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THE UPWIND EXTENT OF FALLOUT FROM A LARGE NUCLEAR DETONATION

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The various fallout models which attempt to predict the pattern of radioactivity deposited at the surface following a large nuclear detonation give little quantitative consideration to the up-wind extent of the fallout pattern. The "Effects of Nuclear Weapons" (pp 417-421) suggests that the upwind extent of contamination for megaton-range surface bursts may be estimated from the fission fraction and the radiological cloud radius with only a small correction for the "effective wind speed" (see Table 9.71, P. 417). Other models treat the up-wind extent of contamination with considerable subjectivity.

Limited data available from past Pacific tests indicate that the extent of up-wind contamination is dependent upon the mean tropospheric wind speed* to a considerable degree. This initial fallout seems to have consisted primarily of slurry (a mixture of radioactive particles and water). The arrival time of the first fallout has been observed to be on the order of 30 minutes for all distances up-wind of the shot point, except possibly very close to the shot point.

In some cases the data indicated that particles actually arrived in the dry state, but their sizes required a longer fall time than was observed. This early arrival of a small particle can be explained by assuming that an initially large droplet of slurry evaporated during descent and that the residual particle consisted of a loosely bound conglomerate of smaller particles which disintegrated upon impact. A slurry droplet of about 5 millimeters in diameter which is near the greatest possible size of a raindrop (Johnson, 1954), could bring the radioactive particles from 60,000 feet to the surface in about 30 minutes.

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* The true wind speed determined for the layer from the surface to the altitude of the tropopause.

If, in fact, precipitation from the mushroom head is the mechanism that deposits this up-wind contamination at the surface and if the precipitation rate is assumed to be constant over a reasonable time period, then the intensity of activity at a point under the cloud is dependent upon the length of time the rain occurs at that point. The precipitation interval at the point in turn depends upon the cloud radius and the wind through which the particles fall.

Figure 1, estimated from Pacific test data, gives the up-wind extent for several dose rate contours as a function of total yield based on a 7 knot mean tropospheric wind speed and an 80 percent fission yield. The dose rates are for the total fallout, converted to a reference time one hour after the burst. To estimate the up-wind extent of a given dose rate for other wind speeds, multiply the distance of the dose rate contour from the cloud radius (ordinate of the graph) by the ratio of the actual mean tropospheric wind speed to seven knots and subtract this distance from the cloud radius. For example, if the actual mean tropospheric wind speed was determined to be 14 knots for a 5 MT, 80 percent fission burst, the up-wind distance of the 1 roentgen per hour contour would be:

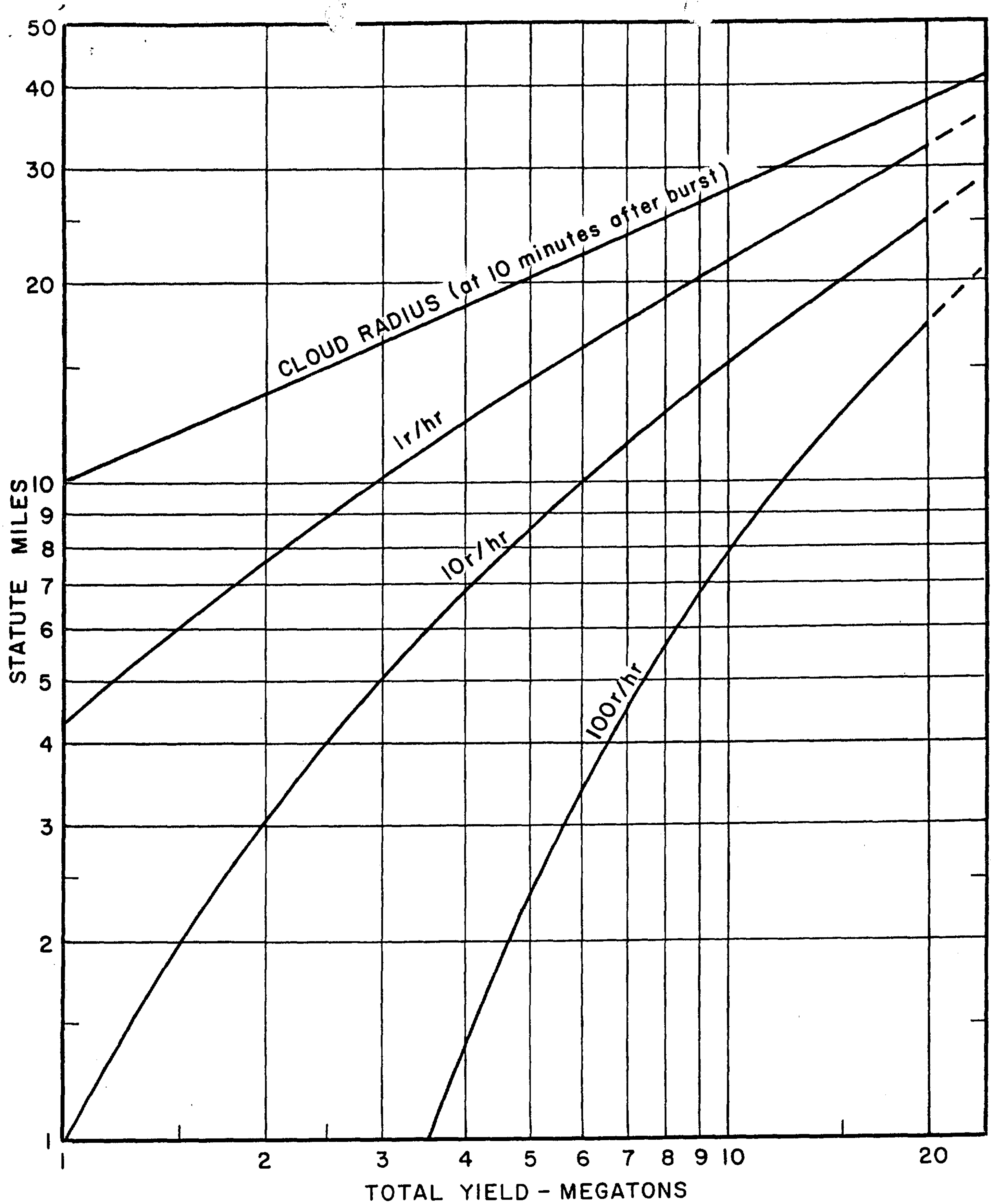
$$D = 20 - \left(\frac{14}{7} \times 6 \right) = 8 \text{ Statute miles}$$

For detonations of other than 80 percent fission yield the dose rate value must be multiplied by the ratio of the actual percent fission to 80 percent fission.

This method should give a rough approximation of the up-wind distance for the dose rate contours between the cloud radius and the crater area of the burst. When the "D" is negative, it indicates that this contour would not exist up-wind beyond the area of throwout or induced activity.

Application To Other Regions Of The World

The high water content of the lower troposphere in the Marshall Islands area and the sea water incorporated in the nuclear cloud may have given rise to a greater amount of precipitation (slurry) than would be expected in drier regions of the world. This approach may thus exaggerate the up-wind extent of contamination for bursts in the middle latitudes. Even so, the up-wind extent of contamination estimated by this method would be considerably less than present methods would predict.



UPWIND CONTAMINATION (r/hr at h+1) AS A FUNCTION OF YIELD
(7 KNOT MEAN TROPOSPHERIC WIND SPEED)

REFERENCES

"The Effects of Nuclear Weapons", U. S. Government Printing Office, Washington, D. C., 1957.

Johnson, John C., Physical Meteorology, (P. 314), John Wiley and Sons, Inc., New York, 1954.

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