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GABRIEL PROJECT, REOPENED

Nicholas M. Smith, Jr. [redacted]
Oak Ridge National Laboratory

404834

Introduction

The Gabriel Project has been reopened on the request of Dr. Shields Warren, Director of Biology and Medicine Department of AEC. Specifically, the question was asked, "Does recent data on Ranger and Greenhouse tests enable one to state more definitely the probability of large scale disaster from the dispersion of the debris of a large number of atomic bombs?"

The new data has shown the following: in the first place the size distribution of the particles formed by the radio-active material has been shown to have a peak in the 3/10 micron region by the NRL group. This situation has been suspected by Tracerlab* measurments and its investigators conclude that their technique has missed the particles of small size. The implication of this discovery is that the debris on the whole settles out much more slowly than assumed in previous calculations, and that turbulence and precipitation must play a major rôle in the distribution of the bomb debris. Thus, any calculation based on Stokes Law fall out is of value only as a frame of reference. The new collection data indicate that the particles are deposited over a much wider area than would result if Stokes Law settling and wind transport were the only means of dispersion. One of the major problems then is to deduce the expected dispersal from the published data. This is usually difficult since the experimenters were more often interested in relative than in absolute measures of activity.

There is further evidence concerning the nature of the particles which will have a bearing on this project. The AFOAT-1 group reporting on the Tracerlab findings state that particles from ground burst shots are comprised of essentially glassy materials and are much more difficult to dissolve than particles from air burst shots which are presumably mostly oxides. There is some evidence presented by the NRDL investigators** that the

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* 14-TR-144

** USNRDL AD-320 (RX)

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ORGANIZATION & MANAGEMENT

[redacted] being present by amounts

strontium is present in less than theoretical ~~amounts with numbers~~ ranging from one to ten percent of yield. This is thought to be true also of other fission products having gaseous precursors. The suggestion is thus raised that the rate of dissolution of the particles in the soil is a factor which should be taken into account. It was pointed out by the Tracerlab investigators that enough debris material is on hand to make experiments on the dissolution and plant uptake using the actual material rather than the corresponding soluble salts. Detectable amounts of strontium in the bones of animals picked up on the Alamagordo site have been reported[+].

The health physics problem, that is the toxicity of ingested strontium requires a relatively small revision. It appears that the toxicity of radium as estimated from Silberstein's data[**] on radium poisoning is slightly in error. This error has resulted from the assumption that all of the poisoning was due to radium, whereas it has since been discovered that a large fraction of the poisoning was caused by meso-thorium. According to Marinelli radium is possibly only 1/4 the toxicity of meso-thorium so that the radium mid-lethal doses should be increased by a factor of from two to four. Since the toxicity of strontium 90 was based on the experimental comparison of the toxicity of strontium 89 with radium in rats and on the absolute toxicity of radium calculated from Silberstein's data the estimated toxicity of strontium 90 must also be increased by a factor of from two to four. In spite of this kind of uncertainty the toxicity of strontium 90 is one of the most certain factors in the entire analysis.

add current Ra data

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Dispersion Density

The data of three groups[♂,♀,σ] is presented in such a manner that absolute estimates of dispersion density may be estimated. These groups are the BNL, KAPL and NRL. The cloud from the Ranger Able shot fired at

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♂ BNL-C-4737, "OBSERVATIONS ON FALL OUT FROM THE NEVADA TESTS, JANUARY 27 THRU FEBRUARY 6, 1951," Weiss and Kuper.

♀ KAPL-559, EVALUATION OF THE EFFECTS OF ATOMIC BOMB DETONATIONS IN THE STATE OF NEVADA ON AIRBORN CONTAMINATION AT KAPL, KNOLLS SITE AND ENVIRONS", Cherubum et al., 7 May 1951.

σ NRL-3866RD-57, "REPORT ON COLLECTIONS OF RADIO-ACTIVITY FROM THE RANGER A-BOMB TESTS", Keene et al., 1 August 1951.

+ UCLA-111, "SUMMARY OF THE RADIOLOGICAL FINDINGS IN ANIMALS FROM THE BIOLOGICAL SURVEYS OF 1947, 1948, 1949 and 1950," J. T. Leitch, 12 February 1951.

** M-1695 "A Survey of the Literature Dealing with the Toxicity and Metabolism of Absorbed Radium," 26 May 1945, Silberstein

 [redacted]

0845 EST on 27 January 1951 was estimated to pass over BNL at 2100 EST on 29 January 2.5 days later. The cloud from Baker-1 shot fired at 0845 EST on 28 January was estimated to pass over BNL at 0600 EST on 31 January, 2.8 days later. The cloud from Easy shot fired 1 February 1951 was estimated to require about 7 days to reach BNL; that from Baker-2 fired 2 February arrived about the same time. The cloud from Freddy missed BNL entirely. Two kinds of observations were made: one on the collection of radio-activity of snowfall precipitation and the other on filters drawing ten cubic meters of air per sample. From the snowfall activity of 1.4×10^{-11} curies per cc it was estimated that about .9 curies per sq. mi. of snowfall activity was brought down with the snow on 31 January (presumably Baker-1 shot). Making some allowance for neptunium content, it appears that the total bomb debris, about a fraction of 5×10^{-9} per sq. mi. was deposited at Brookhaven, or the residuum from about 2×10^{15} fissions per sq. mi. per kT. The filters reported an average activity of around 1800 disintegrations per minute. It is interesting to note that if activity of this density is uniform in the atmosphere and if, furthermore, the precipitation brings down all activity from a height of around 5000 meters that the activity deposited would be about 1.4 curies per sq. mi. The evidence from the material settling out on the ground at times when there is no precipitation indicates that the particles from a height of only ten to fifty meters are deposited.

The NRL investigators report gathering of fission debris from roofs of labs at Denver, Pensacola and Washington, D. C. Their technique is particularly accurate in that the activity of the fission product molybdenum 99 was separated and measured, allowing one to compute that a fraction of 5×10^{-11} per sq. mi. of the debris from Baker-1 shot was precipitated at Denver; 5×10^{-10} per sq. mi. of the Baker-2 shot settled at Pensacola; and 8×10^{-9} per sq. mi. of the Able shot settled at Washington, D. C. While these numbers are valuable the samples were not collected for the most part at places where major fall out occurred.

KAPL reports that dispersion of 3×10^{-12} curies per cc of snow from Baker-1 shot is about 1/6 of that reported by BNL. As an exploratory calculation the following figures are assumed:

1) fall out density is 5×10^{-9} of bomb debris per sq. mi.,

2) that a fraction 10^{-3} of strontium is ingestible ~~per year~~,

[redacted]

[redacted]

3) 200 persons are supported per sq. [redacted]

4) that an ingestion of 10μg. of strontium 90 is a threshhold lethal dose per person, i.e. that the mid-lethal integrated dose is 100μg - years.

There are 55 grams of strontium 90 per standard (20 kT) bomb. This results in 1.5×10^{-5} μg. per person. Therefore one concludes that a number of standard bombs in the order of 10^5 (all dispersing debris in the same manner) would be required to raise the level of toxicity dangerously high.

Another way of putting this same conclusion is to say that dangerous levels of toxicity will reach only at places where the external radiation has reached dangerously high levels. For example, fall out from one of the Greenhouse shots resulted in an integrated exposure of 3r to the personnel attending the tests. This corresponds to a deposition fraction of 2×10^{-6} per mi^2. For a yield of 600 grams of strontium 90 (George shot ?). There would result an uptake of 2×10^{-3} μg /George bomb/person per year. Thus some 5000 detonations made at the same relative position with identical meterological conditions would be required. It would take 5000 of such dispersions to raise the fission product density in the soil high enough to make the ingestion per year of strontium reach threshhold actual level. This would correspond to a total radiation of around 15000r at this site. Thus it appears that dangers from internal and external effects are reached by about the same density of fission products. It is suggested, therefore that the problem of internal poisoning by fission products is part of the Civil Defense, that dangerously high levels of fission poison will be reached only under freak circumstances (such as rainfall from a high density cloud) and that in all cases one's attention to the presence of toxicity will be called by the high level of Gamma and Beta radiation.

Conclusions and Recommendations

The number of standard atomic bombs required to reach lethal levels of debris poisoning is in the order of 10^5 under expected circumstances. This estimation may be 100 too low-- or ≈10 times too high. It is suggested that high levels of toxicity can be discovered through National Civil Defense monitoring.

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It is recommended that panel discussions of this problem as suggested by Dr. Warren be conducted and that such a panel be constituted of persons having experience in theory and experiment of particle formation, debris distribution, plant uptake, and internal toxocity, as well as genetic effects. It is further recommended that the library of pertinent papers assembled for this study be kept intact. It is suggested that the NRL technique of separating one fission product to get at an absolute measure of fission product concentration be adopted. More measurements in the region of 100 to 1000 miles of burst center are needed.

8 November 1951

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