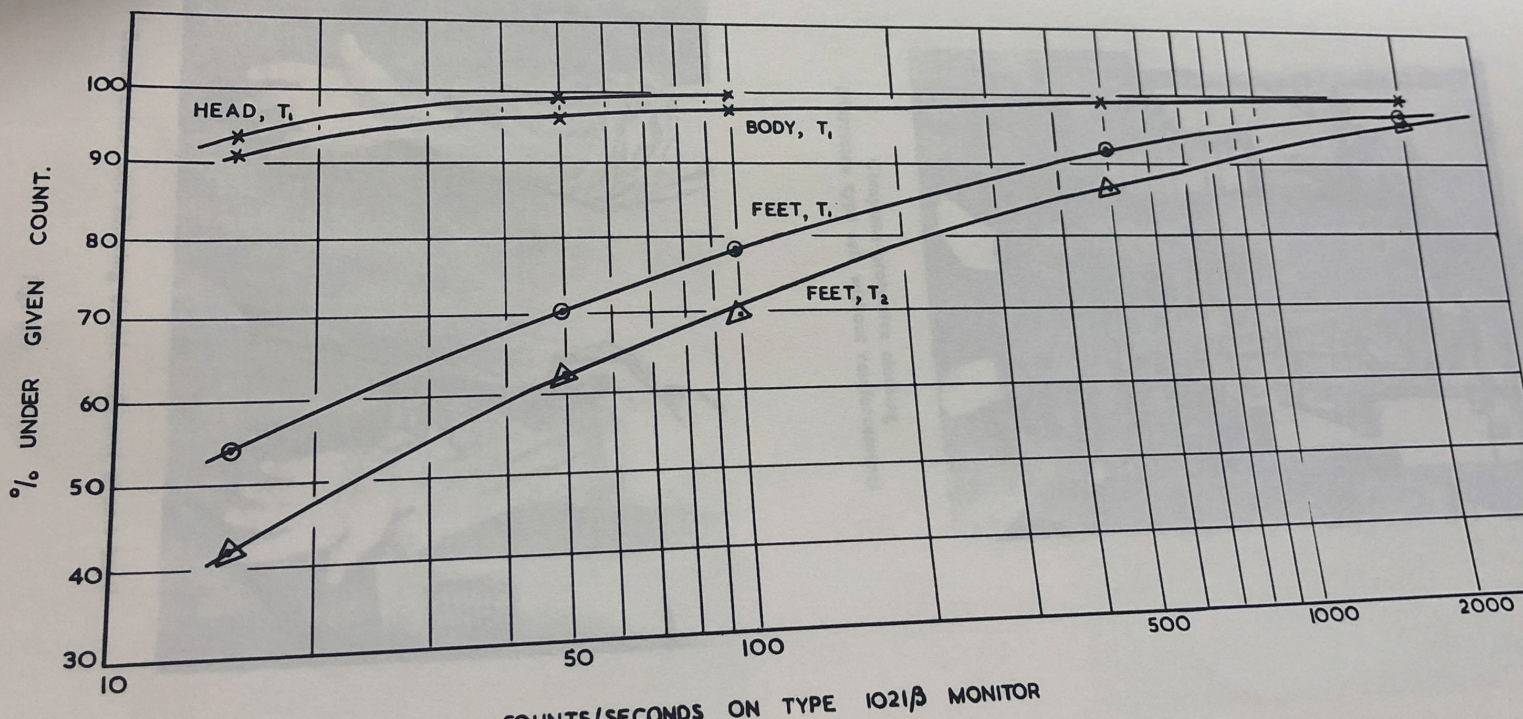
FIGURE 4.

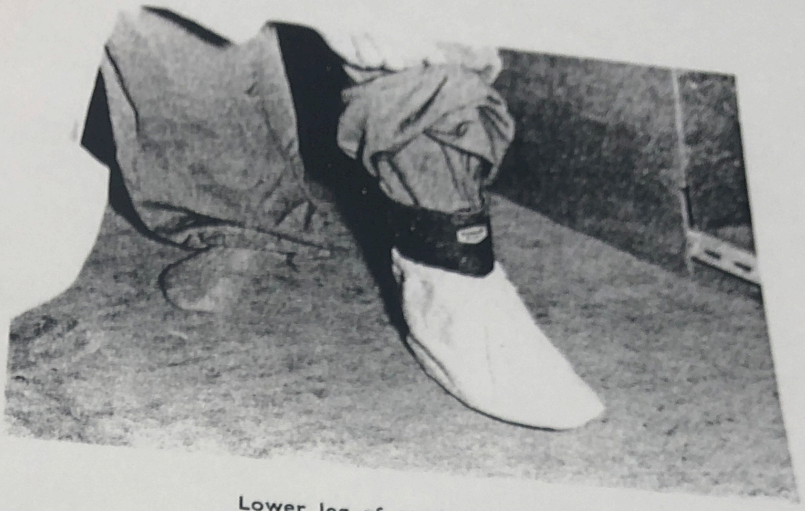
RETURNING FROM SORTIES. TOTEM 1 & 2.



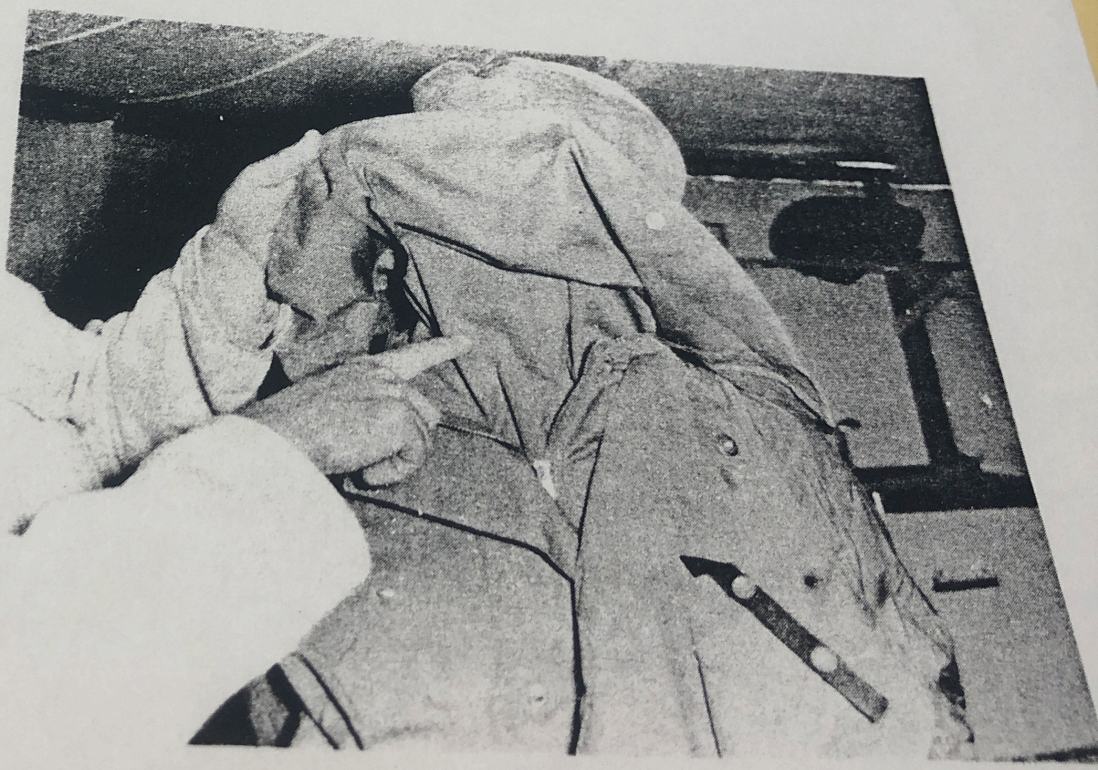
Complete protective clothing
(Hurricane type suit without reinforcement)

Combination suit, showing double cuffs and thumb-band.

Fig. 5



Lower leg of combination suit.



Rear of hood and suit, showing double skirt to hood

Fig. 6