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AEROSPACE NUCLEAR SAFETY

EVALUATION OF MICROSCOPIC-SIZED GRAPHITE AEROSOL
FROM A ROVER REACTOR DESTRUCT TEST JUNE 1965

D. R. Parker, 3311

PRIME CONTRACTOR TO THE
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ALBUQUERQUE, NEW MEXICO
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D. R. Parker, 3311
Sandia Laboratory, Albuquerque

December 1965

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Approved by:

W. H. Kingsley
W. H. Kingsley, 3310

V. E. Blake
V. E. Blake, 9310

S. P. Bliss
S. P. Bliss, M.D., 3300

Alan Pope
A. Y. Pope, 9300

ABSTRACT

~~This report covers~~ the methods used to evaluate the environmental health aspects of particle makeup and dispersion following the destruction of a full-scale model of a ROVER-NERVA reactor. It describes the methods used to collect airborne samples and the methods of analyzing the microscopic-sized particles. The total number and the particle-size distribution of the aerosol are determined.

(see summarized.)

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EVALUATION OF MICROSCOPIC-SIZED GRAPHITE AEROSOL
FROM A ROVER REACTOR DESTRUCTION TEST
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Introduction and Summary

The use of a ROVER/NERVA space propulsion engine for space flight must be preceded by an acceptable evaluation of the safety criteria. These safety criteria are dependent on a knowledge of the debris size, velocity, and distribution when the reactor is disposed of after flight operation. This report describes only the techniques used to collect, size, and analyze the airborne debris resulting from the destruction of a full-scale ROVER/NERVA mockup engine. The joint AEC/NASA Space Nuclear Propulsion Office requested the joint participation of Aberdeen Proving Ground and Sandia Corporation in a destruct test of a full-scale mockup ROVER/NERVA space propulsion engine. This test was scheduled and completed at the Army's Aberdeen Proving Ground in June 1965. This destruct test was performed to provide complete debris data as well as airborne debris data which will allow the safety analyses to be completed on the space engine.

Air sampling of the airborne debris generated by the explosive destruction of a mockup ROVER/NERVA space propulsion engine, partially fulfills the Sandia Corporation responsibility to the AEC for the safety analyses of all nuclear materials to be used in space.

The air sampling was performed with 24 midget impingers surrounding the mockup engine. The midget impingers were suspended at 30, 50, and 70 feet above the ground and at 100 feet from ground zero. This array formed a cylinder 200 feet in diameter by 70 feet high and collected airborne particles for a maximum time of 37 seconds.

The analyses of the collected microscopic particles within the airborne cloud show that (1) 80 percent of the airborne particles are between 0.5 and 3.5 microns in diameter, (2) the uranium particles contained within the core are not carried in the airborne cloud, (3) the air sampling of a multijet debris cloud does not produce reliable data as to the concentration of particles in the cloud, and (4) a minimal environmental health hazard may be expected from the uranium in the core.

Test Setup

The full-scale mockup of the ROVER/NERVA space propulsion engine which was destroyed is shown in Figure 1.

The mockup engine destroyed consisted of a natural uranium core, graphite reflector, aluminum reflector, magnesium reflector segments, aluminum control drums, and a pressure vessel. The mockup was destroyed with four simulated 105-mm projectiles, each containing 26 pounds of DATB, placed parallel to the longitudinal axis at the geometric midpoint of each quadrant.

The airborne debris comes from the destruction of the core and graphite reflector. These two components weigh about 3150 pounds.

Figure 1. Test model reactor in test configuration. The unit measured about 9 feet high and 60 inches in diameter.

The atmospheric samples were collected by means of midget impingers suspended from overhead cables (Figure 2). The cables were held about 80 feet above and around ground zero. A total of 24 midget impingers were secured to 8 drop lines from the overhead cables and located so that samplers were fixed at 30, 50, and 70 feet above the ground. Each line of impingers was located 100 feet from ground zero; the resulting array formed a cylinder of samplers 200 feet in diameter and 70 feet high. This 360-degree coverage would allow a representative sample to be taken in a light and variable wind.

The individual lines were suspended through pulleys on the overhead cable so that the array could be raised and lowered as necessary. Each line was held in place at ground level with a 22-foot length of 1-1/4-inch steel pipe. The pipe had a welded loop on one end for the line; the other end of the pipe was slipped over a 3-foot stake in the ground. The pipe provided the necessary weight to hold the array line taut and acted as protective conduit for the pump motor cords.

The midget impingers were filled with 10 cc of 1-percent ethanol collecting solution, and were driven with small 110-volt AC vacuum pumps (Gast miniature pump, 0330-V102A-15). The pump and impinger were housed in the type of wooden box shown in Figure 3. This sampler is not wind-direction dependent, so no wind-orientation device was used.

Figure 2. Schematic of sampler array. The array of airborne dust collectors was suspended from cables around ground zero. The letters refer to the line of samplers and the numbers refer to the elevation of the sampler.

Figure 3. Sample collector, showing pump and midget impingers. Power was supplied from generators on the ground and the airflow rate was adjusted by the by-pass valve on the side of the box.

On the day of firing, the impingers were filled with filtered collection solution and their flow rate adjusted to draw 2.8 liters per minute. At the time of firing, an 8- to 12-mph wind blew across ground zero from a SSE direction. This velocity was recognized to be at the upper limit of acceptability for atmospheric sampling.

The sample array operated from 10 seconds before firing to 37 seconds after firing, when the cloud was observed to expand to about a 250-foot radius. It was then carried by the wind in a northerly direction. Sample collectors on the north side were enveloped in the cloud for the full 37 seconds. The samplers in the other quadrants sampled the cloud for a proportionally shorter time.

Analysis

Photographic

A series of sequential photographs were made with two high-speed cameras located on the south and west side of ground zero. The photographs made at intervals of 2 seconds, starting at zero time, allowed both a view of the cloud as it developed and a view of the sampling equipment to show time of arrival and duration

2 of the cloud over the samplers (see Figure 4). The photographs were also used to calculate the wind velocity, to estimate the size and density of the cloud, and to determine which samplers were enveloped in the cloud.

Atmospheric Sampling

Samples of the atmosphere at the time of the destruction test were collected in 23 of the 24 samplers in the array. Twenty-one of these were finally analyzed and their results used in this report (one sample was lost in the laboratory, and the results of one did not fall within the range of statistical probability).

A study of the sequential photographs revealed that nine samplers were never enveloped in the cloud of graphite particles. The average dust concentration calculated from the results of these samples indicated a background of 6.06×10^6 particles per cubic foot of air (Table I). This high concentration of atmospheric dust is reasonable in view of the natural conditions existing at the test site. The area around ground zero (700-foot radius) had been scoured of all vegetation during the preparation of the test site.

TABLE I
Background Dust Concentration

<u>Sample No.</u>	<u>Total Particles in Sample</u>	<u>Particles per Cubic Foot</u>
C ₁	1.6×10^5	2.64×10^6
D ₁	2.10	3.36
D ₂	3.35	5.35
E ₁	5.15	8.24
E ₂	2.64	4.22
F ₁	3.84	6.14
F ₂	3.87	6.19
G ₁	6.08	9.74
G ₂	5.41	8.65
Average	3.79×10^5	6.06×10^6

The photographs showed that samplers were in the cloud for times ranging from 4 seconds on the upwind side to 37 seconds on the downwind. As Table II shows, the variation in sampling time is considerable. Compensation for the wide variation in the volume of the cloud actually sampled by each sampler was made when the average concentration for the cloud was calculated. The samplers which collected the greatest volume were given a proportionally greater

Figure 4. Destruction of ROVER-NERVA reactor model

weighting in the overall determination. The average concentration of 54.9×10^6 particles per cubic foot is difficult to apply to the total volume of the cloud for two reasons: wide variation in concentration between samples, and the irregular shape of the cloud. The cloud did not form a true geometrical shape to which a model could be applied. The five major arms or jets extended far beyond the range of the photographs; they were not sampled and were not included in the estimation of the cloud size. For purposes of calculation, based on information from available photographs and from eye-witness accounts, it was assumed that the greatest amount of the fines were in the area that formed roughly a rectangular shape around ground zero and then expanded as it was carried downwind. Table III indicates the approximate growth of the cloud during the first 20 seconds after detonation.

TABLE II
Concentration of Graphite Cloud

<u>Sample No.</u>	<u>Particle Count Less Background</u>	<u>Particles per Cubic Foot (c)</u>	<u>Sample Time (st)</u>	<u>Weighted Concentration</u>
A ₁	14.8×10^5	176.0×10^6	5 sec	7.85×10^6
A ₂	7.1×10^5	21.3×10^6	20 sec	3.81×10^6
A ₃	64.4×10^5	103.0×10^6	37 sec	33.99×10^6
B ₁	13.9×10^5	13.9×10^6	6 sec	0.74×10^6
B ₂	2.1×10^5	7.9×10^6	16 sec	1.13×10^6
C ₂	0.2×10^5	2.9×10^6	4 sec	0.10×10^6
D ₃	0.2×10^5	2.0×10^6	6 sec	0.11×10^6
E ₃	1.1×10^5	16.2×10^6	4 sec	0.58×10^6
F ₃	1.38×10^5	18.8×10^6	6 sec	0.74×10^6
H ₁	0.8×10^5	11.8×10^6	4 sec	0.42×10^6
H ₂	10.3×10^5	152.0×10^6	4 sec	5.43×10^6

Equation for time weighting samples:

$$\bar{c} = \frac{(st)_1(c)_1 + (st)_2(c)_2 + \dots (st)_N(c)_N}{\sum_{1}^N (st)}$$

$$\bar{c} = 54.9 \times 10^6 \pm 53 \times 10^6.$$

TABLE III
Estimation of Cloud Dispersion

<u>Time (sec)</u>	<u>Height (ft)</u>	<u>Width (ft)</u>	<u>Length (ft)</u>	<u>Volume (ft³)</u>
0 + 2	30	250	250	18.7 x 10 ⁵
+ 4	35	250	300	26.2 x 10 ⁵
+ 6	50	250	350	43.7 x 10 ⁵
+ 8	50	250	350	43.7 x 10 ⁵
+ 10	50	250	375	46.9 x 10 ⁵
+ 12	60	275	400	66.0 x 10 ⁵
+ 14	60	275	425	70.2 x 10 ⁵
+ 16	60	275	450	74.0 x 10 ⁵
+ 18	60	300	475	85.5 x 10 ⁵
+ 20	60	300	500	90.0 x 10 ⁵
Average				5.65 x 10 ⁶

Based on the average size of the cloud from this model, the total number of airborne particles is estimated to be 3.11×10^{14} particles.

Particle Counting

The graphite particles in the aqueous suspension were returned to the laboratory where they were diluted and deposited on a membrane filter. The filter was placed on a microscope slide and made transparent with a prepared fluid which had a refractive index of 1.5.

The particles were sized and counted in one operation by moving the membrane filter slide so that the particles appeared to move through a calibrated gate projected on a light microscopic field of view.² As each particle passed through the scale on the gate, its maximum horizontal diameter was recorded in one of three major divisions: 0.5 to 3.5 microns, 3.5 to 10 microns, and greater than 10 microns. There were no particles larger than 20 microns. The number of particles counted over a measured distance of the filter, times the width of the gate, gave the concentration on the filter per unit area. From the average of five such counts at different unit areas on the filter, the total concentration in the sample was calculated.

The total number of particles in each sample was derived from the following equation:

$$\text{Particles in sample} = \frac{Pc \times Vs \times D \times 960}{Gw \times Lt}$$

Pc = particles counted

Vs = volume of sample

D = dilution factor

960 = area of filter paper (mm²)

Gw = gate width

Lt = lineal distance traveled to make count.

Particle Sizing

The results of particle size analysis are shown in Table IV. The percentages shown on the table are for the percent of the particles in that size group out of the total number of particles in the sample. The remarkable similarity in the particle size distribution between the background dust and the graphite aerosol can be partially explained because the midget impinger is most efficient in the capture of particles in the size range of 0.5 to 20 microns.³

TABLE IV
Particle Size Distribution

Sample No.	Percent of Particles in Size Ranges		
	0.5-3.5 Microns	3.5-10 Microns	10-20 Microns
<u>Background</u>	<u>(%)</u>	<u>(%)</u>	<u>(%)</u>
C ₂	86.6	12.9	0.5
D ₁	80.6	19.0	0.4
D ₂	84.6	14.3	1.1
E ₁	81.2	17.7	1.1
E ₂	79.5	19.8	0.7
F ₁	73.6	24.0	2.4
F ₂	78.1	20.7	1.2
G ₁	78.2	19.8	2.0
G ₂	82.9	15.5	1.6
Median	80.6	19.0	1.1
<u>Graphite Cloud</u>			
A ₁	85.2	14.3	0.5
A ₂	82.8	13.1	4.0
A ₃	81.5	16.9	1.6
B ₁	94.0	5.5	0.5
B ₂	77.5	22.5	0
B ₃	74.3	21.2	4.5
C ₃	80.6	17.8	1.6
D ₃	79.9	19.0	1.2
E ₃	74.4	23.7	1.9
F ₃	65.6	31.3	3.6
G ₃	81.1	16.9	2.1
H ₃	79.0	20.8	0.2
H ₃	76.1	21.0	2.1
Median	79.9	19.0	1.6

The electron microscope photographs show that the particles in the 0.5- to 3.5-micron range have no characteristic shape. The platinum shadowing in Figure 5 shows the particles range in shape from platelet to nearly cubic in form. Since only limited data was available, a model of an average-shaped particle was not made. A correlation between particle size, number of particles and the total weight they represent was not made.

Chemical Analyses

Analyses of the composite airborne samples were made for the presence of uranium using (1) a gamma-scan in a low background multi-channel analyzer and (2) a fluorometric method. The results of both methods were negative for the detection of uranium. The minimum level of detectability for the fluorometric method of analysis was less than 0.2 microgram per sample. The atmospheric samples represent a total volume of the cloud of 0.248 cubic foot and a maximum atmospheric concentration of less than 0.028 mg of uranium per cubic meter.

Conclusions

The atmospheric analysis of the aerosol resulting from the destruction of a graphite core from a reactor can be made with reasonable reliability only if ideal sampling conditions exist at the time of the test. Natural conditions such as high wind velocities and bare earth around the test site tend to increase the background dust concentrations and limit the reliability of the sample data.

The configuration of the aerosol cloud after the blast is of great importance in determining the effectiveness of the array of samplers. The multijet cloud of this test did not lend itself to any feasible method of sampling a truly representative portion of the cloud. The samples taken from the main body of the cloud close to ground zero collected only those particles which did not have a mass-velocity ratio great enough to be projected beyond the 100-ft radius.

The size of the airborne particles was measured to be well within the respirable range; however, the very low concentration of uranium in the airborne material minimizes the environmental health hazard which would be expected during a test of this type.

Figure 5. Electron micro-photograph of graphite particles. Note the irregular shape of the 1-micron particles. (Scale $\overline{1\mu}$)

LIST OF REFERENCES

1. Evan Campbell, from an unpublished report, Los Alamos Scientific Laboratory.
2. "Procedure for Evaluating Contamination," APR 743, Society of Automotive Engineers (August 8, 1962).
3. Frank A. Patty, Industrial Hygiene and Toxicology, Vol. 1 (New York: Interscience Publishers, 1958).

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