JOINT TASK FORCE ONE
TECHNICAL STAFF
U S S KENNETH WHITING (AV-14)
FLEET POST OFFICE
SAN FRANCISCO, CALIFORNIA

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SERIAL 30

19 June 1946.

MEMORANDUM.

From: Dr. W. G. Penney.
To: Rear Adm. Parsons.
Dr. R. A. Sawyer.
Col. S. L. Warren.
Comdr. R. Revelle.

Subj: Height of water column in test BAKER.
Relationship to radioactive hazards.
Quick estimate of tonnage in test BAKER.

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Statements have been made that the water column in test BAKER may reach a height of 12,000-20,000 ft. This expectation has received confirmation from experiments made by Dean O'Brien, assuming that the height of the column is proportional to the cube root of the charge weight. Insofar as the predictions are based on model charges, the largest of which was 1,000 lb., the prediction must remain suspect unless good grounds are discovered for believing scaling law.

The writer is of the opinion that the prediction is reasonably accurate, but that the true height of the column for a 20,000 ton explosion will be 8,000 ft. The main reason for the failure of the scaling law is that the relatively much greater time that the full-scale column takes to develop permits gravity to have a relatively much greater effect. In small explosions (a few tons of TNT or less) air friction is completely dominant over gravity in controlling the height, but this is not the case in the full scale explosion.

Using Dean O'Brien's height-time curve for the water column produced by 600 lb. of explosive at mid-depth in 4.5 ft. deep water, the deceleration of the top of the column is related to the velocity by the equation

$$a = -5.68 \times 10^{-4} v^{2.492}$$

where the units of length are feet and of time as seconds, and v ranges from 300 f/sec. to 2700 ft/sec.

The equation of motion of the column for an explosion whose linear dimensions are 40 times larger (i.e. 20,000 tons at 90 ft. deep in water 180 ft. deep) is

$$\frac{d^2s}{dt^2} = -1.42 \times 10^{-5} v^{2.492} - 32$$

where 32 represents gravity.

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Solving this equation subject to the initial condition that the initial velocity is 2700 ft/sec, the height of the column is 7100 ft. At this height, of course, the air density is less than at sea level, and an estimated correction for varying atmospheric density gives the height of the column as 8,000 ft.

The width of the water column will scale as the cube root of the wieght, and using Dean O'Brien's data, the width for a 20,000 ton explosion should be 2400 ft.

If the approximate height of the column is 8,000 ft. and the diameter is 2400 ft., we shall know that the bomb exploded at approximately 20,000 tons. It is suggested that photographic measurements of the water column provide the easiest method of making a quick estimate of the tonnage for test BAKER.

Since the water column will be highly contaminated by fission products, and will reach nearly its maximum height very quickly (10-20 seconds) it is clear that the radioactive hazards to aircraft are as great in BAKER as they are in ABLE. The collapse of the water column in the strong turbulence developed will certainly cover many ships with water and contaminate them.

W. G. PENNEY