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Nevada Test Site Fallout Atom Ratios: $^{240}\text{Pu}/^{239}\text{Pu}$ and $^{241}\text{Pu}/^{239}\text{Pu}$

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NEVADA TEST SITE FALLOUT ATOM RATIOS:

$^{240}\text{Pu}/^{239}\text{Pu}$ and $^{241}\text{Pu}/^{239}\text{Pu}$

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The exposure of the population in Utah to external gamma radiation from the fallout from nuclear weapons tests carried out between 1951 and 1958 at the Nevada Test Site (NTS) has been reconstructed from recent measurements of ^{137}Cs and plutonium in soil.¹ The fraction of ^{137}Cs in the fallout from NTS events was calculated from the total plutonium and the $^{240}\text{Pu}/^{239}\text{Pu}$ ratios measured in the soil, using the values of 0.180 ± 0.006 and 0.032 ± 0.003 for that ratio in global fallout and NTS fallout, respectively. The total population exposure from NTS events was then calculated on the basis of exposure rates resulting from short-lived radionuclides associated with the ^{137}Cs at the time of deposition.²

While the $^{240}\text{Pu}/^{239}\text{Pu}$ ratio is constant in global fallout, this ratio varies greatly in the fallout from individual events. While the composition of fallout on Utah from NTS events is rather uniform, the Off-Site Radiation Exposure Review Project is currently reconstructing radiation exposures for locations close to NTS where the fallout may be predominantly from one event. Therefore, the authors compiled the pertinent ratios in order to provide information concerning the exposure resulting from any individual event.

The plutonium ratios measured at 30 days postshot, shown in Table 1, were compiled from unpublished values in the archives of the Nuclear Chemistry Division of LLNL and INC-11 of LANL. These ratios are pertinent to fallout data. Dates for each event were taken from a publication by the Nevada Operations Office of the Department of Energy.³

This work was funded by the Off-Site Radiation Exposure Review Project.

TABLE 1. Some NTS Fallout Plutonium Atom Ratios
30 Days Postshot

Event	Date	Ratio		Event	Date	Ratio		Event	Date	Ratio	
		$\frac{240\text{Pu}}{239\text{Pu}}$	$\frac{241\text{Pu}}{239\text{Pu}}$			$\frac{240\text{Pu}}{239\text{Pu}}$	$\frac{241\text{Pu}}{239\text{Pu}}$			$\frac{240\text{Pu}}{239\text{Pu}}$	$\frac{241\text{Pu}}{239\text{Pu}}$
OPERATION RANGER				OPERATION UPSHOT-KNOTHOLE				OPERATION PLUMBBOB			
Able	1/27/51	4.2×10^{-4}	-	Annie	3/17/53	0.0246	0.0010	Boltzmann	5/28/57	0.0787	0.0060
Baker	1/28/51	0.0267	6.2×10^{-4}	Nancy	3/24/53	0.0283	0.0012	Franklin	6/2/57	2.1×10^{-4}	-
Easy	2/1/51	0.0179	3.8×10^{-4}	Ruth	3/31/53	1.5×10^{-4}	-	Wilson	6/18/57	0.0818	0.0065
Baker-2	2/2/51	0.0256	5.0×10^{-4}	Dixie	4/6/53	0.0217	5.5×10^{-4}	Priscilla	6/24/57	0.0108	-
Fox	2/6/51	0.0261	5.4×10^{-4}	Ray	4/11/53	1.8×10^{-4}	-	Hood	7/5/57	0.0673	-
				Badger	4/18/53	0.0342	0.0011	Diablo	7/15/57	0.0624	-
OPERATION BUSTER-JANGLE				Simon	4/25/53	0.0267	6.2×10^{-4}	John	7/19/57	0.0591	0.0048
Baker	10/28/51	0.0326	0.0011	Encore	5/8/53	0.0517	0.0028	Kepler	7/24/57	0.0722	0.0054
Charlie	10/30/51	0.0283	0.0010	Harry	5/19/53	0.0375	0.0018	Owens	7/25/57	0.0702	0.0047
Dog	11/1/51	0.0282	0.0010	Grable	5/25/53	9.7×10^{-4}	-	Pascal A	7/26/57	0.0761	-
Easy	11/5/51	0.0355	0.0011	Climax	6/4/53	0.0342	9.0×10^{-4}	Stokes	8/7/57	0.0074	-
Sugar	11/19/51	0.0010	-	OPERATION TEAPOT				Shasta	8/18/57	0.0571	-
Uncle	11/29/51	9.7×10^{-4}	-	Wasp	2/18/55	0.0533	0.0036	Doppler	8/23/57	0.0700	0.0046
OPERATION TUMBLER-SNAPPER				Moth	2/22/55	0.0778	0.0065	Franklin Prime	8/30/57	0.0029	-
Able	4/1/52	6.9×10^{-4}	-	Tesla	3/1/55	0.0189	3.1×10^{-4}	Smoky	8/31/57	0.0058	-
Baker	4/15/52	7.2×10^{-4}	-	Turk	3/7/55	0.0326	8.0×10^{-4}	Galileo	9/2/57	0.0753	0.0060
Charlie	4/22/52	0.0506	0.0028	Hornet	3/12/55	0.0577	0.0036	Wheeler	9/6/57	0.0376	-
Dog	5/1/52	0.0346	0.0012	Bee	3/22/55	0.0853	0.0071	Coulomb B	9/6/57	-	-
Easy	5/7/52	0.0236	5.4×10^{-4}	Ess	3/23/55	-	-	Laplace	9/8/57	2.4×10^{-4}	-
Fox	5/25/52	0.0236	5.9×10^{-4}	Apple I	3/29/55	0.0245	5.5×10^{-4}	Fizeau	9/14/57	0.0630	0.0040
George	6/1/52	0.0257	0.0015	Wasp Prime	3/29/55	0.0522	0.0034	Newton	9/16/57	0.0716	0.0058
How	6/5/52	0.0271	5.0×10^{-4}	HA	4/6/55	0.0510	0.0033	Whitney	9/23/57	0.0734	-
				Post	4/9/55	0.0194	5.0×10^{-4}	Charleston	9/28/57	0.0735	-
				Met	4/15/55	0.0068	1.4×10^{-4}	Morgan	10/7/57	0.0773	0.0063
				Apple II	5/5/55	0.0313	8.0×10^{-4}	Coulomb C	12/9/57	-	-
				Zucchini	5/15/55	0.0319	8.1×10^{-4}				

- No analytical data available.

TABLE 1. Some NTS Fallout Plutonium Atom Ratios (Cont.)

Event	Date	Ratio	
		$\frac{240\text{Pu}}{239\text{Pu}}$	$\frac{241\text{Pu}}{239\text{Pu}}$
OPERATION HARDTACK II			
Otero	9/12/58	0.0521	0.0035
Eddy	9/19/58	0.0503	0.0038
Mora	9/29/58	0.0544	0.0040
Hidalgo	10/5/58	-	-
Quay	10/10/58	0.0541	0.0041
Lea	10/13/58	0.0542	0.0038
Hamilton	10/15/58	0.0537	0.0042
Dona Ana	10/16/58	0.0530	0.0038
Vesta	10/17/58	-	-
Rio Arriba	10/18/58	-	-
Socorro	10/22/58	0.0568	0.0045
Wrangell	10/22/58	0.0513	0.0037
Rushmore	10/22/58	0.0519	-
Catron	10/24/58	0.0487	0.0041
Sanford	10/26/58	-	-
DeBaca	10/26/58	0.0637	0.0049
Chavez	10/27/58	0.0500	0.0037
Humboldt	10/29/58	0.0518	-
Titania	10/30/58	-	-
Santa Fe	10/30/58	0.0538	0.0037

Event	Date	Ratio	
		$\frac{240\text{Pu}}{239\text{Pu}}$	$\frac{241\text{Pu}}{239\text{Pu}}$
OPERATIONS NOUGAT THROUGH BOWLINE			
Danny Boy	7/5/62	0.0682	0.0072
Sedan	7/6/62	0.0625	-
Johnny Boy	7/11/62	4.3×10^{-4}	-
Small Boy	7/14/62	0.0650	0.0056
Little Feller I	7/17/62	0.0660	0.0053
Sulky	12/18/64	-	-
Palanquin	4/14/65	0.0651	0.0061
Cabriolet	1/26/68	0.0628	-
Buggy	3/12/68	0.0649	-
Schooner	12/8/68	0.0656	0.0049

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