UNIVERSITY OF CALIFORNIA [redacted]

Los Alamos Scientific Laboratory

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$1,900,000 cost

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TO: A. C. Graves

FROM: G. V. LeRoy

The material submitted herewith is a proposed summary of the Biomedical Program for presentation to the RDB, 19 September 1951, and for the information of USAEC, Division of Biology and Medicine, and Division of Military Application. In the event that the KT rating of EASY Shot is released from classification, this is the Biomedical material that I believe should be published as soon as possible. If desired, a summary declassified statement of approximately 100 pages could be prepared for distribution October, 1951.

1.0 Introduction

1.1 General remarks on success of the study, acknowledgements, etc.

1.2 Costs, budgeted and actual.

1.3 Scope of present report.

1.3.1 Detailed description of effects observed on Easy Shot.

1.3.2 No discussion description of effects observed on other shots, except 1.3.4 and 1.3.5.

1.3.3 Biological evaluation of estimates of yield, biological determination of mean free path, and data on neutrons are omitted.

1.3.4 Brief description of study of FP in drones.

1.3.5 Brief statement regarding the foxhole study.

2.0 Experimental Data

2.1 Estimation of dose with biological material.

2.1.1 Mouse thymus-spleen system, results compared with film and ionization chambers.

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2.1.2 Mouse MLD system.

2.1.3 Tradescantia.

2.2 Estimations of RBE (bomb effect/X ray effect).

2.3 Observations made to date on surviving mice - cataract, etc.

2.4 Studies of Large Animals.

2.4.1 MLD for swine, control and field results.

2.4.2 MLD for dogs, control and field results.

2.4.3 Summary of Pathological studies.

2.4.4 Summary of clinical studies: hematology, biochemistry, bacteriology, etc.

2.5 Investigation of the Quality of the Radiation.

2.5.1 The dosimeter systems used.

2.5.2 Depth-dose and HVL studies.

2.5.3 Reproduction of 2.5.2 using laboratory sources.

2.6 Study of Burns.

2.6.1 Comparison of clinical characteristics of AB burns and searchlight burns, threshold values, etc.

2.6.2 Comparison of predicted and observed values for incident thermal energy as a function of distance. Speculations on reason for the discrepancy.

2.6.3 Spectrum and clinical burns.

2.6.4 Time relationship of clinical burns.

2.7 Relation between Gamma radiation and exposure to FP in drones.

2.8 Miscellaneous Data: studies of Glomerella, corn, induced radioactivity in the skeletons of pigs, etc.

3.0 Conclusions

3.1 Estimates of dose using biological systems, film packs, ionization chambers, etc., are substantially similar within the range of biomedical interest. (except for cataracts)

3.2 The RBE is approximately unity for mice and Tradescantia.

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Cobalt 60 rays about 60% less
effective than bomb

Betatron at 10 MEV (3 MEV effective)
20KT bomb about equivalent to X rays of above

Burns very similar (equivalent)
to 60 inch searchlight at Rochester

No ultra violet beyond 600 yds

Dust actually washing factor

$$\frac{\text{Dose radiation delivered}}{\text{dose fission products inhaled or swallowed}} = \frac{100}{30}$$

But fission products were taken into body
- I^{131} in thyroid shafts

[redacted]

3.3 Estimates and prediction of dose of neutrons is not reliable to date. *vastly more effective than expected*

3.4 For radiobiological research using mice 200 - 2,000 KVP X rays are acceptable substitutes for an atomic bomb.

perhaps 5×10^6 X ray

3.5 The MLD of swine and dogs is approximately the same as the MLD for man. *LD ± 200 r (perhaps different for length of exposure)*

3.6 For radiobiological research using large animals, gamma rays of Co^{60}, and 2,000 KVP X rays are acceptable substitutes for an atomic bomb.

3.7 The clinical course, complications and pathological lesions of wholebody radiation injury caused by gamma rays from an atomic bomb, and appropriate ionizing radiation produced in the laboratory, are essentially the same in man and large animals.

3.8 Using mice, there is evidence for the existence of at least two types of lethal mechanism, or lethality functions, with ionizing radiation.

3.9 The effective energy of the initial gamma radiation of an atomic bomb is somewhat greater than the effective energy of gamma rays of Co^{60}. The scattering in exposure equipment has a significant effect on the response of biological systems, such as mice, and is important in the design of experiments.

3.10 Interference of some sort reduced the incident thermal energy at the distances where animals were exposed by a factor of 2 to 5. Under the conditions that existed in the field, burns were not observed beneath the filters which transmitted the ultraviolet. The burns under the infra red filters were less severe than those under either the clear quartz or the visible light transmitting filters. Burns did not occur during the first 25 to 30 msec; and burning was largely completed by 0.3 to 0.5 sec after the detonation.

3.11 The clinical appearance of the burns was substantially the same as those produced by the 60 in. searchlight with exposure times of less than 1 sec.

3.12 In drone aircraft, in the cloud the dose of gamma radiation exceeds the exposure from FP by a factor 30 to 100.

3.13 The blast studies were inconclusive.

3.14 The neutron studies were inconclusive, although it appeared that neutrons may be of considerable biological significance.

4.0 <u>Recommendations</u>

4.1 The triple verification of the RBE suggests that most types of radiobiological research can be done in the laboratory with appropriate sources.

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4.2 The value of MLD for dogs is considered good enough to be used as the basis for planning the design of future studies where these animals may be used.

4.3 The value for MLD in dogs can be applied properly to man, and used as the basis for design and calibration of personnel dosimeters and for planning the quantity of medical care required after an atomic attack.

4.4 The dog is a better large mammal than the pig for studies of whole-body radiation injury, experimental pathology, etc.

4.5 The histopathological studies indicate the occurrence of generalized vascular damage which may be of real significance to future studies of the nature of radiation disease.

4.6 It should not be necessary to conduct further field studies to establish the analagous character of the radiation injury inflicted by the gamma rays from atomic bombs and appropriate laboratory sources of ionizing radiation.

4.7 An atomic bomb is an excellent source of radiation for critical pharmacological and therapeutic studies where it is desired to reduce variation in the response of large animals.

4.8 Additional burn studies should be done to eliminate the effect of the interference that occurred at Eniwetok.

4.9 Additional blast studies will be needed to explore the various factors that affect survival in foxholes and shelters.

4.10 Additional studies should be done to develop a method for measurement of neutrons, and to study in animals the effects neutrons emitted during a nuclear explosion.

It is our understanding that you approve presentation to the RDB, and The Division of Biology and Medicine and Division of Military Application, AEC; and that you have no objection to the conclusions and recommendations. It is also our understanding that any further dissemination of this material is under consideration.

GEORGE V. LEROY

WRIGHT H. LANGHAM

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