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April 4, 1962

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Activation Dose Rates from System Components

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Results of computations to date on posttest dose rates from activated materials comprising system components and support structure are summarized below.

1. Comparison of Materials

Decay dose rates 90 days after shutdown following 10,000 hours of operation at 10 Mw are for materials located at the reactor midplane (1) within the reactor shield cavity and (2) at 10 feet from the center of the shielded reactor.

Dose rates at one foot from one pound of material are as follows:

Material	Radioisotope	(1) r/hr	(2) mr/hr
Columbium 316-SS	Ta ¹⁸²		0.17
	Co ⁶⁰	45	0.034
	Co ⁵⁸	12	0.009
	Fe ⁵⁹	0.6	0.0002
	Cr ⁵¹	1.7 59	0.0006 0.044
304-SS	Co ⁶⁰	35	0.026
	Co ⁵⁸	9.5	0.007
	Fe ⁵⁹	1.8	0.0002
	Cr ⁵¹	0.6 47	0.0007 0.034
	Co ⁶⁰	1.8	0.0013
405-SS	Co ⁵⁸	0.5	0.0004
	Fe ⁵⁹	0.7	0.0003
	Cr ⁵¹	1.3 4.3	0.0005 0.0025
	Fe ⁵⁹	0.8	0.0003
	Sc ⁴⁶	1.2	
1020 Steel			
Titanium			

Reactions that produce the radioisotopes are as follows:

Reaction	Half-life of Radioisotope
Ta ¹⁸¹ (n, γ)Ta ¹⁸²	115 day
Co ⁵⁹ (n, γ)Co ⁶⁰	5.3 year
Ni ⁵⁸ (n, p)Co ⁵⁸	72 day
Fe ⁵⁸ (n, γ)Fe ⁵⁹	45 day
Cr ⁵⁰ (n, γ)Cr ⁵¹	27.8 day
Ti ⁴⁶ (n, p)Sc ⁴⁶	85 day

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Several shorter half-life isotopes produced by reactions not shown above become significant for shutdown times less than 20 days. Impurities assumed were as follows: 0.1 wt. percent tantalum in columbium; 1.0 wt. percent cobalt in nickel; and 0.5 wt. percent nickel in type 405 stainless steel.

2. Dose Rates from System Components

The decay dose rates from system components located within the test cell but outside the reactor shield are based on the above decay dose rates from materials located at the reactor midplane. To obtain the decay dose rate from components irradiated at distances other than 10 feet, an inverse square variation was assumed and the shortest straight line distance between the center of gravity of the component and the center of the reactor was used. The tabulation given below is presented to give a feeling for an order of magnitude of the activation dose rates involved. In evaluating the results, one should realize that it would be physically impossible to be simultaneously at one foot from all system components. Self shielding and the decrease expected in the neutron flux above and below the midplane were neglected; therefore, the computed dose rates are believed to be conservatively high.

DECAY DOSE RATES AT ONE FOOT FROM COMPONENTS 90 DAYS AFTER SHUTDOWN

Component	Dist. from Reactor (ft)	lbs. of Columbium	lbs. of 316-SS	Dose Rate, mr/hr, at one ft.		
				Nb	SS	Total
Li pump & sump	16.7	1140	640	75	10	85
Li pump motor	16.7		250		4	4
NaK pump & sump	18.7		1680		21	21
NaK pump motor	18.7		250		3	3
Li heat exchanger	12.1	200		24		24
NaK heat exchanger	18.1		180		2	2
Li tank	14.2		750		16	16
NaK tank	14.2		400		8	8
Li piping	10	198	214	34	9	43
NaK piping	14.5		295		6	6
Secondary piping	15		310		6	6
Fill & Drain Piping	64		64		6	6
Li Add Tank	33.8		300		1	1
Total		1538	5333	133	92	225

All the results given above are expressed as dose rates at one foot from a given amount of material. If the activity in curies is preferred, the results can be readily converted. Curie-to-dose rate conversion factors that were used are as follows:

Radioisotope	mr/hr per curie at one ft. from a point source
Ta ¹⁸²	7×10^3
Co ⁶⁰	14.3×10^3
Co ⁵⁸	6.9×10^3
Fe ⁵⁹	7×10^3
Cr ⁵¹	0.76×10^3
Sc ⁴⁶	12.2×10^3

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