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February 15, 1966

RS 3415 45805

Mr. William N. Caudle
Sandia Corporation
P. O. Box 5800
Albuquerque, New Mexico

Attention: Organization 3428-3

Subject: Field Observation
Operation Sunday

Dear Mr. Caudle:

This letter is written to convey our observations of the impacts which were part of Operation Sunday. The first, dropped from a nominal 9,500MSL, will be called Experiment 1. The second, dropped from a nominal 16,500MSL, will be called Experiment 2. The actual drop heights, fall times, impact velocities, plan locations, documentary photographs, and airphoto coverage are being accumulated by others; and, because they are not yet available, will not be included here.

DOE 6(3)

Some Observations:

Figures 1 and 2 attached, are scaled sketches of our observations of Experiments 1 and 2 respectively. Both units impacted in gravelly sandy soil which is described in detail on the figures.

Experiment 1, Figure 1, hit near a hummock of dry root-bound dune sand, covered by mesquite. The hummock slightly altered the shape of the crater; but, in our opinion, the hummock had no other effect on Experiment 1.

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DEPARTMENT OF ENERGY DECLASSIFICATION REVIEW	
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Gravels and small rocks, up to 4 or 5 inches in diameter, had been broken by the impact.

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The nose ring had sheared off, but no other structural damage was apparent in the unit at the time of recovery. The crater for Experiment 1 was similar to the crater for Experiment 2. For this reason, the craters will be described in detail further below.

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Experiment 2, Figure 2, hit in a small, flat, dry-wash between sand hummocks.

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The nose ring had sheared off, but no other structural damage was apparent in the unit at the time of recovery.

Description of Craters:

The craters for these experiments (see Figures 1 and 2) were typical for this type of impact in all but the softest or hardest of soils.

The crater and its rays (ejecta) appear darker than the adjacent ground surface immediately after impact. The darker color is due to the higher moisture content of the expelled material, which comes from just below the drier ground surface. Immediately after impact, the crater and its rays are easily visible to an untrained observer within perhaps 20 feet. From previous experience, we can state that the crater and its rays would be strikingly visible to an airborne observer or on airphotos, immediately after impact.

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Within a few hours, due to drying, the crater and its rays blend with the adjacent drier ground, and are thus difficult for the untrained eye to detect. Within one day, the coloration of the crater and its rays will be indistinguishable to the untrained eye. Therefore, after one day, the crater shape will be the only diagnostic feature of the impact point. These shape features will now be discussed.

The rays are raised only about 1/8 inch above the adjacent ground surface. The lip, Figures 1 and 2, is only 1 or 2 inches high and is very difficult to see as a relief feature. It is unlikely that either the rays or the lip could be used as a guide to the crater location.

The crater walls are steep, at a slope of about 45 degrees. The walls grade gently into the floor to form a soft, smooth, bowl-like depression whose width is about 3 or 4 times its depth. The smoothness and lack of sharp relief make the depression difficult to see and easy to destroy by careless traffic. For example, shadow detail will be of little help at midday. Moderate amounts of adjacent foliage could easily hide a crater of this type.

The material in the crater is loose and fluffy. The material will not support a man, who would easily sink in above his ankle.

It is important to point out that the impacting object is completely buried beneath the crater.

DOE b(3)

Penetration:

The penetrations for these experiments are given in Figures 1 and 2, and are discussed above.

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Applicability of These Experiments:

Exceptions
are saturated loose sands, soft clays (shear strength less than 500 psf), and stiff-fissured clays. In the former two cases, the crater would be very small, and the penetration would be greater. In the latter case, the blocky nature of the rays and the floor material could be detected by the trained eye.

We would not expect distinct craters to form in rocks or very rocky soils.

Suggestions For Search:

Because we are not aware of the search techniques which have been used, some of the following suggestions may be redundant. All of the following suggestions should be made Standard Procedure for future accidents of this type.

Exhaustive airphoto coverage is required. We recommend stereo strips, with at least 60 percent overlap, flown at perhaps 1,000 feet above terrain. The films to be used should include normal-contrast BW, high-contrast BW, color, and infra-red. This coverage should be obtained as soon as possible. The photos should be studied jointly by airphoto interpretation experts and experts in ground impact.

The magnetometer
is easier to use, but depends on the magnetism of the object. For example, a common metal detector might be quite useful since the object is likely within 5 feet of the surface. If the unit is not magnetic, an adaptation of the gravimeter could probably be made for speedy search.

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In promising areas, simple probing with a metal rod is recommended. The fall-in over the unit is quite soft, and can easily be penetrated by a ½-inch diameter steel rod (the units of this experiment were located by this technique).

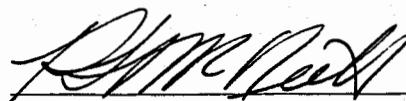
All traffic, foot and vehicular, should be severely restricted: typical craters, such as those of these experiments, can easily be destroyed by careless foot traffic and would certainly be destroyed by vehicle traffic. Permissible traffic channels should be set only after close prior inspections by experts in ground impact. Above all, no defoliation at all should be done until the areas have been cleared by ground-impact teams: it is probable that normal craters would be destroyed or filled in by the defoliating crews.

The search should be conducted by experienced ground-impact teams. In no case should large bodies of inexperienced men be used for ground search: they will undoubtedly miss the crater, and they will likely destroy it also.

Please call if we may be of further help in the interpretation of these experiments.

Very truly yours,

WOODWARD-CLYDE-SHERARD & ASSOCIATES



Robert L. McNeill
Special Projects Division

RLM:jmh

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Distribution:

M0659A Elva Barfield, FOIA Officer/OPA; DOE/AL

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Figure 1

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Figure 2

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