1. Group Tasks

The main task of the Decontamination Group on Operation Mosaic was the provision of a general decontamination service for the Royal Air Force following the participation of their aircraft in cloud sampling and tracking.

It was anticipated that decontamination work on the Monte Bello Islands would be of a minor nature only and would not justify the existence of a forward team. Any problems arising could be handled by the Health Physics Group.

Conversely, Health Physics representation at RAAF, Pearce, the operational base, was limited and most of the aspects normally covered by the latter group were executed by the Decontamination Group.

In practice the overall task resolved itself into the following duties:-

(a) Aircraft reception

(i) Marshalling.

(ii) Removal of sampling filters.

(iii) Crew alighting.

(iv) Refuelling and after-flight servicing.

(b) General monitoring and survey work.

(c) Provision of a clean exterior to the aircraft.

(d) Supervision of servicing.

(e) Health control.

(f) Laundry.

2. Facilities

Although RAAF, Pearce, was chosen as the Operational Base it was not provided with active facilities and the intention was to use facilities at Amberley, 2500 miles away, for decontamination. However, it was finally agreed that a personal change hut and the minimum of other facilities would be provided at Pearce.

The change hut comprised clean and active change areas and a store, all contained in a space 20 ft square. Hot water for showers and wash basins was provided; a mobile petrol driven generator supplied the power to an immersion heater in addition to monitors, interior lighting and a system of lights along the parking area.

The change hut was situated on a disused runway which intersected the main runway. 300 yd of this disused runway became the active parking area, the near end of which, 100 yd from the hut, being designated the washdown area. This particular area was coated with a circular layer, $1\frac{1}{2}$ in. thick and 150 ft in diameter, of oil-bound sand, which was originally intended to take a large circular plastic sheet. Although this idea had been abandoned the sand pan was unfortunately still provided.

Effluent was drained to a 1000 gallon storage tank, but no local disposal was permissible, apart from liquids close to the drinking water tolerance. This meant that all liquid together with solid waste would ultimately have to be transported to Maralinga. Even if adequate washdown facilities were available decontamination work would have been severely limited by disposal problems. Flight to Amberley, together with the necessary organizational and administrative difficulties, was not considered practicable and therefore very little decontamination work could be attempted.

3. Staff

The Group comprised two AWRE staff, as Group Leader and Deputy Group Leader, and a RAF team of 20 NCO's and airmen as a Decontamination Team, or more strictly, an Active Handling Flight. The RAF team had no previous training or experience and were instructed during the course of the Operation.

The Group maintained close liason with the Technical Wing of the Task Group.

4. Operational Procedures

In the course of the Operation, which was the first in which aircraft

participated on such a scale, many procedures familiar in principle to the UKAEA but new to the RAF had to be evolved. Since the problem is of a long term nature full details have been written up in a manual [Ref. 2] which is being issued separately. Specific instructions covering various aspects of the work were issued in a RAF/AWRE series, and copies of the relevant issues are appended to this report as Appendices A, B and C.

4.1 Aircraft Reception

In the Operation time was of importance and all procedures were planned in detail to reduce delay to a minimum. The RAF team was divided into smaller units with specific duties.

4.1.1 Marshalling

Aircraft taxied direct into the active area from the runway and came under the control of a "batsman" in the normal manner.

4.1.2 Removal of Samples

Three types of sampling were undertaken. The Active Handling Flight was organized to remove these samples with utmost speed, taking due regard of the hazards involved. This took precedence over other tasks. Full details are outside the scope of this report.

4.1.3 Assistance to Crew

It was considered desirable that the aircrew should be able to alight without sustaining additional contamination, since with cabin air filtration they should be relatively clean. A well rehearsed procedure was laid down (Appendix B) and functioned very well. A variation of the procedure was issued for the benefit of aircrews likely to land away from base.

4.1.4 Refuelling and After-Flight Servicing

After the completion of all vital and urgent duties it was usual to allow the contamination to decay as much as possible and no further attention was given to the aircraft for some days after the normal after-flight routine inspections had been completed.

Where towing was necessary, careful operation avoided contamination of tow bars, etc., and the overalls of personnel

Minor decontamination of equipment, etc., was occasionally necessary and Southend Paste was usually used. (This is a mild abrasive paste containing a complexing detergent solution.) Greasy undercarriage legs, etc., which became lightly contaminated, were cleaned with rags moistened with kerosene.

4.4 Supervision of Servicing

It is normal for a full servicing programme to be carried out regardless of radioactive contamination. Thus primary star servicing is repeated at 28-day intervals and other minor inspections are carried out far more frequently. The system established during the course of the Operation used the normal squadron ground crew for such work, supervised in respect of radioactive precautions and monitored by the RAF Active Handling Flight.

5. Health Control

A Health Control system was operated from the Decontamination Hut. During all periods of work in the active area a monitor was stationed in the hut to enforce compliance with the usual principles. A detailed instruction (Appendix A) covering entry and exit from the area was drawn up and issued.

The normal working issue was as follows:-

White boiler suit type overall.

Cotton drill cap.

Rubber or cotton gloves.

Wellington boots or overshoes.

Respirators were worn only for special duties such as the removal of sampling filters.

A waterproof suit comprising gown, leggings and hood, based on a Biological Warefare garment, was provided for wet work. These were worn extensively and provided excellent protection against the violent storms which frequently swept the area during the Operation.

Toilet soap was used for all routine personal decontamination. Teepol served as a shampoo and resistant contamination was removed with Southend Paste.

No underclothing was provided and a few instances of penetration of activity through the overalls were noted, all of these occurring within the first two days after each round. A few items of personal clothing had to be washed as a result.

A more serious situation arose with staff returning from the N.W. coast of Australia. This will be discussed later.

6. Laundry

During the planning of the Operation it was laid down that it would not be possible to launder active clothing at Pearce and therefore elaborate precautions were worked out to minimize the contamination of clothing. However, as soon as the first round was fired it became obvious that a laundry was essential. Whereas trained scientific staff might have been able to keep relatively clean, inexperienced RAF tradesmen tended to adhere to normal non-active routines and considerable contamination arose.

A simple laundering unit was set up at short notice by purchasing an Australian-made (Lightburn) washing machine. The unit was housed in a derelict WT truck towed to a site adjacent to the Decontamination Hut. Hot water was supplied by hose from the hut.

As a normal rule "Persil" purchased locally was used as the detergent. The laundry was run by the RAF team and from time to time Teepol was brought in. This was discouraged, as it is far inferior to a fully-built detergent.

7. Results

7.1 Levels of Contamination

Quantitative data are given in Tables 1 and 2.

The sampling aircraft from Round 1 returned with general external levels close to the surface of 100 to 150 mr/h, with rather more near the engines. On Round 2 the corresponding figures were 200 to 400 mr/h. The time of return in each case was H + 2 hours. These levels are not unduly hazardous and the levels decayed to below the normal industrial working rate after 1 to 2 days.

Smear tests indicated that the cabin was relatively clean and that no decontamination action was necessary. The interior of the fuselage was also fairly clean. Direct monitoring in such sites revealed very

little contamination. It is likely that much internal contamination was quite loose and almost wholly smearable. External contamination is exposed to the airstream and all that sticks is fairly well held.

Of the data given in Table 1, those for WH 976 and 978 relate to primary cloud samplers in both rounds. In the first round WL 754 penetrated the cloud at H + 4 hours, but in Round 2 it did not penetrate but was contaminated on the ground by fallout (see below). WH 980 tracked the cloud at H + 8 hours after Round 2.

7.2 Contamination Patterns

It was expected that leading edges would be considerably more highly contaminated than sides and tracking edges. Although this was found in some cases, it was by no means the rule. On Round 1 very little difference could be detected between the levels on leading edges and behind, but since the aircraft let down through rain no valid conclusion was possible. The areas contaminated on the primary sampling aircraft on Round 2 showed some tendency towards that expected. The lower aircraft penetrating the base of the cloud showed a ratio of 10:1 between the leading edges and the underside of the wing. The upper aircraft passing above the centre gave a ratio of only 2 to 3 : 1. As a rule the under surfaces were more highly contaminated that the upper surfaces.

The tracking aircraft were even more uniform. Very little difference between leading and other surfaces was detectable. Cracks and crevices were usually more contaminated, and open areas such as the tailplane actuator slot appeared to retain a considerable amount of activity.

The results would indicate that although impaction may play a part at early stages, most of the contamination is retained by an absorption process.

In all cases where an area of the aircraft was left free of barrier paint no detectable difference in contamination level was noted. Similarly, no marked difference was found between "Perspex" and painted areas

7.3 Decay

The decay of smear samples from Round 1 was followed for approximately 6 weeks, and from Round 2 for 3 weeks. It was found that there was no significant difference between the decay of smear samples taken from the exterior of the aircraft and from internal areas, such as wheel bays which

were out of the air stream. In all cases the contamination appeared to be a representative sample of the cloud.

The decay of smears taken on D + 2 was compared with the decay rate of the aircraft as measured by direct monitoring, and within the limits of experimental error no differences were noticed. The decay rate of upper surfaces exposed to the weather was essentially the same as elsewhere, and it appeared that apart from a possible initial effect on first wetting, very little contamination washed off the aircraft.

Some contamination was detected on the sand pan, particularly where rainwater dripped off the aircraft, but compared with the contamination on the aircraft this was negligible.

7.4 Engine Contamination

By far the most highly contaminated items on the aircraft were the engines, and these caused some difficulty in monitoring adjoining areas by virtue of the high γ background. The levels at the surface of the nacelle rose as the probe was moved back, giving a peak at a position adjacent to the 11th and 12th stages of the compressor. After falling a little, a further rather higher peak was registered adjacent to the combustion chambers. Further back still the levels fell steadily. The maximum reading recorded in Table 1 relates to the dose rate adjacent to the combustion chambers.

7.5 Cabin Filter Contamination

Data were obtained on Round 1 only. The external surface dose-rates after removal were noted and then the units were opened up. The results are given in Table 3 below. Dose and count rates have been converted to D + 1 for comparison with the data in Table 1.

Table 3 relates, of course, to a single cloud penetration.

TABLE 3

Cabin Filter Contamination

Aircraft	Filter	Day of Measurement	Dose Rate at D+1, mr/h
WH 976	Port Roughing Filter	D+14	4
	Stbd. " "	D+14	42
WH 978	Port " "	D+13	12
	Stbd. " "	D+13	7
	High Efficiency Filter	D+27	Nil at D+27
	" "	Internal count rate 2300 counts/sec at D+1	

The count rate ($\beta\gamma$) of the roughing elements after removal was equivalent to the external dose-rate (mr/h) multiplied by 500.

7.6 Contamination Arising from Fallout

Slight fallout was detected on the N.W. coast of Australia after each round. Aircraft operating from airfields in the vicinity after Round G1 sustained a little contamination. In the case of aircraft operating from Onslow, a total of eight were involved, all air-cooled piston engined; contamination levels on engines ranged from 15 up to 1000 counts/sec $\beta\gamma$ on D + 2 to D + 5 when the measurements were made. The general level at Onslow was 30 to 40 counts/sec $\beta\gamma$ on D + 2.

The fuselages of aircraft were generally clean, except those which stayed at Onslow over the night of D/D + 1. These had a uniform level on upper surfaces. The main sites of contamination were engines, oil coolers and undercarriages, and any other greasy surfaces aft of the propellors.

The rate of decay was normal for fission product contamination.

One or two high spots were cleaned with rags moistened with kerosene, but in general levels were sufficiently low to be allowed to decay without further action.

After the second round, WL 754 (Canberra) acting as H + 4 tracker completed her task by visual observation and put into Port Hedland for

refuelling. Although more or less clean on arrival (D2-Day evening) this aircraft was exposed to fallout over the area during the night and on return to Pearce the following day, all upward facing surfaces were moderately contaminated while lower surfaces were no more active than on D2-1.

The decay in this particular instance did not follow the normal pattern but approximated to that of sodium 24. It would therefore appear that the "fallout" was in fact salt spray with induced radioactivity. The incidence of contamination through fallout on all aircraft, except sampling and tracking aircraft, is given in Appendix D.

8. Sundry Observations

The meteorological conditions prevalent at Pearce during the course of the Operation were not in any way anticipated. A total rainfall of approximately 20 in. occurred during May and June, much of this falling in violent squalls. While it is normal in austerity operations with temporary facilities for much to be done in the open air, conditions such as those experienced give rise to the need for rather more covered space than otherwise necessary.

The waterproof decontamination clothing served well under these conditions and the Active Handling Flight were better off than the remainder of the Task Group.

Plastic catchment sheets with inflatable edges, provided to retain effluent from decontamination work, proved unsatisfactory, since under the slightest breeze they proved difficult to control. They were used in the decontamination of one lightly contaminated aircraft, but were weighted down.

A prototype vacuum washing machine was tested on non-active aircraft, and although promising it was considered unsatisfactory for wider use. It was used as a wet pickup cleaner for collecting effluent from such decontamination work as was done, but the barrier paint was not removable sufficiently readily for the machine to be used on aircraft.

The sand pan proved to be an embarrassment, and as mentioned earlier, should not have been laid. The rain washed much of the oil out and the top layer tended to blow about. Both the sand and oil readily collected on equipment. Experience has shown that contamination washed off aircraft may be ignored, and that no sand pan is necessary to collect it.

A total of 5000 gallons of effluent was produced. Fortunately, although this included effluent from the RC Group caravans, the activity was not greatly in excess of the drinking water tolerance and all was allowed to soak away in a large pit.

Solid waste (approximately 10 cwt) was flown to Maralinga for disposal.

The distance between the Health Control hut and the nearest aircraft proved reasonably satisfactory. Readings taken with Type 1021 instruments showed that backgrounds were tolerable. Background figures near the two aircraft at H + 2 to 3 hours on D2, when levels of 250–500 mr/h and above were measurable at the surface, were:–

20 yd : 4 mr/h (400 counts/sec γ)

40 " : 100 counts/sec

100 " : 30 counts/sec

180 " : 10 counts/sec

It is unlikely that a Type 1027 hand and foot monitor could be used nearer than 200 yd, or possibly 300 yd, to the aircraft.

9. Conclusions and Recommendations

The work of the Group on Operation Mosaic was in some respects incomplete since full decontamination was delayed until the end of Operation Buffalo. Thus valid conclusions can be drawn only after taking into account the experience on the latter operation.

The barrier paint proved invaluable, and without it the successful completion of the work at Operation Mosaic would not have been possible. The paint itself requires further development but already it is of great assistance and it should continue to be used both as a barrier over the standard finishing system and also as a sealing coat over contamination.

The levels of contamination were not unduly hazardous and after a day or so no γ hazard at all remained; however, care had to be exercised to avoid spreading loose contamination until it had been sealed with barrier paint.

The various procedures evolved to facilitate handling of active aircraft proved satisfactory and the efficiency of the RAF Active Handling

Flight improved with experience. Thorough indoctrination and strict discipline is essential.

Recommendations regarding future organization have been made in the Buffalo Decontamination Group Report, Ref. [1]. The proposals, briefly, are that Health Physics should be considered separately from the technical aspects of servicing and decontamination, and that each should be under the control of an RAF officer, a Medical Officer for Health Physics and an engineer for servicing and decontamination. Since decontamination is only partly at a routine state, close liason between the RAF and AWRE must be considered essential if further progress is to be made. It is recommended that the Decontamination Officer be considered a member of the DC Group.

Facilities at Pearce were not entirely adequate since the strength of the Group was insufficient for the task. The following must be considered to be **absolutely essential** in any similar operation:-

Parking/working area

Washdown area

Decontamination/servicing bay

Active storage area

Active laundry

Laboratory (measurements and reagents)

Active change room with personal decontamination

Clean change room

Lavatory accommodation

Stores - clothing

- equipment and instrument

Waste storage and disposal - liquid

- solid.

Each item should be capable of dealing with peak loads. The maximum load on the Health Control hut on Mosaic was approximately 30 at one time. A normal throughput per day may be up to 50 to 60.

Recommendations in this respect are discussed fully elsewhere [Ref. 2].

The Group should have adequate transport and should be independent of other Groups.

Far wider recommendations covering facilities, organization, staff, and methods are included in the Buffalo Decontamination Group Report [Ref. 1].

TABLE 1

Contamination of Sampling and Tracking Aircraft (Canberras)

Aircraft	Part of Aircraft	Round 1		Round 2	
		Dose Rate at D + 1, mr/h (γ)	Count Rate at D + 10, counts/sec ($\beta\gamma$)	Dose Rate at D + 1, mr/h (γ)	Count Rate at D + 10, counts/sec ($\beta\gamma$)
WH 976	Nose, front	5	150	10	550
	" side	5	200	6	350
	Cabin, side	9	180	6	250
	Stbd. wing, under } trailing	14	1000	20	1000
	" " above } edge	8	300	6	400
	Stbd. tip tank, inboard	8	600	7	500
	" " " outboard	5	180	6	340
	Fuselage (Stbd.)	8	300	6	300
	Engine (max.)	180	10 mr	100	
	Cabin dose rate (H+2), pilot's position	D1 = 80 mr/h (both after removal of filters)		D2 = 13 mr/h	
WH 978	Nose, front	3	250	12	700
	" side	4	100	7.5	200
	Cabin, side	8	150	10	450
	Stbd. wing, under } trailing		500	50	1000
	" " above } edge		250	15	700
	Stbd. tip tank, inboard	3.5	300	11	700
	" " " outboard		150	10	600
	Fuselage (stbd.)	10	250	17	600
	Engine (max.)	180	8 mr	100	
	Cabin dose rate (H+2), pilot's position	D1 = 70 mr/h (both after removal of filters)		D2 = 200 mr/h	

		Count Rate at D + 1, counts/sec ($\beta\gamma$)		Count Rate at D + 1, counts/sec ($\beta\gamma$)	
WL 754	Nose, front	80			
	" side	80			
	Cabin, side	200			

TABLE 1 (Cont.)

Aircraft	Part of Aircraft	Round 1		Round 2	
		Dose Rate at D + 1, mr/h (γ)	Count Rate at D + 10, counts/sec ($\beta\gamma$)	Dose Rate at D + 1, mr/h (γ)	Count Rate D + 10, counts/sec
	Stbd. wing, under } trailing	600		50	
	" " above } edge	400		800	
	Stbd. tip tanks, inboard			20	
	" " " outboard	200		400	
	Fuselage (Stbd.)	500		25–600	
	Engine (max.)	20		60	
				Counts/sec ($\beta\gamma$)	
WH 980	Nose, front	C		600	
	" side	L		450	
	Cabin, side	E		450	
	Stbd. wing under } trailing	A		400	
	" " above } edge	N		400	
	Stbd. tip tank, inboard			500	
	" " " outboard			900	
	Fuselage (Stbd.)			1000	
	Engine (max.)				

Round 2

Count Rate at D + 10, counts/sec (βγ)

TABLE 2

Smear Test Data

(20 cm² Smears, Counts Related to D + 1)

	Round 1		Round 2	
	WH 976	WH 978	WH 976	WH 978
	d.p.m.	d.p.m.	d.p.m.	d.p.m.
Battery compartment 1, interior	2×10^3	4×10^3		
" " 2, "	1×10^3	600		
Cabin 1, "	300	300		
" 2, "	100	400		
Stbd. wheelbay roof, "	400	600	5×10^5	8×10^5
" " door, "	2×10^6	1.5×10^6	2.5×10^6	8×10^5
Port " roof, "	1.2×10^4	400		
" " door, "	2.5×10^6	1×10^6		
Front " door, "	7×10^3	4×10^4	1.3×10^5	6×10^4
Engine cowling, port, "	9×10^4			
" " stbd., "	1.2×10^5			
Outside of engine casing, port, "	2×10^4			
" " " " stbd., "	2×10^5			
Rear camera compartment, "		3×10^4		
Nose, exterior	4×10^6	2.5×10^6	3×10^6	2×10^6
Cabin door, "	4×10^5	3×10^5		
Fuselage, barrier painted, exterior	4×10^5	1.7×10^6	4×10^6	1.3×10^6
" unpainted, "	8×10^5	3×10^6		

APPENDIX A

RAF/AWRE Instruction No. 4

Procedure for Entering and Leaving the Active Area

A1. Introduction

(a) No one will enter the Active Area unless detailed to work in that area or having permission from the Decontamination Group Leader, his representative or the STO.

(b) Normally monitoring crews will be in attendance to assist entry and exit.

A2. Clothing

(a) All persons entering the Active Area will, with only the exceptions listed below, were the following:-

(i) White protective coverall.

(ii) Rubber boots, or if merely visiting, overshoes.

(b) If a person is required to touch an active object or come very close, he will wear:-

(iii) A white cloth cap.

(iv) A pair of gloves (cotton or rubber, as required).

NOTE: He may remove and re-don these as may be necessary, providing the approved technique is used.

(c) If it be wet or if a person be required to carry out an operation involving the possible spillage of active liquids, he will wear:-

(v) White p.v.c. gown, leggings and hood in place of items (i) and (iii) above. Rubber gloves only will be used.

(d) For particularly hazardous tasks, e.g., removing filters, changing cabin filters and all other tasks where loose dust may be generated, respirators will be worn.

When in doubt, consult the Decontamination Group Leader or the Health Physics Adviser.

A3. Entry Procedure

(a) All personnel will enter via the decontamination hut (clean side).

(b) All personnel will leave surplus clothing on the clean side of the hut and proceed to the active side to be issued or obtain clothing as specified in Section A2.

(c) When dressed, personnel will proceed into the active area, putting their boots or overshoes on, at the barrier, last.

(d) **Exceptions**

(i) A tractor driver may enter the area under instructions from the Marshalling Crew. He may not leave the tractor until outside the area again.

(ii) Aircrews about to fly off active aircraft will proceed straight through the decontamination hut and will don overshoes only at the barrier. They will proceed direct to their aircraft and will remove their overshoes immediately prior to entering the aircraft (except Varsity crews who will be wearing overshoes in flight.)

A4. Conduct within the Area

(a) NOTHING is to be touched unnecessarily.

(b) All observers should stand up wind of any site of action on the aircraft.

(c) The various anti-contamination measures detailed elsewhere will be carried out FULLY.

(d) All contaminated solid matter will be placed in the bins provided.

(e) All liquid waste will be disposed of under instructions from the Decontamination Group Leader.

5. Exit Procedures

(a) Exit will always be via the decontamination hut.

(b) At the barrier all personnel will remove their gloves, using the approved techniques, placing them as directed, and will then remove

their overshoes or boots, leaving them on the dirty side.

(c) All personnel will submit themselves to the monitor and if clean may remove coverall and cap, wash if desired, claim surplus personal clothing, and proceed out to the clean side.

(d) If monitoring shows contamination above tolerance on the cap or coverall this item will be removed and put in the dirty clothing receptacle. If hands or face are contaminated the person will wash at the dirty basin, or in extreme cases use the shower. All personnel must satisfy the "clean" monitor after washing.

(e) **Special Cases**

(i) Aircrews will be given overshoes before alighting and will remove these at the barrier. They will be monitored and will surrender their flying suits only if dirty. (Subsequent return will be at the discretion of the Decontamination Group Leader.)

(ii) Tractor drivers who have not left their vehicles may drive straight out, after clearance of the tractor by a monitor.

(iii) Personnel wearing the waterproof p.v.c. clothing will decontaminate same under the showers before undressing.

A6. Equipment

All equipment will be monitored and if necessary, cleaned before passing out of the area.

A7. Radiation

(a) All personnel will wear film badges continuously and will show them when entering the active area. These will be changed at regular intervals.

(b) Certain personnel may be required to wear dosimeters.

(c) All work on the aircraft must have ultimate sanction from either the Decontamination Group Leader or Health Physics Adviser.

A8. Duties of the Monitoring Team

(a) To monitor all personnel on re-entering the decontamination hut from the active area, and if found dirty, to monitor after decontamination.

(b) To assist in selection and issuing of clean clothing and disposal of active clothing. If necessary they will assist personnel to undress from contaminated clothing.

(c) They well keep records:-

(i) Of all detectable personnel and clothing contamination, noting intensity, site, and duties of the person concerned.

(ii) The allocation and state of all protective clothing, so that further supplies may be obtained in advance, and that every item may be accountable.

(d) They will monitor gloves and boots left at the barrier, leaving clean goods for further use, disposing of cotton gloves above tolerance, and wash active rubber gloves and boots using procedures laid down by the Decontamination Group Leader.

(e) They will monitor all equipment leaving the active area.

(f) In the decontamination hut, they will wear a white coverall only; normal shoes will be worn. They will not touch anything shown to be active without donning gloves. If required to enter the active area, they well follow the procedure already laid down. At least one monitor must be on duty whenever the active area is occupied.

D. G. Stevenson
GL/DC
RAF/AWRE

11th May, 1956.

APPENDIX B

RAF/AWRE Instruction No. 5

Procedure for Leaving and Re-Entering Active Aircraft

B1. Applicability

All sampling and other aircraft which have penetrated the cloud without detection instruments within H + 6 hours will carry out this procedure.

All tracking aircraft whose detecting instruments indicate an increase in background by a factor of more than five will also adopt this procedure. (Background corresponds to 1 count/sec at ground level on a modified Type 1320 set or 2 to 3 counts/sec on an unmodified Type 1320 set.)

B2. Location

At base all aircraft in the above categories will taxi to the active parking area and come under the control of the marshalling crews.

Away from base the station concerned will be consulted before landing and the aircraft will taxi to a convenient parking site away from other aircraft and buildings. Non-essential ground equipment will be kept well away.

B3. Canberras

B3.1 At Base

(a) When sited to the satisfaction of the marshalling crew and told to cut, freight checks being completed, the pilot will open the DV window to equalize pressure and close again, without touching the outside.

(b) When this has been done he will give "thumbs up" to the marshalling crew standing on the starboard side of the cabin, as a signal to open the door.

(c) The marshalling crew will open the door, handling with small sheets of paper or plastic, and secure the stay. They will also give the aircrew a pair of overshoes each; these should be donned before alighting.

(d) The marshalling crew will then affix a prepared plastic or

paper sheet round the hatch, securing with self-adhesive tape, and position the alighting ladder or platform.

(e) The aircrew will then alight without touching the unprotected exterior of the aircraft, and proceed direct to the decontamination hut for passage to the clean area.

(f) If any bags (navigation equipment, etc.) have to be removed from the cabin the first member of the aircrew to alight will receive these from those still aboard. Such items will not be touched by the ground crew nor should they touch the ground.

B3.2 Away from Base

(a) Procedures listed in Sections B2.2 and B3.1(a) will be carried through.

(b) The cabin door will be opened from the inside and secured.

(c) One member of the crew will attach a plastic sheet, provided, round the door, securing with self-adhesive tape and, aided if necessary by the remainder of the crew, will alight.

(d) Once outside this member will fix the protective sheet more firmly and the remainder of the crew will alight.

In all this care will be taken to ensure that no clothing or skin touches the exterior of the aircraft.

(e) When this is complete refuelling if applicable will be carried out according to procedures laid down elsewhere. Protective clothing will be donned outside the aircraft. The minimum amount of ground equipment will be used, and this will be protected.

All contaminated material, i.e., all that has touched the outide of the aircraft, will be packed in a bag provided and taken aboard ain.

(f) Re-entry will be as for alighting but in reverse. After the crew are aboard the protective sheet will be removed, folded dirty side in, and placed in the bag, which should be closed and stowed away.

(g) The cabin door will be closed and fastened from the inside.

B4. Varsities

The procedure for Varsities will be the same at base and away.

(a) The door will be opened from inside and swung well back, taking care not to touch the outside.

(b) A sheet of paper or plastic may be fixed as a push plate if desired, to ease handling.

(c) The ladder will be fixed and the crew will alight, taking care not to touch the exterior of the aircraft.

(d) See Section B3.2 (c) if away from base. If at base the crew will proceed to the decontamination hut for clearance to the clear area.

B5. Unserviceability Away From Base

(a) Should an aircraft become unserviceable, once the crew have alighted, guard should be mounted and base notified.

(b) Tracking aircraft will have means of self monitoring and if clear, crews may move about freely.

(c) In the event of an active sampling aircraft becoming unserviceable base should be signalled immediately, and crews should remain near their aircraft until arrival of the Emergency Flight Section from base. There should be no eating, smoking or drinking during this time.

B6. All clean aircraft or aircraft below 5 times background may operate normally. (Five times background corresponds to 5 counts/sec on the ground, using the detecting Type 1320 instrument or 10–15 counts/sec on the unmodified Type 1320 set.)

D. G. STEVENSON
GL/DC,
RAF/AWRE

11th May, 1956

APPENDIX C

RAF/AWRE Instruction NO. 6

Procedure for Refuelling Contaminated Aircraft

C1. Personnel Entry and Exit From the Active Area

All personnel entering the active area will comply with the relevant procedure as laid down in RAF/AWRE Instruction No. 4.

C1.1 Bowser - Entry

The bowser will enter under instructions from the NCO in-charge at the time and will move as directed. It must be established beforehand that the ground to be traversed is clear; this should be checked by a monitor operating a Type 1320 set.

The driver will remain in his cab throughout the time he is within the area, unless provided with protective clothing.

C1.2 Bowser - Exit

After refuelling has been completed and all shrouding removed from the hose, the bowser will drive to the "clean/dirty" fence to be monitored by a member of the monitoring team.

Special attention will be paid to:-

All tyres.

The hose.

The nozzle.

C2. Preparation

The short hose will be swathed with a strip of plastic approximately 6 to 8 in. wide wound spirally for a distance of approximately 12 ft. This will be secured at the end of each piece with self-adhesive tape.

A servicing platform of convenient height for stepping on to the leading edge of the wing should be covered with stout paper and the treads and sides of any ladders should preferably be covered in paper or plastic. An additional sheet of plastic approximately 2 ft square will be lightly fixed at the front end of the platform.

C3. **Refuelling - Canberras**

(a) Only one man will normally step on the aircraft. In addition to the normal clothing he will have one pair of overshoes and either a piece of plastic about 12 in. square or plastic bags to act as overgloves.

(b) Once on the servicing platform, this man will don overshoes and step on to the wing; he will then undo **all** tank caps, using a plastic sheet or overgloves to prevent contamination of his own gloves. When all caps are open he will fold the plastic sheet dirty side together and pass it to a man on the servicing platform for disposal by a person on the ground.

The bowser will come in **alongside** the port wing, as close in as possible, with the short hose boom out of its stowage and the nozzle held by a member of the refuelling team. It will be possible to refuel all fuselage tanks and the port wing tanks from this position, without the hose touching the aircraft.

The bowser will then move over to the starboard side for refuelling the other wing tanks.

It is possible to refuel in this way without the hose touching the aircraft.

C4. **After Refuelling**

After refuelling is complete the man on the aircraft will be given another small sheet of plastic and will close all tank caps. This should be done by holding the lever marked "PUSH" only. This sheet of plastic will be disposed of as before.

The bowser will back away slightly and one man on the ground will peel off the plastic sheeting from the hose, working towards the nozzle, rolling the sheeting up. The bowser will then move to the monitoring area with the boom and hose still unstowed and controlled by a member of the refuelling team.

The man on the aircraft will step off on to the plastic sheet on the platform, and take off his overshoes, stepping back on to the clean part of the platform. He will then remove his gloves, and roll up both gloves and overshoes in the plastic sheet and place them in the disposal bay.

C5. Refuelling Away From Base

The above procedure will be used except that a member of the aircrew will don the coverall after alighting and obtain a suitable platform or step ladder.

Using a step ladder with a flat top, a sheet of plastic should be lightly fixed to the top platform. At the end of the operation, when overshoes are being removed, it is possible to step out of the overshoes on to the first step down.

C6. Variation for Varsities

The basic procedure is the same. The bowser should come in straight with the short hose boom unstowed. The overshoes will be removed when the first wing has been refuelled and will be re-donned after moving the platform for refuelling the other wing.

C7. General Notes

(a) Work slowly and consider each move.

(b) Any sheet of paper may be used by a "clean" person to handle an active article providing the paper is disposed of in the "dirty" bag after use.

D. G. Stevenson
GL/DC
RAF/AWRE

11th May, 1956.

APPENDIX D

Contamination of Aircraft Due to Fallout (Excluding Sampling and Tracking Aircraft)

D1. Varsities

WL 673

This aircraft was used for ground survey work over the crater area. It returned on D + 2.

Day	Position	Count Rate, counts/sec ($\beta\gamma$)
D + 2	Background	5
	Back end of oil cooler duct, port	300
	" " " " " " , stbd.	150
	Front cylinders, reaching inside engine cowl:-	
	Stbd.	300
	Port	>1000 on one spot
	Mostly	600
	Dust slip behind engine cowl, Stbd, under wing	80
	Starboard wheel leg	80–100
	Chocks (ex. Onslow)	20–25
	Fuselage and wing tips	6–8
	Nose	15
	Interior - background, except red dust inside door, where chocks had been stowed	20–30
D + 3	Starboard wheel leg	50
	Chocks	12
	Port engine cylinders	350–400
	Dust behind engine cowl, stbd.	40

WL 635

Not inspected until after 673 had been checked. Returned with WL 673.

Day	Position	Count Rate, counts/sec ($\beta\gamma$)
D + 3	Port engine, inside cowl	80
	All chocks (ex. Onslow)	45
	Starboard engine	70
	Inside wing flap	60
	Back of wheel legs, both port and stbd.	45–50
D + 5	Wheel legs	20
	Wing flap	20

WL 639

This did not arrive until late on D + 3, having flown via Broome.

D + 4	Stbd. engine, inside cowl	400
	Port engine " "	600
	Chocks	30
	One part of port wheel leg	400
		(general level 80)
	Underside of engine cowl,, aft	100
	Fuselage – background	

D2. Neptune

A89 - 303

This arrived back on D–Day but was not inspected until later.

D + 3	Front end wheel bay door:-	
	Port outboard	200
	" inboard	40
	Stbd. inboard	200
	" outboard	40

Day	Position	Dose Rate, counts/sec(6)
D + 5	(The propellers were anticlockwise rotation) General level round wheels and undercarriage Engines The fuselage was clean. Front end of wheel bay doors:- Port outboard } Stbd. inboard } (After opening cowlings on D + 6 the cylinders gave 600 counts/sec β (40 counts/sec γ))	30-40 15 80

D3. Hastings

556

D + 2	Hot spot on undercarriage	800
D + 5	Hot spot on undercarriage	300
	Engines on D + 2 were about 200 counts/sec	

509

D + 3	Engines mainly 60 counts/sec with one at 200 counts/sec	

D4. Civil Aircraft

VH-MMA (DC3)

D + 5	Mops used to clean wings	40
	Port engine	200
	Stbd. engine	60
	Back end of radiators	200

VH-MMF (DC3)

	Stbd. and port engines	60

VH-MMK

	Engines and radiator	60

VH-MMM (to Learmouth only)

	Radiator	10

All except MMM had been through Onslow.

References

1. D. G. Stevenson: "Operation Buffalo: Decontamination Group Report." Part 3: Aircraft. AWRE Report No. T22/57. June, 1957.

2. D. G. Stevenson: "Manual for Handling, Servicing and Decontamination of Radioactive Aircraft". AWRE Report No. (To be published).

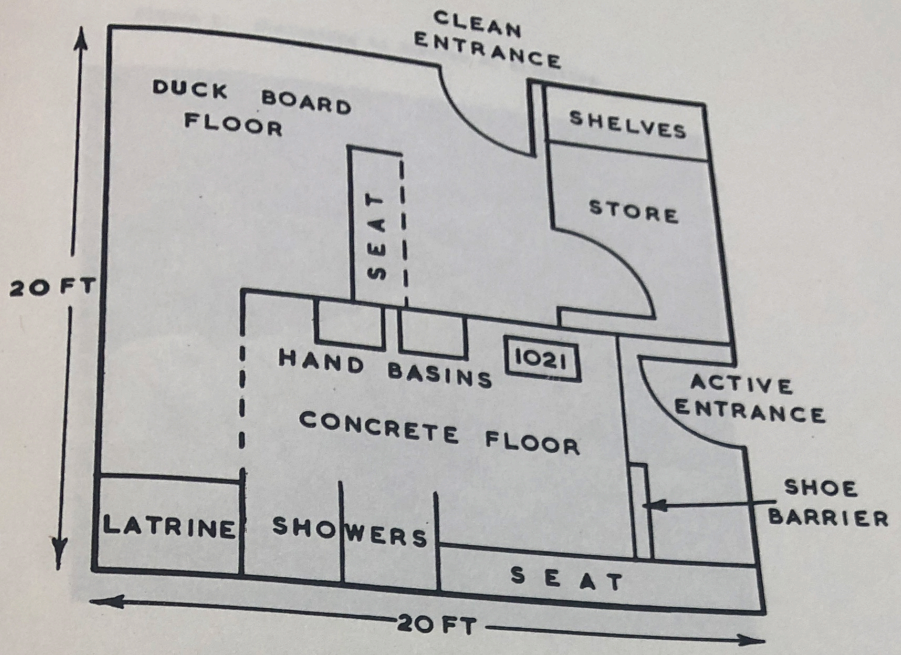

FIG. 1. PLAN OF HEALTH CONTROL HUT

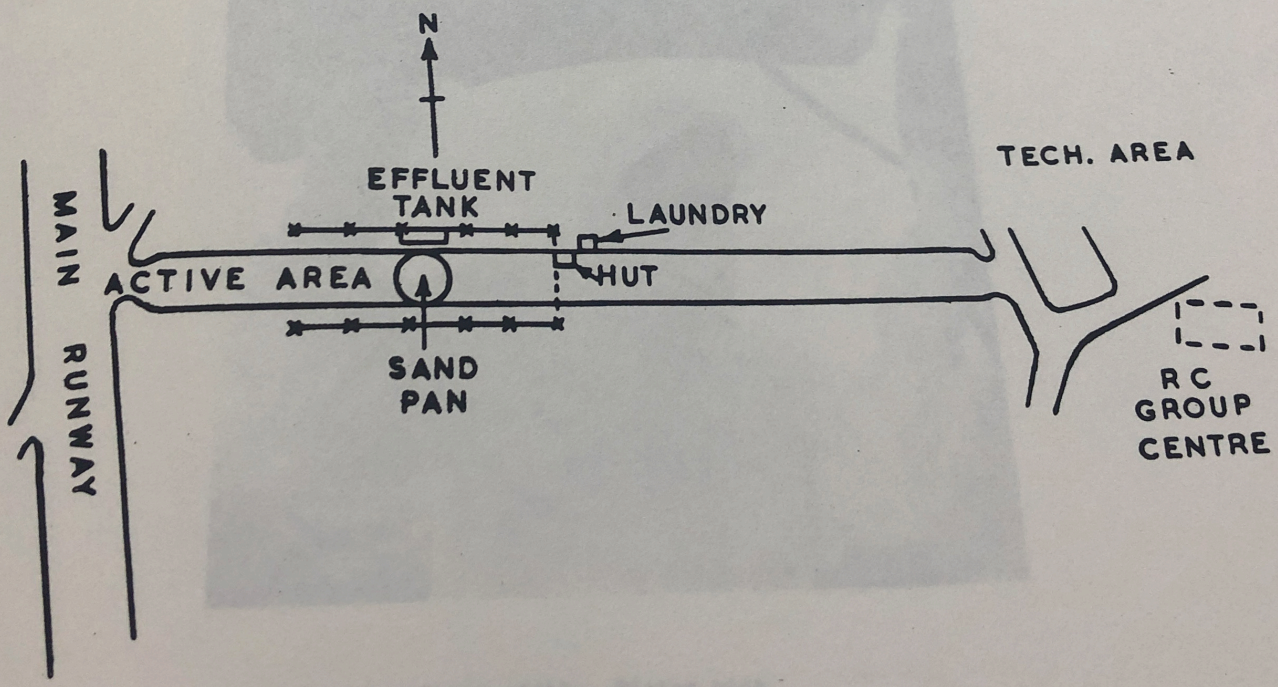

FIG.2. LAYOUT OF AREA

Figure 3. Assistance to Aircrew on Alighting.

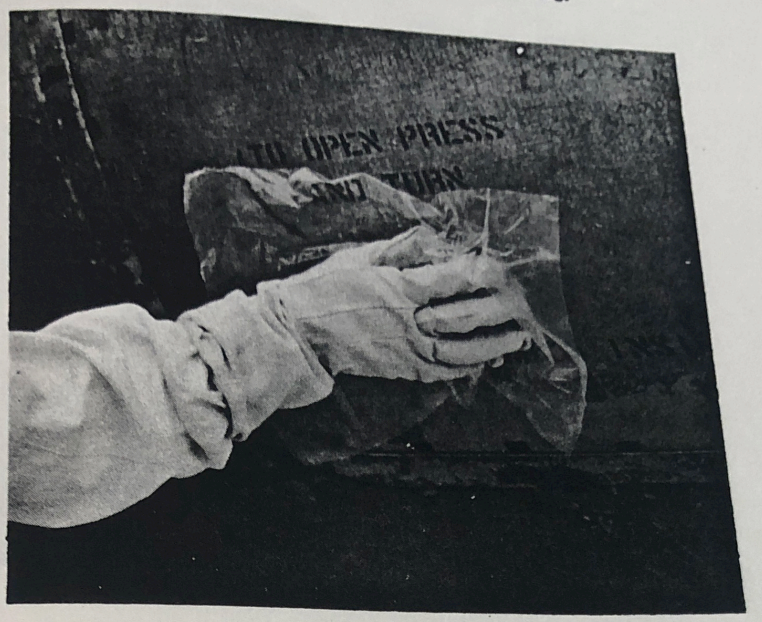

Figure 3(a). Opening cabin door.

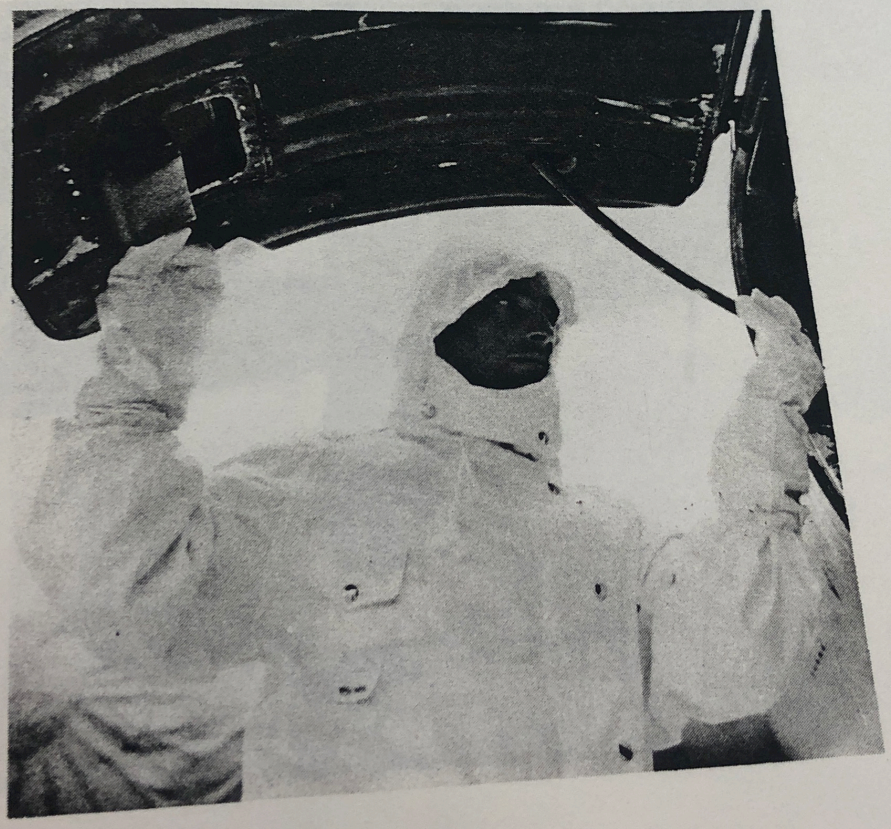

Figure 3(b). Fixing stay.

Figure 3(c). Fixing paper shield.

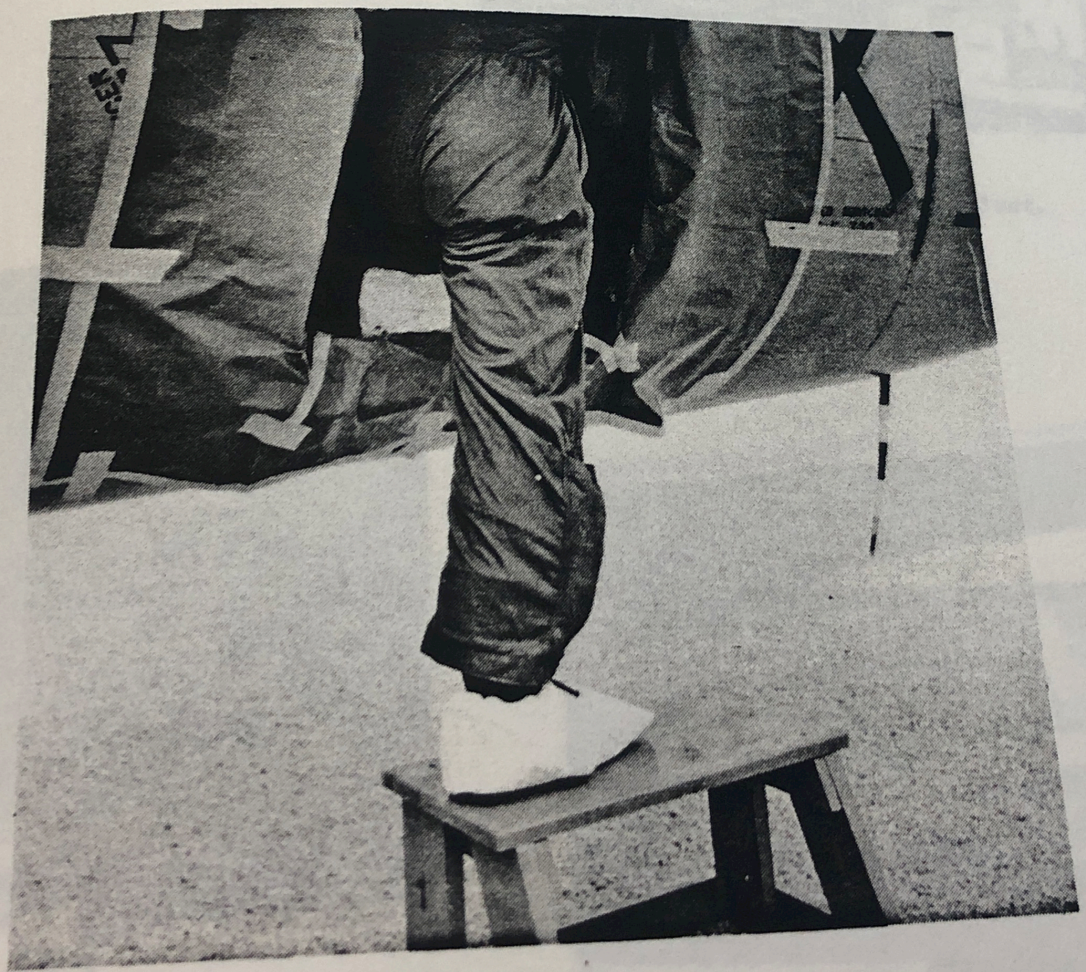

Figure 3(d). Shield in position, crew alighting.

Figure 4(a). Filter Removal. Mk. 8 duct.

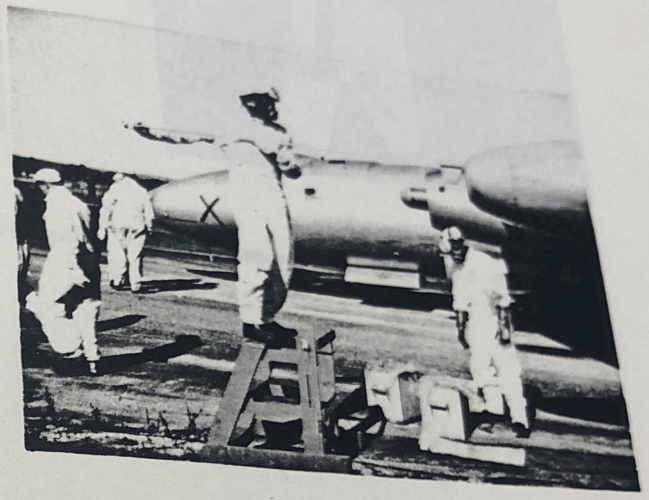

Figure 4(b). Mk. 3 duct.

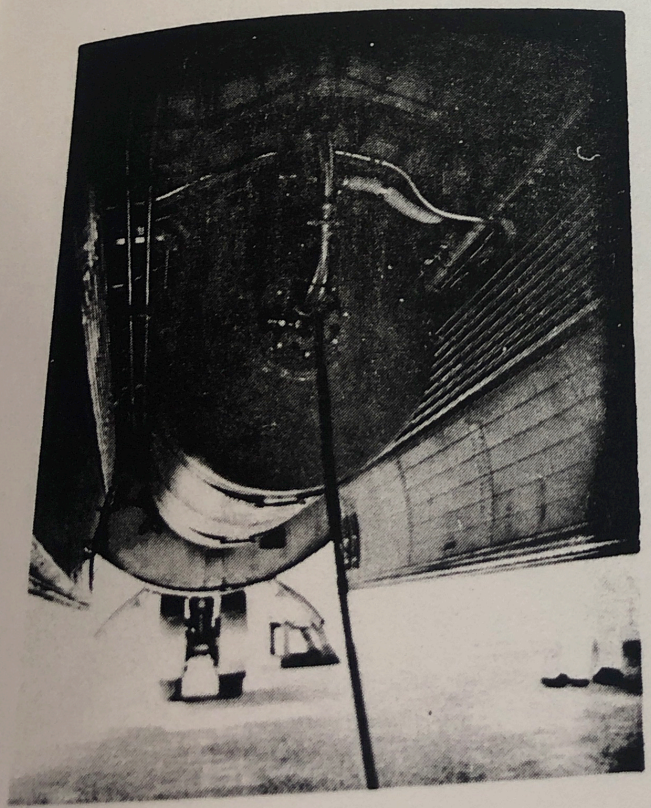

Figure 4(c). Gas sample - bomb-bay bag.

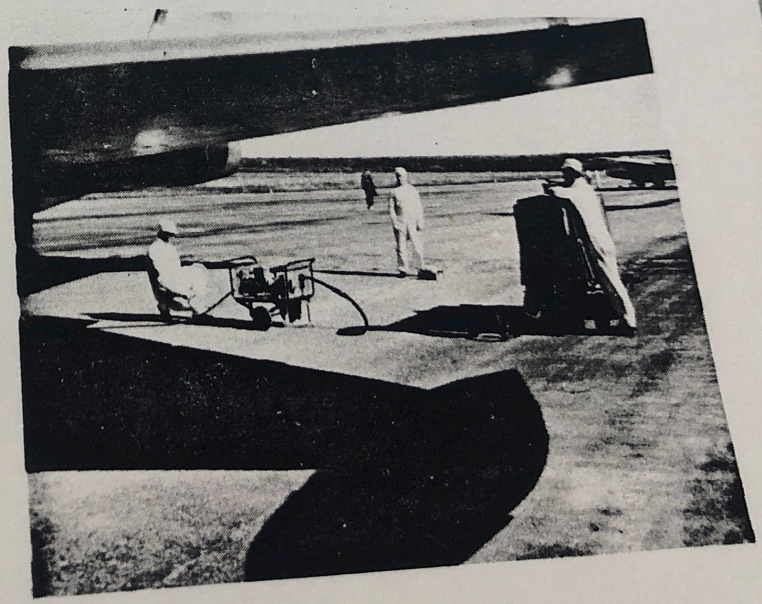

Figure 4(d). Compressing sample into air bottle.

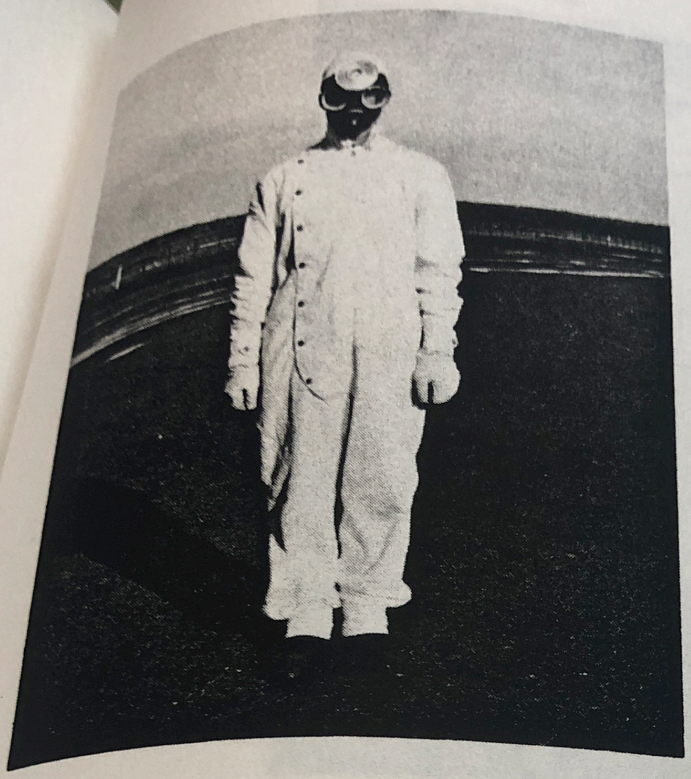

Figure 5(a). Normal issue, with A.W.R.E. respirator.

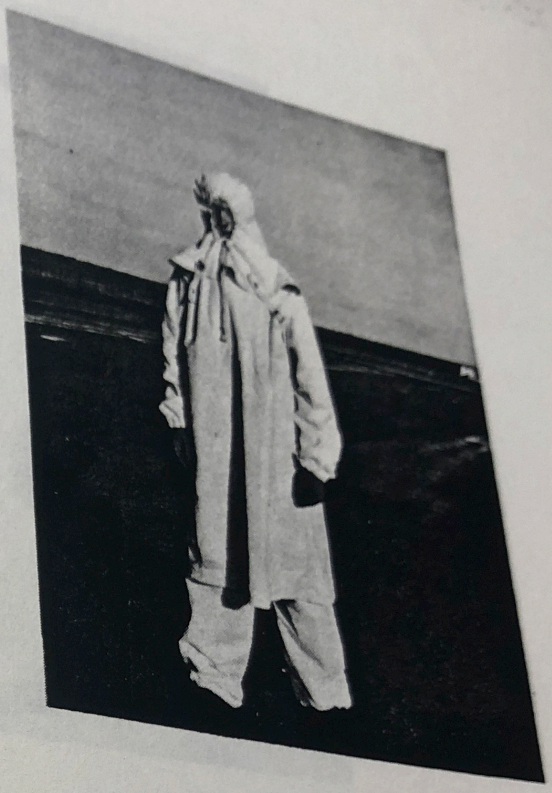

Figure 5(b). Waterproof clothing.

Figure 5. Protective clothing.

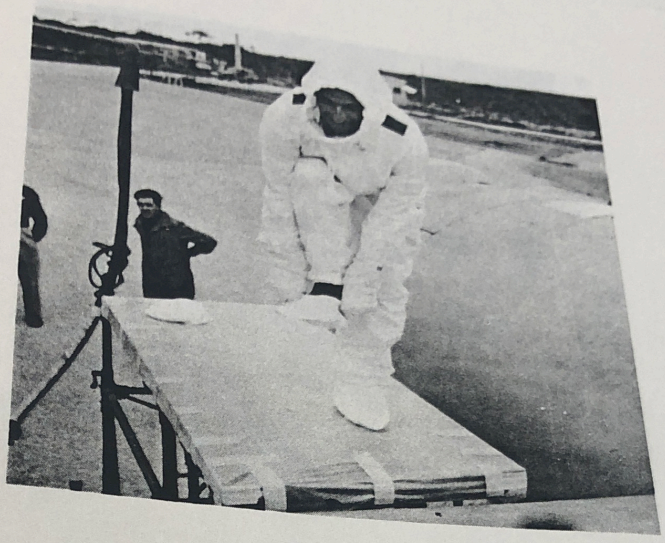

Figure 6(a). Donning overshoes

Figure 6(b). Opening tank caps.

Figure 6. Refuelling procedure.

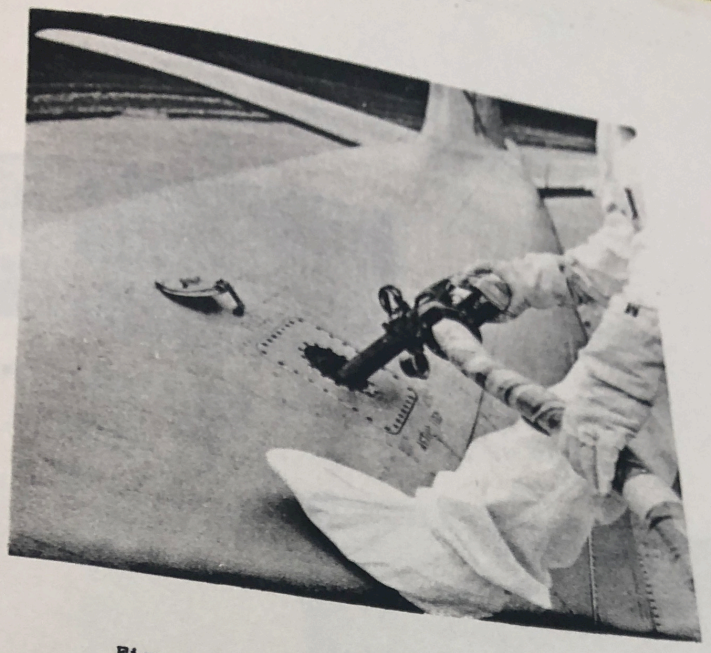

Figure 6(c). Refuelling (Note swathed hose).

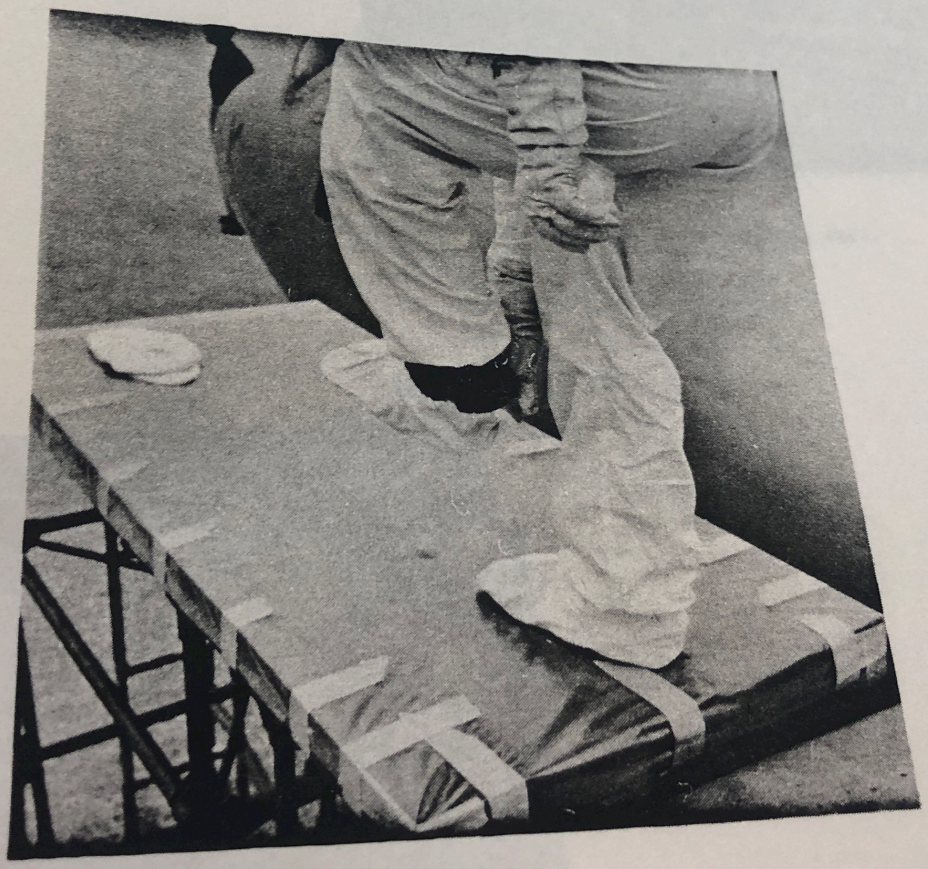

Figure 6(d). Removing overshoes.

Figure 7(a). Hut, laundry truck and area, facing west.

Figure 7(b). Area facing east.

Figure 7(c). Mortuary (Group laboratory)

entering the cabin were carefully checked. Ground locks and intake bungs were inserted in the normal way, a spare set being used for active work.

Refuelling required careful planning and a further instruction (Appendix C) was issued to lay down the correct procedure. Carelessness in this direction can readily lead to contaminated hoses and bowsers. Refuelling necessitates one man standing and walking over a highly contaminated wing. Overshoes were used to restrict the spread of contamination.

All the above aspects were handled by the RAF team after instruction.

4.2 General Monitoring

All monitoring of aircraft was kept in the hands of the AWRE representatives. Dose Rate Meters Type 1824 were used on initial surveys and for dose rates above 10 mr/h. Contamination Meters Type 1320 were used after the first day or so and were found to be a very convenient instrument. Surface contamination was estimated from the apparent $\beta\gamma/\gamma$ difference on this instrument. Smear tests were employed widely.

Results are included in Tables 1 and 2, and discussed below.

4.3 Sealing of Loose Contamination on the Aircraft

As already mentioned adequate facilities for decontamination work were not available and any such work was kept to a minimum.

At the beginning of the Operation all aircraft were sprayed with AWRE Barrier Paint after thorough cleaning. Between rounds all contaminated aircraft were partially recoated to seal in the loose activity over all areas where servicing access was necessary, e.g., around ground supply hatches, cabin door, refuelling points, wing tops, etc. In this way smearable contamination was reduced to zero.

At the end of the Operation the primary sampling aircraft were fully re-sprayed to enable them to be released for normal service, but with restricted servicing. Final decontamination was delayed until the end of Operation Buffalo. For details of the methods used and also fuller details of the application and properties of the barrier paint Refs. [1] and [2] should be consulted.