

OAK RIDGE NATIONAL LABORATORY

OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION



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705003

September 29, 1964

PRIVACY ACT MATERIAL REMOVED

TO: Dr. Alexander Hollaender
FROM: P. Carolyn Gooch
SUBJECT: Leukocyte chromosome aberration analysis of individuals involved in the United Nuclear Corporation criticality accident of July 24, 1964.

Chromosome aberration analyses have been completed on leukocyte cultures of blood samples obtained within one week after the accident from five of the individuals present at the site. Suitable material was obtained from one additional individual within 2-1/2 weeks after the accident. Additional follow-up samples also have been analyzed for the two "higher dose" men. Unfortunately, blood taken from the fatally injured man before his death was frozen and, therefore, unusable for our purposes. An attempt was made to culture blood drawn after death, but probably because several hours elapsed between death and the drawing of the blood, the culture attempt was unsuccessful.

Blood samples were obtained from the two hospitalized men () and () the morning of July 27 (3 days after the accident). However, apparently because of toxicity problems, the cultures were not satisfactory.

Tuesday morning, July 28, blood samples were taken from the other four men () and () and cultures were set up. Friday morning, July 31, a second set of samples was obtained from () and (). These blood samples were refrigerated and, along with the cultures of () and (), were returned to Oak Ridge. Cultures were prepared in Oak Ridge from the refrigerated blood samples.

Material suitable for chromosomal analysis was obtained from the four-day blood samples of (), (), (), and (), and from the one-week sample of (). The one-week sample from () was also unsuccessful. This failure is perhaps not unexpected: we have routinely seen poor preparations from cultures made between approximately one day and one week after the irradiation from individuals who are noticeably upset by an accident.

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Primary Accident - United
Nuclear Corp. - July 24, 1964
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This report will cover the results obtained from the 4-day samples of [redacted], [redacted], [redacted], and [redacted]; the one-week, 2-1/2 and 3-1/2-week samples of [redacted]. Follow-up samples were not taken from [redacted], [redacted], [redacted], and [redacted].

From our studies of the previous accidents we have found that there is no significant difference in aberration rates for samples taken from 4 hours after the accident up until approximately 4 weeks post-accident; consequently, the results for H and Sm are from pooled data. Up until 4 weeks, chromosome deletions and fragments associated with dicentric production are usually still present, indicating that the cells examined have not undergone an in vivo mitosis. Since in previous cases there is no difference in aberration rates up to 4 weeks, it is also assumed that those cells released into the peripheral blood from the time of the accident up until 4 weeks are of the same radiosensitivity as those present in the peripheral blood at the time of the accident.

Table I shows the results of our visual scoring. The chromatid aberrations recorded arise spontaneously in culture and are not included in dose calculations. The "other" column includes chromosome exchanges which, although they are only rarely seen in control material, are not included in dose calculations either because many aberrations of this class are impossible to detect and also because of the subjectivity of scoring them.

Since so little information is available concerning this accident, we have calculated doses two ways; first, assuming that only gamma irradiation was received and second, assuming that only neutron irradiation was received. We used both one- and two-hit aberrations for the calculations. The results are presented in Table II. The coefficients of aberration production used in the calculations were derived from in vitro experiments and are as follows:

Gamma rays
 $.09 \times 10^{-2}$ deletions/cell/rad
 $.6 \times 10^{-5}$ dicentrics/cell/rad²
 fission spectrum neutrons
 $.45 \times 10^{-2}$ deletions/cell/rad
 5.5×10^{-3} dicentrics/cell/rad

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The spontaneous deletion frequency for deletions is .0025 deletions per cell.

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The methods of dose calculation are presented in detail elsewhere (Bender, M. A, and P. C. Gooch, Proc. Natl. Acad. Sci., U. S. 48: 522-532, 1962).

The aberration yields for [redacted], [redacted], and [redacted] show that they received low total doses. Very accurate determination of these doses is not possible, however, for several reasons. First, the yields are so low that sampling errors have a large effect on estimated dose. Second, lack of information about the gamma ray-neutron ratio for the doses received also contributes uncertainty to the dose estimates. It seems best, then, to simply state that the doses for [redacted], [redacted], and [redacted] were in the range of 3-20 rad, probably of the order of 5-10 rad of mixed gamma rays and neutrons.

As may be seen from Table I, the ratio of dicentric chromosomes to deletions in the sample from [redacted] is high. This is also true of the sample from [redacted], although less significance can be assigned to this fact where total aberration yields are very low. Such high ratios suggest one of two things; either there was a large neutron component in the total dose, or the dose was very inhomogeneously distributed over the subject's body. While the aberration analysis for [redacted] suggests a large neutron component in the total dose he received, the analyses for [redacted] are quite compatible with a much lower neutron component in his dose. In any case, in the absence of additional physical information about the exposures of [redacted] and [redacted], it is probably best to estimate that they received rad doses of between 30 and 40 rads, probably with some neutron component.

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Rhode Island Accident

Table I

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Individual	Time of Sampling	Cells scored	Chromatid aberrations	Chromosome-type aberrations				Breaks (%)
				2n = 46	deletions	dicentrics	other	
	1 week	150	4	17	7	0	0	4.0
	2-1/2 weeks	100	1	8	2	0	1	2.0
	3-1/2 weeks	100	1	4	4	1	0	6.0
	2-1/2 weeks	150	1	21	2	3	3	5.3
	3-1/2 weeks	100	1	7	0	2	1	2.0
	4 days	150	1	11	3	0	1	2.0
	4 days	100	0	5	2	0	0	2.0
	4 days	150	1	8	0	2	0	2.7
	4 days	150	1	4	2	0	0	2.0

Table II

Individual	Dose Estimates Assuming only γ irradiation (rads)		Dose Estimates Assuming only neutron irradiation (rads)	
	Deletions	Dicentrics	Deletions	Dicentrics
	38.5	22.0	7.69	.52
	6.1	58.0	1.2	3.6
	19.4	--	3.9	--
	19.4	--	3.9	--
	--	46.5	--	2.4
	11.7	--	2.4	--

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