OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA GEN. REG. NO. 27

5010-107

UNITED STATES GOVERNMENT

Memorandum

COPY

TO : Robert W. Kirkman, Director, Region I,
Division of Compliance, New York

DATE: October 5, 1964

FROM : Herman M. Roth, Director
Research and Development Division
Oak Ridge Operations

SUBJECT: ORNL REPORT ON CHROMOSOME ABERRATION ANALYSIS OF INDIVIDUALS INVOLVED IN THE UNC ACCIDENT IN RHODE ISLAND, JULY 24, 1964

ORB:CSS

In accord with conversations between Dr. C. S. Shoup of this Division and Messrs. Dubinski and Resner, we are enclosing two copies of the subject report dated September 29, 1964, and two copies of a supplement dated October 1, 1964. This material is for your use and retention and was prepared by P. Carolyn Gooch of the Biology Division, Oak Ridge National Laboratory as a part of accumulated data bearing on cytogenetics research. In this kind of work, both in human and animal material, an attempt is made to relate radiation dose to radiation-induced chromosomal aberrations. Statistical validity of the method as it applies to man depends upon timing and control over sampling and is the subject of a considerable research effort.

/s/ Herman M. Roth

Herman M. Roth

Enclosure:
Report and Supplement

cc: C. L. Dunham, HQ, w/encl.
Leo Dubinski, HQ, w/encl.
R. C. Armstrong
K. D. McCasland

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OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831

September 29, 1964

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 [ ] the morning of July 27 (3 days after the accident). However, apparently because of toxicity problems, the cultures were not satisfactory.

Ex. 6

Tuesday morning, July 28, blood samples were taken from the [ ] and cultures were set up. Friday morning, July 31, a second set of samples was obtained from [ ] These blood samples were refrigerated and, along with the cultures of [ ] 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 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

This report will cover the results obtained from the 4-day samples of [redacted] the one-week, 2-1/2 and 3-1/2-week samples of [redacted] Ex.6 Follow-up samples were not taken from [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 [redacted] 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/rad^2

fission spectrum neutrons

$.45 \times 10^{-2}$ deletions/cell/rad

5.5×10^{-3} dicentrics/cell/rad

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

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 [ ] 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 [ ] were in the range of 3-20 rad, probably of the order of 5-10 rad of mixed gamma rays and neutrons.

Ex. 6

As may be seen from Table I, the ratio of dicentric chromosomes to deletions in the sample from Sm is high. This is also true of the sample from [ ] 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 [ ] suggests a large neutron component in the total dose he received, the analyses for [ ] 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 [ ] it is probably best to estimate that they received rad doses of between 30 and 40 rads, probably with some neutron component.

Rhode Island Accident

Table I

Individual	Time of Sampling	Cells scored	Chromatid aberrations	Chromosome-type aberrations				Breaks (%)
				2n = 46	deletions	dicentrics	other	
Ex. 6	1 week	150	4	17	7	0	0	4.7
	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	
	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
Ex. 6	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	--

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

October 1, 1964

TO: Dr. A. Hollaender

FROM: P. Carolyn Gooch

SUBJECT: Addendum to memo of September 29, 1964 on "Leukocyte chromosome aberration analysis of individuals involved in the United Nuclear Corporation criticality accident of July 24, 1964."

Additional information has been received concerning the Rhode Island criticality accident. Independent analyses have indicated a neutron component in the doses of [ ] Taking this into account, our data best fit doses of 35 rad γ + 1 rad neutrons for H and 5 rad γ + 3 rad neutrons for Sm.

Ex. 6