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FORECAST FALL-OUT PLOT

a. Procedure for Ground Forecast of Fall-Out Contamination from Nominal Bombs Exploded at NPG from 300 ft. Towers. (Note: Air drops do not produce any appreciable fall-out).

(1) Location and Intensity of Maximum

In order to find location and intensity of maximum fall-out area assume that all of the activity of the bomb is located at a point somewhat lower than the center of the mushroom of the atomic cloud. Then follow the trajectory of a 125 micron particle whose density is 2.56 gm/cm^3. This procedure is recommended since the NMD of the soil at NPG is between 100 to 150 microns. This means that the particle is located approximately 7000 ft. from the top of the mushroom and falls with the speed of 15,000 ft. per hour down to 20,000 ft. msl, and at the rate of 12,000 ft/hr from 20,000 ft. down to the ground. This is based on Stoke's Law and the difference in rate of fall is due to change of viscosity of the air with temperatures. Using the above data it is possible to locate the maximum fall-out area on a map. See paragraph (8) below for detailed analysis of the method used to obtain the location of the maximum fall-out area. It should be noted that the maximum fall-out occurs between two to three hours after H-hour since the average cloud rises to approximately 40,000 ft. msl. The actual time of fall-out depends upon the terrain, the height of the tropopause and the equivalent KT of the bomb. In the event that the maximum fall-out from a nominal bomb does not occur within three hours, then the fall-out will be generally less contaminating. If the maximum occurs in $1\frac{1}{2}$ hours or less the fall-out will be quite intense and highly contaminating. To evaluate the maximum fall-out using integrated infinity dose in roentgens, the following empirical relation may be used:

$$D = \left(30 - \frac{A}{5} - \frac{B}{30} \right) y/15 \quad \text{- - - - Equation 1.}$$

Where

$A = \Delta\omega =$ maximum angular wind shear in the region from 10,000 ft. to 40,000 ft. msl.

$B = \Delta V =$ maximum wind speed shear from 10,000 ft. to 40,000 ft. msl.

Y = Equivalent KT of the bomb.

(2) The area covered by the different integrated dose lines may be obtained as follows:

(a) The area of the maximum fall-out given above is very small. It is so small in fact that it may be taken as a point. The value of this maximum fall-out point is given by Equation 1.

(b) Around the maximum fall-out point draw an ellipse whose area varies between 150 to 300 square miles. The major axis of the ellipse will be drawn parallel to the fall-out plot of the 125 micron particle as shown in paragraph (8) below. That focal point of the ellipse which is nearest to ground zero will be placed at the theoretical maximum fall-out point. The outer boundary of the ellipse will indicate the integrated isodose line obtained by dividing the value of Equation 1 by approximately 4 or 5.

(3) Similarly, an elliptical area of from 500 to 1000 square miles will be drawn about the maximum fall-out point. The integrated dose value of the line bounding this area is approximately one tenth of the value obtained by using Equation 1.

(4) Starting with Ground Zero and using the fall-out plot of the 125 micron particle indicated in paragraph (8) as a guide, draw a rectangular area of from 3000 to 5000 square miles. Then proceed to fit this rectangular area around ground zero and around the maximum fall-out point somewhat as indicated in paragraph (8) below. The line bounding this area has a value of approximately one fiftieth of the value obtained ~~by using Equation 1~~.

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(5) Starting from ground zero and going out 15 to 20 miles on the fall-out plot of the 125 micron particle, draw an area of approximately 150 to 200 square miles. The line bounding this area has a value of from one fifth to one tenth of the value obtained by Equation 1. If the winds aloft are low in speed (5 to 20 knots) then this area will be highly contaminated. If the winds aloft are stronger (30 to 80 knots) then this area will be smaller and not as highly contaminated.

(6) In the event that the tropopause is lower than 35,000 ft. msl, the fall-out will be somewhat greater than indicated above and the time of fall-out of the maximum contamination will be two hours or less for a 10 to 40 KT tower shot. If the tropopause is above 42,000 ft. msl, the fall-out will be less than indicated, and the time of fall-out of the maximum contamination will be three hours or more after H-hour.

(7) Normally the maximum fall-out area will be in a radius of from 40 to 80 miles from ground zero, depending upon the direction and speed of the winds aloft. If the winds aloft are relatively low in speed (10 to 20 knots) the fall-out in the immediate vicinity of ground zero will be greater and the "dish-ose" and "missile" fall-out within 10 to 20 miles of ground zero will be much greater. Therefore at NPG, in the event of a 10 to 30 KT 300 ft. tower shot, Groom Mine will be most likely to get contaminated with a 2 to 10 roentgen integrated infinity dose if the winds are from the South, SW or West and weak. In the event that the wind speed aloft is high (40 to 80 knots) then the maximum fall-out area will threaten towns such as Tonopah, Caliente, Pioche, Panaca, Crystal, Hiko, Alamo, St. George, etc. The towns mentioned above may receive from 5 to 30 roentgen integrated infinity dose from a 15 to 40 KT, 300 ft. tower shot. The most important factor in reducing intensity of fall-out is angular wind shear. If the winds aloft are moderate to strong and the shear is large (90° to 180°), then the fall-out will be minimal, since the contamination will be spread over a larger area. Ely, Nevada is approximately 170 miles from ground zero, hence it will not come under the maximum fall-out. It will receive from 0.5 to 2 roentgen integrated infinity dose. However, Ely, Nevada will probably receive two or three such doses in view of the prevailing winds at NPG.

(8) The following example will be worked out in detail to illustrate the procedure outlined above. Wind information obtained at 0330 PST, 24 March 1955. Shear height estimated at 43,000 ft. msl, tropopause height, 40,000 ft. equivalent yield 30 to 40 KT.

Level	Wind Direction and Speed	Multiplication Factor	Weighted Wind Speed and Direction
6000 ft	120°/05 knots	1/6	120°/0.8
8000	140°/14	1/6	140°/2.3
10,000	180°/16	1/6	180°/2.7
12,000	190°/14	1/6	190°/2.3
14,000	200°/14	1/6	200°/2.3
16,000	210°/10	1/6	210°/1.7
18,000	210°/12	1/6	220°/2
20,000	220°/18	1/4	220°/4.7
25,000	230°/27	1/3	230°/8.4
30,000	230°/27	1/3	230°/8.1
35,000	240°/26	1/6	240°/4.3
40,000	250°/36		

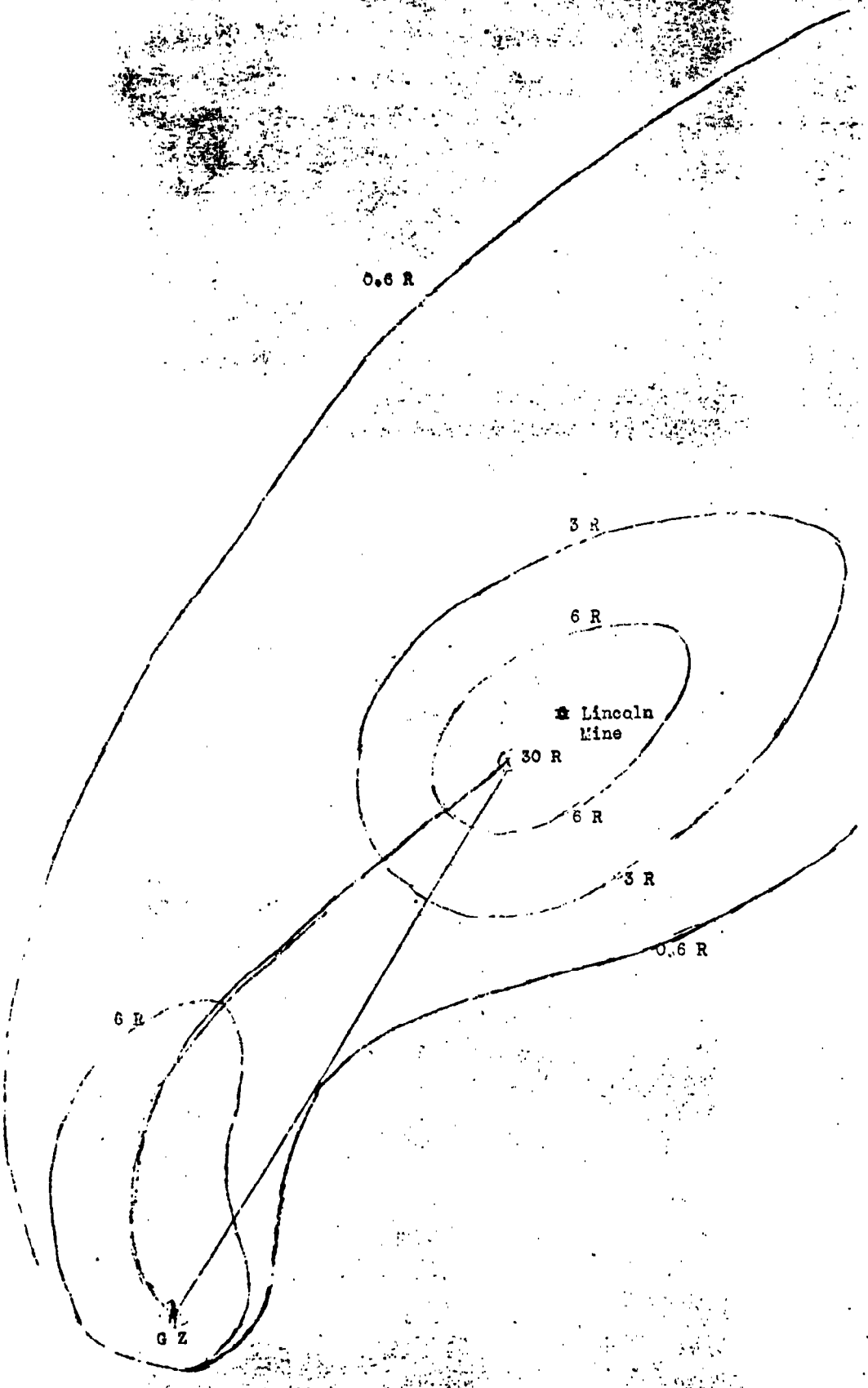
This places the maximum fall-out at 42 miles from ground zero on a bearing of 32°. The maximum integrated dosage is, from Equation 1,

$$D = \left(30 - \frac{A}{5} - \frac{B}{30}\right)\frac{y}{15} \text{ roentgens}$$

$$D = \left(30 - \frac{70}{5} - 1\right)2$$

$$D = (30 - 14 - 1)\,2 = 30 \text{ roentgens}$$

D = 30 r integrated [redacted] of maximum fall-out.



1 Inch = 8 miles

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Time of fall-out estimated to occur 2 hours and 10 minutes after H-hour.

The first area shown in the illustration around the maximum fall-out point is approximately 250 square miles and the line inclosing this area indicates 6 roentgen integrated infinity dose. The next area is of approximately 750 square miles, and 3 roentgens, etc. This example represents the prediction that may have been made for UPSHOT/KNOTHOLE, Second Shot on 24 March 1953. It is surprising how closely the actual fall-out approximated the above prediction. The maximum fall-out at Lincoln Mine (48 miles from ground zero) occurred at H/2 hours and had a value of from 4 to 5 roentgen infinity dose. Ground readings at Sunnyside to Jackson (North to North-East of Lincoln Mine) further verified the forecast plot. The fallout-metering station approximately 15 miles north of ground zero verified the values in fall-out. This method of analysis must be used with caution. It should be remembered that this procedure applies only to 300 ft. tower shots at NTG and when the cloud top reaches 35,000 to 45,000 ft. msl (10 to 50 KT bombs). If the tower heights are lowered to 200 or 100 ft., or if the bombs are detonated on the surface the contamination will increase by several orders of magnitude. If the equivalent bomb yield is significantly less than 1 KT then the cloud may only rise to 15,000 to 20,000 ft. msl. Under such an eventuality the maximum fall-out will occur much closer to ground zero (within a radius of 20 to 40 miles), and the time of fall-out will be more nearly one hour after H-hour.

N. M. LULEJIAN
Major, USAF
Control Officer

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