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N. E. Bradbury, Director, LASL

August 4, 1951

(492)

Gaelen Felt, Group J-15

SMALL-PARTICLE CONCENTRATIONS

SD-4962

The concentration near the ground of radioactivity carried by particles in the range from 0 to 5 microns has been estimated, following your request, on the basis of the fall-out model described in my memorandum to Graves (LAB-J-2362). Since a calculation of the general expression for the distribution of activity with cloud height as a function of time is more complex than warranted by the results, the approximation has been made that all of the small-particle activity has fallen from the same height. The simplified expression for the total small-particle activity from an interval of height Δh at $\bar{h}$ is therefore:

$$\Delta A = \frac{1.2 \times 10^3}{\sqrt{\pi}} \left(\frac{V}{D}\right)^{1.2} \cdot \left\{ \int_0^{x_5} x^2 e^{-x^2} dx \right\} \cdot \left\{ \frac{9}{2} \frac{\bar{h}^{7/2}}{h_0^{9/2}} \Delta h \right\} \text{megacuries}$$

where

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V = wind velocity in mph

D = distance the cloud has traveled in miles

$x = \frac{\text{particle diameter "d" in microns}}{\text{mean particle diameter "a"}}$

$x_5 = \frac{5}{a}$

h_0 = cloud height in miles

$\bar{h} = \frac{x_5^2 a^2 D}{7.26 V} \times 10^{-3}$

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The general assumptions leading to the above expression for ΔA are discussed in the memorandum to Graves. The specific values of the parameters for the present estimate are:

V = 10 mph
D = 50 miles
h_0 = 1 mile
a = 75 microns

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The choice of $\bar{h}$, the height from which the 5-micron particles must fall by Stoke's Law in order to be near the ground at D, leads to a conservatively high value for the concentration. The activity carried by particles smaller than 5 microns and contained in the same volume at D should properly be weighted by a factor $h^{7/2}/h_o^{9/2}$ where $h \leq \bar{h}$.

The volume occupied by the small-particle activity at D is assumed to be

$$\Omega = \pi\left(\frac{D}{12}\right)^2 \Delta h$$

Substitution of numbers into the various expressions leads to an average concentration

$$\frac{\Delta A}{\Omega} = 5.13 \times 10^{-7} \text{ microcuries/meter}^3$$

A change of the parameter "a" from 75 microns to 5 microns will increase this estimate approximately by a factor 2×10^3. One should note in addition that at 50 miles the concentration varies as $V^{-2.3}$ for $V \geq 1/6$ mph.

CARLTON FELT
Group J-15

CLF:lh

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