ANNEX A

AWRE O 24/86

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ATOMIC WEAPONS RESEARCH ESTABLISHMENT

AWRE REPORT No. O 24/86

Isotopic Composition of Plutonium and Americium in the Vixen B Safety Trials at Taranaki, Maralinga, 1960 - 1963

(UK UNCLASSIFIED)

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AWRE,
MOD(PE),
Aldermaston, Berks

R00214

January 1987

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Recommended for issue by

Superintendent

Approved by

Head of Division

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1. INTRODUCTION

The broad aspects of residual hazardous materials resulting from UK trials in Australia have been considered in an earlier report (1). It is shown there that the principal hazard arises from plutonium at Taranaki, both in surface soil and 21 burial pits. All this plutonium arose from the three Vixen B safety shot series (VB1 in 1960, VB2 in 1961 and VB3 in 1963) which formed part of the minor trials; they were the only minor trial firings at Taranaki. It therefore seems worthwhile to publish the composition of the plutonium used. None of the firings gave rise to any significant nuclear yield so that all the materials used in the rounds are still present, in one form or another, as residuals essentially in the Taranaki area (1).

Some details of these shots are given in table 1, largely compiled from references (3) and (4). It is worth noting that the pad allocation in MTS(61) VB (3) is probably incorrect; the pad allocation in table 1 is that given in handwritten records by who acted as health physicist for the trial, these records now being in the hands of The isotopic composition of the enriched uranium was typically

2. MASS OF PLUTONIUM IN INDIVIDUAL SHOTS

was the principal alloying material, generally present at about by mass. Other small amounts of impurity were present but relevant data has only been found for the VB3 series together with shots 1 and 3 of VB2 in archive records given below. For these six shots we have a good measure of the percent , table 2. However, from the data for these six it became clear that the sum of all impurities, was very close to For the other shots the percent has been derived by subtracting the measured content from are given in brackets in table 2.

3. INITIAL ISOTOPIC COMPOSITION FOR INDIVIDUAL SHOTS

Complete detailed information is not readily available and only the unbracketed values in table 2 have been found in archive material. For the VB3 series details were extracted from documents in archive box number W0011; it is evident from document dates that analytical measurements were made about six months before the firings. For the VB2 series data was obtained from document WD5/2050/884 in box W0059; this differs slightly from that in document 0133365 in box J0510 in that. for VB2(5), this latter gives the which seems an unlikely value, especially since the value is quoted elsewhere (6). For VB1 the data was taken from reference 13026/007 in box K3026.

To derive reasonable, estimated values for other isotopes use has been made of the paper by (2) who plotted the ratios against the different ratio for two in the reactor. Using the known values for VB3 it was found that the ratio involving was in close agreement with the data in paper for a of about which enabled reasonable values for and to be derived. The two values of for VB2 gave points on graphs suggesting a much lower and other plutonium isotope values were obtained using an extrapolation to this . The absence of any data for VB1 prevented any evaluation of so it was assumed that the was between those applicable for VB3 and VB2.

The only direct data on was for VB3. To derive values for other shots the values were taken as paralleling the content and then multiplied by to allow for a likely longer period since chemical separation. Although this provides fairly poor estimates the vast bulk of the now at Taranaki derives from decay of rather than the initial present.

For all shots the percentage of was taken as 100 less the sum of the percentages of all other plutonium isotopes and the

4. ISOTOPIC COMPOSITION OF RESIDUAL PLUTONIUM AT TARANAKI

From table 2 the actual masses of all nuclides six months before firing can be calculated. If we assume the ARL survey data (5) to have been obtained in November 1984 then decay of the original nuclides to this date can be calculated using decay times of and for VB1, VB2 and VB3 respectively. Residual americium atoms were calculated from initial atoms, and initial atoms, using

where k_1 is the radioactive constant for k_2 the radioactive constant for and t is the decay time. The residuals thus calculated are given in table 3, together with the ratio (Bq of for each shot and the overall % isotopic composition of the total and by alpha activity. Thus, in November 1984 the although only providing of the plutonium residuals, gave rise to over of the alpha activity.

By the year 2050, when almost all the has decayed, the will contribute of the plutonium residuals and of the alpha emissions. At this time the total alpha emissions from all the uranium residuals at Taranaki will only be of that of the

REFERENCES

1. "Review of Contamination and Possible Treatment Options at Maralinga". AWRE Report 023/86 (1986)

2. "The Isotopic Composition of UK Magnox Produced Plutonium as a Function of AWRE Theoretical Physics Note 34/73 (1973)

3. Documents MTS(60)VB, MTS(61)VB and MTS(63)VB, issued by DSc(Nuc)2 (15 March 1985)

4. "Vixen B1, 1960". Classified Report, AWRE T 4/61 (1961). Sanitised version made available to the Royal Commission

5. "Residual Radioactive Contamination at Maralinga and Emu, 1985". ARL/TR070 (April 1985)

6. "Vixen B2, 1961, Radiochemical Analysis". AWRE NR/C-1/62 (1962)

Series	Shot	Date	Pad	Meteorological information	g	g	g	g
VB1 (1960)	Cal	29.8.60	B					
	1	8.9.60	D	6kn, 165° *				
	2	29.9.60	C	13kn, 220° *				
	3	3.10.60	E	9kn, 190° *				
VB2 (1961)	Cal	?	A	?				
	1	13.4.61	H	15kn, 170°				
	2	23.4.61	G	8kn, 165°				
	3	8.5.61	B	9kn, 190°				
	4	18.5.61	J	10kn, 190°				
	5	25.5.61	F	?				
VB3 (1963)	Cal	19.3.63	K	?				
	1	26.3.63	PD	15kn, 170°				
	2	2.4.63	PE	10kn, 190°				
	3	9.4.63	PC	8kn, 165°				
	4	14.4.63	M	10kn, 190°				

* Values only approximate

TABLE 1

Details of Minor Trials Firings at Taranaki

Shot	Date	Mass of Pu alloy g	% Pu in alloy	Mass of	% by atoms about 6 months before firing
VB1(1)	8. 9.60				
VB1(2)	29. 9.60				
VB1(3)	3.10.60				
VB2(1)	13. 4.61				
VB2(2)	23. 4.61				
VB2(3)	8. 5.61				
VB2(4)	18. 5.61				
VB2(5)	25. 5.61				
VB3(1)	26. 3.63				
VB3(2)	2. 4.63				
VB3(3)	9. 4.63				
VB3(4)	14. 4.63				
	TOTAL	22187		21956	

TABLE 2

Details of Plutonium Used in Minor Trials Firings at Taranaki
(Values in brackets are calculated or inferred)

Shot	Total [illegible] at Taranaki Site, November 1984 (g)
VB1(1)	
VB1(2)	
VB1(3)	
VB2(1)	
VB2(2)	
VB2(3)	
VB2(4)	
VB2(5)	
VB3(1)	
VB3(2)	
VB3(3)	
VB3(4)	
TOTAL g	
% by alpha activity	

Plutonium Residuals at Taranaki for Individual Shots in November 1984

Initial Distribution

Internal

No.	1	DAWRE. Mr P G E F Jones
	2	DDM,
	3	HCTD,
	4	BMS,
	5	SCP,
	6	SCT,
	7	SFS,
	8	SPS,
	9	SPT,
	10	SSS,
	11	SSS
	12	SCT
	13	MOD Consultant
	14	SFS
	15	
	16	
	17	

External

18	, DSc(Nuc)1, Ministry of Defence, Main Building, London
19 - 26	, DSc(Nuc)2, Ministry of Defence, Main Building, London

TS

27 - 30	Stock
31	File