

CONFIDENTIAL

PROGRESS REPORT  
OPERATIONS - GREENHOUSE

1. The study of the chronic consequences of atomic exposure of these mice proceeds with no complications. Now, approximately seven months after the exposure, most of the deaths are due to leukemia. Death from incurrent infections has been minimal since receipt of the animals.
2. A slight mortality early after receipt of the mice, occurring mainly among those receiving higher doses, has already been reported. The early lethality from exposure evidently does not end in 30 days, but there is quite a carry-over, terminating in the present series during the sixth or seventh week, when the weekly mortality declined to about one per week or 0.03% of the population.
3. Leukemia began to appear during the fourth month after exposure and is now on its ascendancy. Table 1 indicates a definite relation between leukemia incidence and intensity of exposure, the greatest incidence being among mice exposed to doses higher than the LD 50. Not a single case of leukemia has occurred among the 611 controls. Neutrons have no preferential effect in leukemia induction.
4. Opacities of the lens began to make their appearance about 70 days after exposure, and now all exposed animals have some opacities. This is well explained by our earlier observation that the threshold dose inducing opacities of the lens is somewhere between 30 and 15 r. The progress of cataracts among the animals exposed is indicated in Table 2. There is a distinct preferential neutron effect as concerns cataract induction.

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5. Graying of the hair occurred in animals in definite relation to the intensity of the exposure as one might expect from data in the literature. A summary of observations is given on Table 3.
6. Tumors occurred in the mammary gland region in many exposed mice, as indicated in Table 1. This was unexpected as, according to Dr. Lorenz, mammary tumors occur late in life of mice of this strain exposed to gamma rays, and cutaneous tumors are very rare. Sections of these tumors will be sent to Drs. Shields Warren and E. Lorenz. The question is whether these tumors could be caused by neutron nuclear reactions due to some element present in the accessory glands of the skin or in the mammary ducts. Other types of tumor are not apparent thus far.
7. The X-Ray controls have been received only recently from Dr. J. Bond, U. S. Naval Research Laboratory, San Francisco. As these mice were set up later and reared in the United States, they are not perfect controls but will serve for tentative orientation as to the relative efficiency of neutrons and X-rays in producing graying, cataracts, leukemia, and tumors.
8. It is premature to draw final conclusions, but the following general considerations are submitted:
  - a) Atomic bomb explosions can be utilized for basic scientific and applied studies which in many respects are superior to the laboratory experiments performed thus far, e. g., certain major factors are ideally identical and uniform, such as the exposure source, the period of observation, and other variables related to time and space. Neutron exposure of mammals on a large scale is barely feasible otherwise.

- b) The expense involved in the current study is unduly high, because no proper animal quarters were available. The cages specially constructed are of a type which greatly increases the time involved in animal care. If future experiments are planned, a new type of cage will be designed (and tested) which would cut the expense of animal care by one-third or more and will minimize the health hazards of caging.
- c) The present large scale study need not be duplicated. It seems adequate as a base line to enable the set-up of several much smaller projects well conceived and executed on statistically significant scale.
- d) No suggestions as to the type of research to be undertaken are offered now, but it is recommended that a semi-permanent special advisory committee of the Medical Director of AEC should soon consider problems which are best carried out in field experiments.

Respectfully submitted,

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TABLE I. INCIDENCE OF NEOPLASIA IN O.G. MICE UP TO 11/19/51.

	I	II	III		IV		V		VI	
	Station	Original No. in Group	Received No.	% of II	Living 8/1/51 No.	% of II	Dead with Leukemia* No.	% of IV	Dead with Tumors ** No.	% of IV
	E 70 k	220	1	0	1	0	0	0	0	0
	E 70 m	220	8	3.6	5	2.3	0	0	0	0
	E 70 n	220	16	7.3	15	6.8	0	0	0	0
	E 70 o	220	43	19.6	39	17.8	0	0	1	2.6
	E 70 p	220	77	35.0	72	32.7	6	8.3	0	0
	E 70 q	220	96	43.6	92	41.8	4	4.3	0	0
	LD 90	—	—	—	—	—	—	—	—	—
Unshielded	E 70 r	220	142	64.5	140	63.6	1	0.7	0	0
	E 70 s	220	168	76.4	167	75.9	3	1.8	0	0
	E 70 t	220	192	87.3	191	86.8	3	1.6	0	0
	E 70 u	220	208	94.5	204	92.7	7	3.4	1	0.5
	E 70 v	220	213	96.8	208	94.5	5	2.4	1	0.5
	E 70 w	220	209	95.0	209	94.5	1	0.5	0	0
	(E 71 a	220	43***	19.5	43	19.5	0	0	0	0)
	(E 71 b	220	151***	68.6	150	68.2	1	0.6	3	2.0)
	E 71 c	220	213	96.8	212	96.3	0	0	1	0.5
	E 71 d	220	216	98.2	215	97.7	2	0.9	1	0.5
E 71 e	220	213	96.8	213	96.8	1	0.5	1	0.5	
Lead-shielded	E 85 d	50	46	92.0	44	88.0	0	0	0	0
	E 85 e	50	48	96.0	46	92.0	0	0	2	4.3
	E 85 f	50	50	100.0	50	100.0	0	0	0	0
	G 85 b	30	27	90.0	26	86.6	1	3.3	3	10.0
	G 85 c	30	28	93.3	28	93.3	0	0	1	3.6
	G 85 d	20	20	100.0	18	90.0	0	0	0	0
	G 85 e	30	30	100.0	30	100.0	0	0	1	3.3
	G 85 f	30	27	90.0	27	90.0	0	0	0	0
Control	620	612	98.7	611	98.5	0	0	0	0	

\* Leukemias seen thus far have been thymic lymphosarcomas.

\*\* Tumors encountered to date have been of the type described in the report.

\*\*\* Two trays of mice in stations E 71 A&B were upset in transit to ORNL.

TABLE 2. OPACITIES OF THE LENS IN O.G. MICE EXAMINED WITH THE SLIT LAMP

Months	May	June	July	August	September	October	November	
Degree of Opacity:	0 + ##	0 + ##	0 + ##	0 + ##	0 + ## ##	0 + ## ##	0 + ## ##	
Station	Number of Mice Examined							
Unshielded	E 70 k		1	1	1			
	E 70 m	4	1	1 4	1 4	2 1		
	E 70 n		6	5	1 3	3	2 1	
	E 70 o		7	5 1	5	4		
	E 70 p	11	2 9	7 3		3		
	E 70 q	12	6	10 2	1 2		3	
	E 70 r	24	6		2 1	3		
	E 70 s	23 1	6		4 3	3		
	E 70 t	29	5 1	3 3		1 2	3	
	E 70 u		12 23		3	2		
	E 70 v		1 32	1 5	2 1			
	E 70 w		19	6	6	2	3	
	E 71 a		1 11	7		3		
	E 71 b		5	6		3		
	E 71 c		2 32	6	2	3 1	3	
	E 71 d		6	6	7	3		
	E 71 e		9	12	9			
	Lead-shielded	E 85 d	26 1	21	2 11	2 4	1 4 1	3 1 2
		E 85 e		28 9	8 14	3	3	
E 85 f				3 21	6	6	3	
G 85 b		12	14	5	3 3		3	
G 85 c			28	6 1	2 2	3		
G 85 d			14 2	6		2	3	
G 85 e				3 19	6	6	1 2 3	
G 85 f				6	3	3		
Control	22	68	63	43	27	9	3	

TABLE 3. DEGREE OF DEPIGMENTATION OF FUR IN O.G. MICE

Date of Exam.		7/25/51						10/1/51						11/15/51					
Anatomical Region		Degree of Depigmentation						Degree of Depigmentation						Degree of Depigmentation					
Station		Head	Neck	Shoulders	Abdomen	Dorsum	Sacral Reg.	Head	Neck	Shoulders	Abdomen	Dorsum	Sacral Reg.	Head	Neck	Shoulders	Abdomen	Dorsum	Sacral Reg.
Unshielded	E 70 k	20	20	10	10	10	0							40	30	30	30	20	0
	E 70 m	20	20	20	10	10	0	35	35	27	23	18	15	40	40	40	35	28	13
	E 70 n	25	23	16	12	10	7	27	27	22	18	15	12	39	36	28	26	16	20
	E 70 o	24	20	16	13	10	3	34	37	24	24	19	14	40	40	35	36	24	20
	E 70 p	24	25	14	11	4	1	31	26	24	22	13	9	40	37	32	31	24	18
	E 70 q	22	21	17	13	9	3	27	26	23	21	14	9	39	39	34	33	20	13
	E 70 r	20	20	15	12	8	2	27	27	26	22	13	9	40	36	30	32	22	14
	E 70 s	19	18	15	12	14	5	28	24	18	16	9	4	39	35	32	28	22	20
	E 70 t	17	18	10	10	9	3	28	24	22	21	16	9	38	35	31	30	21	14
	E 70 u	22	21	12	11	10	4	28	23	20	17	14	7	37	33	26	25	15	10
	E 70 v	18	17	8	8	8	3	19	18	18	18	6	4	31	24	21	21	15	9
	E 70 w	12	12	9	9	9	3	16	14	12	13	8	4	16	14	11	15	11	4
	E 71 a	8	8	7	7	6	2	12	13	11	14	10	4	17	10	7	16	10	8
	E 71 b	4	5	4	5	3	0	2	4	2	4	1	1	8	8	7	9	6	3
	E 71 c	2	3	3	3	0	0	2	2	0	3	0	0	1	1	0	2	1	0
E 71 d	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
E 71 e	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	
Lead-Shielded	E 85 d	17	17	13	12	2	0	11	12	10	11	9	4	22	18	16	14	12	8
	E 85 e	5	6	6	6	4	0	2	3	1	4	0	0	4	3	2	4	1	1
	E 85 f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G 85 b	8	10	10	10	10	2	7	7	4	8	4	3	13	16	14	17	13	10
	G 85 c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G 85 d	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G 85 e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G 85 f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

EXPLANATION OF TABLE 3

0- no depigmentation, normal brown color; 10- hair faintly grey;  
20- hair grey; 30- hair greyish-white; 40- hair white.

The figures given in the table represent average values calculated from observations of 10 to 30 mice at each station, except B 70 k for which only 1 mouse is available. Approximately 50 controls were examined on each date given.