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MASTER

NERVA TEST OPERATIONS

REPORT ON

RESULTS OBTAINED ON PEWEE I, EP-III EFFLUENT SAMPLES

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1.0 RESULTS OBTAINED ON PEWEE I, EP-III EFFLUENT SAMPLES

- 1.1 The NTO Radiochemistry Group analyzed the radioactive particulates from ground deposition surveys following Pewee I Experimental Plan III. Unfortunately radioiodine analysis of ground collected filter samples was cancelled due to insufficient sample activity. The samples were analyzed in support of the SNPO effluent program and in cooperation with PAA Health and Safety Department.
- 1.2 Following EP-III, the PAA H&S Department collected approximately 500 particles on six (6) areas that were searched. They were mounted on glass slides for beta counting. The NTO Radiochemistry Group received twenty (20) representative particles for photography, size and weight measurements. Seventeen (17) of these particles, plus two (2) recovered in the R-MAD compound by Radiochemistry personnel, were selected for isotope abundance determinations to evaluate fission product fractionation by particle size, recovery area and composition. It must be noted that these particles tend to represent the few larger and more active samples taken from the ground deposition study and are intended to study the nature of large particulates and expelled fuel beads. Photographs and sizes were reported for nineteen (19) of the particles and weights were obtained on only a few. The particles appear to be very fragile and some difficulty has been encountered during weighing operations. The size, weight, and composition data are presented in Table I.
- 1.3 Of the nineteen (19) particles examined fifteen (15) appeared to be ruptured beads or bead fragments, some with attached graphite. The remaining four (4) appeared to be graphite chips, although three (3) showed fission product spectra similar to those of ruptured beads. This is probably due to embedded partial beads. Niobium carbide liner materials were not encountered in the set of particles studied.

- 1.4 The fission product fractionation data for each particle are shown in Table I. The "fission" values represent the fissions occurring in the particle as analyzed by each of nine (9) isotopes. Normal irradiated fuel beads would show nearly equal "fissions" for each isotope. Low fission values for any isotope would indicate its loss by diffusion or migration during reactor operation. The data for these particles were obtained entirely from non-destructive pulse height analysis using a germanium diode detector. Several of the particles studied were typical high temperature ruptured fuel beads with fairly equivalent non-migrator activities and conspicuously low migrator activities. The normally non-migrator Ba^{140} tended to be low in activity probably due to migration at high reactor temperatures. The migrators I^{131} the activity could be measured on only eight (8) of the particles. It is expected that the much higher than normal exit gas temperature and peripheral heating caused higher iodine migration rates. As expected the graphite debris showed wide fractionation of fission products.
- 1.5 The particulates from Pewee I, EP-III showed notable differences from those of both NRX-A6 and Phoebus 2A both in general composition and fission product spectra. The particles were generally of a uranium fuel material containing a major portion of the non-migrator fission products, whereas the earlier reactors were of a graphite type debris with wide variations in fission product content.

TABLE I
PARTICLE FRACTIONATION DATA FOR EP-III

PARTICLE NO.	ARC (mi)	SIZE (μ)	WT (μg)	DESCRIPTION	FIS 10										MULTIPLIER
					Te ¹³²	I ¹³¹	Ba ¹⁴⁰	Mo ⁹⁹	La ¹³⁸	La ¹⁴⁰	C ¹⁴³	Mn ¹⁴⁷	Zr ⁹⁵		
R-MAD-20	3.0	100 x 120	15.7	Ruptured Bead with Graphite	2.03		1.64	6.17	4.1	1.78	1.72	4.70	$\times 10^{12}$		
R-MAD-21	3.0	110 x 120	14.0	Bead with Graphite	0.35		6.13	17.4	1.2	1.5	1.5	13.2	$\times 10^{13}$		
1119	3.0	100 x 100		Ruptured Bead	0.73	0.27	5.70	19.3	1.7	1.4	1.3	13.3	$\times 10^{15}$		
1131	3.0	180 x 200	4.0 (Crushed)	Ruptured Bead with attached Graphite	0.43	0.14	1.68	30.7	30.5	32.5	1.1	33.8	$\times 10^{13}$		
1141	3.0	100 x 170	3.9 (Crushed)	Ruptured Bead with Graphite	0.60		1.56	6.25	4.04	5.24	1.59	8.37	$\times 10^{13}$		
1087A	3.0	40 x 60		Fractured Bead	0.29	0.98	2.47	3.54	17.31	16.4	36.1	24.7	$\times 10^{12}$		
2024	5.0	110 x 110	14.8	Ruptured Bead	0.24		0.11	5.61	3.67	3.01	2.93	0.11	$\times 10^{13}$		
2089	5.0	80 x 80	6.2	Fractured Bead	0.12		5.26	9.69	8.34	3.54	9.37	7.47	$\times 10^{12}$		
2104	5.0	80 x 110		Graphite	1.03			1.63	12.9	1.55	1.46		$\times 10^{12}$		
2116	5.0	80 x 120	8.1	Graphite Pieces	0.81		9.99	25.1	25.8	27.5	1.4	19.1	$\times 10^{12}$		
6089	10-12	100 x 130		Fractured Bead	0.17	0.10	3.21	9.52	1.44	1.7	1.3		$\times 10^{13}$		
6109	10-12	45 x 70		Bead	0.27		2.74	4.81							
6133B	10-12	40 x 50		Bezel	2.5		1.02	0.13							

TABLE I
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PARTICLE NO.	ARC (mi)	SIZE (μ)	WT (μg)	DESCRIPTION	FISSIONS									MULTI-PLIER
					Te ¹³²	I ¹³¹	Ba ¹⁴⁰	Mo ⁹⁹	Ru ¹⁰³	Ce ¹⁴¹	Ce ¹⁴³	Na ¹⁴⁷	Zr ⁹⁵	
6138	10-12	100 x 110	3.0 (Crushed)	Ruptured Bead	0.06	0.05	1.00	2.07	1.50	1.23	1.31	2.05	3.31	x 10 ¹³
6140	10-12	100 x 120		Ruptured Bead	0.27	0.28	3.80	8.42	2.51	9.31	6.81	18.2	12.2	x 10 ¹²
4105	20-25	60 x 80		Bead Shell	0.25		5.50	11.6	11.7	14.2	14.1	12.1	14.8	x 10 ¹²
4114	20-25	50 x 70		Bead Shell	0.13	1.9	4.60	10.5	8.50	11.7	13.5	11.5	9.70	x 10 ¹²
4207B	20-25	50 x 70		Bead Fragments	0.15		0.35	8.23	0.50	1.21	4.98	2.75	8.26	x 10 ¹²
4207C	20-25	40 x 50		Bead Fragment		0.03	0.65	1.24	1.19	1.84	1.72	1.71	1.94	x 10 ¹³