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A. C. Graves, J-Division Leader — July 17, 1953

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From T. Konkle

COMMENT ON THE PATE-PALMER REPORT TO CJTF-7 DATED 30 JUNE 1953

J-19232

I. Weather Systematics:

a. The discussion of the three classes of weather situations which occur in the Marshall Island area is the most definitive which has been seen on the subject. From a meteorologists point of view his most challenging problem would apparently be to foresee the transition say from the standard trade conditions to either of the other types or back to the trades in terms of rate of development, position and ensuing weather sequences and to relate these to what he should know about the operational requirements of the test experiments. Judging by the number of times the area weather was predicted incorrectly (shot or no shot), one wonders whether the authors understood the systematics of these situations at the time as well as they do now.

b. By the brevity of its mention, the report appears to underestimate the importance of being able to predict accurately the transient effects of the so-called "Easterly Wave" upon the standard trade situation. It also does not mention at all any of the consequences of a possible diurnal variation of the weather which, under conditions of atmospheric instability, might cause (shot or no shot) an unfavorable deterioration in the area weather after early morning. Such a deterioration might be characterized by the growth in number and height of convection cells as the energy input to the earth increases with the sun's approach to the Zenith.

c. The report properly points out in terms of the weather systematics described that mutually exclusive conditions could be required and could be satisfied only with a low frequency probability. If the examples used were chosen from the author's experience, it would appear that the time to have demonstrated this incompatibility was sufficiently in advance of an operation for the proper evaluation and change in planning to be made. For example, although South or South-easterly winds from the surface to high altitudes might be the most desirable from the standpoint of avoiding hazardous fall-out conditions, the fall-out phenomonology of large yield weapons appear to be so different from 100 KT tower shots that it might be worthwhile to attempt to reconcile the fall-out hazard with normal trade conditions. Finally, since some test operations continue for many hours after zero time, it would appear that a most important meteorological requirement would be a reliable prediction of the sequence of area weather changes for at least an eight-hour period, a requirement which does not appear to be incompatible with anything but the skill of the forecaster.

In this memo, HAL agrees that most of the MIKE debris was carried into the stratosphere. Debris was observed to fall from the stratospheric cloud.

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II. Cloud Rise Dynamics:

a. In their discussion of vortex ring formation, cloud cap, and possible spiral structure in the stem, the authors have ignored an excellent analysis of the subject by W. W. Kellogg in the GREENHOUSE Report, Annex 4.1B. The present discussion of the toroidal circulation initially established in the hot gases from an airburst in Nevada accounts nicely for the rise of the dirt column through the torus which is observed to happen if the height is scaled to the yield properly. If the theory outlined were followed to its logical conclusion, the acceleration of the circulation would have to approach zero as the cloud approached altitude stability and T became equal to T and T . Provided there were no negative accelerations acting upon the cloud masses, the statement about the attainment of a maximum vertical velocity at the moment of cloud stabilization would be credible. The authors have ignored, however, the deceleration of rotational velocity which must occur to conserve momentum as the torus rises and expands in radius by adiabatic expansion and the entrainment of ambient air. The latter factor must overwhelm any integrated acceleration effects due to temperature difference because the clouds even from "isolated" air bursts with initially well-established toroidal circulations are in fact observed to decrease in rotational velocity as they approach altitude stability and do not exhibit the "plume" phenomonen held to be a consequence of the present theory.

b. In contrast to airbursts, the early stages of a tower or surface burst are observed to have a very turbulent structure. Only after a considerable time in the course of cloud rise is a general toroid-like structure established. It does not seem admissable to apply a theory which fits the boundary conditions of an airburst to an entirely different set of boundary conditions. At the height at which the general toroid-like circulation becomes established the accelerations causing it, as given by the theory, must be small since T is approaching T and T rapidly. It seems likely that other forces, such as "drag" and differential lift forces, induce a general circulation which is superimposed upon the evidently highly turbulent interior circulation of the rising ball (see photos). Such forces, of course, would die out as the cloud reached altitude stability with decreasing velocity, the horizontal components of the rotational and turbulent motion remaining to account for the lateral spread of material.

c. The theoretical picture used by the author to account for the "plume does not fit the observed facts. According to this picture and the statements made, the "plume" ought to be symetrical and rise from the center of the main cloud mass. In the one photo shown, it appears narrow in dimension and roughly in the center. In other photos taken from different azimuths, however, it is not in the center nor does it have symmetrical dimensions. In none of these photos does it exhibit any evidence of a streamline structure which would appear to be required by the theory presented. Its appearance in all cases is rather that of a portion the main cloud which has simply continued to rise because of a difference between its temperature and that of its environment. The same phenomenon with a similar appearance has been observed in Nevada tower shots where a large mass is associated with the bomb structure.

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Because the turbulence in the ball clearly has a cellular structure, it is easy to account for the continued rise of a portion of the cloud on the basis that it represents an internal cell which has not cooled as rapidly as the rest of the cloud, either because it has not entrained air at the same rate during its rise or contains material which was heated more highly than the rest or had a higher heat capacity. This view is consistent with the fact that no major subsidence is observed in cases where plumes are formed. On the other hand, a plume formed according to the mechanism of this report must subside, assuming that a high vertical velocity with zero upward acceleration does exist in the center of the cloud at the moment of its vertical stabilization. Air carried aloft in this way will undergo an increas ng negative acceleration as adiabatic cooling occurs and its density relative to the external atmosphere increases. When upward motion ceases, it will subside until its density attains equilibrium with the atmosphere.

Evidence from High Yield Detonation:

a. Weather Effects:

Apart from the purely local effects of shock-wave passage through moist atmospheric layers or the effects of ionizing radiation on nearly-saturated moist layers as observed in Nevada far back as Tumbler-Snapper, a large explosion does not appear on the basis of extensive observation to induce long term systematic changes in the weather. It is possible that local or "internal" convection might occur within a large mass of airborne material due to increased absorption of thermal energy from sunlight. There would appear to be no reason, however, for a larger number of convection cells (towering cumulus) to be formed in greater number near the explosion than at a distance. In fact, within the shadow of the overhanging cloud such cells should be less frequent due to a decrease in the thermal energy reaching the surface.

The general instability of the atmosphere resulting in towering cumulus formation was observed prior to Mike Shot. After the explosion this situation did not immediately change for the worse but did so gradually as the day passed in a manner which would have been anticipated in the absence of the explosion. The reconnaissance report which is included in the present document denoting "practically clear" weather is not consistent with the record of local weather observations for the three hours preceding shot time. This record indicates 7/10 cumulus with tops at 1600 feet present at 0500, 0600, and 0700, with occasional lightening in clouds at 0500, and 0600 and variable rain showers at 0600. The surface weather was evidently in a disturbed condition before the shot.

There appeared to be no weather changes associated with King Shot. A disturbance ~~distribution~~ seemed to move into the general area several hours after burst and as the sun became higher cumulus convection cells grew over a wide area. In spite of the report's statement that conditions were superior for convection cell formation to Mike Day there was none of the towering cumulus development which on Mike Day gave clouds with tops at least at 90,000 feet located hundreds of miles from zero point.

b. Cloud Observations

The observations reported for Mike Shot heights and dimension are in disagreement with other data which unambiguously indicate that the bulk of the cloud rose to approximately 100,000 feet at the top with a segment attaining the vicinity of 125-130,000 feet. The lateral dimensions continued to grow to about H + 45 minutes and attained a diameter in the neighborhood of 200 miles. It is believed that the vaporous undercloud which spread out below the upper cloud at an altitude of 40 - 45,000 feet obscured the main cloud from the observers and caused them to attribute a lower and incorrect altitude to the main cloud. There is ample photographic evidence that a large part of the upper cloud extended well into the stratosphere and that the plume formed a trivial fraction of the total material so elevated.

The approach of the whole report is felt to be based on too few observations by observers with too little experience. The result has been the creation of a theoretical picture and conclusions based on this picture which are not supported by the facts. Perhaps the worst point at which its conclusion deviate from the facts is its postulate that little radioactive material should be found at the altitude attainable by the sampling aircraft. Relatively high radiation intensities were found during the course of the whole sampling period falling from 600 R at H + 2 hours to 3 R/hr at H + 6 hours by virtue of decay and dispersion. The area over which this material was spread had a diameter of approximately 80 miles or about one-third the diameter of the cloud above the sampling altitude. Transmitted light from both the upper cloud and the cloud at sampling altitude indicated a relatively uniform and extensive distribution of primary bomb material.

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