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ARMED FORCES
SPECIAL WEAPONS PROJECT
252 FEB 24 1958

Staff Study by Maj. T. A. Gibson, Jr., USA, 14 March 1952

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Figure 8.101 of "The Effects of Atomic Weapons" (1) will be assumed to be correct. (Assumption No. 1) This gives the dose rate at 1 hour after the explosion as observed on ships. Had the contamination fallen on land, the rates would be increased by about a factor of four due to the absence of run off and the presence of a greater contaminated area. That is, after a short time, a ship is a limited contaminated area surrounded by an essentially uncontaminated area. The final results of this paper should be multiplied by 4 to be made applicable to land adjacent to an underwater burst.

Roger Revelle, in his "Characteristics of the Base Surge," (2) gives the observed movement of the Bikini-Baker surge. He also gives predicted surge movement for other surface winds. These will be assumed to be correct. (Assumption No. 2)

The pattern of the Bikini residual contamination was observed to lie in an area almost identical with the area covered by the base surge. It will be assumed that all of the residual contamination comes from the base surge. (Assumption No. 3)

The fourth and final assumption will be that the rate of deposition of contaminant can be expressed as:

$$\frac{dD}{dt} = K/t^2 \quad \text{where: } K \text{ is a constant to be determined}$$

Integrating and letting, t_0 = time of explosion

t_1 = time surge reaches an area

t_2 = time surge leaves an area

$$D_{t_2} = -K t^{-1} \frac{t_2}{t_1}$$

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$$D_{t_2} = K \left\{ \frac{1}{t_1} - \frac{1}{t_2} \right\}$$

D_{t_2} = Amount of radioactive material on surface after base surge has passed over between times t_1 and t_2 .

Since the dose rate at one hour at any point is directly proportional to the amount of radioactive material on the surface at that point, we can test the validity of this equation. We have a good estimate of the dose rate at one hour at various points, Figure 8.101, "The Effects of Atomic Weapons." (1) We have the observed movement of the surge, Revalla's paper.

So if,

$$\frac{\text{Dose rate at 1 hr}}{\frac{1}{t_1} - \frac{1}{t_2}} = \text{Constant,}$$

our fourth assumption is valid. The following table shows that the assumption is valid.

Also listed are the results if one assumes $\frac{dD}{dt} = K/t$ or $\frac{dD}{dt} = K/t^3$.

Table Showing that Rate of Fall Out from Base Surge
Equals K/t^2

Distance downwind in miles	r/hr at 1 hr	$\frac{r/hr}{\frac{1}{t_1} - \frac{1}{t_2}}$	$\frac{r/hr}{\ln t_1 - \ln t_2}$	$\frac{r/hr}{\frac{1}{t_1^2} - \frac{1}{t_2^2}}$
.5	500	178	121	
.9	250			203
1.0	215	212	64	
1.4	120			309
1.5	100	213	36	
1.6	90			398
1.75	70			554
2.0	50	242	23	985
2.5	26	327	18	2360
3.0	13	879	11	
3.1	12			8920
3.5	7	232	3.5	

It is to be noted that the dose rate varies by a factor of 100, yet the figures in the third column are essentially constant over this wide range.

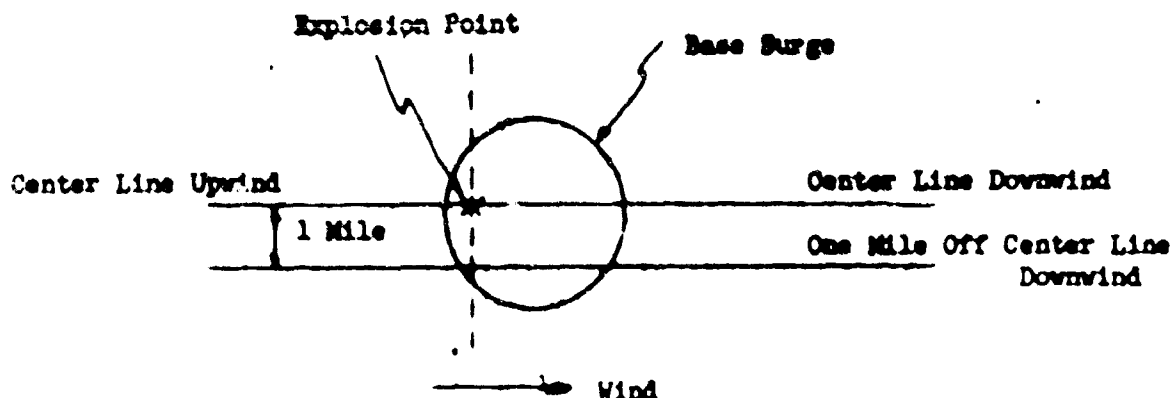
We now have a method of predicting the downwind dose rate one hour after the explosion at any distance for various surface winds. The method is to use Revelle's predictions for the movement of the surge in various winds. The time the surge reaches any point and the time it leaves the point are determined for various points and wind velocities. See Figures 1, 2, 3, and 4 for plots of these data. Then the dose rate at one hour at any point is given by,

$$\text{dose rate at one hour} = \frac{K}{1/t_1 - 1/t_2},$$

where K is the average constant determined from the Bikini-Baker observations.

This dependence of downwind residual radiation on surface wind is shown in Figure 5:

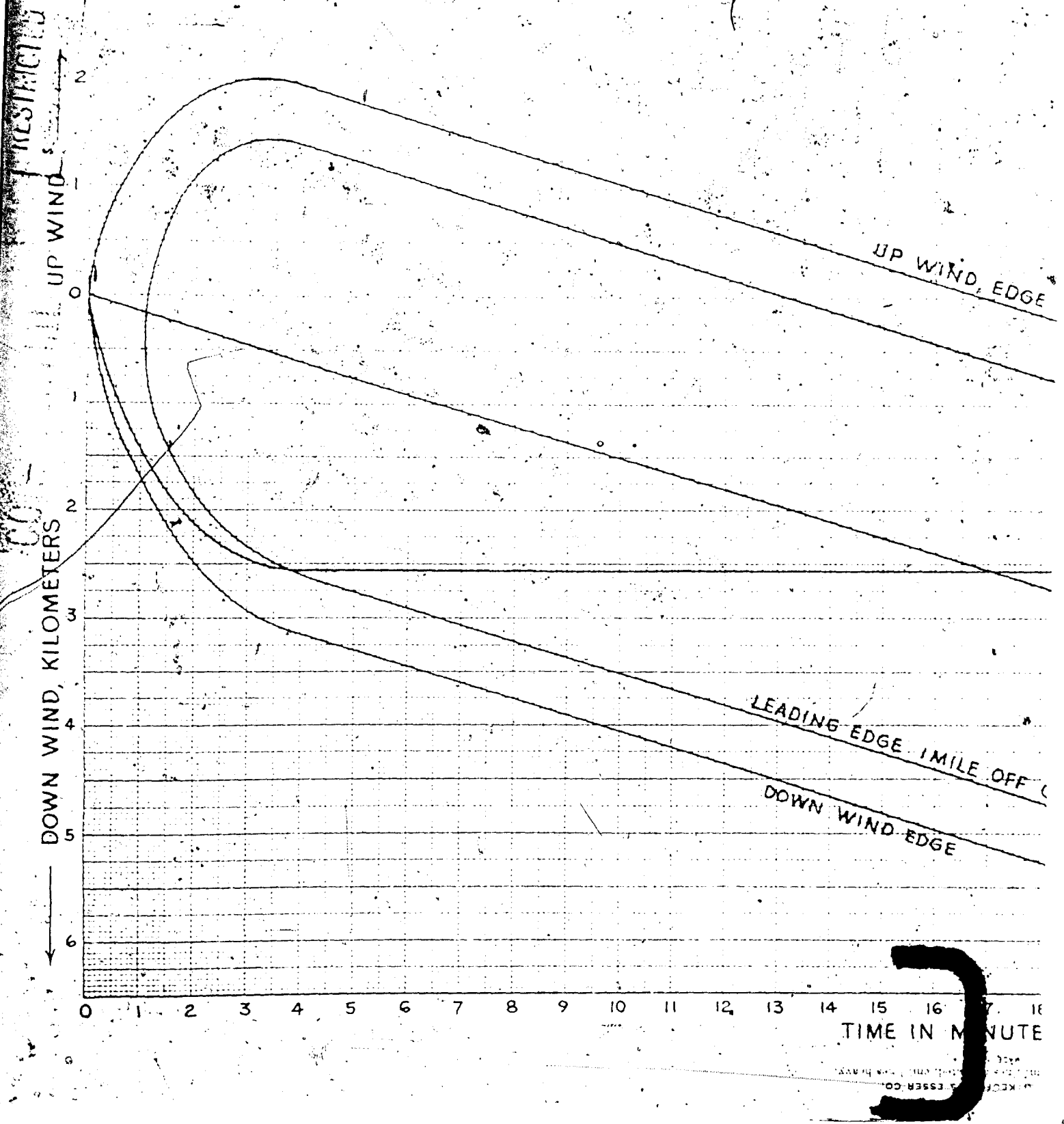
A similar analysis can be applied along a center line drawn upwind from the point of the explosion and along a line displaced one mile off center and drawn downwind.



Figures 6 and 7 show the dependence of the residual contamination on wind velocity along these lines. The upwind data as given by Figure 8.101 of "The Effects of Atomic Weapons" have been adjusted to agree with the data of Figures 8.91a, b, and c. By using Figures 5, 6, and 7 one can obtain at least four points on a constant dose rate contour line and draw such contour patterns for various wind velocities. Examples of such contours are shown in Figures 8 and 9.

References:

1. "The Effects of Atomic Weapons," June 1950, U. S. Government Printing Office.
2. "Characteristics of the Base Surge" by Roger Revelle. AF5WP Technical Library File Number 10-5.



MOVEMENT OF BAS MEASURED FROM

NO EDGE

RADIUS

TRAILING EDGE 1 MILE OFF

1 MILE OFF CENTER LINE

CENTER

6 18 19 20 21 22 23 24 25 26 28 29 30 31 32 33 34 35 36 37
MINUTES AFTER EXPLOSION →

53 0 3X 71-65E

FIGURE 1

MOVEMENT OF BASE SURGE IN A 5 KNOT WIND,
MEASURED FROM POINT OF EXPLOSION

TRAILING EDGE 1 MILE OFF CENTER LINE

CENTER

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48

REPRODUCED FROM THE REPORT OF THE
NAVY DEPARTMENT, BUREAU OF NAVAL
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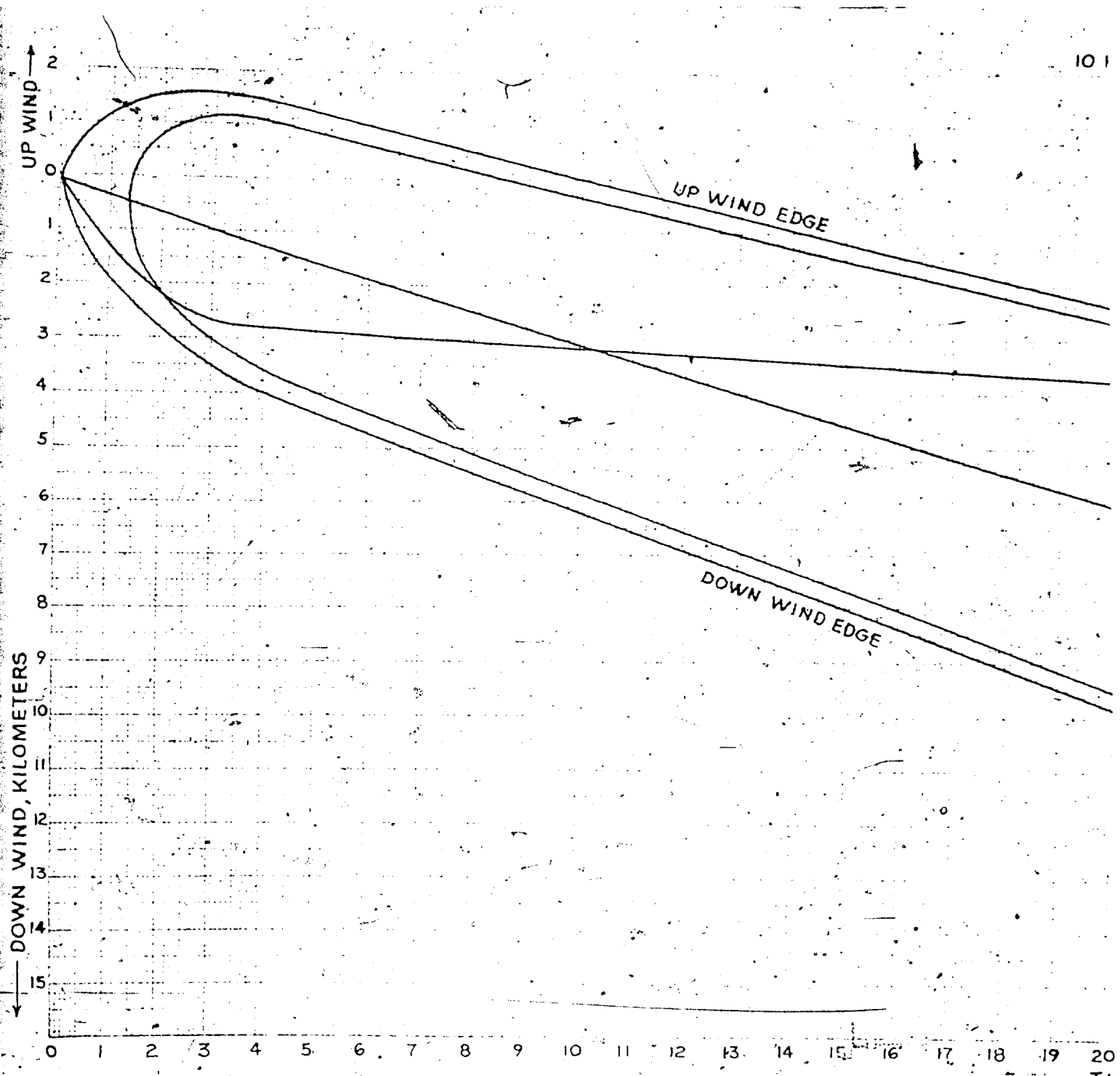
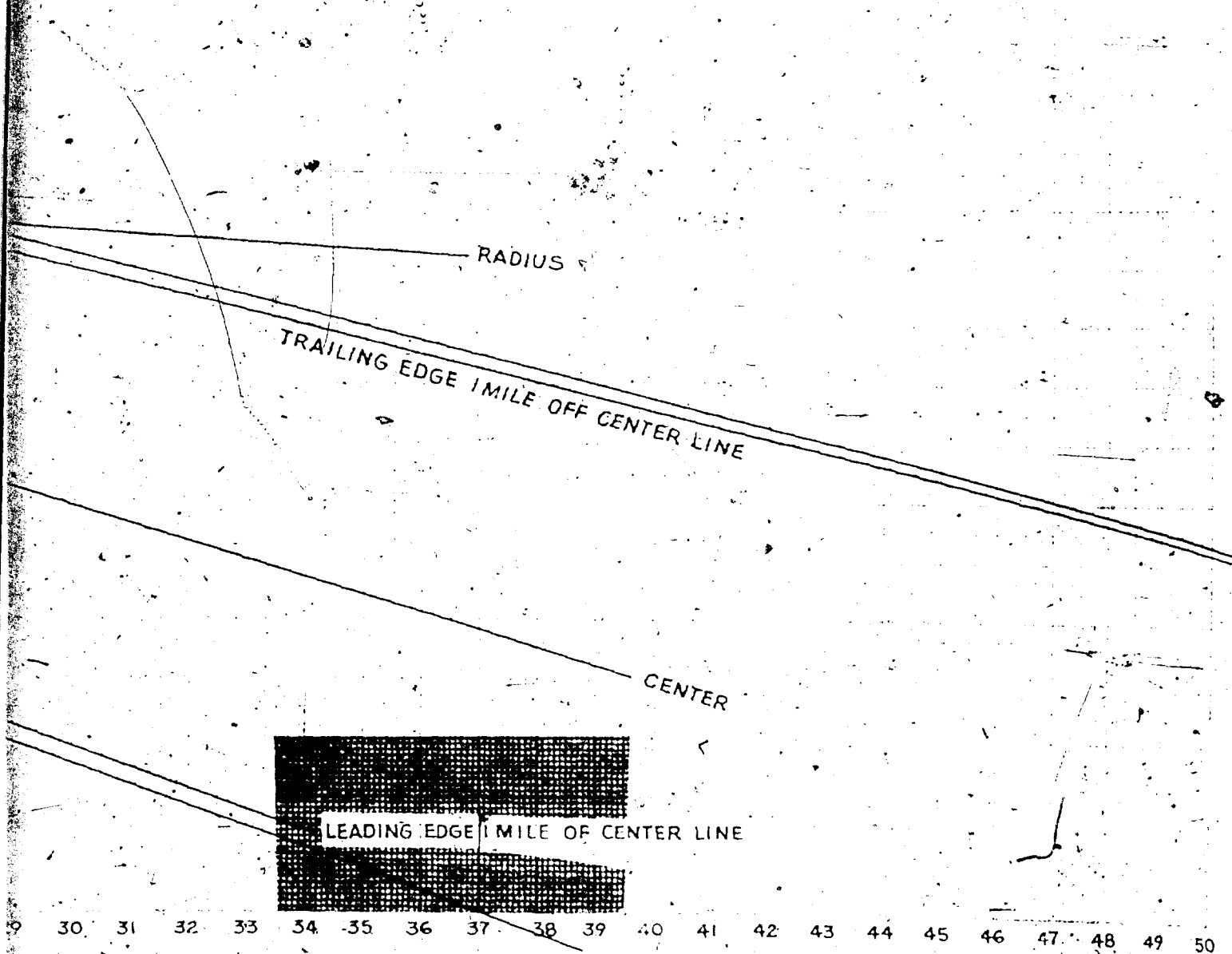


FIGURE 2

MOVEMENT OF BASE SURGE IN A 10 KNOT WIND,
MEASURED FROM POINT OF EXPLOSION



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UP WIND

DOWN WIND, KILOMETERS

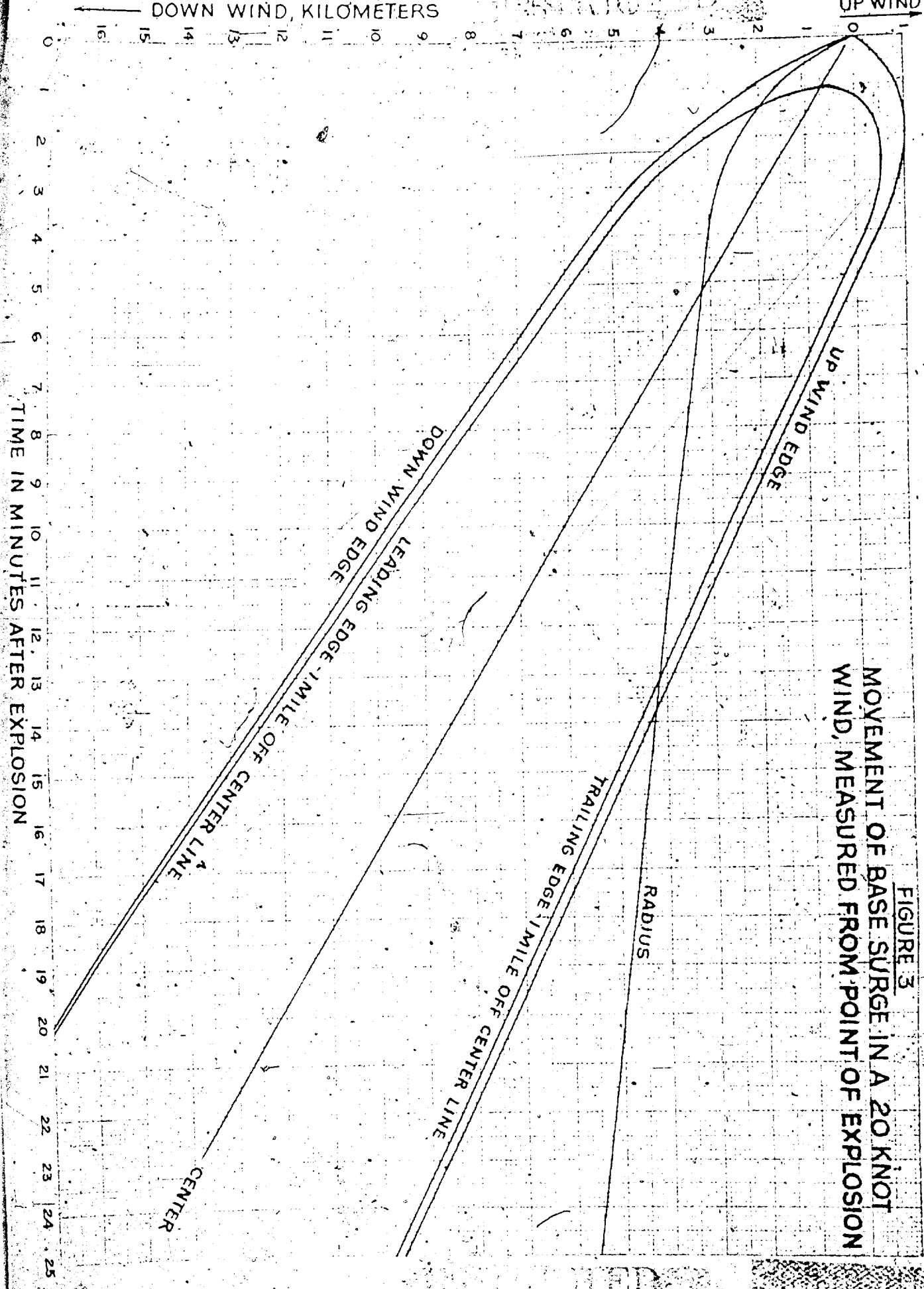


FIGURE 3
MOVEMENT OF BASE SURGE IN A 20 KNOT
WIND, MEASURED FROM POINT OF EXPLOSION

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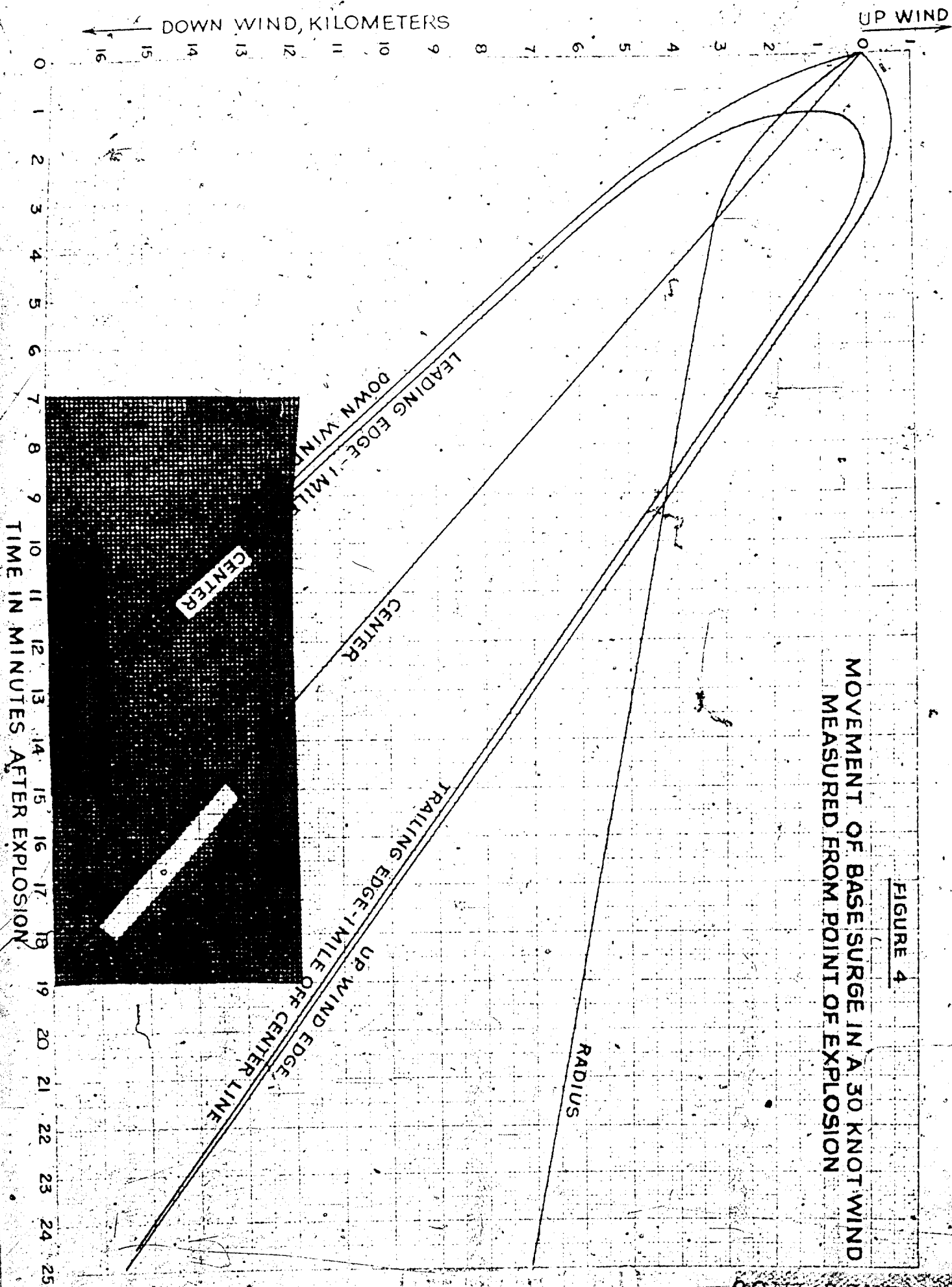
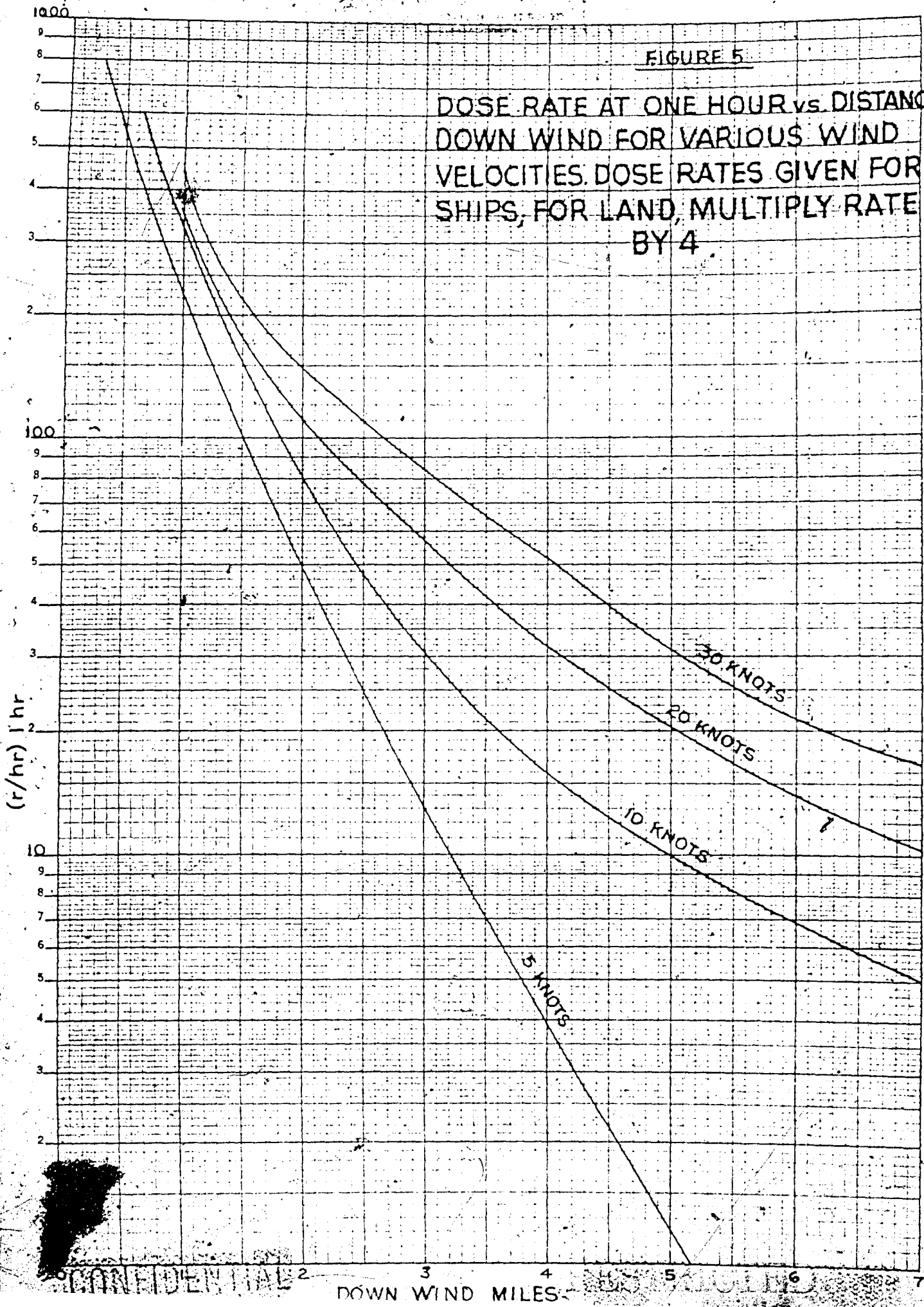


FIGURE 5

DOSE RATE AT ONE HOUR vs. DISTANCE
DOWN WIND FOR VARIOUS WIND
VELOCITIES. DOSE RATES GIVEN FOR
SHIPS, FOR LAND, MULTIPLY RATE
BY 4.

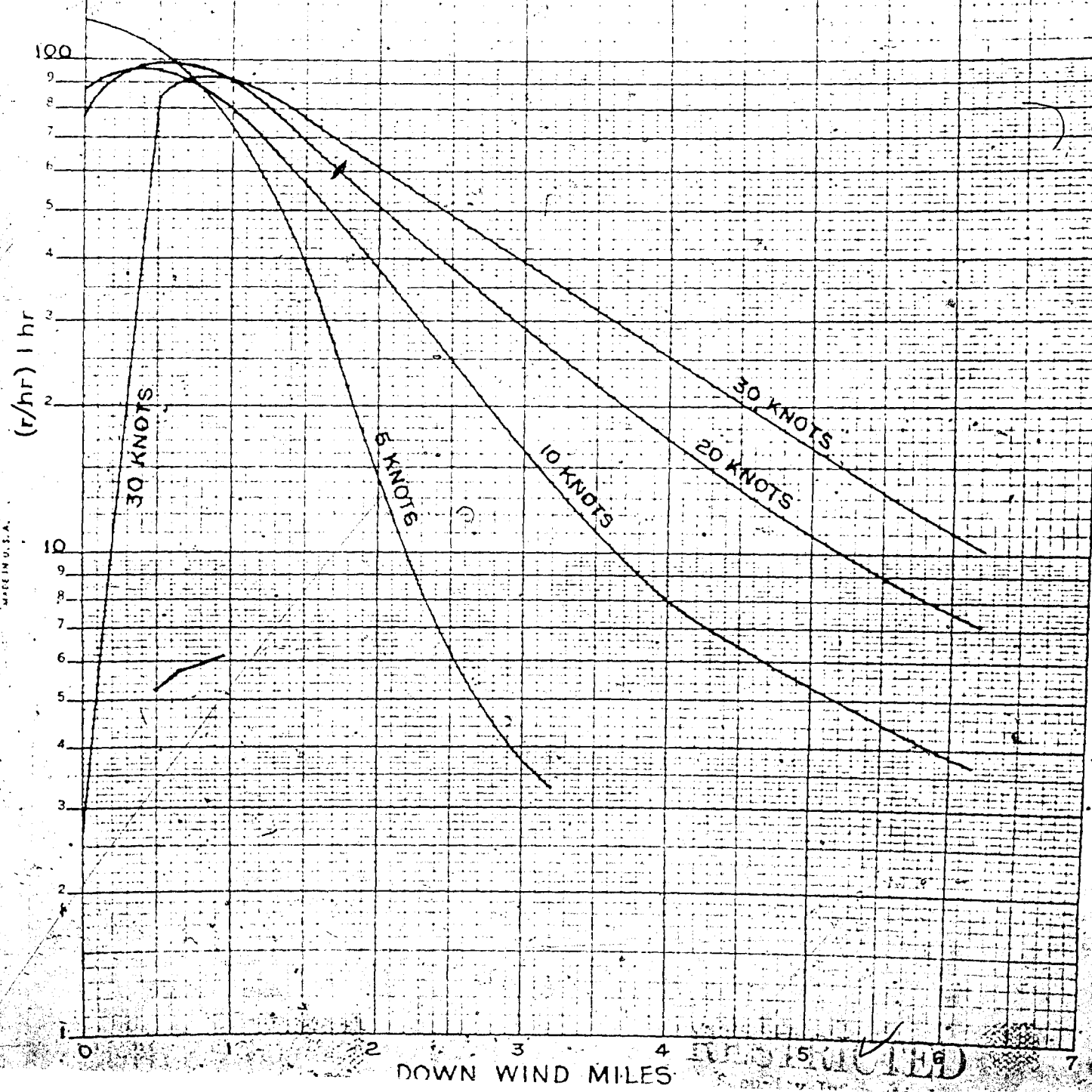


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FIGURE 6

DOSE RATE AT ONE HOUR ALONG A LINE
1 MILE OFF CENTER (SEE FIGURE 8 & 9)
FOR VARIOUS WIND VELOCITIES. DOSE
RATES GIVEN FOR SHIPS, FOR LAND
MULTIPLY BY 4

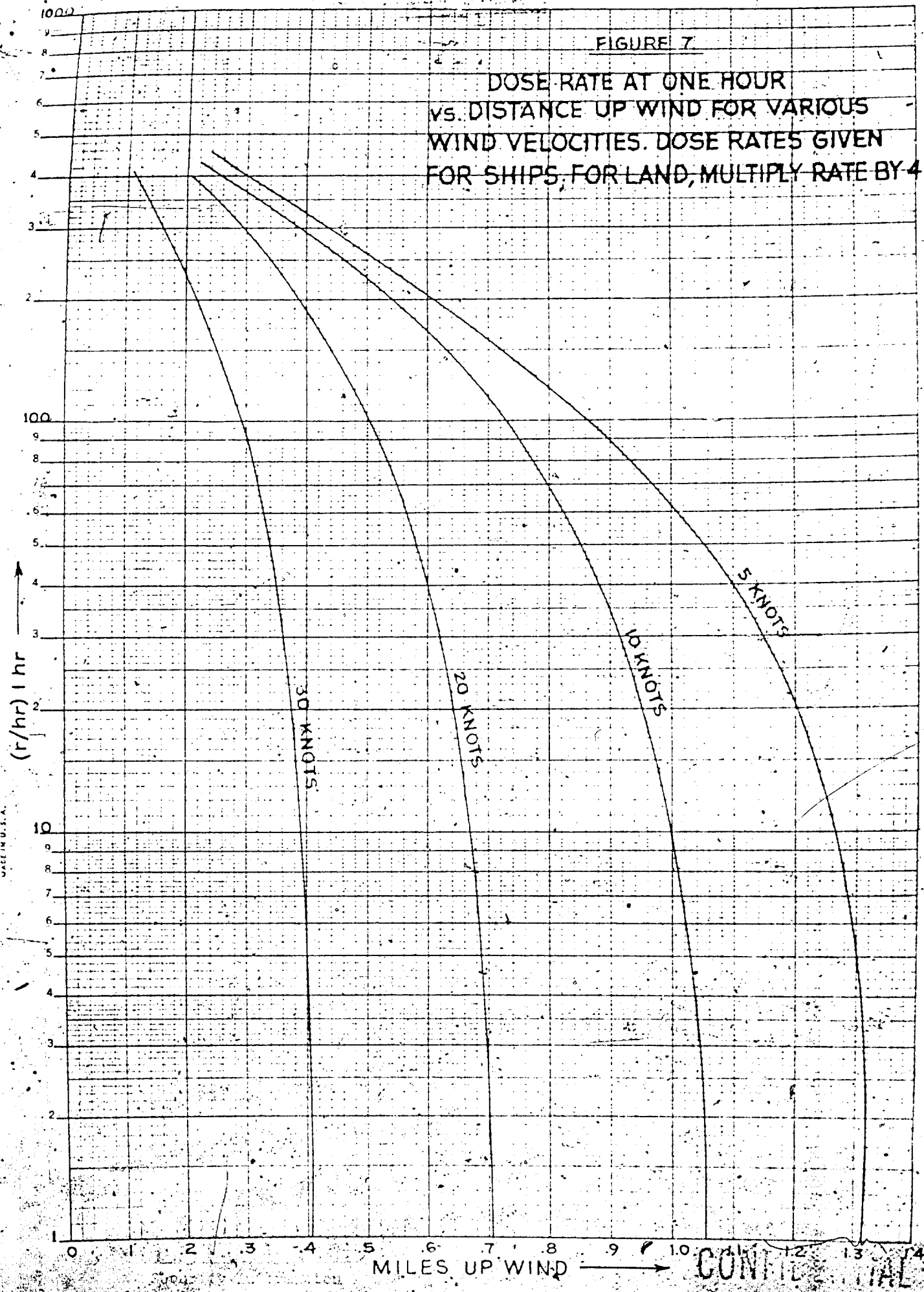


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FIGURE 7

DOSE RATE AT ONE HOUR
VS. DISTANCE UP WIND FOR VARIOUS
WIND VELOCITIES. DOSE RATES GIVEN
FOR SHIPS, FOR LAND, MULTIPLY RATE BY 4



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FIGURE 8

CONTOURS OF GAMMA DOSE
RATE AT Ht/hr, UNDERWATER
BURST, FOR SHIPS, FOR LAND
MULTIPLY RATES BY 4

1/4 X 5 to the 1/2 inch

6
5
4
3
2
1
0
1
2

ONE MILE OFF CENTER LINE

CENTER LINE

20r/hr

50r/hr

100r/hr

300r/hr

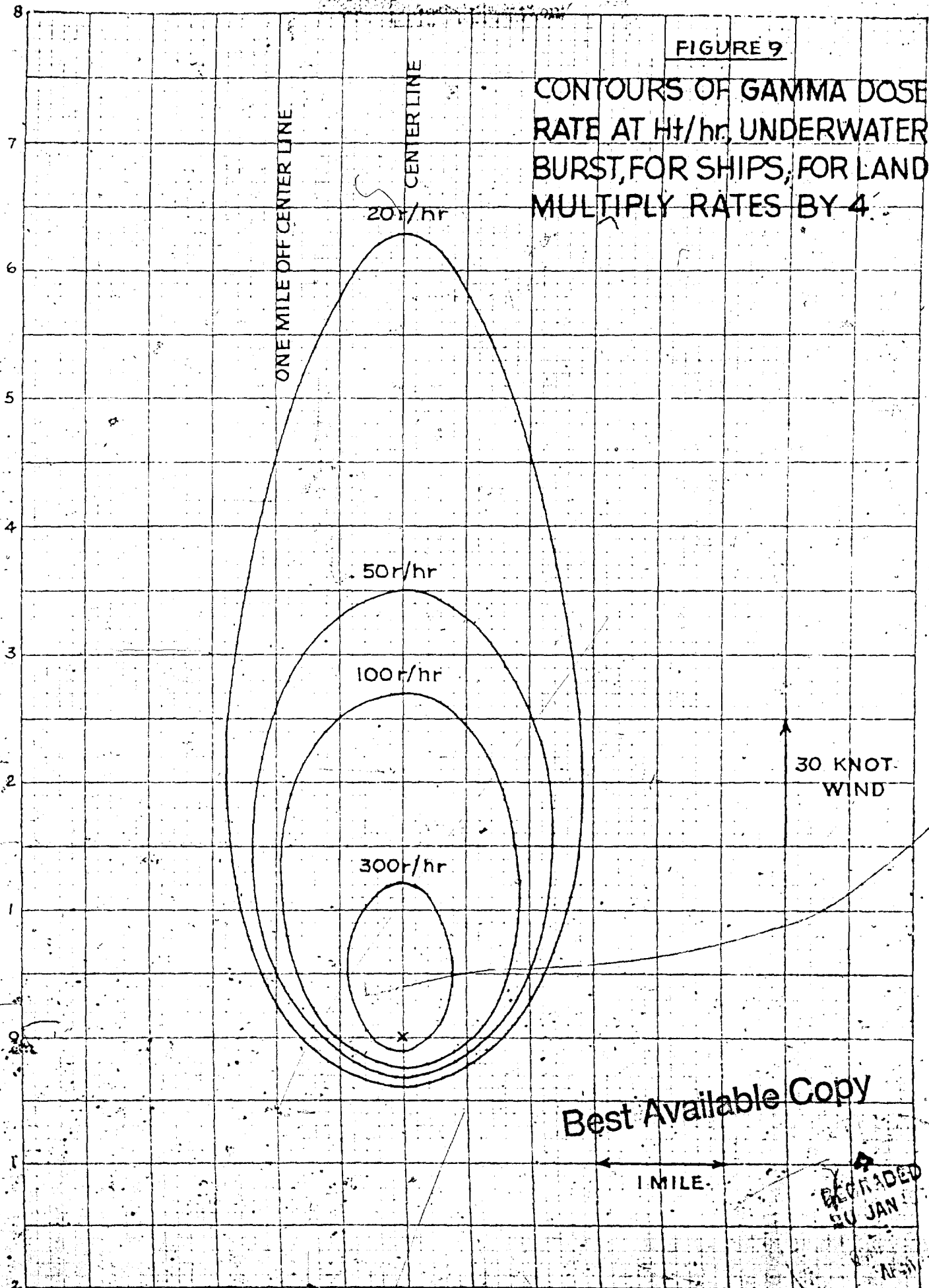
5 KNOT WIND

1 MILE

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FIGURE 9

CONTOURS OF GAMMA DOSE
RATE AT Ht/hr, UNDERWATER
BURST, FOR SHIPS, FOR LAND
MULTIPLY RATES BY 4



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