



Ministry of Defence

Our Ref: FOI2018/06695

Ministry of Defence
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United Kingdom

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25 September 2018

Dear [REDACTED],

Further to our letter dated 7 September 2018, we are writing to provide a response to your Freedom of Information Act request and apologies for the time taken to do so. You requested the following information:

Refined request in response to FOI2018/05260

- 1. Any AWRE health physics papers and internal discussion of radiation doses received by aircrew in the course of air sampling at the Grapple operations (redacted for names of personnel where necessary)*
- 2. Dose readings of cloud sampling aircrew including pilot, navigator and wireless operators, at Grapple Y, again redacted where necessary.*

As confirmed previously, the Ministry of Defence does hold information related to your request and this is now enclosed. As you recognised, under the terms of the Act, we have redacted information contained within the attached documents under the absolute exemption Section 40 (Personal Information). In addition, a small amount of information has been redacted under the qualified exemption Section 24 (National Security). This redacted material relates to site information at the Atomic Weapons Establishment. All redacted material is indicated in black. Section 24 is a qualified exemption and is subject to public interest testing, which means that the information requested can only be withheld if the public interest in doing so outweighs the public interest in disclosure. We concluded that while it is recognised that there is public interest in the operations of Government being as open and transparent as possible, there is a stronger public interest in safeguarding the security of the nation by not putting into the public domain any information that could be used by adversaries and would be likely to result in harm to national security.

We must advise that the documents contained information that does not fall within the scope of your request (for example references to a test other than Grapple) and so has been removed. This has resulted in gaps in some documents.

As you will appreciate, much of the information in scope was created many years ago and as a result the quality of the scanned pages, particularly the hand-written documents, in some cases is barely legible. We have, despite our best efforts, been unable to improve

the quality of the material provided and apologise for the poor images. Also, some of the records did not contain titles or dates for reference, in particular pages 10-22 of the attachment, which are related to Part 2 of your request.

For pages 20 and 21 of the attachment, we have not attempted to remove the information that refers to nuclear tests other than Grapple, which is out of scope of your request. This is because the quality of the document is extremely poor, making accurate removal of the information impossible. The personal data has, however, been redacted.

If you have any queries regarding the content of this letter, please contact this office in the first instance. Please remember to quote the reference number above in any future correspondence.

If you wish to complain about the handling of your request, or the content of this response, you can request an independent internal review by contacting the Information Rights Compliance team, Ground Floor, MOD Main Building, Whitehall, SW1A 2HB (e-mail CIO-FOI-IR@mod.gov.uk). Please note that any request for an internal review should be made within 40 working days of the date of this response.

If you remain dissatisfied following an internal review, you may raise your complaint directly to the Information Commissioner under the provisions of Section 50 of the Act. Please note that the Information Commissioner will not normally investigate your case until the MOD internal review process has been completed. The Information Commissioner can be contacted at: Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire, SK9 5AF. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website at <https://ico.org.uk/>.

Yours sincerely,

Defence Nuclear Organisation Secretariat

CRBAT

0265

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LOOSE MINUTE

UNCLASSIFIED

(SSS)

To : Task Force Commander, Operation Grapple 'X'

20194
Etc
0265

Cloud Sampling

1. It is agreed that the meteorological conditions at Christmas Island, although ideal in some ways, pose considerable problems in others. Firstly, the tropopause at Christmas Island varies between 55,000 and 59,000 ft; this is in contrast to the tropopause in the U.S. Eniwetok area which is more usually around 45,000 ft. and, under conditions of small, i.e. under two megaton bursts, may give quite different cloud concentrations. In the Eniwetok area the mushroom tends to leave some cloud at tropopause and then go on up producing a small sample at tropopause level, but the main body being much higher does not cause the problem of "shine" that is caused at Christmas Island where the difference of 12,000 to 15,000 extra feet in tropopause level tends to result in the upward rise of the cloud immediately after this level being slower and the spread immediate thereby causing an embarrassing amount of "shine" to the cloud samplers who must be over 50,000 ft. The other thing which I think must be borne in mind is the temperature at the 60,000 ft. level in the Christmas Island area. If this is minus 90° or over, trouble may well be expected from "flame-out" in rocket assisted turbo-jet aircraft. It is frequently minus 82° at 53,000 ft.

2. We have tended to find in past trials that the area between the base of the cloud and the sea is, to all intents and purposes, free from significant radiation. The stem at 10,000 and 20,000 ft. is also substantially free from fission products which, in air samples, may start to be found at 30,000 ft. and upwards. With the bigger yield weapons (two and over megaton) the same substantially holds, but even at 45,000 ft. the main body of the fission products will not be found, they are quite obviously in the area of 55,000 to 60,000 ft. and above.

3. Arrangements have been made for the employment of Scorpion Canberra B.6's flown by firm's pilots to take part in Grapple 'Y'. This to enable sampling to be carried out at a height of 60,000 ft. Such a plan carries with it at least three main problems:-

- (a) By the expected date for Grapple 'Y' only one of these special rocket powered Canberras will be available and will not in any event reach the area until about 'D' minus 7 days.
- (b) Apart from the serviceability of such complicated machines on the day there is the fact that the pilot and navigator will not have had much tropical experience in these aircraft and will not have had any experience whatever of cloud sampling. They may therefore find their first cloud sampling operation difficult in this area for, due to lack of acclimatising, excessive perspiration can be very embarrassing by the misting up of the helmet, etc.
- (c) For technical reasons connected with Grapple 'Y' the Scorpion Canberra will not be taking off until immediately after the burst, and can therefore not be expected to do its 60,000 ft. sampling run until at least H + 1 hour.

UNCLASSIFIED

WETA [redacted] 20.7.84

filed 4
13

[redacted]
Health Physics Division, Building [redacted]

England.

Our ref. WG/HP.H7001

5th February, 1958.

00-76 Squadron R.A.F.,
R.A.A.F. Edinburgh Field,
Salisbury,
South Australia.

Subject: Integrated Radiation Dose - 76 Squadron Aircraft

With reference to your 76S/C 1020/Air of 30 Jan 58.

1. Attached as Annexure A is a list of the doses received by the aircrew you mention and the date on which they may be further exposed to gamma radiation of less than 0.3r per week without application to higher authority.
- 2.
3. It is noted that [redacted] and [redacted] were in the Air Controllers aircraft and received doses in the order of 1 roentgen. With reference to Health Physics Group, Op Antler, letter HP/G/2 dated 17 Sept 57 these officers were not to be exposed to further radiation until 21 Dec 57 and 4 Jan 58 respectively. As will have been appreciated from my letter W/HP.67001 of 19 Nov 57 it was believed at the end of Antler that these officers had probably exceeded 10r over Grapple and Antler trials, in which case application should have been made for the special higher integrated dose. However the error in the Grapple Doseage figures on which we worked in Australia may have been realised at Christmas, in which case application for the higher integrated dose would have been sufficient. It is assumed that this was done.
4. It is understood that on future operations from Christmas Island personnel who wish to receive the special higher integrated dose of which the gamma component is greater than 10r but less than 25r may do so only on the express permission of the Scientific Director for the trial. If it is anticipated that any of the officers who received over 7r on Grapple X are to be employed on Grapple Y in sampling aircraft it would be appreciated if their names could be made known as soon as possible to this office.
5. In the event of a previous integrated dose not having been worked off when a second dose is acquired, it is the practise to add the whole of the first dose to the second. On no account must the sum of the two ever exceed 25r.



c.c. Air Ministry (HSA)
S.S.T.D.
S.R.H.P.



File

GRAPPLE Y

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Encls:

~~UNCLASSIFIED~~
~~CONFIDENTIAL~~

RAF/AWRE/Instruction No.3.

RAF/AWRE/S.1334

OPERATION GRAPPLE 'Y'

RECORDING DOSE RATE METER

Introduction

1. The purpose of this equipment is to record automatically on film the dose rate in the cabin throughout the sampling operation. The equipment is installed in the high altitude sampling 'Scorpion' aircraft only.

2. Equipment Details

The equipment comprises three assemblies, all of which are installed in the cabin. Two assemblies are mounted on a rack, one above the other. The rack is secured by bolts and shock-mounted to the floor in the space previously occupied by starboard Navigator's seat. The third assembly is mounted on seat rail for the starboard seat adjacent to the bulkhead.

3. The upper of the two assemblies on the rack comprises an 8 mm Camera, a 270 degree Scale microammeter and a watch. The maximum running time of the camera is two hours thirteen minutes, which is one frame per second; there being 8000 frames on the film. The microammeter has a logarithmic scale and the scale reading is equivalent to a range in dose-rate from 5 milli-roentgen to 5000 roentgens per hour. The power supply for the camera motor is taken from the 28 volts D.C. aircraft supply. The dial of the meter is illuminated by twelve 24 volt bulbs.

4. The lower of the two assemblies on the rack comprises two sub-assemblies, namely a logarithmic amplifier and a transistor power supply. On the front panel of the logarithmic amplifier is a small meter monitoring the reading shown on the large meter in the upper assembly on the rack. On the front panel are also the power supply switches and a rotary switch to check the equipment is functioning correctly.

5. The third assembly mounted on the seat rail comprises an ionisation chamber and a pre-amplifier. The latter is a logarithmic amplifier using one electrometer valve.

Principle of Operation

6. Radiation present in the cabin causes ionisation to take place in the ionisation chamber. This results in a variation in voltage applied to the pre-amplifier. This change is amplified by the pre- and main amplifiers. The output of the main amplifier is connected to the meter in the upper assembly on the rack and the monitoring meter. A watch is mounted on the meter face in the blank 90 degree arc on the dial. Thus the reading on the meter i.e. the dose rate and the time are recorded on the same frame.

Preparation and Operation of Recording Dose Rate Meter

7. On the ground. The servicing of the equipment is the responsibility of A.W.R.E. (R.M. Group) specialists. The camera will be loaded by the A.W.R.E. specialists. The pre-flight functioning check using the rotary switch on the front panel of the logarithmic amplifier and the switching on of the power supplies to the electronic equipment will be done by the R.A.F./A.W.R.E. Health Physics Officer.

8. In the Air. The switch for the Camera and associated indicator light are mounted on the port side of the upper assembly on the rack adjacent to the navigator. The Camera must be switched 'ON' by the Navigator on receiving instructions from the controller to begin the sampling operation.

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OPERATION GRAPPLE 'Y'AIR SAMPLING IN CANBERRA B.6 CABINS1. Introduction

In order to test the efficiency of the cabin air filtration system on the Canberra B.6 aircraft, being used on Operation Grapple 'Y', it will be necessary to position air sampling equipment inside the cabin of the aircraft.

Equipment

The apparatus consists of:-

- a) A Vacandair pump unit (2 amps at 24V.)
- b) A 3" filter holding a millipore filter.

The pump is fed from a lead into the 24 volt supply on the starboard wall of the aircraft and is located on the starboard side of the step below the observers seat. The filter holder is clamped into position by a small clamp attached to the rib in line with the step and the diffuser normally located between observer and plotter is re-routed down the starboard side of the cabin so that air from it can impinge directly on to the millipore filter paper held in the holder, (see fig. 1).

2. Method of Operation

When at height and prior to sampling, the observer will switch the pump 'on' by means of the small switch in the side of the pump casing. The equipment is to be switched 'off' on return to base.

3. Handling of Filter

Prior to the flight the filter will be put in position by a member of R.A.F./A.W.R.E. or a nominated member of the Active Handling flight. After the flight it is to be removed from its clamp, detached from its rubber tubing and brought to the Mobile Laboratory in the Active area, in the special tin provided.

Note: This equipment may also be required to be used in any other type of aircraft of the Grapple Task Force which may fly through radioactive air.

10th March, 1958

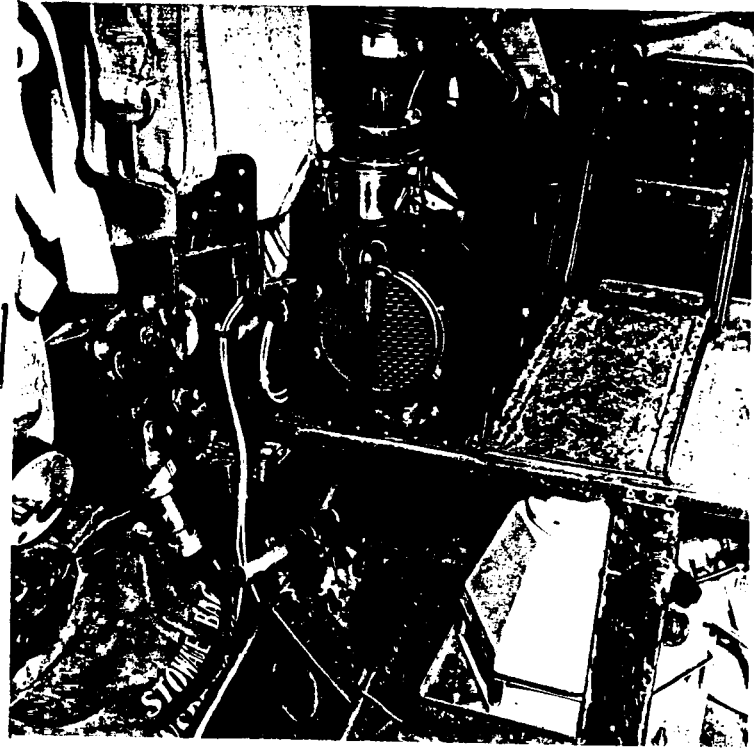
R.A.F./A.W.R.E.

Distribution:

T.F.C. Grapple	1	R.M. Group	16
D.T.F.C. "	2		17
S.A.S.O.	3	A.D. Ops. A.H.T.	18
Wg. Cdr. Ops.	4		19
S.T.O.	5	RAF/AWRE	
O.C. 76 Squadron	6-11	O.C. RAF/AWRE	20 - 21
O.C. Active Handling Flight	12-13	H.Q. Bomber Command	22
Scientific Director	14	Spares	23 - 30
Scientific Superintendent	15		

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Filter and
Holder



Cabin Sampling in Canberra B.6.

Fig.1.

OPERATIONS RECORD BOOK

OF (Unit or Formation) No. 76 Squadron

PAGE NO. 7
NO. OF PAGES USED FOR MONTH .11

PLACE	DATE	TIME	SUMMARY OF EVENTS	COMPILING OFFICER	REF. TO APPENDICES
Christmas Island	April 27	1958	<p>Operations</p> <p>Background Sampling This was a sortie to assess the amount of radio activity, if any, in the local area, and was carried out on April 27th (D-one).</p>	OPERATION GRAPPLE 'Y'	
Christmas Island	April 28	1958	<p>All personnel were up and about by 0400 hours. The sun rose some three hours later, after a prolonged and heavy shower of rain and it was seen that there was almost complete cloud cover. There was considerable speculation as to whether the weapon would be set off that day as the Squadron Aircrews sat around straining to hear the extremely inadequate tamony across the dispersal tarmac. The Valiant take off was initially put back one hour, then another 30 minutes and the final delay was 1 hour 35 minutes, making 2-hour 000 hours. V. Eventually, however, all aircraft were in their correct orbits and at their respective heights in good time. The final live run was not known until 9 minutes from release and the burst occurred at 1004 hours. About two minutes prior to release all aircraft turned away from ground zero as planned. The Air Controller altered heading to enable his aircraft to be brought at right angles to ground zero as soon as possible after burst, thus enabling the Observer to time the fireball's rise to height through the periscope sextant; this was given the code name of 'Flagpole'.</p> <p>The fireball and the cloud's development was an awesome sight from the air. From his position in orbit the Air Controller flew in towards Ground Zero as planned and made the necessary measurements and assessments of the nuclear cloud before calling in the Primary Sampler ('Sniff One'). From that time onward the whole operation proceeded almost exactly as rehearsed. Control of the sampling aircraft was maintained without difficulty and each of the three employed carried out the necessary runs entirely as required.</p> <p>'Sniff Two' obviously struck the 'hottest' zone and slightly exceeded his maximum permitted dose in the course of only one penetration. 'One' and 'Four' were both ordered back to base whilst their instruments showed them to be within acceptable limits.</p> <p>Unfortunately however, 'Sniff One' was subsequently proved to have slightly exceeded his and the Squadron was thus faced with the unfortunate need to replace two crews instead</p>		

PLACE	DATE	TIME	SUMMARY OF EVENTS	REF. TO APPENDICES
			<p>of the one philosophically accepted as 'expedient'.</p> <p>After landing and the tedious business of personal decontamination had been completed, flying clothing navigation kit and aeroplanes were left in the active-handling area with many premises of 'we'll have them out for you just as soon as they're clean' - (a period which, in the event, varied from two days for clothing to two and a half weeks for the last aircraft).</p> <p>Another Sampling Operation, the Squadron's fourteenth, had been successfully completed. Just how successful was only revealed the following day when it was made known that for quality and quantity the samples obtained by all three aircraft were the best ever. A gratifying climax to four months of preparation and one reflecting, perhaps, the greatest credit upon the Squadron groundcrew whose consistently high standard of servicing had made it possible.</p>	
Christmas Island	April 28	1958	<p><u>Bodies of Aircrew in Grapple 'Y'</u></p> <p><u>Air Controller</u></p> <p><u>WJ 754</u></p> <p><u>Sniff One</u></p> <p><u>WJ 757</u></p> <p><u>Sniff Two</u></p> <p><u>WJ 980</u></p> <p><u>Sniff Three</u></p> <p><u>WJ 576</u></p>	

76 SQDN CANBERRAS AT GRAPPLE Y

Taken from 76 Sqn reports

For Grapple Y, seven aircraft were detached to Christmas Island, WH976, WH978, WH980, WJ754, WJ757, WT206, and WT208. All were equipped for cloud sampling.

On April 1 1958, Squadron ground crews (including presumably [redacted] were given lectures and practical demonstrations relating to the health physics aspects of servicing contaminated aircraft.

First rehearsal was on April 16 All aircraft were flown, two (unspecified) returning through DC. The second rehearsal was on April 18; again two aircraft returned through DC. The third rehearsal was on April 22; all aircraft went through DC.

On April 24, all personnel who would be on the ground on shot day were issued with protective clothing and the aircraft were painted with barrier paint.

Full dress rehearsal was on April 25, again all aircraft went through DC.

All aircraft were airborne for D-Day. Duties were;

WJ754	Air Controller
WJ757	Sniff 1
WH980	Sniff 2
WH976	Sniff 3
WH978	Sniff 4
WT206	Scorpion Controller
WT208	Scorpion 1

All aircraft turned away from GZ two minutes before release (This implies that they were within the range at which blast damage was possible). The ORB states that three aircraft were committed to the cloud; these appear to be Sniff 1, 2 and 4. It is not clear why Sniff 3 was not committed. Sniff 1 slightly exceeded the pre-planned dose limits.

After landing, all aircraft went through DC. All aircraft and personal flying kit was left in the Active Handling Area. It took two days to clear all clothing and two and a half weeks to clear the last aircraft (Number not specified).

Not necessary

76 Ex

HEALTH PHYSICS GROUP. GRAPPLE "Y"

Film Number	0-5 R. Dosimeter Number	00-50 R. Dosimeter Number	Name	Group	Density		Film Dose (R)	Dosimeter Dose (R)	
					Shield.	Unsh.		0-5	0-50
• S 97947	4086	4086					C-45	0.7	-
• S 60254	4071	4071					C-38	0.4	2.0
• S 116729	4070	4070					C-34	0.9	-
• S 116772	4083	4083					C-35	0.5	1.0
• S 97846	4078	4078					13.0	4.2	9.0
• S 97845	4080	4080					10.0	-	9.0
• S 116756	4088	4088					10.5	4.2	10.0
• S 303	4085	4085					13.0	-	13.5
• S 331	4074	4074					10.75	-	10.0
• S 126	4084	4084					10.75	-	15.0
• S 116759	4082	4082					NIL	-	-
• S 116767	4079	4079					.07	-	-
• S 116737	5.97984	5.97984					NIL	-	-
• S 116774	4081	4081					7.5	-	5.0
• S 116730	4072	4072					5.0	3.8	4.0
• S 116764	4077	4077					5.5	3.6	4.0

Swift box.
75#

Swift I.
757.

Swift II
980

Swift III
976

Swift IV
978.

Did not sample.

16

73 Spahn HEALTH PHYSICS GROUP. ©

(17)

did not fly.

Film Number	0-5 Dosimeter Number	0-50 Dosimeter Number	Name	Group	Density		Film Dose (R)	Dosimeter Dose (R)	
					Shield.	Unsh.		0-5	0-50
2	5 97843	4433	[REDACTED]				NIL	-	-
0	5 116769	5-97843	[REDACTED]				NIL	-	-

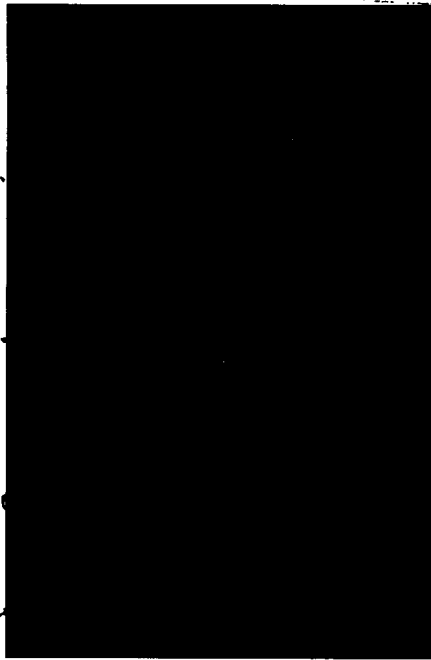
Assume (new)



E148

GRAPPLE Y

MAY 1958.



~~0.45 R~~

~~0.38 R~~

~~0.34 R~~

~~0.35 R~~

13.0 R

10.0 R

10.5 R

13.0 R

10.75 R

10.75 R



} Did not
SAMPLE.



~~7.5 R~~

~~5.0 R~~

~~5.5 R~~

2 [redacted] DOB [redacted] [redacted] [redacted]

Grapple Y 18.04.58 to 17.05.58 No entry

3 [redacted] DOB [redacted] [redacted] [redacted]

Grapple Y 76Sqn. 18.03.58 to 17.05.58 10750 mrem.

4 [redacted] DOB [redacted] [redacted] [redacted]

Grapple Y 76Sqn 18.03.58 to 17.05.58 340 mrem

5.

1.

6.

[Redacted]

DOB

[Redacted]

[Redacted]

[Redacted]

Grapple Y

18.03.58 to 17.05.58 No entry.

7.

DOB

8.

9.

10.

76 Squadron, Officers (Air and Ground), NCO Aircrew.

Up 144, 105 4... 88 > ...

Totals

c y

[Redacted]

2,

GY 350

[Redacted]

GY -

[Redacted]

GY -

[Redacted]

GY -

[Redacted]

GY 13000 ✓

GY 10,000

13000

[Redacted]

GY -

[Redacted]

GY -

[Redacted]

GY -

[Redacted]

GY 13000

[Redacted]

GY 450

‡ Accidental exposures

* Uncertainty over Grapple, exposures.

76 Squadron (continued)

85

Totals

[Redacted]

GY —

[Redacted]

GY —

[Redacted]

GY 10750

10750

[Redacted]

GY —

[Redacted]

GY —

[Redacted]

GY 10500

[Redacted]

GY —

[Redacted]

GY 10750

10750

[Redacted]

GY 340

[Redacted]

GY —

[Redacted]

GY —

GY —

GY —

[Redacted]

GY 5500

[Redacted]

GY 380

[Redacted]

GY 7500

‡ Accidental exposure

76 Squadron (continued)

221

(4)

9

Totals

[Redacted]

GY —
GY —

[Redacted]

GY —
GY 70

[Redacted]

GY 5000

[Redacted]

GY —

* Uncertainty over Grapple/ exposures

- 1. Rank. (Present or on release)
- 2. Retired or still in Service.
- 3. Vital status.

Rank. Name Number DOB Experience Trial Retired
 mem. no.

[Redacted Name and Number]

10 000 (GY) [Redacted]

13 000 (GY) [Redacted]

[Redacted Name and Number]

13 000 (GY) [Redacted]

[Redacted Name and Number]

10 750 (GY) [Redacted]

10 500 (GY) [Redacted]

10 750 (GY) [Redacted]

GY 6 - (2x 13'000, 4x 10,500)

CTNO 0951

UNIT NO 1-11

(1)
623

Results for Personnel Not on Regular Film Badge List


NAME	SERVICE No.	GRADE - RANK	BRANCH - SERVICE	DOSSE	NAME	SERVICE No.	GRADE - RANK	BRANCH - SERVICE	DOSSE
[REDACTED]			RAF.	0.35	[REDACTED]			RAF	10.75
[REDACTED]			RAF.	0.02	[REDACTED]			RAF	10.34
[REDACTED]			RAF.	0.07	[REDACTED]			RAF	10.09
[REDACTED]			RAF.	0.13	[REDACTED]			RAF	0.04
[REDACTED]			RAF.	0.07	[REDACTED]			RAF.	0.02
[REDACTED]			RAF.	0.07	[REDACTED]			RAF.	0.02
[REDACTED]			RAF.	0.030	[REDACTED]			RAF.	0.02
[REDACTED]			RAF.	0.10	[REDACTED]			RAF.	0.03
[REDACTED]			RAF.	0.40	[REDACTED]			RAF.	0.15
[REDACTED]			RAF.	0.05	[REDACTED]			RAF.	0.02
[REDACTED]			RAF.	0.04	[REDACTED]			RAF.	0.02
[REDACTED]			RAF.	10.00	[REDACTED]			RAF.	5.50
[REDACTED]			RAF.	0.02	[REDACTED]			RAF.	0.07
[REDACTED]			R.A.F.	13.00	[REDACTED]			RAF.	0.25
[REDACTED]			RAF.	0.01	[REDACTED]			RAF.	0.38
[REDACTED]			RAF.	0.03	[REDACTED]			RAF.	10.10
[REDACTED]			RAF.	0.01	[REDACTED]			RAF.	4.50
[REDACTED]			RAF.	0.03	[REDACTED]			RAF	0.09
[REDACTED]			RAF.	0.075	[REDACTED]			RAF.	0.03
[REDACTED]			RAF.	0.865	[REDACTED]			RAF.	0.02
[REDACTED]			RAF.	0.01	[REDACTED]			RAF.	0.07
[REDACTED]			RAF.	0.02	[REDACTED]			RAF.	0.07
[REDACTED]			RAF.	13.0	[REDACTED]			RAF.	0.08
[REDACTED]			RAF.	0.04	[REDACTED]			RAF.	0.10
[REDACTED]			RAF.	0.45	[REDACTED]			RAF.	0.04
[REDACTED]			RAF.	0.08	[REDACTED]			RAF.	0.14
[REDACTED]			RAF.	0.10	[REDACTED]			RAF.	0.05
[REDACTED]			RAF.	0.05	[REDACTED]			RAF.	0.85
[REDACTED]			RAF.	10.75	[REDACTED]			RAF.	0.07
[REDACTED]			RAF.	0.02	[REDACTED]			RAF.	0.08
[REDACTED]			RAF.	0.16	[REDACTED]			RAF.	0.08
[REDACTED]			RAF.	0.045	[REDACTED]			RAF.	5.00
[REDACTED]			RAF.	10.50	[REDACTED]			RAF.	0.08
[REDACTED]			RAF.	0.15	[REDACTED]			RAF.	0.10
[REDACTED]			RAF.	0.03	[REDACTED]			RAF.	0.02
[REDACTED]			RAF.	0.02	[REDACTED]			RAF.	0.10
[REDACTED]			RAF.	0.03	[REDACTED]			RAF.	0.07

Film badges were issued to all members of AWRE and to service personnel to groups. They were also issued to all aircrew flying on shot day, to the handling flyer, and to the ground crew concerned with the routine maintenance of active aircraft.

A total of 340 badges were issued during the trial to 260 persons. Complete lists of all persons who received doses of over 20 milliroentgens are held by SHP AWRE.

With the exception of those aircrew detailed in table no persons involved in the trial received more than 3 roentgens. All were members of 76 Sqn RAF.

Table

Persons incurring whole body gamma radiation dose greater than three roentgens.		
Name and rank	Dose (roentgens)	Date until which no further exposure should take place
	10.75	28th April, 61
	13.0	28th April, 61
	10.75	28th April, 61
	13.0	28th April, 61
	10.5	28th April, 61
	10.0	15th December, 58
	7.5	20th October, 58
	5.0	25th August, 58
	5.5	8th September, 58

The statistics of all doses received on the trial are given in Table .

~~SECRET~~

6. Sampling Effort on D-Day

only normal sampling Canberras could be used for sampling on Grapple-Y.

By 0600 hours local on D-Day, five aircraft had been fitted with Mark 3, 9 and 10 filter elements, drums, evacuated and spiked gas bottles, cabin air sampling filters and integrating dosimeters. All external equipment had been dried and was covered with polythene bags containing silica gel packets to combat moisture. These bags were removed just before the aircraft taxied from dispersal. The detailed operational procedure is given in a No. 76 Squadron report).

The cloud did not rise to the expected altitude and the sampling procedure had to be re-assessed by the sampling controllers ([REDACTED]) in Sniff Boss (aircraft WJ.754).

Sniff Boss first reconnoitred the cloud at 1025 hours local and made two passes through cloud stem at 42000 ft, each of about a minute duration. At 1049 Sniff 1 (WJ.757) entered the cloud on a first run at 46000 ft approximately, on a heading of 350° and took no indicated integrated dose. Sniff 2 (WH.980), was sent in at 1055½ hours, made one pass lasting 2½ minutes at 52800 ft indicated and received an indicated maximum dose of 10.6r on returning to base. Sniff 2 was then sent in again at 50000 ft at 1109 hours for five minutes, and subsequently once more for a further six minutes, receiving in all an indicated dose of 8.3r.

Sniff Boss contacted "Cleaner" (Decontamination Control), to enquire whether the sample from Sniff One and Two was sufficient but as Sniff Two had not returned, Sniff Boss was advised to send in Sniff Four, Sniff Three having become unserviceable with a non-functioning Mark 3 duct actuator. Sniff Four made three runs between 1150 and 1223 hours and returned to base at 1250 hours.

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P (34)

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from: [redacted] Health Controller, A.W.R.E., Christmas Island

To: O.C 76 Squadron, Royal Air Force, B.F.P.O. 170

Copies to: See Distribution List

Date: 2nd May, 1958

Ref: RM/1

Radiation Doses

1. Arising from the operation on 28th April, 1958 a number of members of 76 Squadron received doses greater than 3 r and consequently their future exposure to radiation has to be controlled. The rules governing exposure to radiation are contained in "Radiological Safety Regulations, Christmas Island" paragraph 2.1.

2. The Officers concerned are:-

<u>Name</u>	<u>Dose received</u>	<u>Date further exposure may commence without special authority</u>
[redacted]	10.75	28.4.61
[redacted]	13.0	
[redacted]	10.75	
[redacted]	13.0	
[redacted]	10.5	
[redacted]	10.0	15.12.58
[redacted]	7.5	20.10.58
[redacted]	5.0	25.8.58
[redacted]	5.5	8.9.58

Distribution:-

Task Force Commander
S.A.S.O.

[redacted] (for Air Ministry Medical Directorate MA4)

Trials Director
Trials Superintendent

[redacted]
Group Leader RM Group

[redacted]
Spare (2)

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OPERATION GRAPPLE-Y

INTERIM REPORT

PART 7. RADIOLOGICAL MEASUREMENTS

[REDACTED]

With Statements on Health Physics Control by

[REDACTED]

[REDACTED]

(Decontamination Area)

<u>Contents</u>	<u>Page</u>
1. Group Tasks	1
2. Results of Measurement Tasks	1
3. Discussion and Conclusions on Measurement Tasks	5
4. Nuclear Instrumentation	6
5. Health Physics Control - General	6
6. Health Physics Control - Decontamination Area.	7
Table 1	11
Figures 1 (RM) to 3 (RM)	

The members of the Group were:

[REDACTED]

Trials Planning Branch,
A.W.R.E.,
Aldermaston, Berks.

June, 1958.

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OPERATION GRAPPLE-Y - INTERIM REPORT

PART 7. RADIOLOGICAL MEASUREMENTS

1. Statement of Group Tasks

RM1 To measure the integrated gamma dose/distance relationship, and the variation of dose rate with time for the initial gamma radiation.

RM2 To measure the variation of integrated neutron flux with distance.

RM3 To measure fallout contamination at points close to Ground Zero.

RM4 To measure fallout at surrounding islands.

RM5 To measure the gamma dose in cloud sampling aircraft.

RM6 To advise on health physics and radiological control.

RM7 To provide a dose measuring service.

RM8 To provide nuclear instrumentation.

RM9 To radiograph and monitor the neutron output of weapon components.

RM10 To carry out a radiological survey and the analysis of a sea water sample from surface zero.

RM11 To make radiological survey in an emergency.

RM12 To arrange for fish monitoring.

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2.6 Task RM5 Measurement of Gamma Dose in Cloud Sampling Aircraft

Both integrating and dose-rate instruments were supplied for use in the cloud sampling aircraft and these appear to have functioned satisfactorily.

It had been intended to instal a gamma dose-rate recorder in the cabins of the high altitude Scorpion Canberras to ascertain how the dose-rate varies with time but this measurement was eliminated as the high altitude aircraft were not used for sampling.

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5. Health Physics - General (Tasks RM 6 and 7)

5.1 Film Badge - Service and Radiation Doses

5.1.1 AWRE A total of 160 film badges were issued. So far (3rd May 1958) no member of AWRE has received a dose in excess of 3.0 roentgens. A number of badges still remains to be developed.

5.1.2 Services Film badges were issued to service personnel attached to AWRE groups, and were included in the AWRE total

Nine RAF crew received more than 3.0 roentgens. Particulars are given below:-

<u>Name</u>	<u>Dose received (r)</u>	<u>Date further exposure may commence without special authority</u>
[REDACTED]	10.75	28.4.61
	13.0	
	10.75	
	13.0	
	10.5	

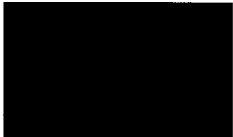
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<u>Name</u>	<u>Dose received</u> (r)	<u>Date further exposure may</u> <u>commence without special</u> <u>authority</u>
	10.0	15.12.58
	7.5	20.10.58
	5.0	25. 8.58
	5.5	8. 9.58

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6.4 D-Day

Prior to leaving the area all buildings and tents were vented and instruments were cached in two old bomb shelters in the D.C. area to meet the possible destruction of B14 (this building was damaged on Grapple-X).

Arrival and handling of the sampling Canberras (5) followed accepted practice, all being received within 3 hours of burst. Details of the doses received by the aircraft are as follows:-

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A/c	Stbd. Tank r/h	Stbd. Eng. r/h	Nose Wheel r/h	Crews Door r/h	Port Eng. r/h	Port Tank r/h	Charlie r	Time	Code	
980	5	5	1	1	4.5	5	14	11.00	Sniff 2	
757	2	2	0.4	0.4	2	2.8	10	11.45	Sniff 1	
976	Did not sample								11.53	Sniff 3
754	0	.02	0.01	0.01	0.02	0	1.8	12.43	Sniff Boss	
978	0.6	0.6	0.2	0.1	0.6	0.8	0.7	12.47	Sniff 4	

Eurst time 10.05. Charlie = Integrating Dosimeter. Sniff = code for sampler aircraft.

At approximately 1930 hours the radiological survey Shackleton aircraft was admitted into the D.C. Area having become contaminated during the course of its operational sortie. Smearable activity off-scale on a 1320 was recorded from many points on the skin of the aircraft and smearable activity was detected in the cabin. The crew were passed through the decontamination building and it was necessary to remove aircrew clothing and kit from certain members of the crew. The somewhat apprehensive crew were reassured.

All Canberras were refueled without incident.

6.8 Sampling Aircrew Dosage

Five Canberra B6 aircraft were airborne on sampling detail. Of these only four entered the cloud. The initial penetration, a fringe cut, by the sampling controller gave a very low dose-rate yet enabled subsequent control of samplers to be judged very accurately in respect to obtaining the necessary quantity of particulate matter. Two crews received dosages over 10r.

Crew dosages are tabulated below and can be correlated with the table in Section 6.4 above:-

Sniff Boss A/C 754	[REDACTED]	Badge Dose	0.45r [REDACTED]
			0.38r
			0.34r
			0.35r [REDACTED]
Sniff 1 A/C 757	[REDACTED]		13.0r
			10.0r
			10.5r
Sniff 2 A/C 980	[REDACTED]		13.0r
			10.75r
			10.75r
Sniff 3 A/C 976	[REDACTED]) Did not sample
)
Sniff 4 A/C 978	[REDACTED]		7.5r
			5.0r
			5.5r

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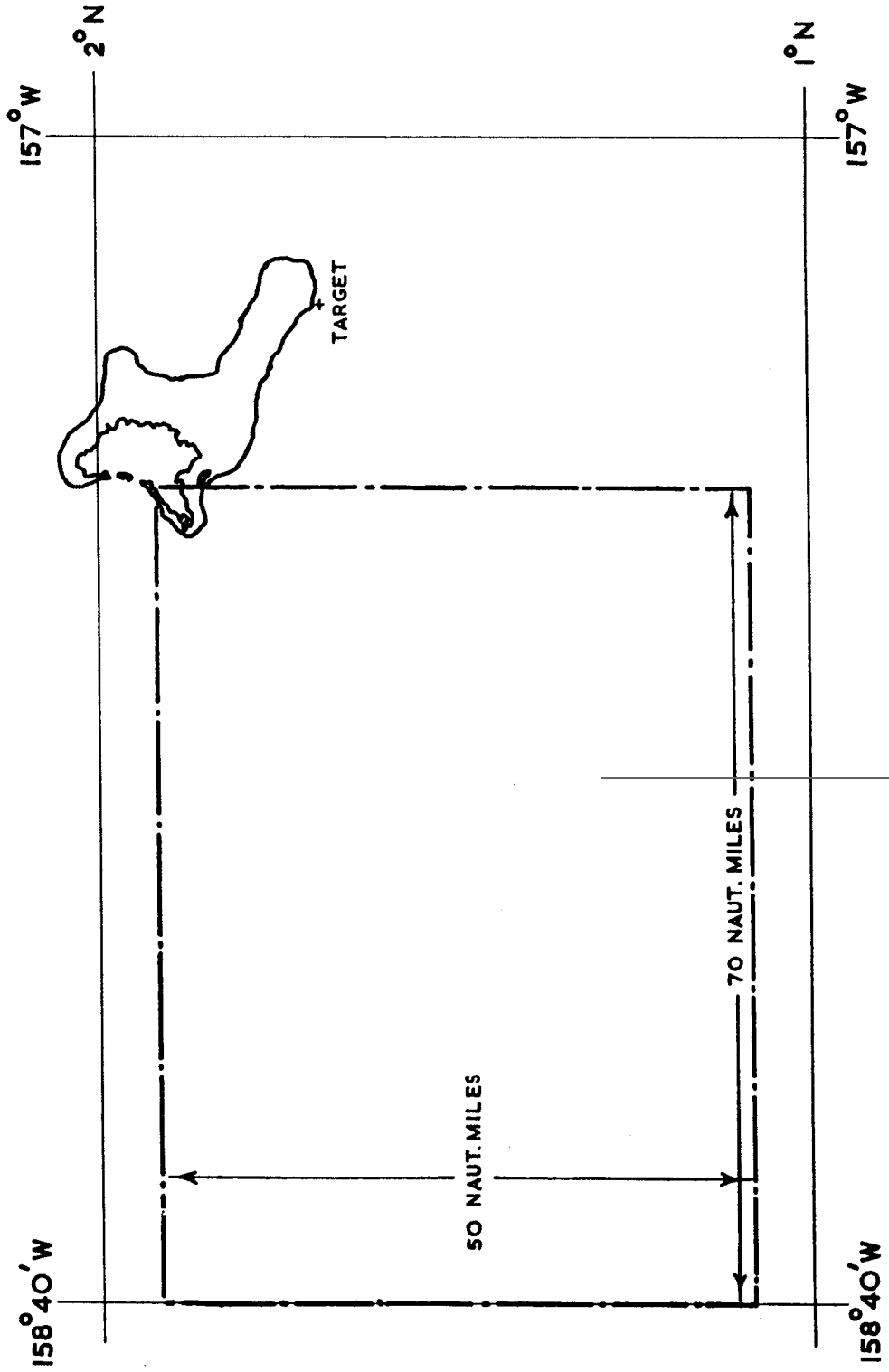


FIGURE I (TP) AREA OF AERIAL RADIOLOGICAL SURVEY

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Reference SRHP/H.7006

Film Doses - Grapple Y

Shielded

1. Attached as annexures to this letter are the dosages in roentgens incurred by AWRE and service personnel on Grapple Y.
2. A few results are still to come. They are contained in some paperwork which has not yet returned from Christmas.

Building [REDACTED]
Extn. [REDACTED]
4th June, 1958.

c.c. Air Ministry (for Grapple P and MA 4) with Annexure B and C
O.C. 76 Sqn. RAF with Annexure B
O.C. 240 Sqn. RAF with Annexure B
O.C. 38 CORPS REGT R.E. with Annexure A

[REDACTED]
-17/6/58.

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R.A.F.

Annexure B

76 Squadron



Dose
(Roentgens)

0.45
0.35

0.38
13.0
10.75
5.0

0.34
13.0
10.0
10.5
10.75
0.07
7.5
5.5

240 Squadron



0.020
0.020
0.020
0.020
0.070
0.020
0.020
0.030
0.080
0.070

Helicopter Squadron



0.020
0.030

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~~SECRET~~
Group Leader TP Group.

804

806

GRAP
1034

CINO 0270
0399

In the Flagpole sampling sorties three Canberra crew members received radiological doses considerably in excess of the 10r authorised for this exercise and it is necessary that this should be investigated.

You have been nominated to take charge of this investigation, which should be completed as soon as possible. Your terms of reference are:-

"To investigate circumstances in which the crew of sampling Canberra No. WH 976 exceeded their authorised radiological doses on Flagpole sampling and to recommend immediate steps to prevent a recurrence during Grapple Zulu."

You will be assisted in your enquiry by ~~SECRET~~

~~SECRET~~
Scientific Director

J.O.C.
3 September 1958

c.c. ~~SECRET~~

(for info)

~~SECRET~~

Scientific Director.

WH 0401

Flagpole - Sampling by Canberra No. WH 976

In accordance with your letter of 3rd September, I have investigated the circumstances in which the crew of sampling Canberra No. WH 976 exceeded their authorised radiological doses on Flagpole sampling; and I have considered what immediate steps should be taken to prevent a recurrence during Grapple Zulu.

I have discussed the matter with [redacted] and [redacted]. I have not talked with the crew of the aircraft, believing that they could shed no further light, and thinking that anything suggestive of a formal enquiry would only cause them needless anxiety.

Herewith my report and recommendations.

1. The Instruments

For the sake of completeness it is useful to begin by listing the radiation instruments carried in sampling aircraft. I use the code names that are employed during the sampling process.

- Romeo : gives dose rate
- Charlie : gives total dose
- Salmon : indicates success of sampling

In addition, each member of the crew has a personal film badge and a personal quartz fibre dosimeter, both indicating total dose, the first after development and the second by an immediate meter reading.

2. The Men

Three men are involved in the control of each sampling aircraft, viz., the Captain of the aircraft, Sniff Boss, and Sniff Controller. Sniff Boss is the accepted term for the airborne sampling controller [redacted] (Flagpole); for the sake of brevity in this report I have invented the term Sniff Controller for the ground-base sampling controller [redacted] (at Flagpole).

In broad terms Sniff Boss directs each aircraft during the sampling process, and Sniff Controller exercises a general supervision through Sniff Boss. The Romeo, Charlie and Salmon readings are transmitted by each aircraft to Sniff Boss and Sniff Controller; with one exception, the Captain of the sampling aircraft takes no action based directly on his interpretation of the readings of his radiation instruments. The exception is that, if his Charlie reading reaches 8r, he immediately takes his aircraft out of the radioactive region and awaits instructions from Sniff Boss.

3. The Events at Flagpole

Three sampling aircraft were employed at Flagpole, Sniff 1, Sniff 2, and Sniff 3. In chronological order, sampling runs were made as follows: one run by Sniff 1, one by Sniff 2, one by Sniff 1, and six by Sniff 3. It was during these last six runs that the crew of Sniff 3 (Canberra No. WN 976) exceeded their authorised doses.

The Appendix gives the Romeo, Charlie and Salmon readings reported at the time by Sniff 3, from which it is seen that, in spite of quite high Romeo readings (of dose rate) the final Charlie reading (of total dose) was only 8.5r which is less than the permitted maximum of 10r. Calculation

of the total dose by integration of the Romeo readings gives a value of 17r; thus the Romeo and Charlie readings are significantly inconsistent. Later development of the film badges gave values of total personal dose varying from 25r to 30r; and reading of the quartz fibre dosimeters gave values ranging from 16r to 24r. Finally, a check of the Charlie meter has shown it to be defective owing to leakage of air at the low ambient pressure existing in the aircraft at the time of sampling. It is believed that this would result in the Charlie readings being low by a factor of about 3; when allowance is made for this, the value of 8.5r is corrected to 25r. In short, allowing for the effect of air leakage, we have the results:-

Corrected Charlie :	25r
Film Badges :	25r to 30r
Dosimeters :	16r to 24r
Integrated Romeo :	17r

4. Conclusions

4.1 It is certain that the permitted maximum of 10r was exceeded, but the actual value is less certain, in the absence of detailed experience of the accuracy of the various measurements. The integrated Romeo value will be low because readings are available only for the periods when the aircraft was passing through radioactive cloud: there is a suggestion that readings were "very low" for the remainder of the time, but no great weight can be attached to this. On the other hand, Sniff 1, after completion of his last run, reported a final Charlie reading of 10.9r which may be compared with a value of 6.9r deduced by integrating his available Romeo readings. It is conceivable that part, at least, of the discrepancy of 4r was acquired when the Romeo meter was not being read. The experience of Sniff 2 suggests the same possibility. At exit from the cloud he reported a Charlie reading of 2r, followed by a final Charlie reading of 3r, later corrected successively to 7r and 8.1 r, the final value. Integration of the recorded Romeo readings gives a total dose of 3.1r, i.e. practically the same as his first report of the final Charlie reading. From these facts I conclude that, unless reading of the Romeo meter is continued even when the aircraft is apparently outside the radioactive cloud, a discrepancy of several roentgens can arise between the actual total dose and the value deduced by integrating the Romeo readings. I arbitrarily allow 3r in the present case, thereby obtaining a corrected integrated Romeo value of 20r. Taking the average film badge reading as 27r, and the average dosimeter reading as 20r, I accept $(25 + 27 + 20 + 20)/4 = 23r$ as the probable dose received by the crew of Sniff 3.

4.2 I can see no way in which the defect in the Charlie meter, the primary cause of the incident, could have been detected during the sampling operation.

4.3 The question arises as to why the discrepancy between the Charlie readings and the implications of the Romeo readings was not appreciated by Sniff Controller or Sniff Boss. It is clear, after the event, that sufficient information existed at the time of sampling to show that something was significantly wrong.

The answer is that the discrepancy was appreciated qualitatively, but not quantitatively. And the reason for this lies in the fact that, the samples obtained by Sniff 1 and Sniff 2 being thought to be very poor, both Sniff Boss and Sniff Controller were preoccupied with the consequences of poor sampling by the remaining aircraft, Sniff 3.

4.4 The question arises as to what action would have been taken had it been thought by Sniff Boss and Sniff Controller that the permitted dose of 10r had been reached while only very poor samples had been achieved. There is some uncertainty here concerning the application of the appropriate sections 3.1.1(c) and 3.1.1(d) of "Radiological Safety Regulations: Christmas Island". I believe that Sniff Controller, if unable to obtain an immediate ruling, might have thought himself forced to decide whether the success of the trial warranted a dose greater than 10r.

4.5 In the time available, little can probably be done to improve instrument reliability for the remainder of Grapple Zulu. If possible, the Charlie meters should be enclosed in a pressurised box which would prevent the same defect occurring again; but action should be taken on the assumption that this modification cannot be carried out: if it can, so much the better.

5. Recommendations

5.1 Rather than rely solely on the Charlie meter to obtain total dose, more use should be made of the personal dosimeters and the Romeo meter. To this end the readings of the dosimeter of one crew member should be transmitted to Sniff Controller at, say, two minute intervals while the aircraft is on a sampling run.

5.2 The readings of the Romeo meter should be continued even when the aircraft is not thought to be in a radioactive cloud. To avoid interrupting the commentary from another aircraft actively engaged in sampling, the readings in a passive aircraft might be recorded within it for later transmission at the commencement of an active run.

5.3 Probably the most immediately useful single step to avoid a recurrence is one of organisation. At present both Sniff Boss and Sniff Controller have two responsibilities, to see that adequate samples are obtained and to ensure that the maximum permitted dose is not exceeded. Rather than both men sharing both duties, each should take one as his primary concern, Sniff Boss planning the sampling runs, while Sniff Controller devotes himself mainly to assessing the total dose experienced by each aircrew.

5.4 In order to make most use of the Romeo meter, Sniff Controller should maintain a record of the total dose as estimated by roughly integrating the Romeo readings as they are announced. With Sniff Controller relieved of the planning of sampling runs, he can perhaps do rather more to this end than calculate mentally the changing average dose rate, from scrutiny of the Romeo numbers. In particular, he might find it easier to assess the total dose by scrutiny of a graph of the changing Romeo readings against time. Quite rough quantitative assessment of this sort would have revealed that something was wrong during the sampling of Flagpole by Sniff 3: sufficient would have been revealed to have made it prudent to withdraw the aircraft without knowing the cause of the trouble. The samples might then have been quite inadequate.

5.5 The matter of the permitted maximum dose needs to be clarified. This might be by a specific instruction to the Sniff Controller prior to each burst. On the other hand it is my reading of the Safety Regulations that the absolute maximum for this purpose has already been laid down as 10r in section 3.1.1(c). In any case it seems essential that any special discussion and authorisation of the sort contemplated in section 3.1.1(d), if it applies, should precede the burst.

5.6 I have not detailed recommendations which are minor and whose implementation is under way as a result of discussion; nor those that could not be implemented in the remaining period of Grapple Zulu. In the first category are investigations directed to checking the film badge estimates. In the second category are suggestions that the Salmon meter stands in need of

/substantial

substantial improvement; that the scale of the 600r per hour Romeo meter should be made less confusing to read in the vicinity of one-quarter of full scale; and that all Romeo meters should read in roentgen per minute instead of roentgen per hour.

[REDACTED]

[REDACTED]

Group Leader TP Group

J.O.C.
6 September 1958

Readings of the Radiation Instruments in Canberra No. WH 976

Romeo readings are in roentgen per hour, Charlie readings are in roentgen, and Salmon readings are in arbitrary units in which 50 is full scale deflection of the meter.

Instants at which readings were reported are numbered consecutively in chronological order; the interval between consecutive readings on a given run is 15 seconds throughout.

The true height of the aircraft was 54,000 feet on all runs.

Run 1

Time of entry = H + 87 min. Time of exit = H + 89 min.

Instant	1	2	3	4	5	6	7	8
Romeo	40	150	160	160	170	180	190	180
Charlie	0	0	0	0	0	0	0	0
Salmon	0	0	0	0	0	0	0	40

Final Charlie = 1.5

Run 2

Time of entry = H + 93 min. Time of exit = H + 95 min.

Instant	1	2	3	4	5	6	7	8
Romeo	120	110	120	110	120	90	40	50
Charlie	2.0	1.8	1.8	2.0	2.2	2.5	2.6	2.6
Salmon	20	3	15	26	46	50+	50+	50+

Final Charlie = 2.8

Run 3

Time of entry = H + 102 min. Time of exit = H + 104 min.

Instant	1	2	3	4	5	6	7
Romeo	60	80	90	100	120	130	130
Charlie	2.6	2.6	2.8	3.0	3.0	3.3	3.5
Salmon	50+	50+	50+	50+	50+	50+	50+

Final Charlie = 3.6

Run 4

Time of entry = H + 108 min. Time of exit = H + 110 min.

Instant	1	2	3	4	5	6	7
Romeo	70	100	120	100	80	80	80
Charlie	4.3	4.5	4.8	4.8	5.0	5.2	5.3
Salmon	50+	50+	50+	50+	50+	50+	50+

Final Charlie = 5.5

C/NO 0078

833

Determination of the whole body dose of Radiation acquired by Aircrew members while on Cloud Sampling detail with special reference to the use of the Standard Film Badge and Cassette

RAISON D'ETRE

Scientific

To outline the present methods of crew dosage assessment with special reference to the use of film badges and to suggest possible fallacies, discrepancies and improvements that might be made in future.

Domestic

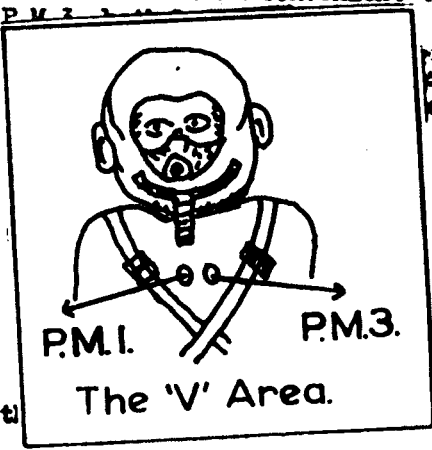
To attempt to minimise future crew wastage rate due to members being discarded on the evidence of doubtful dosage evaluation.

PAST DEVELOPMENT

In the initial trials only one film badge was carried per crew member - Canberra B6 aircraft normally carry a crew of three. Badges were not worn over any specific area of the body and the shielding effects from the aircraft body and equipment were anything but constant.

On all trials sampling has been invariably carried out by more than one aircraft, but as the time of sampling in relation to burst and duration "in cloud" are not constant, the range over which a badge has to record has varied very greatly, and it soon became apparent that, to cover the possible range, more than one type of badge would have to be worn by each individual.

It was found convenient to support the initially used P.M.1 film badge with a P.M.3 in the "V" area. It will be seen in the illustration that this area of the person is not covered by any item of aircrew equipment such as parachute buckles, and also, while in the sitting position, it was thought to give a fair approximation of whole body dose; as it is known that the sitting height, on the average, varies by less than three inches for average crew members.



It will be seen in the illustration that this area of the person is not covered by any item of aircrew equipment such as parachute buckles, and also, while in the sitting position, it was thought to give a fair approximation of whole body dose; as it is known that the sitting height, on the average, varies by less than three inches for average crew members.

this simple standardisation of film badge technique gained:-

- (1) Uniformity of badge position;
- (2) External shielding was avoided from flying harness etc.;
- (3) The dual badges (P.M.1 and 3) ensured that an adequate range was covered and where overlap occurred a check could be obtained.

Note: For the purpose of this paper it is considered that a P.M.1 covers from 0.1r to 6r and a P.M.3 from 1r to 20r. These ranges are those at which the readings are reasonably accurate and at which independent readers would produce similar answers from the film graphs, i.e., the upper and lower limits of the range of each badge are excluded.

As a further insurance all crew members have carried pocket dosimeters, initially reading from 0 - 0.5 r, but later the higher reading 0 - 50 r instruments were adopted. Fair agreement was found to exist between badges and dosimeters, though the latter, as a rule, tended to read low. Dosimeters have normally been carried in the left leg-pocket of the flying overall, being then at approximately mid-tibial level. Though a valuable check and useful for immediate assessment on

It was found convenient to support the initially used P.M.1 film badge with a P.M.3, both badges being worn in the "y" area. It will be seen in the illustration that this area of the

person is not covered by any item of aircrew equipment such as parachute buckles, and also, while in the sitting position, it was thought to give a fair approximation of whole body dose; as it is known that the sitting height, on the average, varies by less than three inches for average crew members.

It was considered that by this simple standardisation of film badge technique the following advantages were gained:-

- (1) Uniformity of badge position;

Note: This is the text which lies underneath the drawing on the previous page.

landing, dosimeters are not considered either accurate or reliable, particularly in wet humid climates where the leak rate can be considerable. No convenient method of carrying dosimeters in the mid-body position has yet been devised for aircrew in full flying clothing.

A further check on general dosage is ensured by a fixed integrating dosimeter consisting of a moderately large and well insulated ion chamber. This instrument is known in the Service as the "Charlie" meter, and is located under the rear right seat of the aircraft. A large, easily read scale, an important factor in the dim light of the cabin, is located on the right rear instrument panel, and allows the wireless operator to note the mounting dose and transmit this information to the pilot of the aircraft and controllers on the ground and in the air. In operation this instrument has proven itself to be most reliable and the dosages recorded have been in fair agreement with the film badges and the pocket dosimeters. One difficulty has, however, arisen, in that the instrument can effect certain electrical instruments in the aircraft. This hazard has been eliminated.

From the three methods outlined above - badge, dosimeter and integrating dosimeter - it has been possible to assess, with some degree of accuracy, the overall body dose acquired by aircrew during their passage through a nuclear cloud. However, it is patent that several difficulties exist: film badges are in some circumstances directional, and though when positioned on the chest in the seated position give a near approximation of the whole body dose, they suffer from shielding from aircraft skin and components - dosimeters worn on the leg are undoubtedly liable to be affected by shielding - the "Charlie" meter positioned under the wireless operator's seat pan cannot be looked on as representative of the general body dose of the occupants, and is, more than likely, affected by considerable shielding from the aircraft and its equipment.

VARIATION IN CREW POSITION AND THE LIKELY EFFECT OF SHIELDING

General

All crew members are seated in ejector seats of steel construction, the back being particularly solid, incorporating much of the firing mechanism and built well above the head of the occupant in the manner of an old fashioned club armchair. Arm rests come to iliac crest level and the seat pan is particularly solid.

Pilot Position

Apparently the most exposed position. Anteriorly bounded by the instrument panel. Laterally instrument boards and aircraft skin to approximately elbow position, rear ejector seat and navigator's consol. Above perspex canopy.

Navigator

Anterior instrument consol. Left lateral instrument panel and aircraft skin. Posterior bulkhead. Above aircraft skin.

Wireless Operator

Anterior part screened by navigator's consol. Right lateral instruments and aircraft skin, above aircraft skin.

Petrol Tank No. 1

Both navigator and wireless operator's positions are screened to some extent by this rear positioned tank, which holds 150 gallons.

Floor

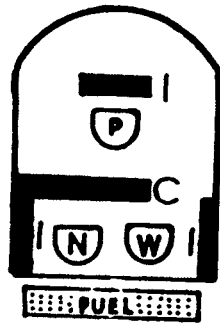
All positions are screened by the relatively stout floor and the outer skin (Note: the aircraft has a pressure hull, which renders it more solid than the conventional aircraft aluminium skin).

APPRAISAL OF SEATING POSITIONS IN RELATION TO SHIELDING

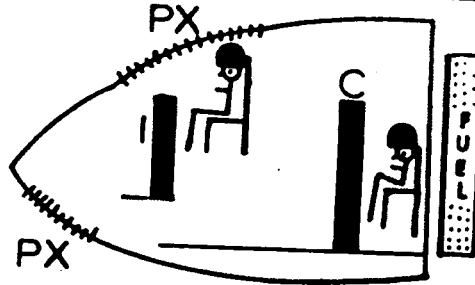
It is clear that the pilot would appear to be the most vulnerable crew member and that he receives little or any shielding, barring the perspex hood, from the waist upwards, the lower part of the body being shielded by the instruments and the ejector seat. The navigator on the other hand appears to enjoy the most shielding, while the wireless operator's situation is better than the pilot's but not as good as the navigator's. Thus in the Canberra B6 it can be envisaged that the two rear seated crew members have the benefit of considerable shielding from the aircraft and its components, while the pilot is much less favourably situated.

The sketches 1 and 2 below give some idea of the relative shielding in the three crew positions.

Sketch 1



Sketch 2

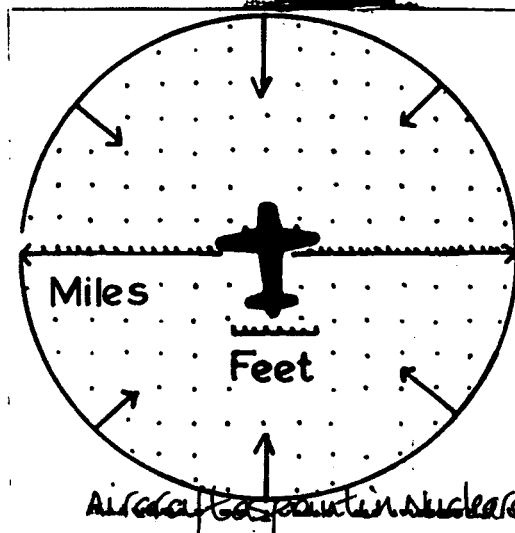


PX = Perspex Canopy
B = Bomb Aimer's Canopy

MECHANICS OF NUCLEAR CLOUD ON FIIM BADGES

In view of the large size of the nuclear cloud in relation to the aircraft, it can, for practical purposes, be assumed that the aircraft is a point within a large diffuse source and that radiation will impinge on the aircraft from all directions.

Sketch 3



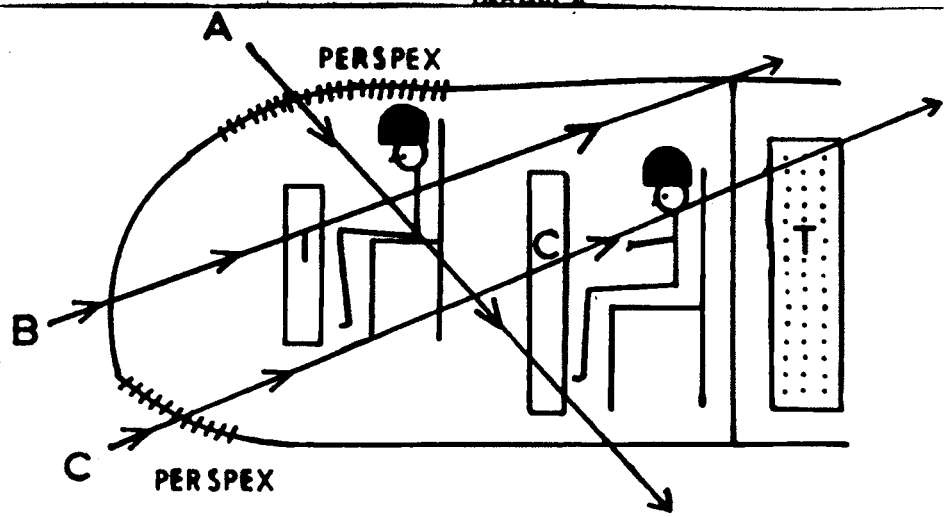
Note:
Title is:
Aircraft as point
in Nuclear cloud

However, if three theoretical rays are drawn passing through the aircraft cabin, it will be seen that certain rays will have a better chance of causing damage to the occupants than others, due to shielding from the aircraft components. In the sketch below it will be seen that rays A and B affect the pilot, while the navigator escapes and that C, though affecting the navigator, will have lost much of its energy due to the shielding effect of the consol.

Sketch 4

(Overleaf)

Sketch 1



- P = Perspex Canopy
- B = Bomb Aimer's Canopy
- I = Instrument Panel
- C = Consol
- T = No. 1 Fuel Tank

Consideration will show that a very large number of shielding factors can occur in a cockpit which is full of bulky instruments and equipment. Furthermore, backscatter can occur from all the equipment surfaces; however, as these are so numerous they may conveniently be neglected, as all occupants are at hazard from this diffusion.

AIRCRAFT MATERIALS AND SHIELDING

As has already been stated, shielding from the floor of the aircraft and ejector seats are common to all crew members, and can be considered as a constant; however, one very big difference occurs in that the pilot alone is shielded by a large area of perspex of considerable thickness, and this would be a most effective shield against beta radiation, and could in certain circumstances be superior to the outer skin, which shields the two rear crew members. Instrument consols are made of light steel racking with instruments bolted in position, and they are, when fully rigged, solid pieces of equipment which would provide very considerable shielding. The main consol is that of the navigator and completely covers his anterior aspect.

PHYSICAL CONSIDERATIONS AFFECTING FILM BADGES

Film badges are carried outside the flying clothing in the "V" area and are thus affected by the ambient temperature of the cockpit. In all sorties sampling is carried out at "height" and temperatures around zero are commonplace in the cockpit. Exposure of the film badge occurs at such low temperatures.

Film emulsion is standardised for exposure at temperatures within the 15 to 19° Centigrade range, and a correction of 0.3 r for every degree above or below the range should be made to obtain a correct assessment. In trials exposures during sampling runs it is reasonable to expect the film badges to read approximately 5% low due to the temperature drop.

Directional affect. A film badge exposes a broad area to the front, but sideways on is a relative knife edge, and clearly the chances of rays impinging are less in the sideways position. However, what rays strike the badge in this side position traverse a much greater distance in emulsion, and hence give an increased effect. It has been suggested by simple experiment that in the lateral position the effect on a film badge is 75% of that which it would be if the badge was presenting its face to a given source.

Clearly, as it is assumed that a cloud is homogenous and that the aircraft is a relative point source, a small proportion of rays impinging on the crew members' body in the lateral aspect will be underestimated by badges in the conventional position.

Chemical and light Affects. Error in film development can occur due to many reasons, in particular chemical impurities in solutions and poor agitation of the developing tank, giving uneven developer concentration. Small quantities of light

may actuate the emulsion through pinholes in the paper shielding.

PRELIMINARY CONSIDERATIONS

Though it must be admitted that film badges offer the simplest and cheapest method of assessment of aircrew dosage during cloud sampling coupled with a very low weight penalty, as opposed to other types of instruments, their accuracy as an indication of whole body dose may leave much to be desired.

Shielding in an aircraft is considerable and very varied in relation to the three crew positions, hence considerable variation will arise from this factor alone.

INITIAL EXPERIMENT

Experience has shown that the secondary sampling aircraft has ^{usually, experience the highest dose rate as} the controller (air) has gained experience from the primary sampler's dose rate (Charlie meter) and is thus more confident in holding the second aircraft in the cloud for the maximum safe period. Thus the initial experiment was carried out on personnel flying the Secondary sampler.

As it was suspected that the chest badge did not give a very fair approximation of the whole body dose, it was decided to use more badges per man in an attempt to get more information. Placing of any number of badges on individuals was not possible, due to technical difficulties associated with aircrew clothing and escape mechanism, and in lieu fixed positions in the aircraft were adopted, these being acceptable to the R.A.F. authorities.

Four P.M.3 badges were placed on the ejector seat in the following locations

1. Head rest 1 inch above head
- 2.) On arm rest upper surface
- 3.)
4. In seat pan 1 inch from testicles.

Care was taken to ensure that as little shielding effect as possible was given by the ejector seat and that no equipment of any description shielded the badges. In addition to these badges the members were issued with the normal chest badges and dosimeters.

Figures derived from the Chest P.M.3 and O - 50 dosimeter

	<u>Badge</u>	<u>Dosimeter</u>
Pilot	13 r	13.5 r
Navigator	10.75 r	10 r
Wireless operator	10.75 r	15 r

Figures derived from the four special P.M.3 badges

	<u>Head</u>	<u>L. Arm rest</u>	<u>R. Arm rest</u>	<u>Seat pan</u>
Pilot	18.8 r	12.5 r	12.5 r	8.8 r
Navigator	17.0 r	11.1 r	11.0 r	7.6 r
Wireless operator	17.0 r	10.7 r	12.5 r	7.6 r

Time in Cloud 6 minutes
Time of entry after burst H + 49 m.
Height 51,000 feet
Charlie reading 10.6 r

Note: Conditions of gamma shine were not encountered

<u>Pilot</u>	<u>Navigator</u>		<u>Wireless operator</u>					
18.8		17			17			
12.5	13	12.5	11	10.75	11.1	12.5	10.75	10.7
	8.8			7.6				7.6

Key

Head Badge
Right Arm Chest Badge Left Arm
Testicular Badge

IMPLICATION

General

It will be seen that though the series is small a very considerable degree of agreement exists between all readings, with one exception, that being the dosimeter worn by the wireless operator. It is considered that this is, however, a leak affect due to the wet weather encountered on the trial - dosimeter discrepancy was noted in many other instances and proven to be due to leak.

As reliance has always, in previous trials, been placed on the single or double chest badge, it is interesting to note that this has given, in this series, readings which are consistently above those of the testicular badge. The safety factor being in the region of 50%, on an average, of the three positions of the crew.

The most striking feature is the fall-off in dose recorded between the head and the testicular badge. The distance between these badges being something not more than 2 feet 9 inches, yet a factor of 2 is seen in every set of readings. This clearly suggests that the rays penetrating the cabin were of a soft nature and that beta particles were probably absent, being excluded by the shielding offered by the aircraft hull.

Charlie Meter Reading

This reading is low in comparison to the head doses, but nevertheless approximates to the chest (whole body) dose and can be reckoned to give an indication of the general dose if a 10% addition is made to the reading. It should be noted that it had already been stated that the meter is in a relatively shielded position, which probably accounts for this discrepancy.

Head Doses

In view of the fact that the pilot appears to be very much more exposed than any other crew member, the 1.8 maximum difference (18.8 r to 17.0 r) suggests that the perspex canopy is a far more efficient shield than had been suspected. Nevertheless, the considerable higher general level of radiation to the head would appear a possible hazard in relation to the sensitive eye tissue. But as it appears beta radiation is largely absent from the cabin, this could perhaps be over emphasised, as experiment has suggested human eye tissue to be less sensitive than that of the animals which have been used experimentally.

Arm Rest Badges

Dosages follow the general pattern of the chest badge, suggesting that lateral radiation is probably largely out off by the shielding provided by the pressure hull and instruments. It is, however, surprising that the wireless operator's right arm should show a higher dose, as it would appear to be well shielded by instruments on the adjacent panel.

Testicular Badges

The very significantly lower levels are of interest and cheer in relation to the possibility of genetic damage and in all instances they are a quarter below the reading given by the "Charlie" meter, thus providing an inbuilt safety factor for the land and air controllers.

FURTHER INVESTIGATIONS

Though the figures quoted show mathematical agreement to a surprising degree, the series is, however, small and open to criticism from this fact, and further

periments on similar lines should be conducted.

In view of the possible sensitivity of ocular tissues, badges should be worn at eye level. The difference between eye level and the head badge which is situated at the vertex, is plus 6 inches, and it is more than likely that a fall-off will occur in this distance, short though it be.

The chest badge, being ventrally situated, should be supplemented by a badge on the dorsum in the region of T8 - 10. This would give a better idea of the "whole" body dose.

If possible a badge should be worn next to the skin to give an indication of the shielding effect provided by the flying overall and vent suit.

SUMMARY

Film badges (P.M.3) were placed in a roughly square configuration around three members of a cloud sampling crew in a Canberra B6.

Mathematical uniformity was observed between the separately placed badges and a factor of two was noted between badges situated respectively on the vertex and the testicle.

The integrating dosimeter (Charlie meter) was found to be in general agreement with the film badges, but to read approximately 10% low on the whole body dose.

Further readings are necessary in confirmation, and in particular to check dose received by ocular tissue.

A.W.R.E.
Health Physics.
Aldermaston.


M.A., L.R.C.P., M.R.C.S.

High Radiological Exposures
MoD-AWRE Trials

				<u>Dose in R</u>
1.				
2.				
3.				
4.				
5. a.				
b.				
6.	[Redacted]	RAF	1958	GY 13
7.	[Redacted]	RAF	1958	GY 13 ✓
8.	[Redacted]	RAF	1958	GY 11
9.				
10.				
11.				
12.				
13.				
14.				

The MoD Officers listed above had doses in excess of 10R recorded by their film badges, whilst carrying out Air Operations at AWRE Overseas Trials.

[Redacted Signature]
Supt. Health Physics Branch

28/6/1967

~~COVERING RESTRICTED~~

PWT/5

From

, RAF



MINISTRY OF DEFENCE

1-6 Tavistock Square, LONDON W.C.1

Telephone: ~~London~~
01-387

(2)

30th December 1969

Our reference: AF/10165/68/MA4a(RAF)
Your reference:

Dear

RADIATION SAFETY DURING WEAPONS TRIALS

1. For some time past I have been concerned that we had no narrative report of the health physics supervision of RAF personnel involved in the various weapons trials. There has been a considerable "oral tradition" that I have been able to use when dealing with pensions claims, but memories fade and senior staff retire.

2. Therefore, I asked [redacted] to prepare a report with the assistance of his colleagues at AWRE: I enclose a copy for your information. If you have any additional data to add to it, I would be pleased to receive them and to incorporate them in this "authorized version".

Yours
[redacted]

[redacted]
Institute of Naval Medicine
Alverstoke
Gosport
Hants

[redacted]
Institute of Aviation Medicine
RAF Farnborough
Hants

Copy to: Branch Folder AF/RAD 1/MA 4a(RAF)

~~COVERING RESTRICTED~~

A BRIEF SKETCH OF THE MAIN RADIATION SAFETY PRECAUTIONS OBTAINED
DURING THE UNITED KINGDOM NUCLEAR TRIALS. (RAF INVOLVEMENT.).

(ETS)

(1)

The objective of this paper is to provide a short non-technical summary of the UK Nuclear Trials, from inception to culmination, with special reference to the many steps that were taken to ensure that Royal Air Force personnel were subjected to no undue hazard from any form of ionising radiation. This paper is prepared, at a point in time, when it is still possible to obtain detailed information from persons who either initiated or were responsible for actioning radiation safety precautions or who can offer access to detailed health physics records, either official or in the form of personnel operational diaries.

ColAP

15



K3431
833

834



Comments on Paper on Aircrew Doses

The intention of your paper is admirable, but I feel that one or two statements cannot go quite without some comment.

Page 1 - Past Development

In the word "initial" I know you mean Grapple trials, but I feel that this is a little unfair to A.W.R.E. as in all trials previous to Grapple itself badges are worn specifically as near to the heart as possible, and this has always been a deciding factor in film badge dosimetry which is intended to measure total body irradiation. Further, I am surprised to learn that P.M.1s. only were used on Grapple as previously and subsequently both P.M.1s. and P.M.3s. have been worn.

Page 1 - Last Paragraph, Line 2

I think 0.5 should be 5 r.

The question of pocket dosimeters being effected by humidity and dust has always been solved quite satisfactorily by sealing them in clear P.V.C. which, in the form of a bag, enabled dosimeters to be worn adjacent to the film badges. Again, I am surprised if this was not the practice on Grapple trial.

Perspex Screening

The exact thicknesses of perspex and aluminium in Camberras are what effects the relative screening properties of these two materials. My guess is that the lower absorption through perspex is more than offset by the necessary increase in thickness which I am sure it is necessary to use in order to gain mechanical strength, and therefore I should not be surprised to find that the perspex was at least as effective as normal aircraft skin in screening out gamma radiation.

Your results on the difference between film badges in different position I think, provide an excellent reason for placing the reliance on the film badge on the chest as this appears to give an excellent average dose to the whole body. The question of wearing a film badge next to the skin to give a indication of the shielding effect is possibly a good one, but you realise I hope that the doses measured by a film badge outside clothing including backscatter from the body is by convention a measure of the dose to the bare body underclothing without backscatter.



Extn. 20th October, 1958.

c.c.

available.

AIRCREW TASKS.

1. Sampling.

The use of Canberra aircraft to fly through relatively recent nuclear clouds and collect samples of the radioactive debris was developed over the trial's period. Ultimately a squadron (No: 76.) of six Canberra aircraft were specifically earmarked for these duties. However servicability was of such a high order that only four of these aircraft had to be committed over the trial's period (i.e. 2 remained clean.).

The scientific objective was to collect a suitable sample of the fission products in specially designed apparatus attached to the exterior of the aircraft. The aircraft continued to fly in the nuclear cloud until a sufficiency of sample had been obtained or it was deemed prudent to exit to ensure that the crews did not receive an over exposure to radiation. The whole procedure was controlled both from the air and from the ground. All aircraft were pressure cabin type and as an additional precaution two large filters (Roughing and Fine filter) were interposed in the cabin air supply system. As a further precaution all crew members donned oxygen masks as soon as the aircraft entered the nuclear cloud and these remained in situ until landing.

A variety of other safety measures were obligators. These are listed below with brief descriptions :-

- a. All participating aircrew were briefed on the problems, hazards and manner of conduct when flying in a nuclear cloud. Such briefings were carried out by members of AWRE and the squadron medical officers. The latter being members of RAF/AWRE and attached to the Health Physics Division. The squadron was not subjected to mass postings and experienced members were always available to assist new inexperienced aircrew. This concept ensured that expertise was not squandered - this did not obtain in many other RAF situations in the task force.
- b. All entrant members of the squadron were subjected to a Radiation Medical examination on entry. Their continued good health was the direct responsibility of the squadron medical officers.
- c. All aircrew were exhaustively exercised, under strict supervision, in the drills that were expected of them during sampling sorties. Further practice was carried out on all possible emergencies that might occur in which the covering of the exterior of the aircraft with adherent particulate could cause problems and possible hazard. Emergency health physics kits were carried on aircraft for the use of the crews if unscheduled landings occurred.
- d. All sampling crews carried two film badges per man. As an additional precaution and to provide an immediate check an array of dosimeters were worn by each crew member. It

was usual to carry three covering, in decades, from 0 to 50 roentgens. In addition a large integrating ion chamber was fitted under the navigators seat which read out onto a large quadrant dial which was colour coded. The divisions were green - yellow - red. The interpretation was simple- green = insignificant dose yellow = dose mounting and exit time nearing Red = immediate exit from cloud.

e. An air sampler was installed in each aircraft to monitor the cabin air. The machines used were the well tried Vacanair which sample at approximately resting respiratory rate. High altitude non-sparking brushes were fitted as a flying requirement. No significant levels were ever recorded in cabins though considerable amounts of particulate materials were known to have been stopped in the filters.

f. On landing crews were assisted out of the aircraft after they had donned overshoes and gloves. Other flying equipment was placed in polythene bags. Exit of the crews was accomplished by a non-touch drill developed between the crews and their ground helpers. The aircrew were then passed through a formal decontamination and health control centre. Over the trials period no significant contamination was ever detected on any of the sampling aircrew or their equipment.

g. A trial's limit for wholebody exposure of aircrew was fixed after discussion between RAF and civilian appropriate authorities. The limit was cumulative against the time period between individual sorties. If the upper limit was exceeded in any single sortie the crew or crew member was precluded from any further sampling duties. Records of such doses are held at AWRE, Health Physics branch.

SUMMARY OF RAF PERSONNEL EXPOSURES OVER THE TRIAL'S PERIOD.

The significant exposure of any RAF personnel, with a few predictable exceptions, was unheard of over the test period. The sampling aircrew and sample handlers received significant doses. These were essentially to predicted levels which had received official waivers.

The rarity of doses is due to two factors. Firstly very few persons actually came in contact with radiation and secondly those who did were always under rigid supervision and had received adequate training.

The few RAF personnel who received significant doses have their records preserved either in the office of the Director of Health and Research, Medical Directorate or in the Film Badge Office of AWRE Health Physics Division.

██████████
AWRE. Aldermaston.

████████████████████
Consultant in Radiobiology. RAF.

SFS/OEL/UAB/1(P)
16 March 1982
Provisional Issue



UNITED KINGDOM MINISTRY OF DEFENCE
(PROCUREMENT EXECUTIVE)
AWRE ALDERMASTON

SFS/OEL/UAB/1(P)

Listing of Persons at UK Overseas Defence Nuclear Experimental Programmes
UK (Royal Air Force) (Provisional Issue)
Part 1 (A - L)

Compiled at the direction of
SFS/MOD(PE)AWRE

by

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AWRE Aldermaston
Berkshire

SFS/OEL/UAB/1(P)

16 MARCH 1982

PROVISIONAL ISSUE

UNITED KINGDOM MINISTRY OF DEFENCE
(PROCUREMENT EXECUTIVE)
AWRE, ALDERMASTON

SFS/OEL/UAB/1(P)

LISTING OF PERSONS AT UK OVERSEAS DEFENCE NUCLEAR EXPERIMENTAL PROGRAMMES

UK (ROYAL AIR FORCE); (PROVISIONAL ISSUE)

PART 1 (A - L)

COMPILED, AT THE DIRECTION OF
SFS/MOD(PE)AWRE,

BY

MOD(PE)AWRE, ALDERMASTON
READING, RG7 4 PR,
BERKSHIRE, UK
16 MARCH 1982

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COMPILED AT MOD(PE)AWRE
ALDERMASTON FROM UK SOURCES
OF INFORMATION AVAILABLE AND
REVIEWED UP TO 15 MARCH 1982

(1)

THIS DOCUMENT CONTAINS IN CONFIDENCE A SUMMARY PROVISIONAL LISTING OF NAMES AND RELEVANT ASSOCIATED DATA, OBTAINED FROM AVAILABLE UK INFORMATION SOURCES WHICH WERE ACCESSIBLE TO AND REVIEWED BY AWRE STAFF UP TO 15 MARCH 1982, FOR PERSONS WHO THE INFORMATION INDICATES WERE OR MAY HAVE BEEN CITIZENS OF THE UK AND MEMBERS OF THE UK ROYAL AIR FORCE TAKING PART IN PROGRAMMES OF UK OVERSEAS FIELDEXPERIMENTS, ASSOCIATED WITH UK DEFENCE (NUCLEAR WEAPONS) RESEARCH AND DEVELOPMENT PROJECTS, CARRIED OUT IN AUSTRALIA, IN THE PACIFIC OCEAN ZONE OR ELSEWHERE.

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Run 5

Time of entry = H + 113 min. Time of exit = H + 116 min.

Instant	1	2	3	4	5	6	7	8	9	10
Romeo	85	90	90	80	70	70	80	70	60	60
Charlie	6.2	6.5	6.6	6.7	6.8	6.9	7.0	7.2	7.3	7.3
Salmon	50+	50+	50+	50+	50+	50+	50+	50+	50+	50+

Final Charlie = 7.9

Run 6

Time of entry = H + 119 min. Time of exit = h + 120 min.

Instant	1	2	3	4	5
Romeo	60	60	60	40	32
Charlie	8.1	8.2	8.4	8.4	8.4
Salmon	50+	50+	50+	50+	50+

Final Charlie = 8.5

NOTES ON THE LISTING

1. THE SOURCES CONSULTED IN COMPILING THIS SUMMARY, WITH THE ABBREVIATIONS USED THEREIN, WERE

AHB = AIR HISTORICAL BRANCH RECORDS, MOD (AFD)	ORB = RAF SQUADRON OPERATIONAL REPORT BOOKS, MOD (AFD)
ARMY HB = ARMY HISTORICAL BRANCH RECORDS, MOD	P = AWRE PLANNING DOCUMENTS
HP = AWRE HEALTH PHYSICS DATA	R = AWRE OVERSEAS TRAVEL REGISTER
L = RN SHIPS LEDGERS, MOD (NAVY)	R-W = RAF RADIOBIOLOGIST'S NOTES
MHP = MARALINGA MONTHLY HEALTH PHYSICS REPORTS, AUST. CXRL	TR = AWRE T SERIES REPORTS
MISC = PERSONAL SOURCES, WRITTEN OR VERBAL	

2. ALL UK (AWRE) OVERSEAS DEFENCE NUCLEAR EXPERIMENTAL PROGRAMMES HAVE BEEN INCLUDED

3. ABBREVIATIONS USED FOR OPERATIONS AND ORGANISATIONAL GROUPS ARE DETAILED IN SFS/OEL/68/1(P)

4. RADIATION DOSES ARE GIVEN UNDER TOTAL DOSE IN MILLIREM. COLUMN G IS THE GAMMA COMPONENT, COLUMN AGG IS THE GAMMA + BETA AGGREGATE, LOCALISED GAMMA DOSES ARE GIVEN WHERE APPROPRIATE, OTHER NOTES ARE ALSO PLACED UNDER THIS HEADING.

NO ENTRY, NIL OR BELOW X IN THE DOSE COLUMN INDICATES THAT THE MEASURED FILM DENSITY ON ONE OR MORE FILMS WAS AT THE THRESHOLD LEVEL, OR THAT THE PERSON CONCERNED WAS ENGAGED IN WORK WHERE NO FILM WAS ISSUED OR NEEDED. ? FOLLOWING A DOSE FIGURE INDICATES A DOUBT EXISTS OF ATTRIBUTION OF DOSE

ABBREVIATIONS USED ARE LH = LEFT HAND, RH = RIGHT HAND, H = HEAD, W = WRIST, F D = FILM DAMAGED, F M = FILM MISSING, N/A = FILM NOT RETURNED, T = TOLERANCES

5. 100 MILLIREM (mREM) = 1 MILLISIEVERT (mSv) AND IS APPROXIMATELY NUMERICALLY THE SAME AS 100 MILLIROENTGEN (mR)

6. BRACKETED NUMBERS AFTER ENTRIES HAVE THE FOLLOWING MEANINGS :-

(1) QFD = QUARTZ FIBRE DOSIMETER, THE FILM BADGE DOSES WERE REPORTED AS BEING APPROXIMATELY ONE HALF THIS FIGURE

(2) DOSES LISTED ARE THOSE FROM THE HP FILES COMPILED DURING THE OPERATIONS. OTHER CORRESPONDENCE SUGGESTS THERE WAS SOME LATER CONFUSION BETWEEN GRAPPLE AND ANTLER DOSES AND BETWEEN QUARTZ FIBRE AND FILM BADGE DOSES.

SFS/OEL/UAB/1(P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y		1958					L
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	350			ORB, HP, R-W
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y		1958					L

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	58 S0	21/3/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	99 S0	19/1/58	13/4/58			ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 S0	18/3/58	17/5/58	10000		ORB, HP, R-W
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 S0	1958		20		HP

SFS/OEL/UAB/1 (P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	1958					ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	99 SQ	2/4/58	1/6/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	13000			ORB, HP, R-W

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	99 SQ	30/12/57	19/3/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y		1958					L
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	511 SQ	19/1/58	22/4/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	99 SQ	30/12/57	19/3/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	13000			ORB, HP

SFS/OEL/UAB/1 (P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	450			ORB, HP, R-W
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	99 SQ	30/12/57	19/3/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	24 SQ	21/4/58	25/7/58				ORB

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM		SOURCE
							G	AGG	
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	511 SQ	19/1/58	21/3/58			ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	26/3/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	22 SQ	19/2/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58			ORB, HP
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	10750		ORB, HP, R-W
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	15/3/58				ORB, HP

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	26/3/58					ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y		1958					L
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	15/3/58					ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	19/5/58	10500			ORB, HP
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	49 SQ	26/3/58	6/5/58				ORB

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM		SOURCE
							G	AGG	
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58			ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	99 SQ	13/2/58	18/4/58			ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	10750		ORB, HP, R-W

HP

SFS/OEL/UAB/1 (P)

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM		SOURCE
							G	AGG	
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	49 SQ	23/3/58	4/5/58			ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	22/3/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	49 SQ (P)	1958				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	49 SQ		27/4/58			ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	340		ORB, HP, R-W
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	1958				ORB

[REDACTED]

[REDACTED]

SFS/OEL/UAB/1(P)
16 March 1982
Provisional Issue



UNITED KINGDOM MINISTRY OF DEFENCE
(PROCUREMENT EXECUTIVE)
AWRE ALDERMASTON

SFS/OEL/UAB/1(P)

Listing of Persons at UK Overseas Defence Nuclear Experimental Programmes
UK (Royal Air Force) (Provisional Issue)
Part 2 (M - Z)

Compiled at the direction of
SFS/MOD(PE)AWRE
by
[REDACTED]

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[REDACTED]

AWRE Aldermaston
Berkshire

SFS/OEL/UAB/1(P)

16 MARCH 1982

PROVISIONAL ISSUE

UNITED KINGDOM MINISTRY OF DEFENCE
(PROCUREMENT EXECUTIVE)
AWRE, ALDERMASTON

SFS/OEL/UAB/1(P)

LISTING OF PERSONS AT UK OVERSEAS DEFENCE NUCLEAR EXPERIMENTAL PROGRAMMES

UK (ROYAL AIR FORCE); (PROVISIONAL ISSUE)

PART 2 (M - Z)

COMPILED, AT THE DIRECTION OF
SFS/MOD(PE)AWRE,

BY

MOD(PE)AWRE, ALDERMASTON
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16 MARCH 1982

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COMPILED AT MOD(PE)AWRE
ALDERMASTON FROM UK SOURCES
OF INFORMATION AVAILABLE AND
REVIEWED UP TO 15 MARCH 1982

THIS DOCUMENT CONTAINS IN CONFIDENCE A SUMMARY PROVISIONAL LISTING OF NAMES AND RELEVANT ASSOCIATED DATA OBTAINED FROM AVAILABLE UK INFORMATION SOURCES WHICH WERE ACCESSIBLE TO AND REVIEWED BY AMRE STAFF UP TO 15 MARCH 1982, FOR PERSONS WHO THE INFORMATION INDICATES WERE OR MAY HAVE BEEN CITIZENS OF THE UK AND MEMBERS OF THE UK ROYAL AIR FORCE TAKING PART IN PROGRAMMES OF UK OVERSEAS FIELD EXPERIMENTS, ASSOCIATED WITH UK DEFENCE (NUCLEAR WEAPONS) RESEARCH AND DEVELOPMENT PROJECTS, CARRIED OUT IN AUSTRALIA, IN THE PACIFIC OCEAN ZONE OR ELSEWHERE.

THE LISTING IS NOT CLAIMED TO BE FREE FROM ERRORS, INCORRECT ASSERTIONS OR OMISSIONS AND THE ATTRIBUTION OR NON-ATTRIBUTION OF UK CITIZENSHIP OR SERVICE ASSOCIATION TO A PARTICULAR NAME MAY NOT, IN SOME CIRCUMSTANCES, BE CORRECT: THE INFORMATION AVAILABLE WAS SPARSE, OF VERY VARIED QUALITY, AND OFTEN AMBIGUOUS OR INDETERMINATE.

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NOTES ON THE LISTING

1. THE SOURCES CONSULTED IN COMPILING THIS SUMMARY, WITH THE ABBREVIATIONS USED THEREIN, WERE

- | | |
|--|--|
| AHB = AIR HISTORICAL BRANCH RECORDS, MOD (AFD) | ORB = RAF SQUADRON OPERATIONAL REPORT BOOKS, MOD (AFD) |
| ARMY HB = ARMY HISTORICAL BRANCH RECORDS, MOD | P = AWRE PLANNING DOCUMENTS |
| HP = AWRE HEALTH PHYSICS DATA | R = AWRE OVERSEAS TRAVEL REGISTER |
| L = RN SHIPS LEDGERS, MOD (NAVY) | R-W = RAF RADIOBIOLOGIST'S NOTES |
| MHP = MARALINGA MONTHLY HEALTH PHYSICS REPORTS, AUST. CXRL | TR = AWRE T SERIES REPORTS |
| MISC = PERSONAL SOURCES, WRITTEN OR VERBAL | |

2. ALL UK (AWRE) OVERSEAS DEFENCE NUCLEAR EXPERIMENTAL PROGRAMMES HAVE BEEN INCLUDED

3. ABBREVIATIONS USED FOR OPERATIONS AND ORGANISATIONAL GROUPS ARE DETAILED IN SFS/OEL/GB/1 (P)

4. RADIATION DOSES ARE GIVEN UNDER TOTAL DOSE IN MILLIREM. COLUMN G IS THE GAMMA COMPONENT, COLUMN AGG IS THE GAMMA + BETA AGGREGATE, LOCALISED GAMMA DOSES ARE GIVEN WHERE APPROPRIATE, OTHER NOTES ARE ALSO PLACED UNDER THIS HEADING.

NO ENTRY, NIL OR BELOW X IN THE DOSE COLUMN INDICATES THAT THE MEASURED FILM DENSITY ON ONE OR MORE FILMS WAS AT THE THRESHOLD LEVEL, OR THAT THE PERSON CONCERNED WAS ENGAGED IN WORK WHERE NO FILM WAS ISSUED OR NEEDED. ? FOLLOWING A DOSE FIGURE INDICATES A DOUBT EXISTS OF ATTRIBUTION OF DOSE

ABBREVIATIONS USED ARE LH = LEFT HAND, RH = RIGHT HAND, H = HEAD, W = WRIST, F D = FILM DAMAGED, F M = FILM MISSING, N/A = FILM NOT RETURNED, T = TOLERANCES

5. 100 MILLIREM (mrem) = 1 MILLISIEVERT (mSv) AND IS APPROXIMATELY NUMERICALLY THE SAME AS 100 MILLIROENTGEN (mR)

6. BRACKETED NUMBERS AFTER ENTRIES HAVE THE FOLLOWING MEANINGS :-

(1) QFD = QUARTZ FIBRE DOSIMETER, THE FILM BADGE DOSES WERE REPORTED AS BEING APPROXIMATELY ONE HALF THIS FIGURE

(2) DOSES LISTED ARE THOSE FROM THE HP FILES COMPILED DURING THE OPERATIONS. OTHER CORRESPONDENCE SUGGESTS THERE WAS SOME LATER CONFUSION BETWEEN GRAPPLE AND ANTLER DOSES AND BETWEEN QUARTZ FIBRE AND FILM BADGE DOSES.

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	5500			ORB, HP, R-W
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	15/3/58					ORB



NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	WF	1958					P
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	WF	1958		25			HP
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	511 SQ	1/3/58					ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	1/2/58					ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	380			ORB, HP

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM		SOURCE
							G	AGG	
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	1958				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	1/2/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	24 SQ	21/4/58	9/8/58			ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58		7500	ORB, HP
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ		12/5/58			ORB



NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM G	AGG	LOCALISED	SOURCE
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	1958		850			HP
[REDACTED]	RAF ?		GRAPPLE X or Y	76 SQ	1957/58					ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	70			ORB,HP
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	58 SQ	1958					ORB

NAME	SERVICE	RANK	OPERATION	GROUP	DATE ON	DATE OFF	TOTAL DOSE IN MILLIREM		SOURCE
							G	AGG	
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	76 SQ	18/3/58	17/5/58	5000		ORB,HP
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	9/2/58				ORB
[REDACTED]	RAF	[REDACTED]	GRAPPLE Y	240 SQ	9/2/58				ORB