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The Commanding General
Air Research and Development Command
Post Office Box 1395
Baltimore 3, Maryland

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THIS DOCUMENT CONSISTS OF 3 PAGE(S)

Attention: RDDN



Dear Colonel Isbell:

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Thank you for your letter of 12 January. Please excuse the delay in answering it; I am in the middle of moving our research project to the Hawaiian Islands and have not, until now, had an opportunity of giving undivided attention to the very important topic raised by your letter. The priority of the topic, indicated in the second paragraph of your letter, justifies both the informal style of my answer and its length. I feel that I should explore as thoroughly as possible those points which, in the interests of brevity, had to be omitted from my report.

First, I must give the positive evidence which led me to assume that the mushroom cloud lay in the troposphere. Within a few minutes of the detonation (I forgot how many now, and I have kept no notes) we made a vertical angle measurement on the edge of the mushroom of 92°, in other words, we were at that time just under the edge of the canopy. The details of the cloud overhead were very plain. It consisted of liquid water, at least in all parts which were visible; the edges were hard and bright and, in places where fragments were detached, it had the structure of altocumulus mixed with altostratus. Since it remained in this condition for a considerable time, long after any intrinsic upward motion due to differences in temperature between it and its environment had ceased, it could not have had its base at 60,000 feet but rather somewhere in the layer 25,000-45,000 feet. At 60,000 feet, the temperature in the cloud would be very much below -40° C and the whole cloud would consist of ice particles. The appearance would be quite different from that observed. I watched the mushroom cloud for almost two hours after the explosion; the various parts of the deformed cloud were readily distinguished from natural clouds, which formed in the vicinity, by their colour, characteristically pink or, rather peach-coloured. Although some parts of the tops of fragments had been transformed to cirrus, most of the derivatives of the cloud assumed typical tropical altostratus form. Moreover, rain continued to fall from parts of the cloud, and, in profile and except for the colour of the parent cloud, the rain looked similar to altostratus precipitation typical of the Marshall Islands in disturbed weather. In addition to this, both Major Stopinski and myself had observed certain fragments of natural cirrus (certainly lying within the troposphere) which were almost overhead just before the explosion. The advancing edge of the mushroom cloud stopped in such a position as to underlap part of this natural cloud. Several competent observers agree with me in saying that the edge of the mushroom was lower than the natural cirrus, which was, indeed, relatively undisturbed by its advance. So much for the gross observable structure of the cloud.

Now we come to another kind of evidence. The winds for the day are very well known up to and above the tropopause. If the bulk of the cloud had been in the stratos-

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1ST REVIEW DATE: <i>07-02-97</i>	DETERMINATION (CIRCLE NUMBER(S))
AUTHORITY: <input type="checkbox"/> AOC <input type="checkbox"/> EADC <input type="checkbox"/> ADD	1. CLASSIFICATION RETAINED
NAME: <i>P. Brown</i>	2. CLASSIFICATION CHANGED TO: _____
2ND REVIEW DATE: <i>10-31-97</i>	3. CONTAINS NO DOE CLASSIFIED INFO
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the observer, there will be a very rapid increase in vertical angle, which if interpreted as vertical movement, will lead to gross over estimates in the height of the top. This error was made with GEORGE shot during Operation GREENHOUSE. On the basis of the mis-interpretation the height of that cloud was announced as over 85,000 feet, whereas the true height as measured from photographs long afterwards was considerably less than this. Owing to the enormous lateral extent of the MIKE cloud the chances of this kind of mis-interpretation have been greatly enhanced. For example, if I had made this interpretation of our own angle measurements, crude as they were, I would have had to conclude that within a very few minutes after the detonation, the mushroom cloud had reached to an infinite distance from the surface of the earth.

Even radar measurements are not free from this objection, since it is difficult to be sure what part of the cloud is being measured: is it the active plume or is it the edge of the mushroom cloud? Is it perhaps a knot of reflecting material buried somewhere in the cloud? I cannot answer these questions, since the original data are not available to me, but I suggest, in view of the importance of the topic, that they be asked. The only reliable way of directly measuring the cloud height is to triangulate all parts of the explosion product by means of a network of special cameras. The difficulty with MIKE was that no one seems to have anticipated the great size of the final cloud or the fact that it would set up so much secondary natural cloud and precipitation that complete triangulation would be difficult - it is hard to recognize the same parts of the cloud different photographs. This apart from the fact that very special wide-angle lenses ought to be used on all cameras, and that this, apparently, was not done.

I venture now to suggest certain theoretical reasons why the mushroom cloud lay in the troposphere and not in the stratosphere, chiefly because I think these may help in solving your operational problem. It seems to have been generally assumed that the MIKE cloud differed in no essential way from that formed by conventional shots, except, of course that it was much larger. My own hypothesis on this is, that MIKE was so large that qualitatively different geophysical effects were produced and that it is erroneous to extrapolate from the Nevada shots, say, or even from previous tests in the Marshall Islands. A conventional air-drop, for example, results in the formation of a fireball, which, after being transformed into a ring-vortex, ascends to the tropopause. The vortex ring or mushroom head consists of original bomb material plus water, etc., entrained into it by turbulent mixing; the stem is largely secondary although it too contains radio

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information on this.

As you can see, the evidence upon which the report was based is simply that which any observer of MIKE shot could collect. In the light of your more detailed knowledge you should not put too much weight on it. I have seen no photographs and am relying entirely on memory of the events, a notoriously unreliable proceeding. However, the theoretical reasons for believing that MIKE was altogether a different and new geophysical phenomenon are well founded.

Sincerely yours,

/s/ CLARENCE E. PALMER
Professor of Geophysics

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