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HEADQUARTERS
JOINT TASK FORCE SEVEN
APO 187 (HOW), c/o Postmaster
San Francisco, California

12 April 1954

MEMORANDUM FOR RECORD

SUBJECT: BRAVO Shot, Operation CASTLE

1. PURPOSE: To make a matter of record operational aspects that were considered prior to BRAVO event of Operation CASTLE and to analyze the resultant situation in light of available pre-shot and post-shot information.

2. GENERAL INFORMATION: Operation CASTLE is planned to consist of a series of seven detonations at the Pacific Proving Grounds, which encompasses Eniwetok and Bikini Atolls. BRAVO is the code name that was given the firing of the first device, SHRIMP, at 0645 M on 1 March 1954, off Namu Island, Bikini Atoll.

Subsequent to BRAVO detonation radioactive debris fell on certain inhabited atolls of the northern Marshall Islands. Radiation intensities rose to levels sufficient to warrant evacuation of four atolls and all personnel were removed from these atolls to Kwajalein in accordance with the operational emergency plan of JTF SEVEN. Areas evacuated and gamma dosages received are indicated below:

ATOLL	POPULATION	DISTANCE FROM GROUND ZERO	DOSES RECEIVED
Ailinginae	17	79 NM	80 R (computed)
Rongelap	82	100 NM	100-130 R (computed)
Rongerik	28 #	133 NM	40 - 98 R (film badge)
Utirik	154	270 NM	17 R (computed)

(#) 28 American Service personnel; 25 USAF Weather Detachment plus 3 USA Signal Corps personnel.

All evacuees are under competent medical care.

3. PREVIOUS EXPERIENCE AND CHARACTERISTICS OF NUCLEAR DETONATIONS: Radioactive debris is an inherent characteristic of all nuclear detonations. It originates from fission fragments

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which are the residue of bomb elements and surface materials, soil and water, made radioactive by accompanying radiation fields. Debris is sucked high into the atmosphere by after winds of the explosion. Where this radioactive debris will fall is a major pre-shot consideration and primarily influences the decision to detonate a nuclear explosion at a certain time.

The area over which radioactive debris is spread and the intensity of fall-out on the ground are determined by the yield of the explosion as well as by wind pattern since the larger the yield, the more surface materials are sucked up into the cloud and the more fission fragments are available. The relationship between yield and fall-out is known only qualitatively.

4. PRE-SHOT INFORMATION: The operational aspects of the BRAVO experience were planned and conceived in the light of experience gained from previous operations. These factors were considered:

a. The basis for forecasting where fallout will go is experience gained from overseas test operations CROSSROADS, SANDSTONE, GREENHOUSE and IVY and to a certain extent from tests at the Nevada Proving Ground. Prior to the firing of BRAVO, only one megaton yield device (IVY-MIKE) had been detonated. Although conscientious efforts were made to document the fall-out from MIKE, only about 5% of the total debris could ever be accounted for.

The technique used for forecasting fallout patterns is to consider the cloud as a small area source (about a 15 mile radius); then add vectorially forecast winds from the surface to approximately 100,000 feet. The next step is to outline an area on the ground where fallout is expected. This area is computed by taking into consideration particle size, diffusion into the atmosphere, wind pattern, yield and source radius. Such patterns have been largely confirmed by experience in Nevada as well as by the meager data available here.

b.

c. The surface radex was plotted, with an insurance factor added, i.e., smaller particles than previous experience indicated necessary were considered. This doubled distances from ground zero where fallout was predicted to occur.

d. The upwind intensity of radiation levels at various distances was considered to be of the same order of magnitude as for IVY-MIKE. Radiation versus distance lines were transposed to Bikini Atoll.

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e. A critical problem in predicting fall-out in- forecasting the stability or lack of stability of the attern after shot time. Since radioactive particle tra- determined primarily by the winds at each level, it is d that winds must be from favorable directions or vary- hin the outer limits on favorable directions during the f fallout. The critical fallout period was considered to the order of twelve to eighteen hours for significant to occur. The variation in time arises from considera- f wind shear, with more diffuse and less significant in- es at a given time associated with large angular and hear. For this reason, it was required that actual wind ations and forecasts immediately before shot time and out shot day be continuously considered in their relation e forecast conditions for the first twenty-four hours he shot.

PRE-SHOT BRIEFINGS: The following were presented at -shot command briefings:

a. Weather

Weather conditions during the five days prior to dicated a favorable trend for BRAVO day with easterly elow 15,000 feet and winds of a southerly component The situation presented at E-6 hours for the subsequent period (18 hours after shot time) was satisfactory. The period to begin 18 hours after shot time was predicted an unfavorable trend as northwest winds were forecast 10,000 to 20,000 foot levels.

b. RadSafe

(1) Resultant wind diagrams including latest winds and forecast winds for H Hour and the 72 hour ajectories, which gave a fallout pattern in a narrow to the east northeast and a wide (140°) sector to the h very slow resultant winds. (See Figure 1).

(2) Surface rader, H to H plus 6 hours. (See

(3) Outlooks for:

(a) Bikini: Unfavorable; Eniwetok: Favorable; Favorable, and the native populated atolls in southeast from ground zero favorable, since resultant winds in tion of these areas were considered too slow to move at fallout to the atolls involved.

(b) Task Force fleet: Favorable, provided d out at least 50 miles.

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(c) Air routes through Wake and Kwajalein: favorable.

(d) Surface routing inside 500 miles considered in its relation to all known transient shipping: favorable.

e. Scientific

(1) High altitude sampling operations - favorable.

(2) Light transmission for scientific experiments - favorable.

6. CONCLUSIONS:

a. Lack of fallout information from previous shots of comparable yield was a serious handicap.

b.

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c. The original source cannot be considered as a point or a relatively small area but must be considered to be an area of about a hundred miles in diameter. This diameter also depends on yield.

d. The radioactivity of the debris can be considered proportional to yield. Radioactive material in the cloud was thus two to three times was was expected.

e. An appreciable fraction of the observed fallout can only be accounted for by assuming that it originated in the stratosphere. For such particles to reach the ground at observed times, their diameter must have been in excess of 100 microns.

f. Forecast for shot time winds at shot time was essentially correct. Variation from forecast trajectories was approximately 10 degrees in significant upper levels; unfortunately, the variation was in the wrong direction (See Figure 3). The small variations observed at lower levels were also in an unfavorable direction. Nevertheless, the accuracy of the winds aloft forecast approached the limits of accuracy of the wind observations themselves and were well within the normal forecast error.

g. The fallout pattern extended from the Bikini Atoll to the east northeast. Considerable widening of the pattern took place due to diffusion. The intensity of the

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pattern on the ground was due primarily to superposition of mushroom cloud fallout on the stem cloud pattern; and the superposition can be attributed to the narrow cone within which the winds were acting. The theory that a significant fallout does not come from the stratosphere is not substantiated by the facts of BRAVO.

h. For future high yield shots, the forecast and observed winds for the first twenty-four hour post-shot period should receive as much emphasis as analyses made for shot time.

7. <u>EVACUATION</u>: Evacuation took place in accordance with operational emergency plan and without incident. Evacuation was not effected prior to detonation because no significant fallout was expected on inhabited areas.

ALVIN C. GRAVES
Scientific Director

P. W. CLARKSON
Major General, U.S. Army
Commander

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1. Figure 1
2. Figure 2
3. Figure 3
4. Tab "A" - Weather
5. Tab "B" - RadSafe, Narrative Sequence of Events
6. Tab "C" - Medical (plus addendum)

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