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DATE <u>2-6-58</u>
For The Atomic Energy Commission
<i>W. F. Canale</i>
Chief, Declassification Branch <i>Ju</i>

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dated 1/1/48

April 1, 1948

METEOROLOGICAL CONSULTATION

MARCH 19, 1948

Dr. P. E. Church and the writer met on March 19, 1948 to discuss the "Proposed Problem for Meteorological Consultant" - H. M. Parker to W. M. MacCready, Doc. HW-9170, dated 3/11/48.

Questions involved were:

1. How far can particles roll along the ground?
2. How high can particles rise above the ground?
3. What is the maximum concentration of particles in the air at heights of 2.5, 5, 10, 20, 50 feet above ground, assuming a ground surface concentration of 100 particles per square foot?
4. What is the maximum deposition of particles at distances of 2, 5, 10, 20, 50 miles from the original locus, assuming the above surface concentration maintained for one year?

These questions require to be answered for representative sizes of particles in the range of linear dimensions from 1 micron to 1 mm. If the physical form of the particles is a critical factor, the problem can be initially approached for two idealized species.

1. Natural sand particles as found at Hanford.

2. Pure iron oxide flakes

Dr. Church's proposals are attached.

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It will be noted that he felt that it was more profitable to attempt to trap particles in their locations of deposition than to solve, in detail, the transport problem. The simulated rain experiment has been started.

Later study has shown that approximate solutions are still required. The cost of stabilizing radioactive particles by any proposed scheme is prohibitive, if extended over the total area in which active particles can be detected. It is necessary to know what surface concentration of mildly active particles can be safely left in situ. The original guess by this writer was 0.01 paf. Recent calculations from formulae, incompletely understood by us, have raised the permissible limit to 0.1 paf.

Crudely estimated area of contamination at 0.01 paf or more = 24 square miles
Crudely estimated area of contamination at 0.1 paf or more = 2 square miles

Stabilization costs appear to be of the order of \$500,000.00 per square mile.
If the change in permissible limit is factual,

Estimated saving = approximately \$11,000,000.00

The necessity for an early realistic appraisal of the problem is clear. For this reason, further conferences with the consultant have been scheduled.

H. M. Parker

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METEOROLOGICAL INFORMATION

This document is a copy of the original and is the property of the Atomic Energy Act of 1946, Public Law 49, 601, 10 Stat. 1055, and the provisions of this Act, and is not to be distributed outside the Department of Energy.

In answer to your questions I suggest the following procedures:

1. A thorough literature search to find what published results are in existence that might aid in any and all theoretical and practical aspects of the problem. Such would include studies of:
 1. Shifting of particles on the surface.
 Transport (wind) of sand grains. There is a large literature on this subject in geological papers. I know that some experimental work was done (by the Institute of Meteorology, University of Chicago) on the amount of transport of sand at various levels (close to surface) in relation to the wind velocities at those levels. This study, from data taken in mid-September 1942, included size of particles. I am not sure that the above paper has been published.
 2. Shifting of particles from the surface into the air.
 - a. Wind velocity at various heights above the surface (and rate of change of velocity) with respect to both stable and unstable atmospheric conditions. There is a limited bibliography on this subject; the best I know is Geiger, R. "Das Klima der Bodennahen Luftschichten". (This has been translated by John Leighly, (University of California). However, meteorological instrumentation has not reached the stage yet such that velocity (both vertical and horizontal) can be made in the layers involving the transition from at rest on the surface to airborne.
 - b. Also suggest that search be made in the field of convection and boundary layer problems. See New York Academy of Science Publication No. 7 on "Convection in the Atmospheric Ocean". There are a number of contributors to this publication and each paper has its own bibliography. (I have several copies of this publication).

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- c. Also suggest that literature on the Benard Cell (convection) may be helpful.
3. Effect of size particle on transport through nose.
Not in my field, but suggest that undoubtedly the Chemical Warfare Service, Army Chemical Center, Maryland has data which will be of aid.
 4. Dilution with increasing distance of horizontal transport.
To my knowledge, still the best paper on this problem is the report of work done on this project. (See "Report of Meteorological Section of Work, May 1943 to August 1944"). This report indicates that under unstable conditions the dilution (for airborne aerosols of negligible terminal velocity) is so rapid, with increasing distance from source of pollutant, that it is inconceivable that there could be any deleterious concentration develop at a distance of 2 miles from a "hot" concentration on the ground which later becomes airborne. I believe that we found dilution was of the order of magnitude of 10,000 in 2,000 feet from the source. With stable conditions no particles on the ground will ever become airborne. With wind of 20 mph or more, mechanical turbulence will transport particles from the ground into the air. Under this condition dilution is rapid also, though not as rapid as under unstable conditions.
 5. Altitude to which particles may rise.
After a surface particle becomes airborne it may rise to the altitude reached by ascended air columns, minus the distance the particle falls while in the ascending air. Particles of negligible rate of fall could ascend 10,000 to 15,000 feet in summer (thermal convection) and perhaps, though rarely, 2,000 to 3,000 feet, in winter (mechanical turbulence).

II. In attacking this problem let a number of assumptions be made.

1. That the number of particles being discharged will decrease to the vanishing point within a few months.
2. Because of (1) it is not likely that a comprehensive, large-scale, experimental procedure need be set up yet, if ever.
3. That the particles present, and those yet to fall, must be removed from the surface in such a manner that they do not or cannot become airborne.
4. That the cheapest, most rapid method of fixing in position those particles which are present, and yet to fall, be employed.
5. That the particles may be removed by washing into the ground deep enough so that they will not become airborne.
6. That natural, artificially-induced or simulated rain may wash the specks deep enough.

III. In view of the above assumptions it would be well to conduct some trials as to how much and what rate of fall of rain will bury the particles to a "safe" depth. For this I suggest the method outlined below.

1. Lay out several small plots, approximately 25 square feet or so, count the number of surface particles on each one, and then sprinkle each plot with a different amount. Let them receive the equivalent of 1.01", 0.05", 0.10", 0.25", 0.50" of rain each plot receiving the water at a uniform rate of 0.01"/5 minutes. Recount the number of surface particles. Such a trial must be done in as short an interval as possible, upwind from the stack, to prevent new particles falling on the test plots.
2. If there has been any change in the number of surface particles in any of the above plots, then lay out several other plots, count the number of surface particles, sprinkle each plot the same amount (depending on the choice used from the results of Part 1) at different rates of fall; for example 1, 2, 5, 10, and 20 times the rate used in Part 1. Recount the number of surface particles again. The amount of simulated rainfall can be determined by setting a rain gauge at the edge of each plot and allowing it to receive the same amount and same intensity of (precipitation as the test plot is receiving).

Possible Solution

Because particles fall at all hours, a receiving mat in the form of grass in a continuous turf, kept green (blades erect) over the area involved might be an immediate solution. Most specks would fall to the bottom of the blades where they would not become airborne. To keep the grass green would involve either ditch irrigation or a sprinkler system (the Fire Department could do the latter). The grass should not be cut. Autumn rain and winter rain and snow might further aid in "rooting" the specks.

P. E. Church

Checked and signed H. P. L.
in the presence of P. E. Church.

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