

36

[REDACTED]

410633

A
HANDBOOK
for
OPERATION CASTLE

THIS DOCUMENT CONTAINS 263 PAGES (S)

[REDACTED]

[REDACTED]

The Pogo Staff
of
J Division

LOS ALAMOS SCIENTIFIC LABORATORY
of the
UNIVERSITY OF CALIFORNIA

Los Alamos, New Mexico

1 January 1954

[REDACTED]

RG 326 US ATOMIC ENERGY
COMMISSION
Location LANL
Collection RECORDS CENTER
Folder HANDBOOK FOR
OP CASTLE

JOB-850

CLASSIFICATION CANCELLED
WITH DELETIONS
BY AUTHORITY OF DOE/OC

REVIEWED BY [Signature] 10/25/83
[Signature] 11/5/85

BEST COPY AVAILABLE

Copied/DOE
LANL, J-DIV.

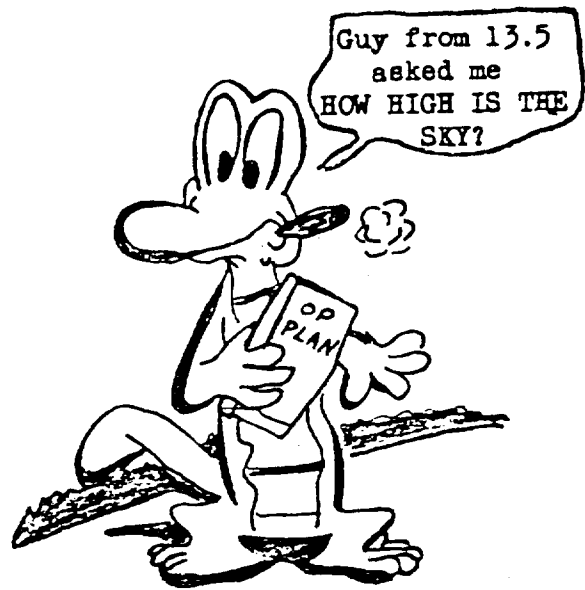
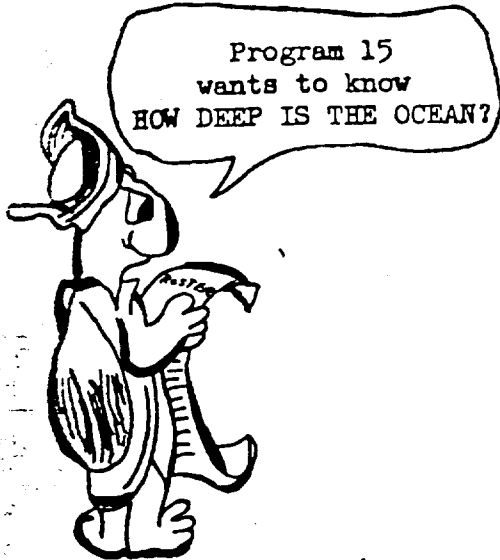
[REDACTED]

[REDACTED]

DISTRIBUTION JAN 6 1954

20 Copies, Series A

A. C. Graves	1/A
N. E. Bradbury	2/A
D. K. Froman	3/A
J. C. Mark ✓	4/A
D. B. Hall ✓	5/A
W. E. Ogle ✓	6/A
R. W. Spence ✓	7/A
L. J. Brown ✓	8/A
G. L. Felt ✓	9/A
N. H. Smith	10/A
K. E. Fields	11/A
P. W. Clarkson	12/A
H. F. York	13/A
D. Sewell	14/A
H. K. Gilbert	15/A
J. L. Gaylord	16/A
LASL Report Library	17/A -- 20/A



██████████

ACKNOWLEDGMENT

It would not be possible, in the limited time available, to mention all of the people who have contributed to this Handbook. Thus, it seems appropriate to say that it was put together by the Staff of J Division, using information largely supplied by E Division, W Division, and DIRX, of the Los Alamos Scientific Laboratory, and by the University of California Radiation Laboratory at Livermore. Information has been extracted from various reports of ORNL and LASL, from field data of other operations, and from the FOG, Ostrich, FWC, and LMG meeting notes. Thus, any value of the book should be credited to the above organizations; its faults belong to me.

Directly contributing authors, who of course derived their information from all the sources mentioned above, are:

R. Lee Amott
Wendell Biggers
Harold Brown
Leon J. Brown
Charles I. Browne
Paul Byerly
George A. Cowan
Arthur N. Cox
Alvin L. Embry

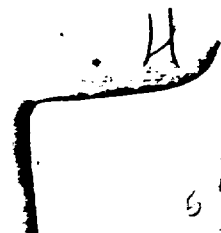
Robert D. England
Herman Hoerlin
David Jones
John S. Malik
William E. Ogle
Daniel Seacord
Newell H. Smith
Roderick W. Spence
Bob E. Watt

and, as usual, D. Whitcomb put it all together.

W. E. Ogle
William E. Ogle

CONTENTS

Acknowledgment	iv
Introduction	xi
CHAPTER 1 THE DEVICES	1-1
1.1 General	1-1
1.2	1-2
1.3	1-4
1.4	1-6
1.5	1-9
1.6	1-13
1.6.1 Fundamental Ideas	1-13
1.6.2	1-14
1.6.3	1-19
1.7	1-21
1.8	1-23
1.9	1-24
CHAPTER 2 MEASUREMENTS	2-1
2.1 General Statements	2-1
2.2 Methods of Measuring Energy Release	2-9
2.2.1 Energy Release By Radiochemical Means	2-9
A. Energy Release from Primary Bombs	2-9
B. Total Energy Release	2-10
C. Energy Release Information from Detectors	2-13
2.2.2 Hydrodynamic Yield from Fireball Photography	2-19
2.2.3 Power vs Time and Time of Minimum Measurement (Bhangmeter)	2-22
2.2.4 Yield Determination by Time of Arrival Method	2-27
2.2.5 Alpha Measurements	2-29
A. Introduction	2-29
B. Expected Gamma-ray Levels	2-32
C. UCRL Measurements	2-33
D. Teller and Scintillation Alpha	2-34
E. Electromagnetic Alpha	2-41



CHAPTER 2 MEASUREMENTS (Cont'd)

2.2.6	Neutron Economy	2-42
2.3	Time Interval Measurements	2-55
2.3.1	Optical Time Interval Measurements	2-55
2.3.2	Time Interval by Electromagnetic Means	2-57
2.3.3	Time Interval by Gamma Rays	2-58
2.4	Radiation Flow and Case Observation	2-59
2.4.1	Frame Pictures	2-59
2.4.2	Hot Spots	2-62
2.5	Thermonuclear Reaction Characteristics	2-69
2.5.1	General	2-69
A.	Ganex Type Measurements, [REDACTED] Experiment	2-69
B.	Tenex Type Measurements, [REDACTED] Experiment	2-70
C.	[REDACTED] Experiments	2-72
2.5.2	[REDACTED] Experiment	2-73
2.5.3	[REDACTED] Experiment	2-79
2.5.4	Temperature Measurement of D-T Reaction from Width of Neutron Energy Peak	2-89
2.5.5	Relativistic Calculation of Velocity of Neutron from D-T Reaction, in Center of Mass System	2-98
2.6	Miscellaneous Experiments	2-101
2.6.1	Temperature [REDACTED]	2-101
2.6.2	Heavy Element Program	2-105
2.6.3	Bomb Spectroscopy	2-108
2.6.4	Prompt Thermal Radiation	2-112
2.6.5	Atmospheric Transmission	2-117
CHAPTER 3	MISCELLANEOUS DATA	3-1
	(See list of figures and tables for contents)	
APPENDIX A	OUTLINE OF SCIENTIFIC PROGRAMS	A-1
APPENDIX B	TASK UNITS OF TG 7.1	B-1

5

FIGURES

CHAPTER 1 THE DEVICES

1.1	[REDACTED] (Over-all Sketch)	1-53
1.2	[REDACTED]	1-54
1.3	[REDACTED] (Over-all Sketch)	1-55
1.4	[REDACTED] (Over-all Sketch)	1-56
1.5	[REDACTED] (Over-all Sketch)	1-57
1.6	[REDACTED]	1-58
1.7	[REDACTED] Base	1-59
1.8	[REDACTED] (Cross-section Sketch)	1-60
1.9	[REDACTED] Hemisphere (Sketch)	1-61
1.10	[REDACTED] Hemisphere (Photograph)	1-62
1.11	[REDACTED] Hemisphere	1-63
1.12	[REDACTED] (Over-all Sketch)	1-64
1.13	Interface Radii vs Time,	1-65
1.14	Interface Radii vs Time,	1-66
1.15	Interface Radii vs Time,	1-67
1.16	Interface Radii vs Time,	1-68
1.17	Interface Radii vs Time,	1-69
1.18	Interface Radii vs Time,	1-70
1.19	Interface Radii vs Time,	1-71
1.20	Sketch of Cobra	1-72
1.21	Sketch of Racer IV	1-73

CHAPTER 2 MEASUREMENTS

2.1	Fireball Radius vs Time--Greenhouse Dog and George; Ivy Mike and King, [REDACTED] Estimated	2-23
2.2	Power vs Time--Greenhouse Dog and George; Ivy Mike and King (NRL Optics Div. Data)	2-25
2.3	Time of Minimum vs Total Energy Release	2-26
2.4	Yield vs Time Difference ("Prediction Plot" for Time of Arrival Measurement)	2-30
2.5	Shock Arrival Time vs Distance	2-31
2.6	Comparison of Plastic at High Gamma Dosage Rates with Terphenyl in Toluene at Lower Rates	2-36
2.7	σv vs Temperature for the D-T and D-D _p Reactions	2-44
2.8	Total Cross Sections for the D-T and D-D _p Reactions	2-45
2.9	Nitrogen Capture Gamma Rays	2-52
2.10	Fission Product Gamma-ray Intensity	2-53
2.11	Fission Product Gamma Rays in Air	2-54
2.12	Geometry of Ganex and Tenex Channels, Experiment	2-74

Copied/DOE
LANL, J-DIV.

6

CHAPTER 2 MEASUREMENTS (Cont'd)

2.13	Computed Spectrum of Neutron Flux at Surface of ██████████	2-85
2.14	Rate of Growth of ██████████ Experiment	2-87
2.15	Expected Signal Behavior, ██████████ Experiment (R vs t)	2-90
2.16	Expected Signal Behavior, ██████████ Experiment (r/sec vs t)	2-91
2.17	Display System Coverage, ██████████ Experiment	2-92
2.18	Relative Number of D- ██████████ Reactions as Function of Energy in Center of Mass System at 10-kev Temperature	2-100
2.19	Thermal Yield vs Radiochemical Yield	2-114
2.20	Predicted Thermal Flux at Sea Level for Atmospheric Conditions Similar to Ivy Mike	2-116

CHAPTER 3 MISCELLANEOUS DATA

3.1	Sketch of Bikini Atoll Showing Zero Points	3-2
3.2	Sketch of Eniwetok Atoll, Showing Zero Point	3-3
3.3	██████████ Alpha vs Time	3-4
3.4	██████████ Alpha vs Time	3-5
3.5	Ivy Mike Gamma-ray Intensity vs Time, 2300 meters (r/sec vs time in μ sec)	3-6
3.6	Ivy Mike Gamma-ray Intensity vs Time, 2300 meters (r/sec vs time in sec)	3-7
3.7	Ivy Mike Gamma-ray Intensity vs Time, 4000 meters	3-8
3.8	Prompt Dose vs Distance, 10 MT (Ivy Mike and Computed Data)	3-9
3.9	Ivy King Gamma-ray Intensity vs Time, 1660 meters	3-10
3.10	Dose Rate vs Time, 550-KT Composite, 1660 meters (Greenhouse Easy and Ivy King Data)	3-11
3.11	Ivy Mike Fall-out Intensity vs Time	3-13
3.12	Contamination from Mike Shot, M Day	3-14
3.13	Contamination from Mike Shot, M + 1 Day	3-15
3.14	Contamination from Mike Shot, M + 2 Days	3-16
3.15	Contamination from Mike Shot, M + 3 Days	3-17
3.16	Contamination from Mike Shot, M + 4 Days	3-18
3.17	Contamination from Mike Shot, M + 5 Days	3-19
3.18	Contamination from Mike Shot, M + 6 Days	3-20
3.19	Contamination from Mike Shot, M + 7 Days	3-21
3.20	Contamination from Mike Shot, M + 8 Days	3-22
3.21	Contamination from Mike Shot, M + 9 Days	3-23
3.22	Contamination from Mike Shot, M + 10 Days	3-24
3.23	Contamination from Mike Shot, M + 11 Days	3-25
3.24	Contamination from Mike Shot, M + 13 Days	3-26

CHAPTER 3 MISCELLANEOUS DATA (Cont'd)

3.25 Contamination from Mike Shot, M + 14 Days 3-27

3.26 Distribution of Radioactivity in Surface Waters
of Bikini Lagoon, Crossroads Baker + 1 Day 3-29

3.27 Distribution of Radioactivity in Surface Waters
of Bikini Lagoon, Crossroads Baker + 2 Days 3-30

3.28 Distribution of Radioactivity in Surface Waters
of Bikini Lagoon, Crossroads Baker + 3 Days 3-31

3.29 Peak Overpressure vs Distance, Yields of 1 - 10
MT, Overpressures of 0.1 - 10 psi 3-32

3.30 Peak Overpressure vs Distance, Yields of 1 - 10
MT, Overpressures of 10 - 10³ psi 3-33

3.31 Peak Overpressure vs Distance, Mike Shot 3-34

3.32 Peak Overpressure vs Distance, Thermal Surface 3-35

3.33 Peak Dynamic Overpressure vs Distance, Over-
pressures of 0.1 - 10 psi 3-36

3.34 Peak Dynamic Overpressure vs Distance, Over-
pressures of 10 to 10³ psi 3-37

3.35 Material Velocity vs Peak Overpressure 3-38

3.36 Radius at Time of Minimum vs Yield 3-39

3.37 Wave Amplitude in Shallow Water vs Distance 3-40

3.38 Contour Map of Greenhouse Dog Crater 3-43

3.39 Contour Map of Greenhouse Easy Crater 3-44

3.40 Contour Map of Greenhouse George Crater 3-45

3.41 Contour Map of Ivy Mike Crater 3-46

Copied/DOE
LANL, J-Div.

8

TOP

TABLES

CHAPTER 1 THE DEVICES

1.1	Approximate Component Weights,	1-26
1.2	Approximate Component Weights,	1-29
1.3	Approximate Component Weights,	1-32
1.4	Approximate Component Weights,	1-35
1.5	Approximate Component Weights,	1-38
1.6	Approximate Component Weights,	1-39
1.7	Approximate Component Weights,	1-41
1.8	Approximate Component Weights,	1-44
1.9	Approximate Component Weights,	1-45
1.10	Integral of pdR --	1-46
1.11	Integral of pdR --	1-47
1.12	Integral of pdR --	1-48
1.13	Integral of pdR --	1-49
1.14	Integral of pdR --	1-50
1.15	Integral of pdR --	1-51
1.16	Integral of pdR --	1-52

CHAPTER 2 THE MEASUREMENTS

2.1	Expected Gamma-ray Levels	2-33
2.2	Cross Sections for Tuballoy (TM-47)	2-46
2.3	Predicted Lighting Times of Core hot Spots	2-67
2.4	Interface Radii, Material Thicknesses, and Neutron Mean Free Paths (Problem AC 1-5)	2-80
2.5	Predicted Penetration Times,	2-106
2.6	Transmission and Thermal Flux Received as Function of Field of View for Conditions Similar to Those Existing on Mike Shot	2-119

CHAPTER 3 MISCELLANEOUS DATA

3.1	Ivy Mike Peak Fall-out Intensity	3-12
3.2	J-11 Threshold Detectors	3-47
3.3	J-12 Threshold Detectors	3-48
3.4	Ivy Neutron Intensities as Seen by Various Threshold Detectors	3-49
3.5	Predicted Neutron Intensities as Seen by Various Threshold Detectors	3-50

11-205 .
PAGES ~~1176~~ WERE JUDGED
IRRELEVANT AND WERE NOT COPIED

CHAPTER 3

MISCELLANEOUS DATA

This chapter is simply a collection of random information that may be of use and not otherwise easily obtainable in the field. No effort has been made to achieve the optimum organization.

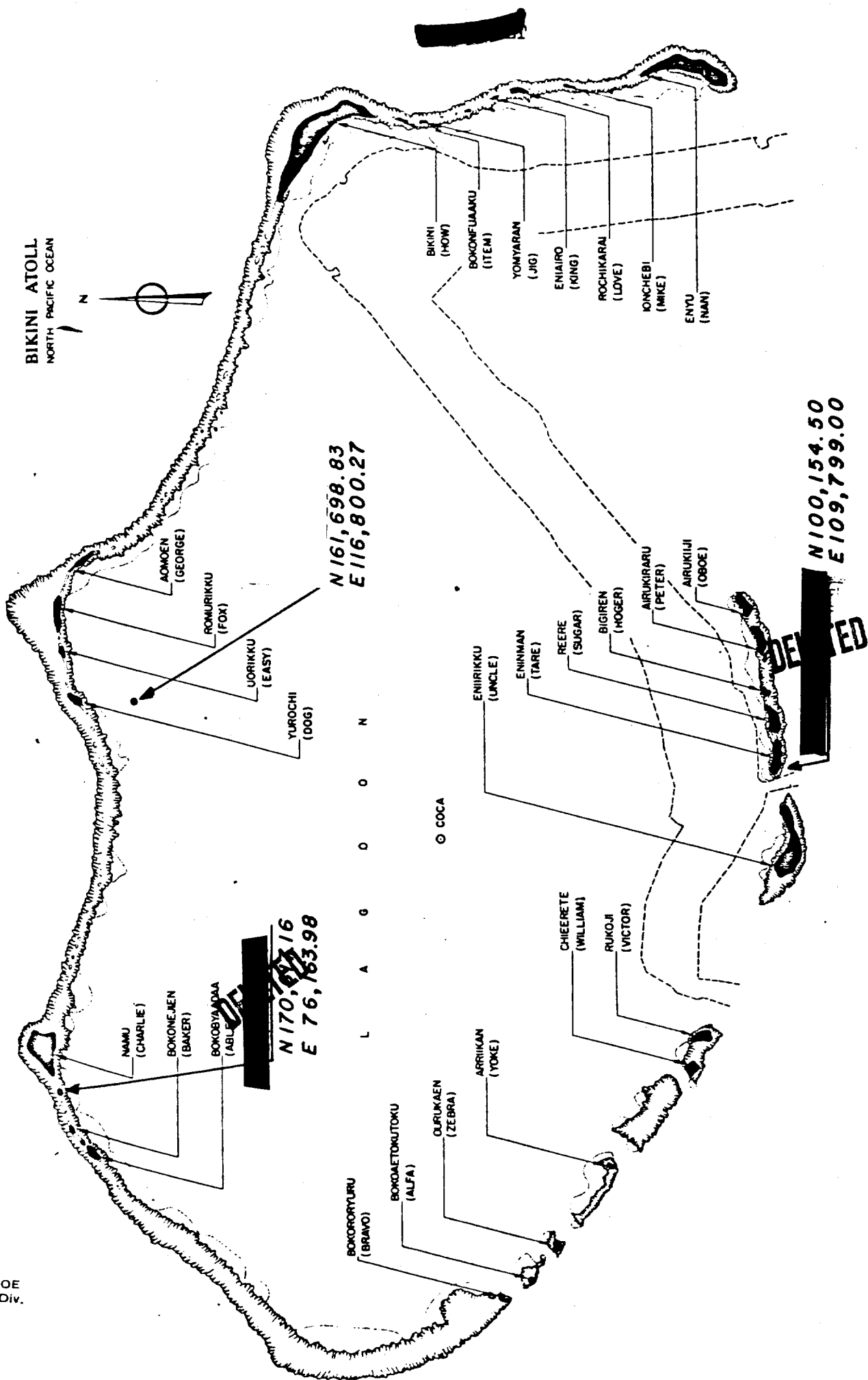


Fig. 3.1 - Sketch of Bikini Atoll,
Showing Zero Points

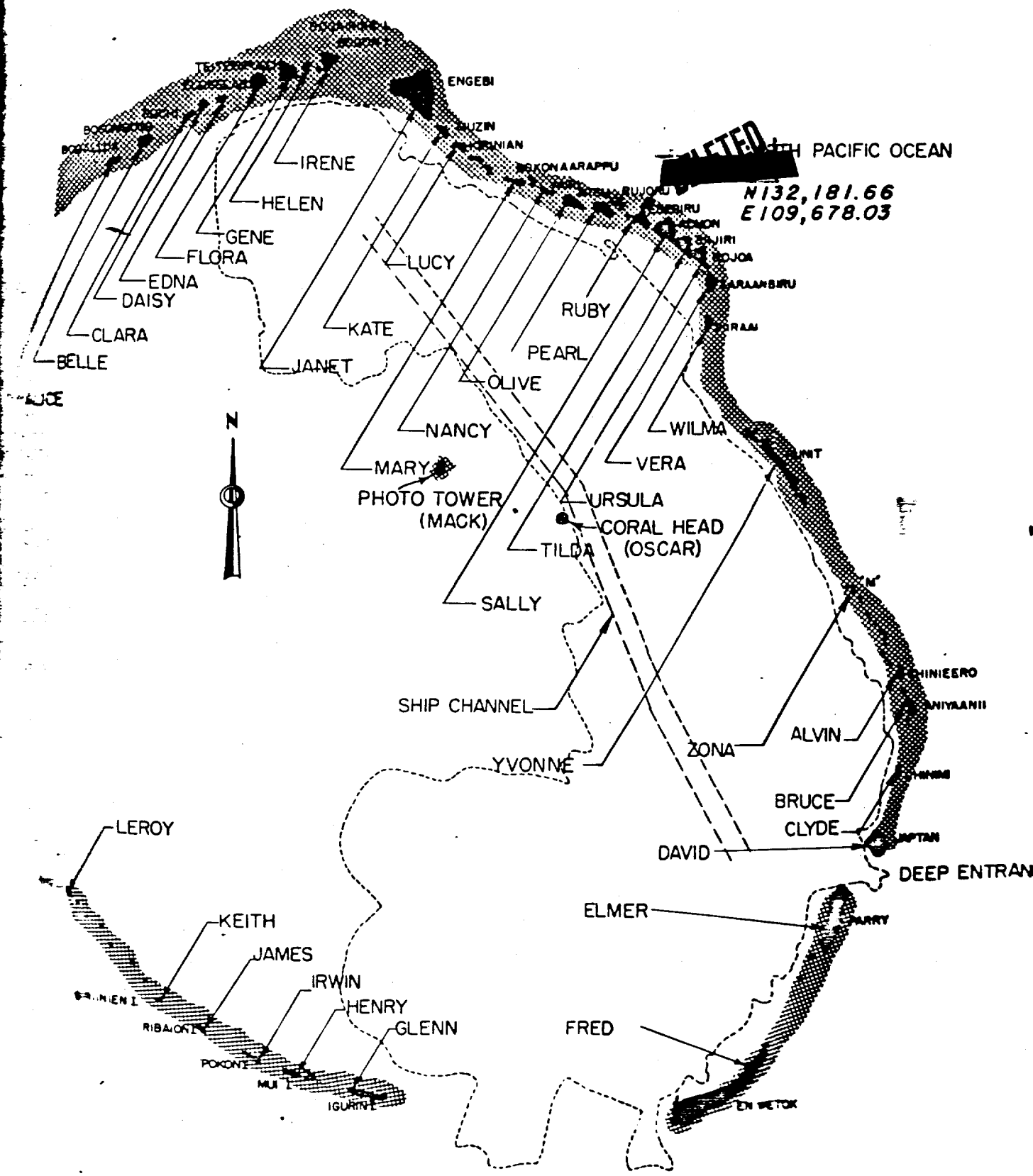


Fig. 3.2 - Sketch of Eniwetok Atoll, Showing Zero Point

12

DELETED

TIME IN SERVICE

COPIED/DCE
L... DIVS

13

09

3

2

(1. HS) D

3-4

LANE 9 DIV 3

DELETED

2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.1
-0.2

(1-HS) D

3-5

21

10
8
6
4
2
0
TIME IN SHAKES (ARBITRARY ORIGIN)

18

16

14

12

10

8

6

4

2

0

1A

ROENTGENS /SECOND

DELETED

Copied/DOE
LANL, J-Div.



DELETED

COPIES/SECTION

3-7



Copied/DOE
LANL, J-DIV.

16
212

1

DELETED

TIME - SECONDS

Copied/DOE
LANL, J-Div

10
ROBERTS/SECOND

10
3-8

17
213

DELETED

DISTANCE - METERS

3-9

DELETED

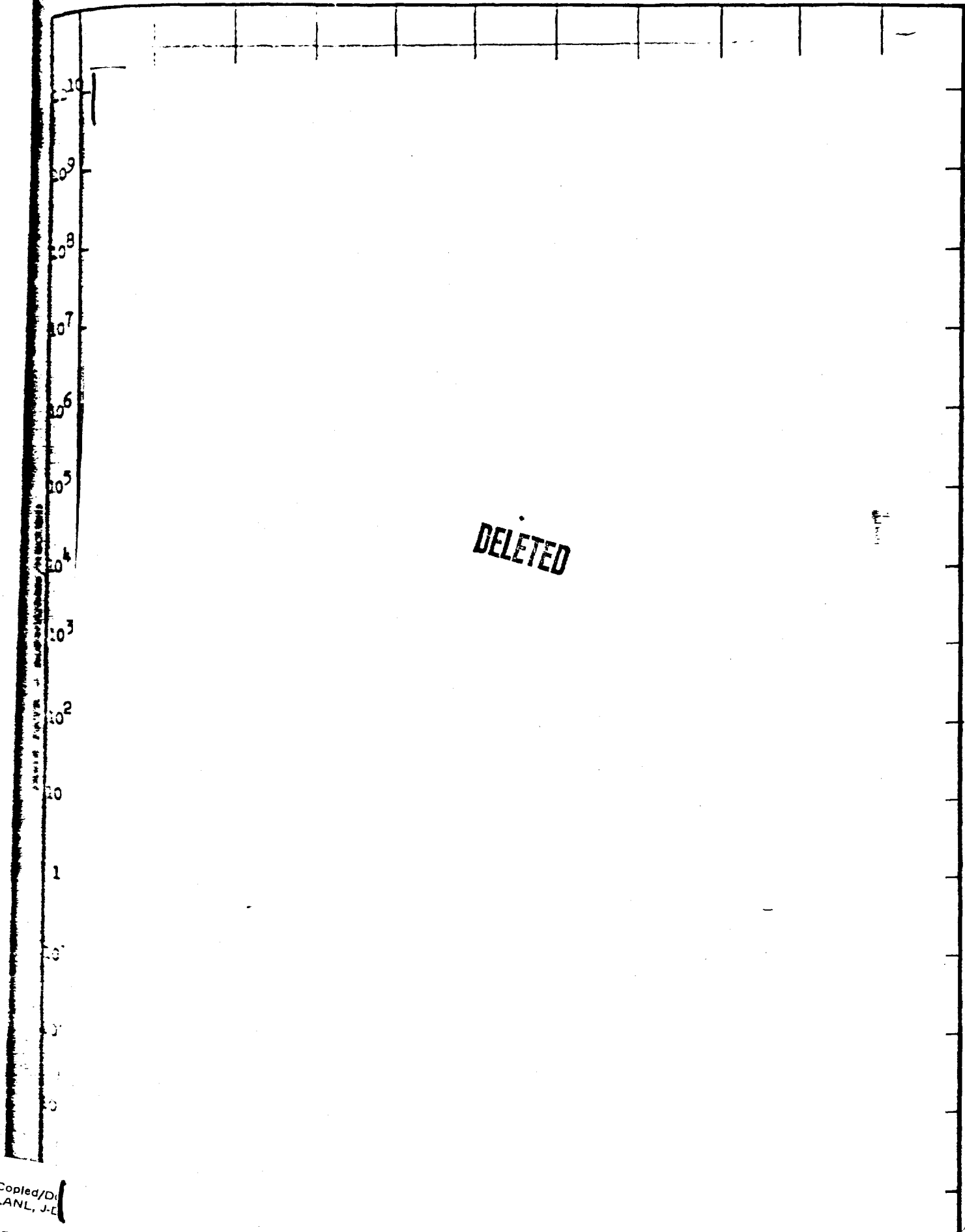
TIME - SECONDS

3-10

Copied/DOE
LANL, J-DIV.

19
21 | 16

~~TOP SECRET~~



DELETED

20

Copied/Di
LANL, J-L

TIME - SECONDS

DETZEN 10-M AGEPROOF

3-11

216

~~CONFIDENTIAL~~

TABLE 3.1
IVY MIKE PEAK FALL-OUT INTENSITY
(M. Klein)

Location	Intensity
Engebi	10^3 R/hr
Aomon	190 R/hr
Runit	9 R/hr
Rigili	.5 R/hr
Aniyaanii	150 mR/hr
Eniwetok	1 mR/hr*

*Questionable

Copied/DOE
LANL, J-DIV.

3-12

~~CONFIDENTIAL~~

21

21

23

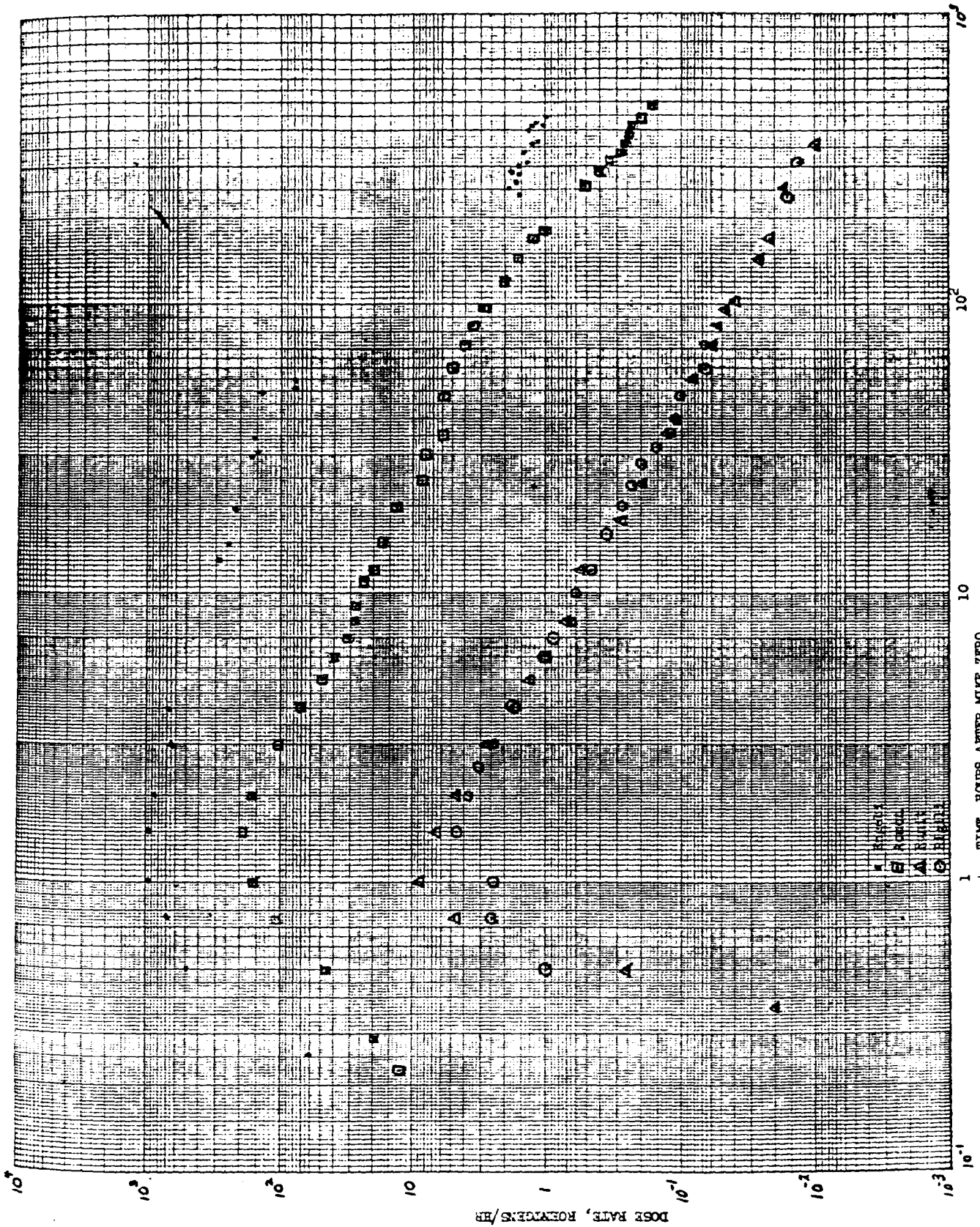


Fig. 3.11 - Mike Fall-out Intensity vs Time (M. Klein)

Copied/DOE
LANL, J-DIV.

~~TOP SECRET~~

27

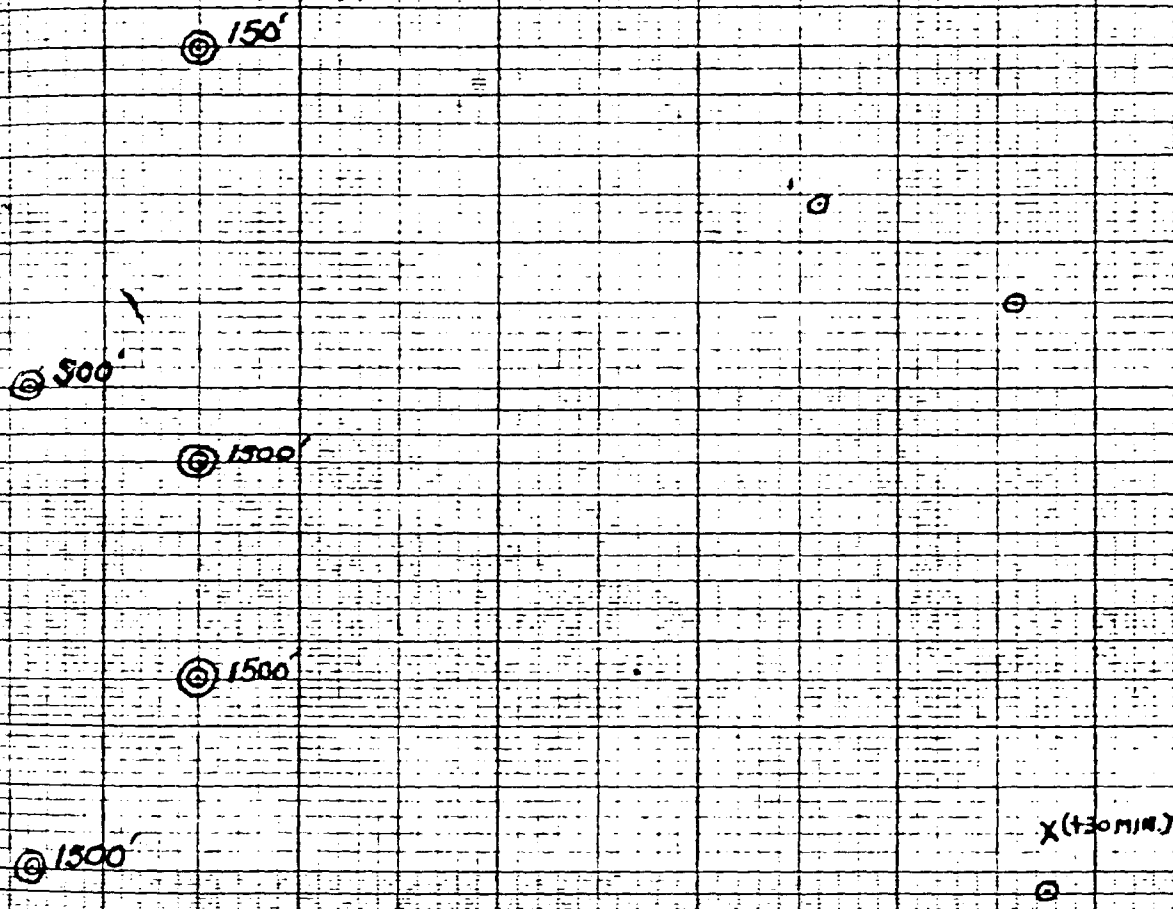


Fig. 3.12

CONTAMINATION FROM MIKE SHOT
M-Day

- X Ground readings--East Side Islands
- Ground readings--West Side Islands
- ⊙ Air Readings--25 ft--East Side Islands
- △ Air Readings--25 ft--West Side Islands
- ⊙ Air Readings Altitude as Shown

NOTE: Figs. 3.12 thru 3.25 are from
RadSafe Data

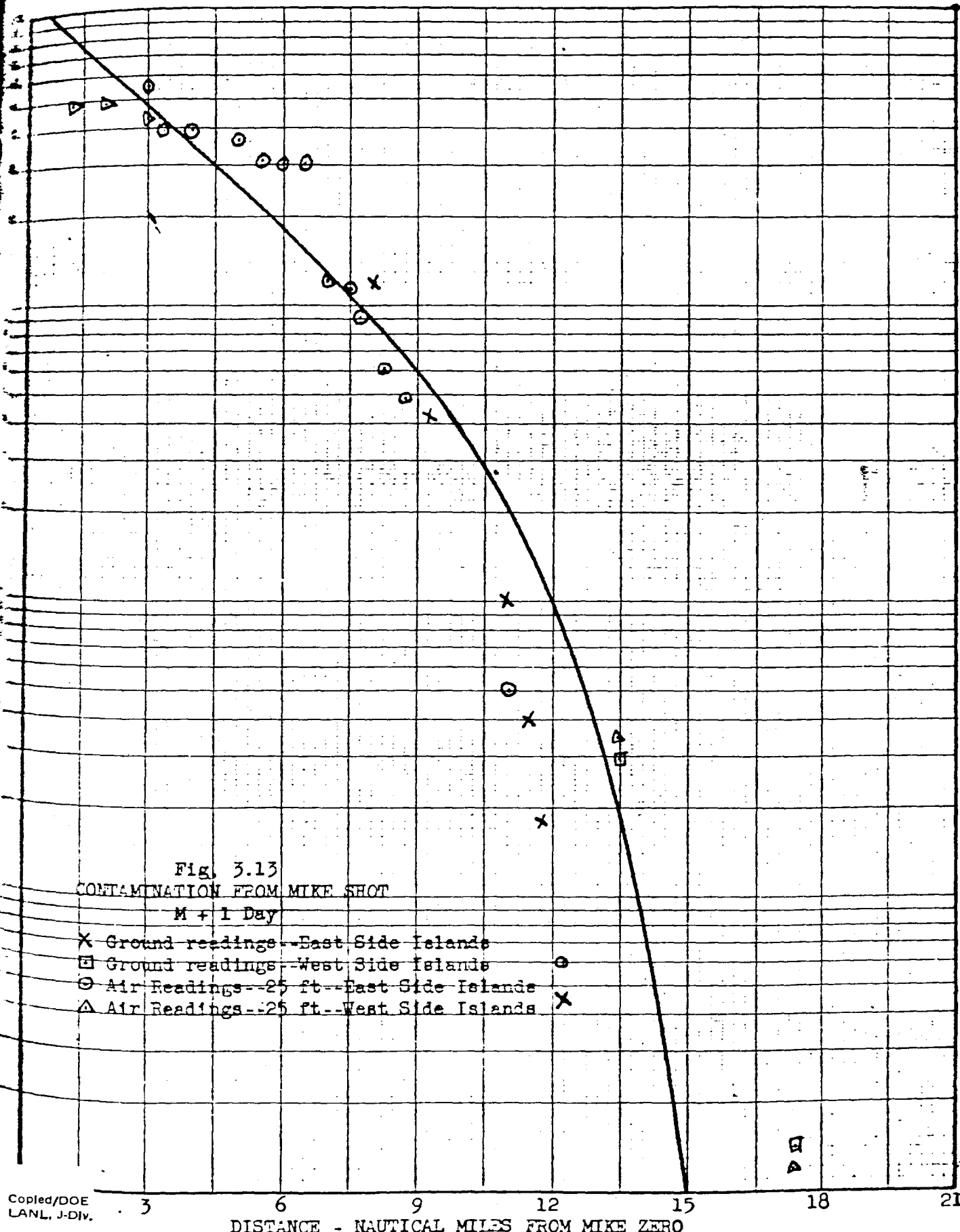


Fig. 3.13
CONTAMINATION FROM MIKE SHOT
M + 1 Day

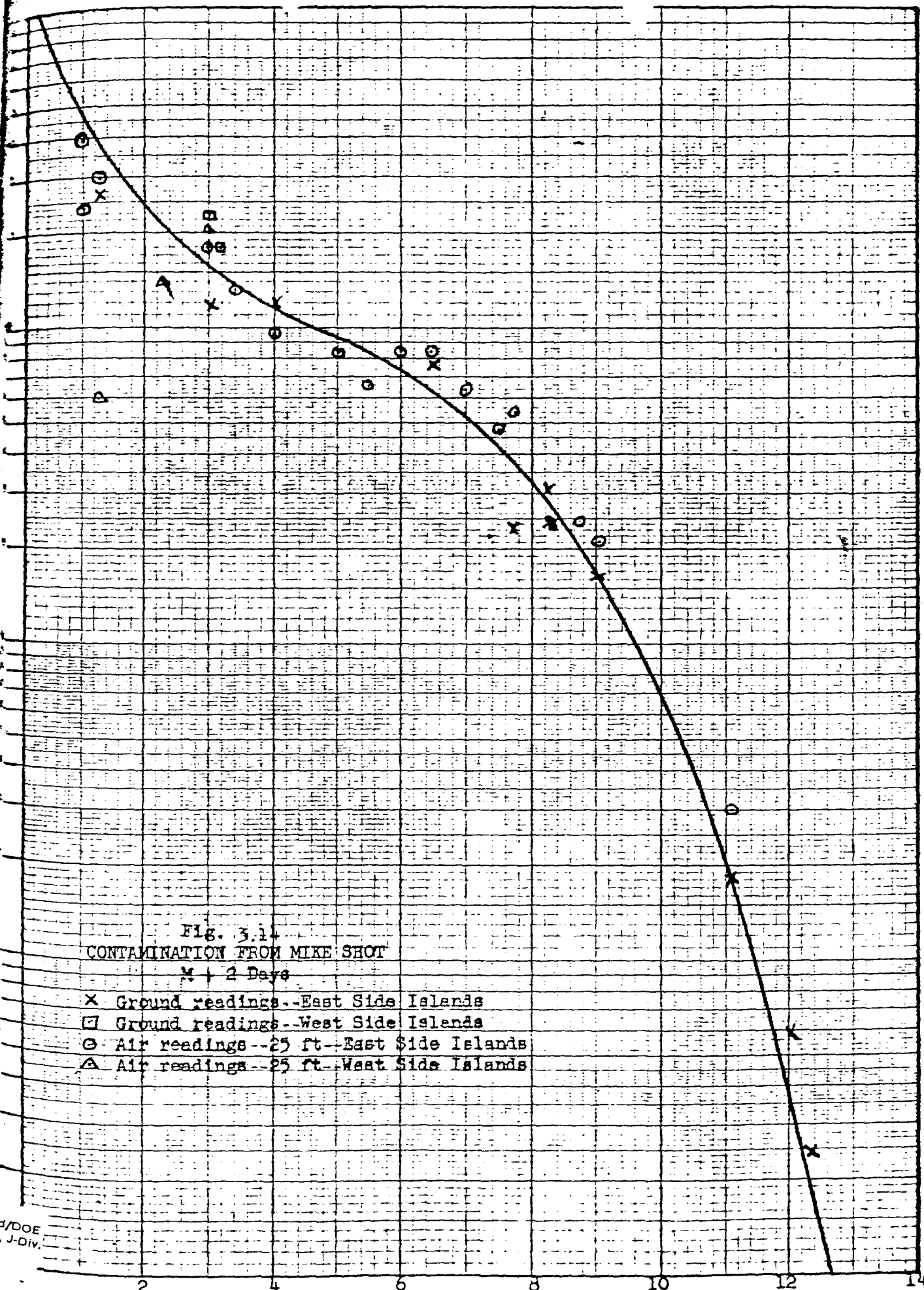
- X Ground readings--East Side Islands
- Ground readings--West Side Islands
- Air Readings--25 ft--East Side Islands
- △ Air Readings--25 ft--West Side Islands

Copied/DOE
LANL, J-DIV.

DISTANCE - NAUTICAL MILES FROM MIKE ZERO

Fig. 3.1
CONTAMINATION FROM MIKE SHOT
M + 2 Days

- X Ground readings--East Side Islands
- Ground readings--West Side Islands
- Air readings--25 ft--East Side Islands
- △ Air readings--25 ft--West Side Islands



Copied/DOE
LANL, J-DIV.

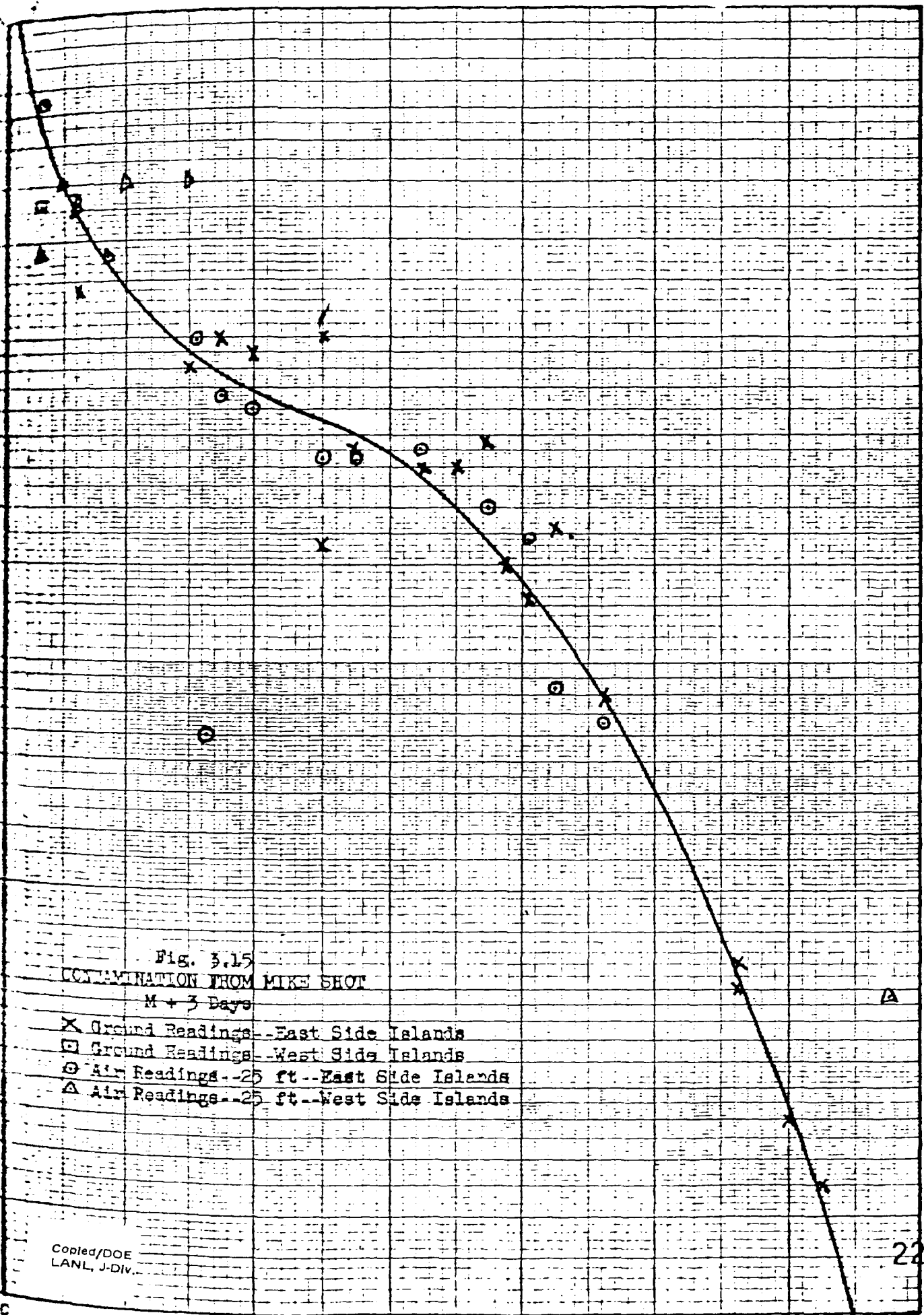


Fig. 3.15
CONTAMINATION FROM MIKE SHOT
M + 3 Days

- X Ground Readings--East Side Islands
- Ground Readings--West Side Islands
- Air Readings--25 ft--East Side Islands
- △ Air Readings--25 ft--West Side Islands

Copied/DOE
LANL, J.Div.

222 26

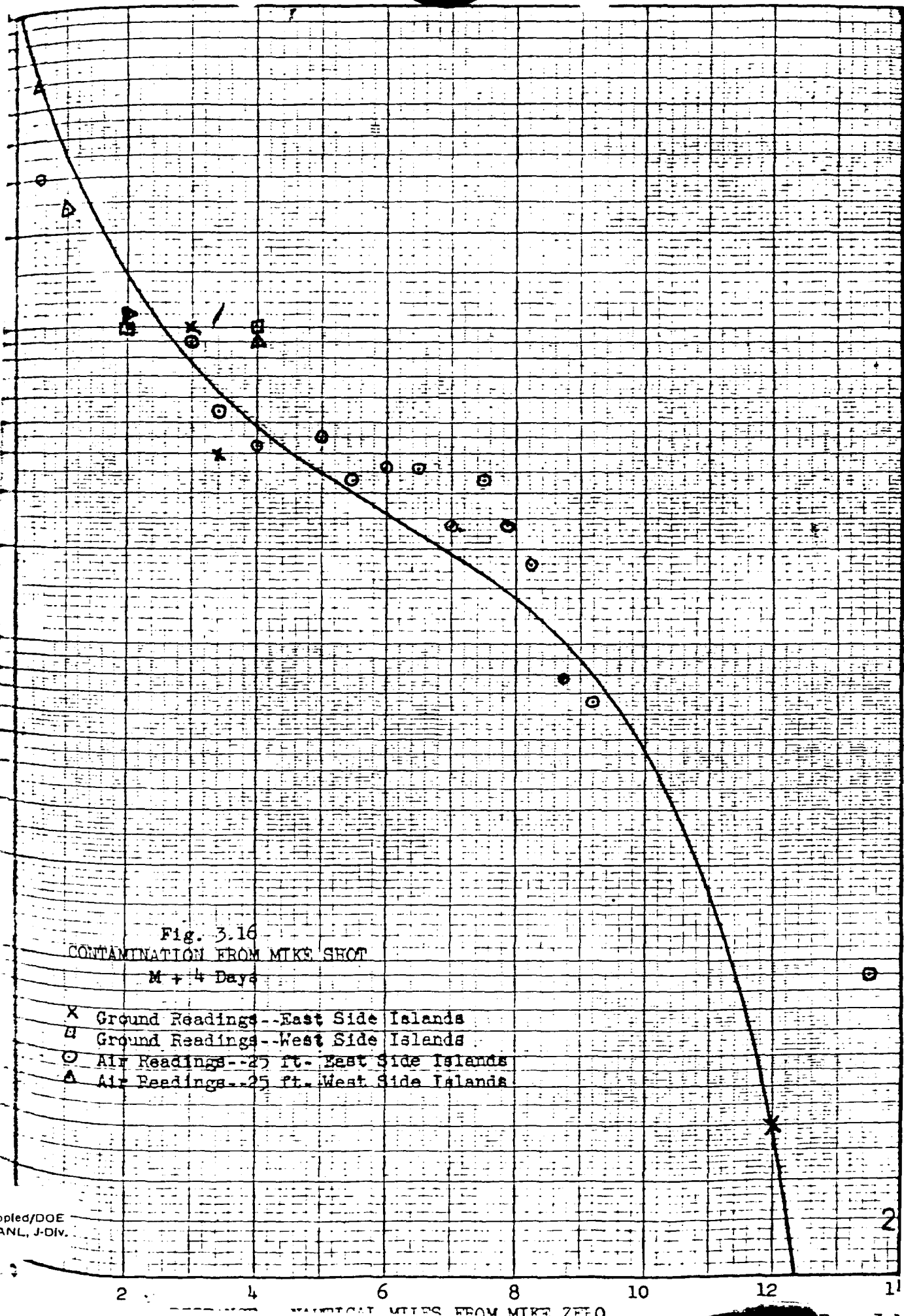


Fig. 3.16
CONTAMINATION FROM MIKE SHOT
M + 4 Days

- X Ground Readings--East Side Islands
- B Ground Readings--West Side Islands
- O Air Readings--25 ft. East Side Islands
- A Air Readings--25 ft. West Side Islands

Copied/DOE
LANL, J-Div.

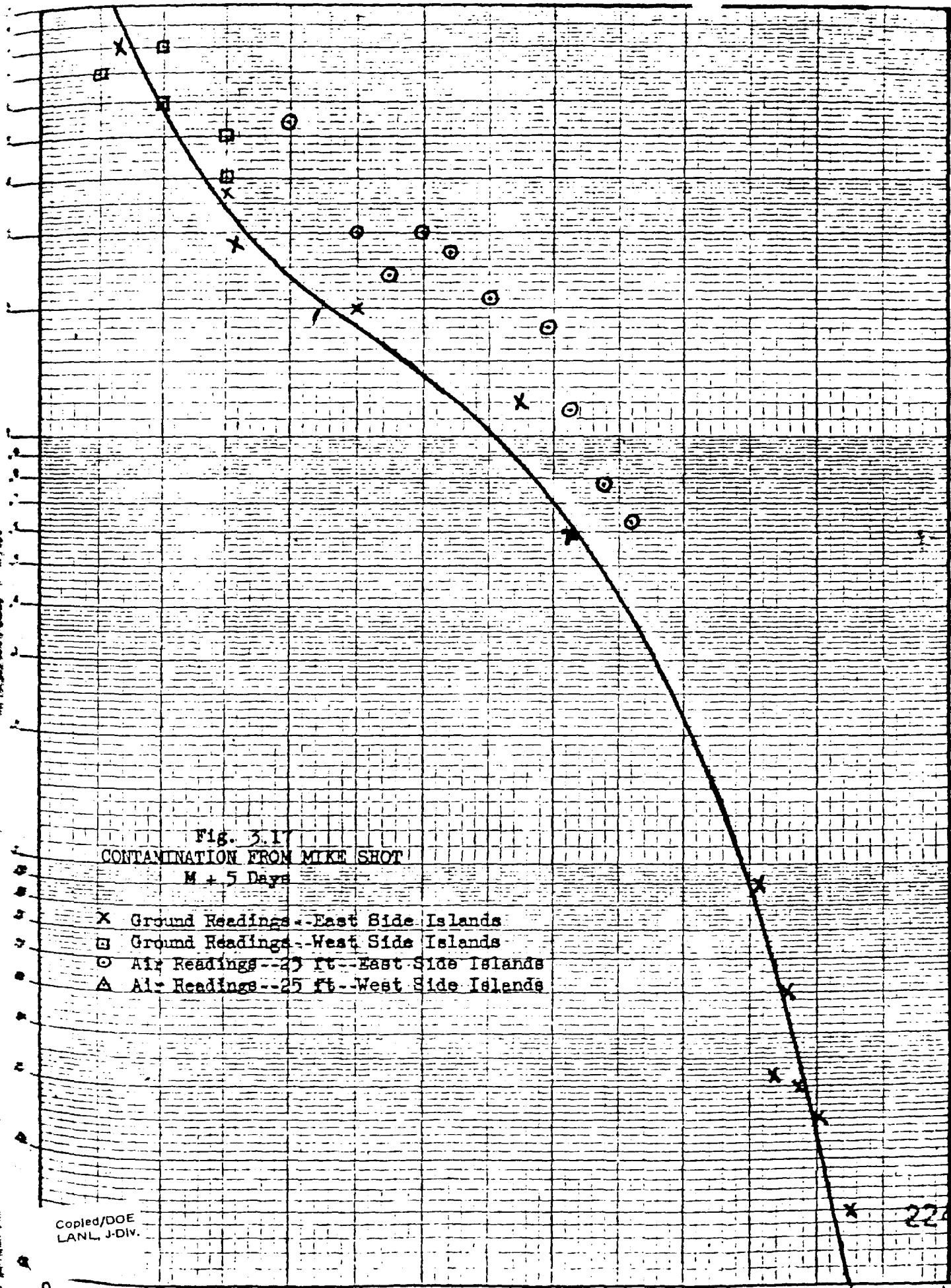
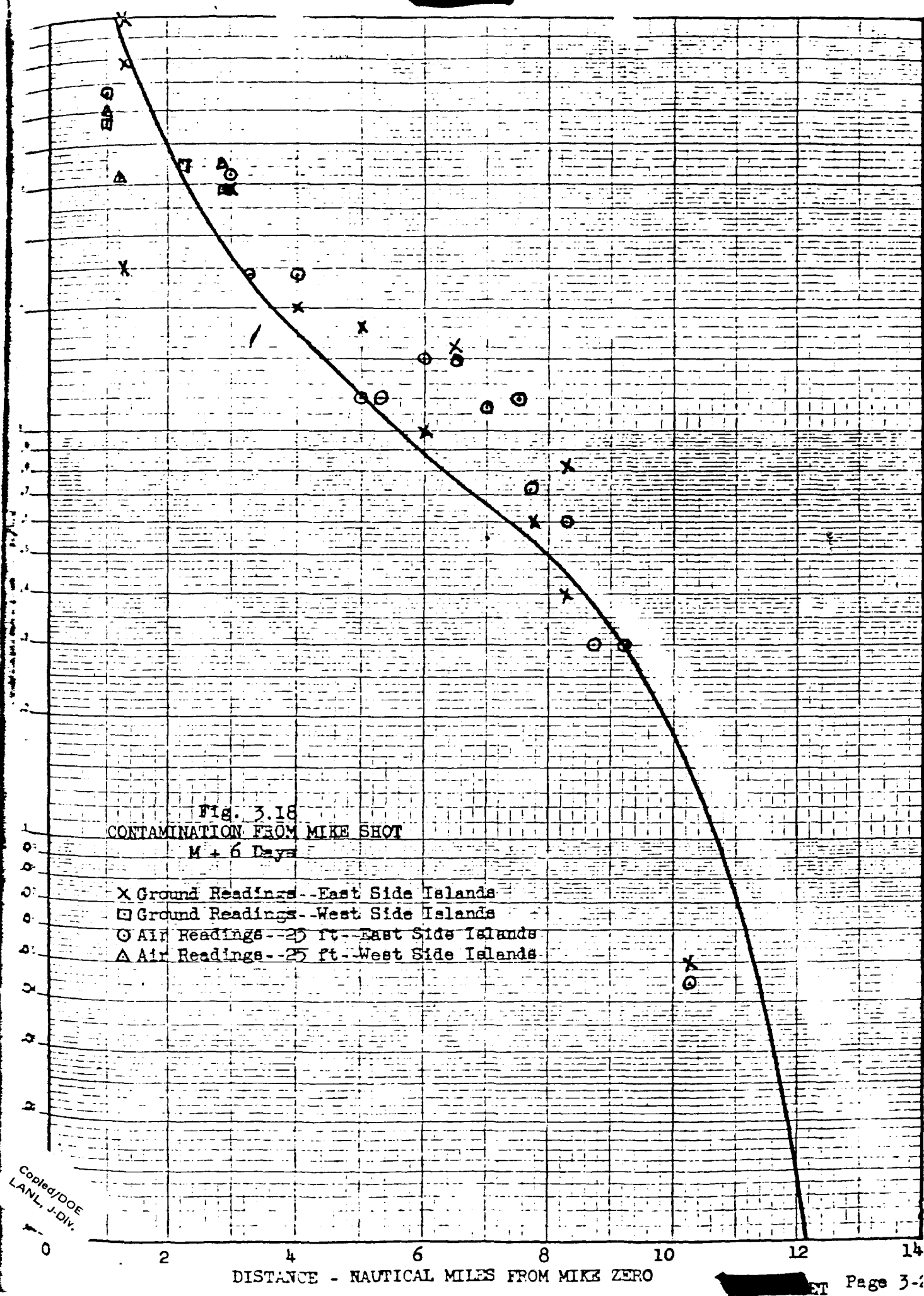


Fig. 3.17
CONTAMINATION FROM MIKE SHOT
M + 5 Days

- X Ground Readings - East Side Islands
- Ground Readings - West Side Islands
- Air Readings - 25 ft - East Side Islands
- △ Air Readings - 25 ft - West Side Islands

Copied/DOE
LANL, J-DIV.

224 28



Copied/DOE
LANL, J-Div.

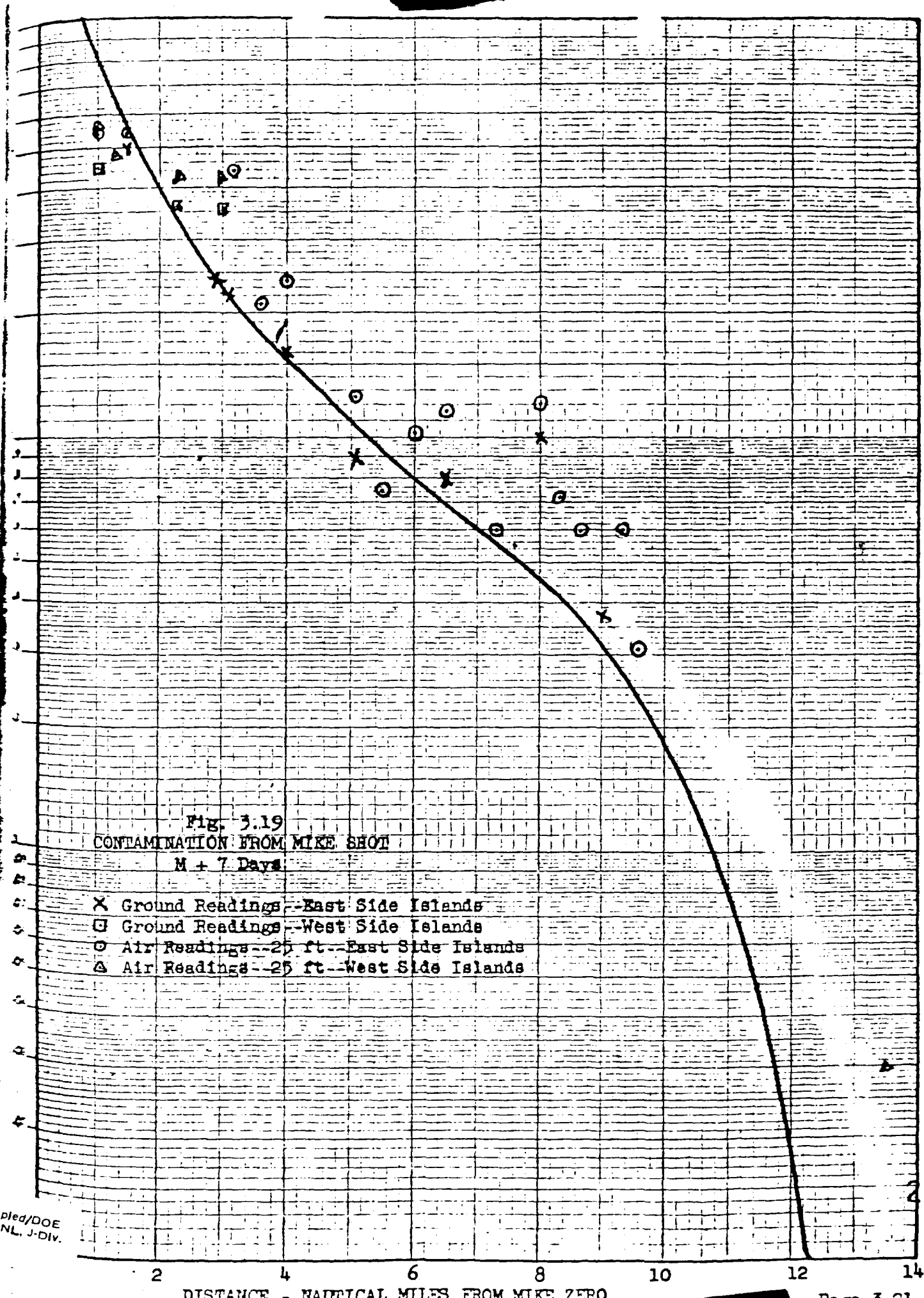


Fig. 3.19
 CONTAMINATION FROM MIKE SHOT
 M + 7 Days

- X Ground Readings - East Side Islands
- Ground Readings - West Side Islands
- Air Readings - 25 ft - East Side Islands
- △ Air Readings - 25 ft - West Side Islands

Copied/DOE
 LANL, J-Div.

226
 27

30

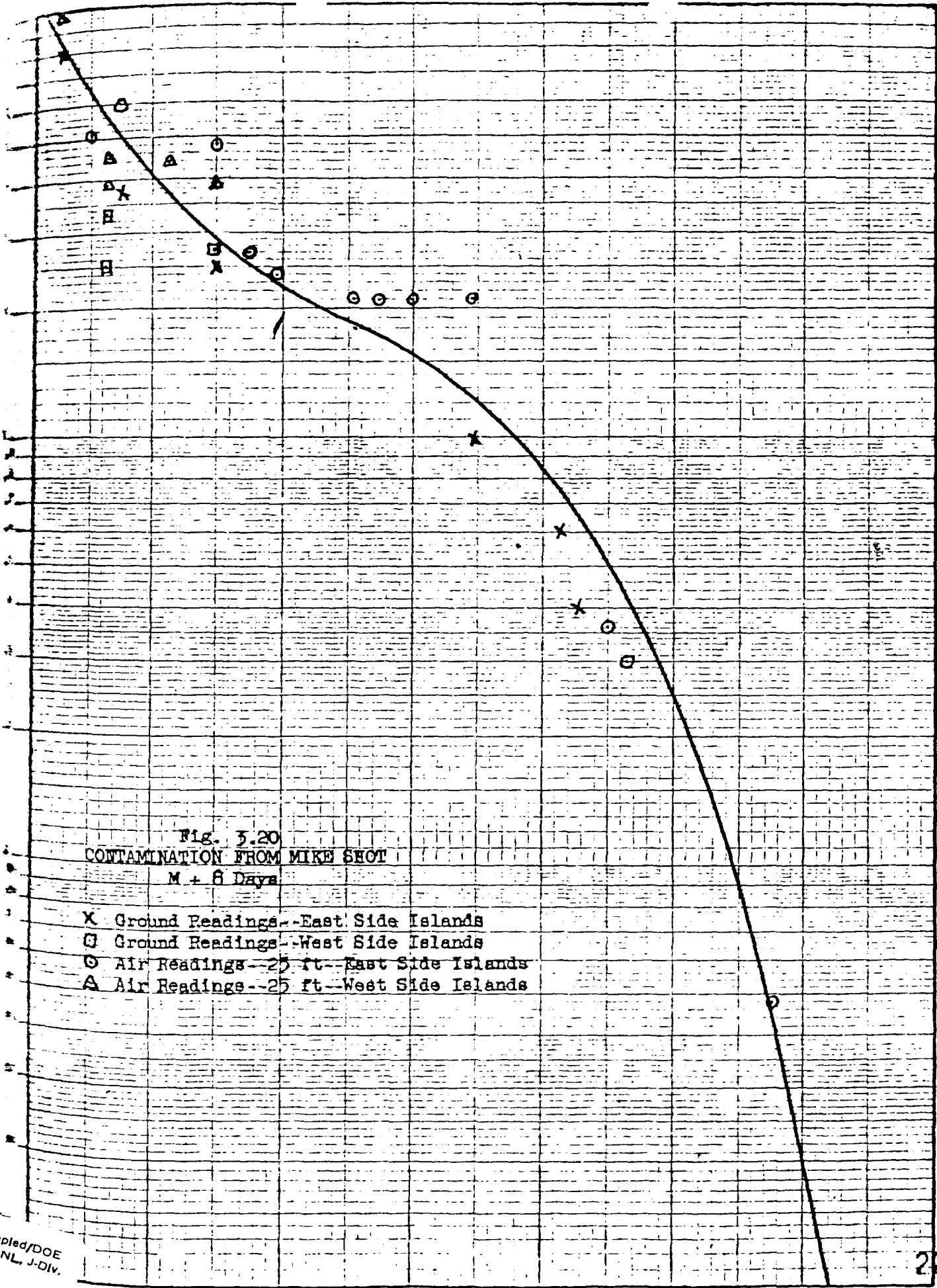


Fig. 3.20
CONTAMINATION FROM MIKE SHOT
M + 8 Days

- X Ground Readings--East Side Islands
- O Ground Readings--West Side Islands
- ⊙ Air Readings--25 ft--East Side Islands
- △ Air Readings--25 ft--West Side Islands

Copied/DOE
LANL, J-DIV.

3
237

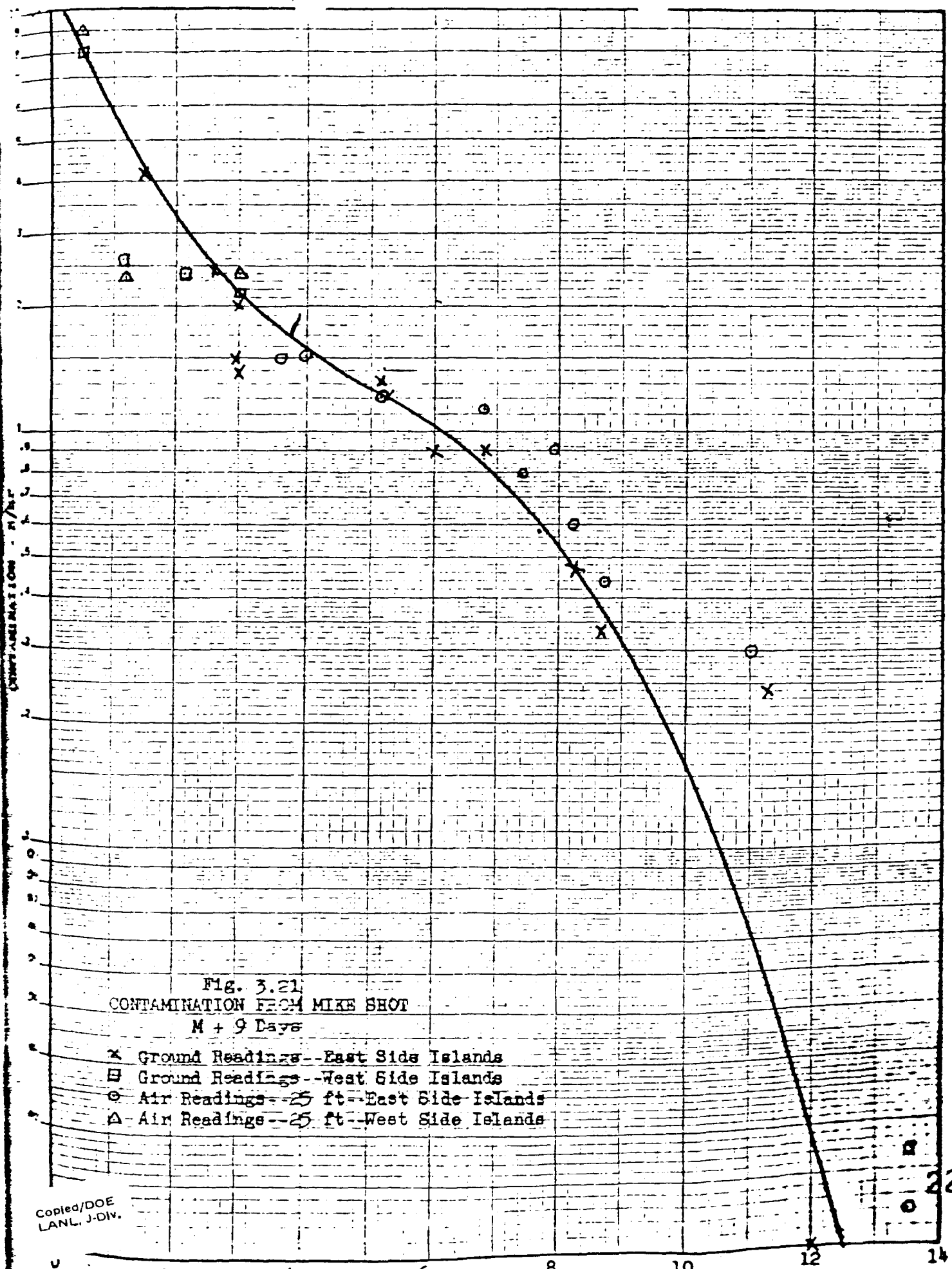


Fig. 3.21
CONTAMINATION FROM MIKE SHOT
M + 9 Days

- X Ground Readings--East Side Islands
- E Ground Readings--West Side Islands
- O Air Readings--25 ft--East Side Islands
- Δ Air Readings--25 ft--West Side Islands

Copied/DOE
LANL, J-DIV.

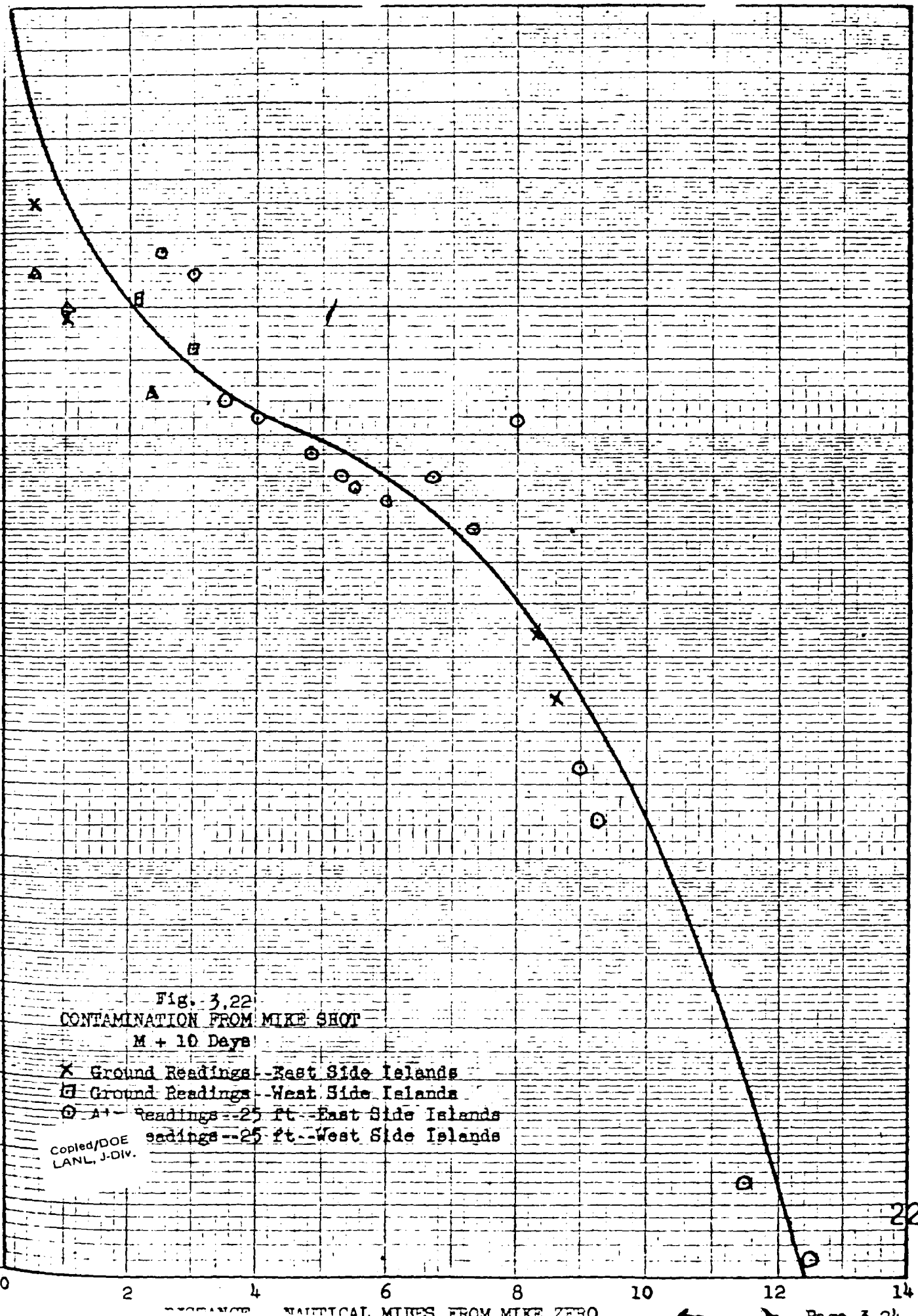


Fig. 3.22
 CONTAMINATION FROM MIKE SHOT
 M + 10 Days
 X Ground Readings - East Side Islands
 B Ground Readings - West Side Islands
 O A+ Readings -- 25 ft -- East Side Islands
 O Readings -- 25 ft -- West Side Islands

Copied/DOE
 LANL, J-DIV.

229

33

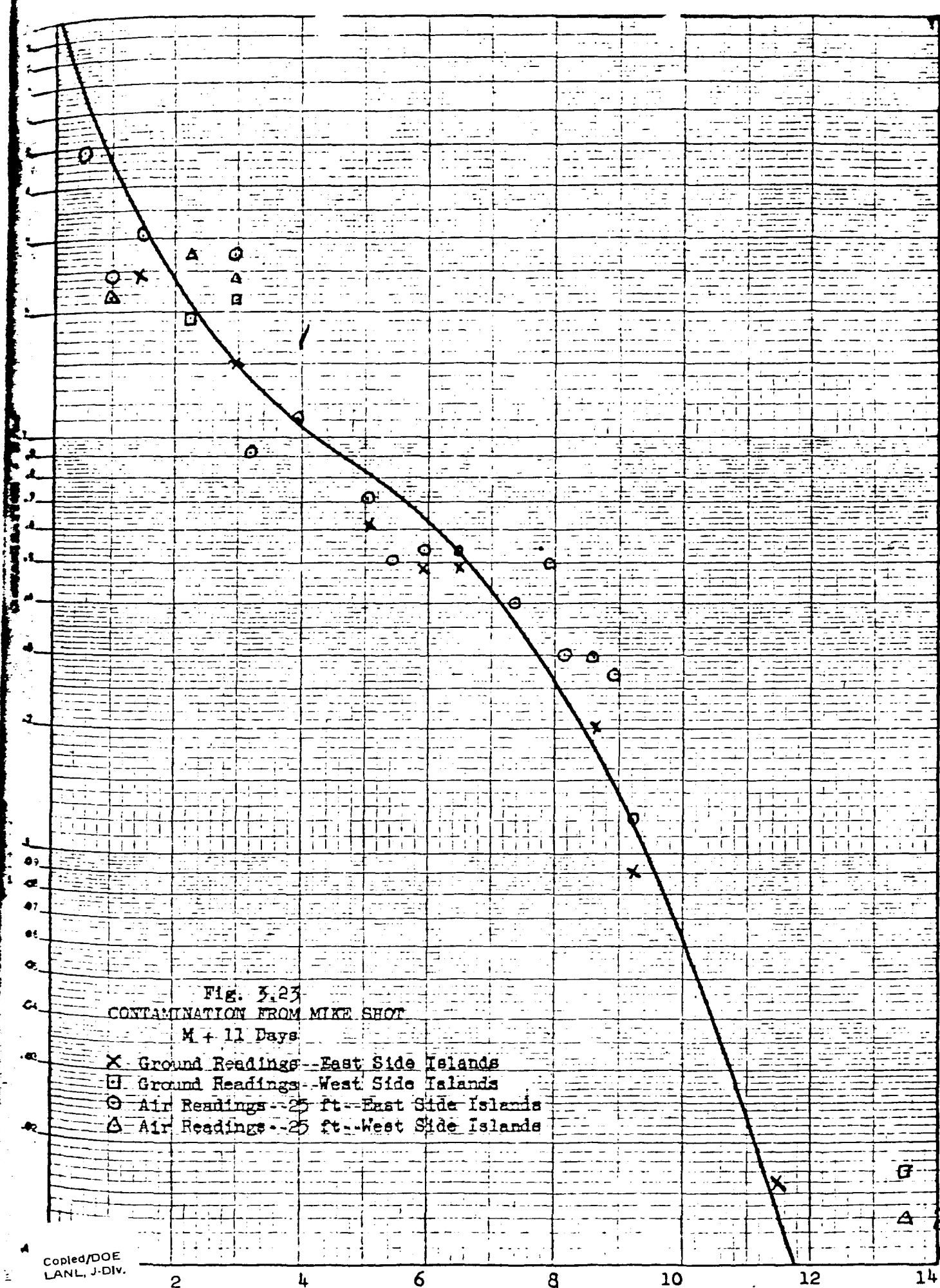


Fig. 3.23
 CONTAMINATION FROM MIKE SHOT
 M + 11 Days

- X Ground Readings--East Side Islands
- Ground Readings--West Side Islands
- Air Readings--25 ft--East Side Islands
- △ Air Readings--25 ft--West Side Islands

Copied/DOE
 LANL, J-Div.

DISTANCE - NAUTICAL MILES FROM MIKE ZERO

230
 34

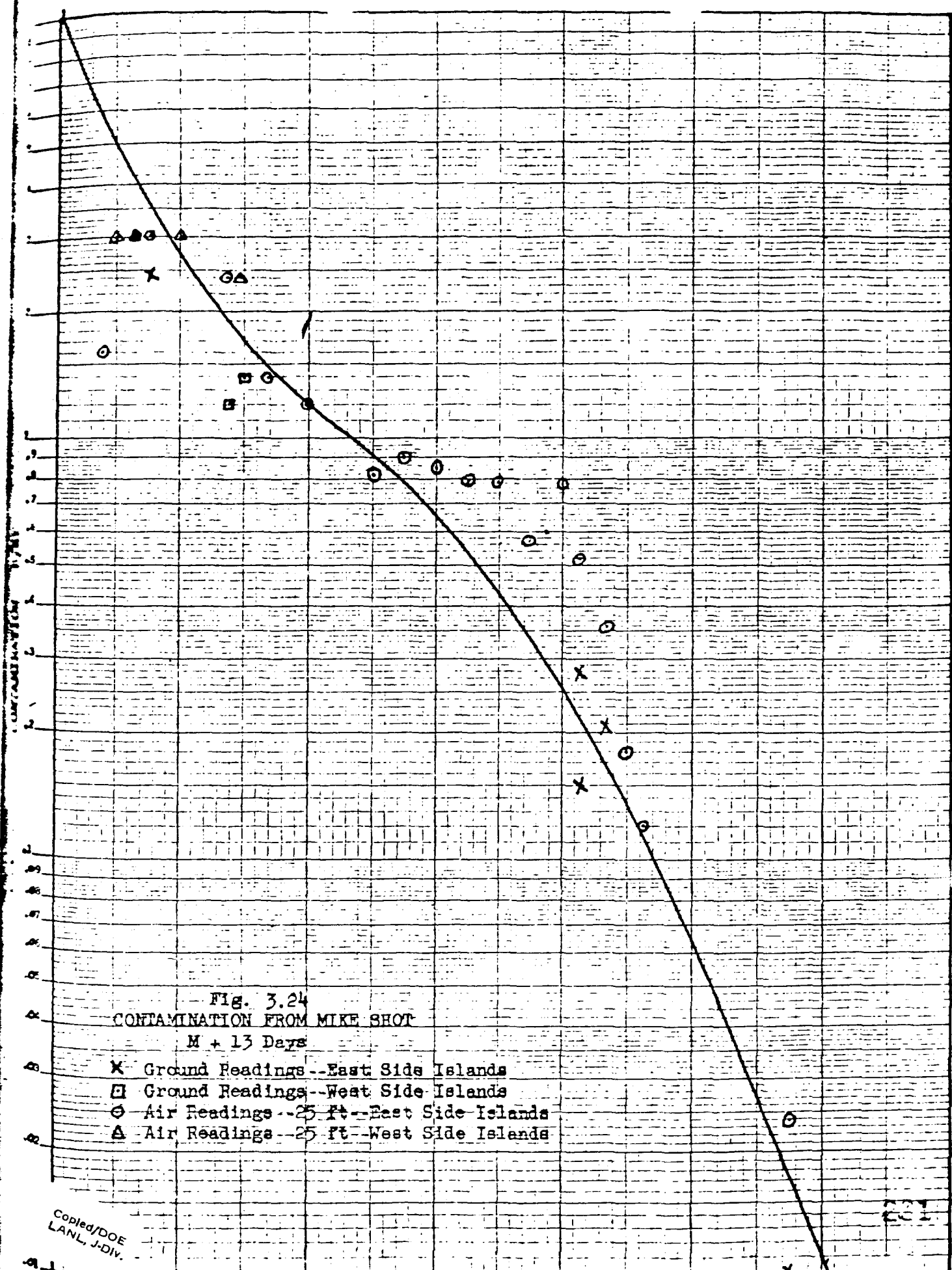


Fig. 3.24
 CONTAMINATION FROM MIKE SHOT
 M + 13 Days

- X Ground Readings--East Side Islands
- Ground Readings--West Side Islands
- Air Readings--25 Ft--East Side Islands
- △ Air Readings--25 Ft--West Side Islands

Copied/DOE
 LANL, J-DIV.

30

35

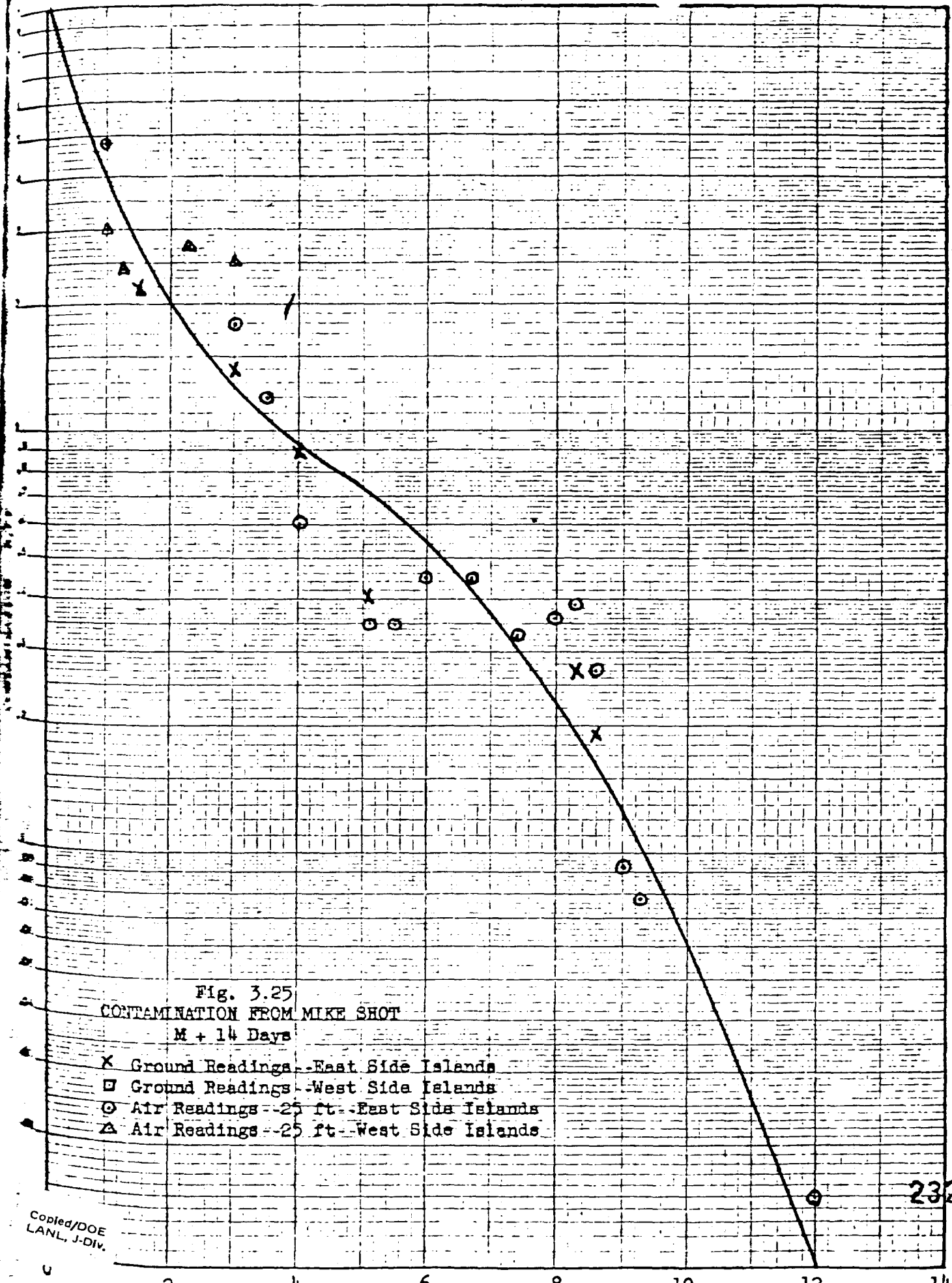


Fig. 3.25
CONTAMINATION FROM MIKE SHOT
M + 14 Days

- X Ground Readings--East Side Islands
- Ground Readings--West Side Islands
- ⊙ Air Readings--25 ft--East Side Islands
- △ Air Readings--25 ft--West Side Islands

Copied/DOE
LANL, J-DIV.

31

[REDACTED]

Radioactivity From Crossroads Baker Shot

The curves of Figs. 3.26, 3.27, and 3.28 show the radioactivity in the surface waters of Bikini Lagoon on the first three days after Crossroads Baker Shot. The values shown are in mR/hr. Since this shot was in late July, wind and current conditions were somewhat different than those to be expected in March and April, when the trade winds are blowing. The prevailing trade winds are from east-northeast, averaging 15 to 20 knots, while on B day there were light breezes estimated at less than 5 knots from south-southeast. On B + 1 the light breezes alternated with periods of calm, and on B + 2 and B + 3 the wind increased somewhat and hauled to the southeast.

(The figures shown are from an article, "Diffusion in Bikini Lagoon", by W. H. Munk, G. C. Ewing, and R. R. Revelle, of the Scripps Institution of Oceanography; Transactions of the American Geophysical Union, v. 30, pp. 59-66, 1949. The following note accompanies the figures: "Qualitative description of the diffusion of contaminated water--In examining the distribution shown . . . one should hold in mind that they are based on measurements extending over many hours, rather than on simultaneous measurements.")

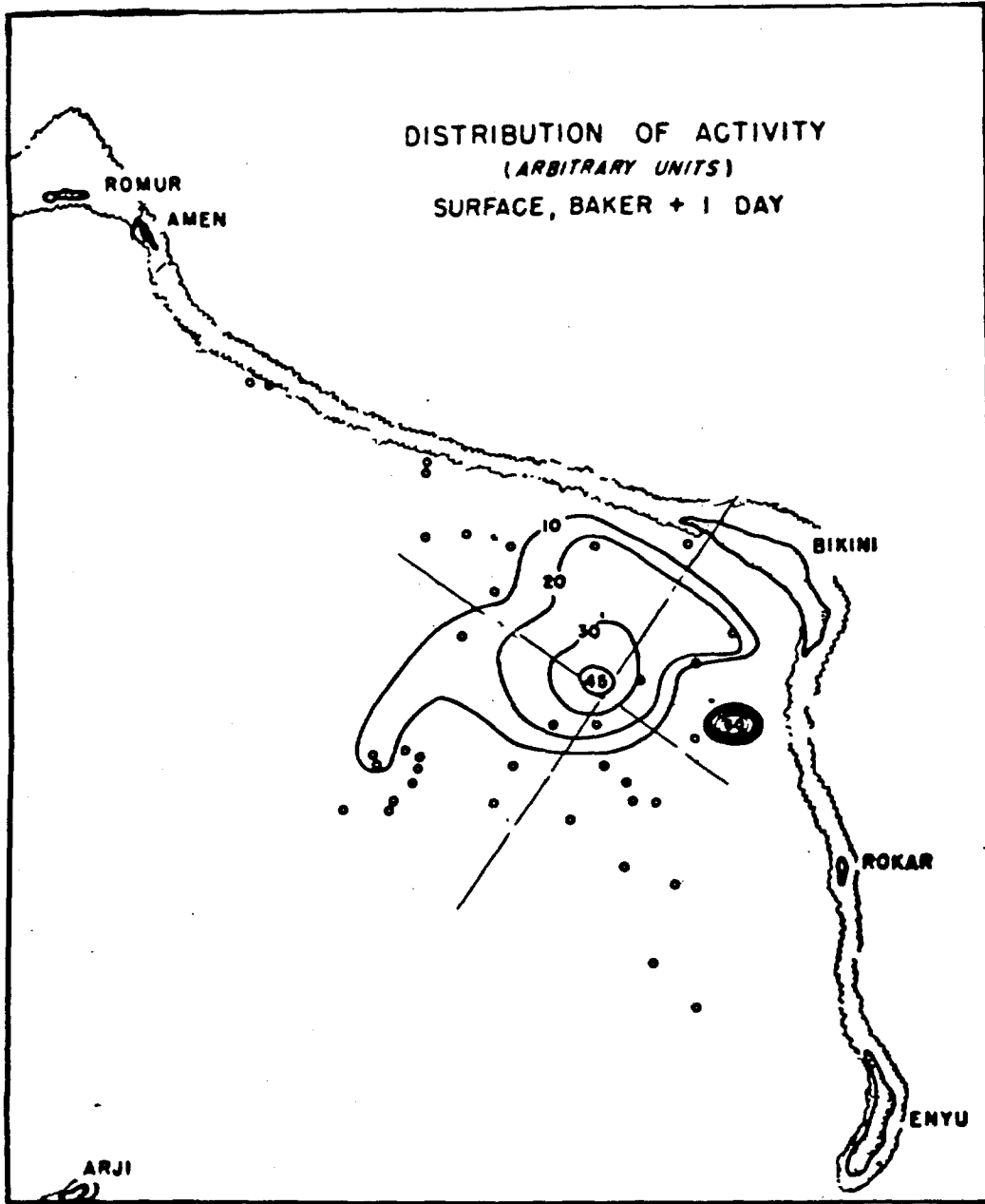


Fig. 3.26 - Distribution of Radioactivity in Surface Waters of Bikini Lagoon; Baker + 1 Day

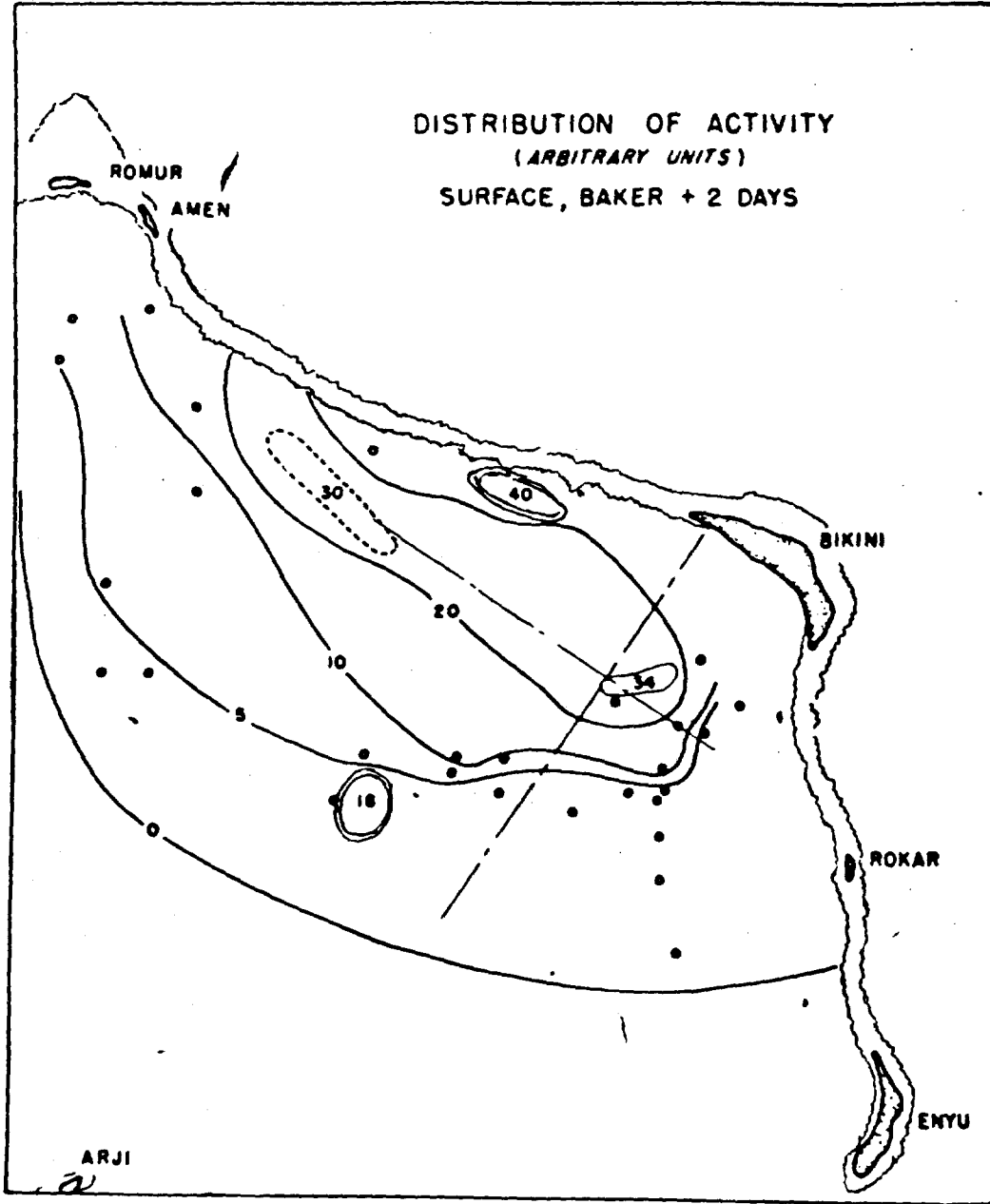


Fig. 3.27 - Distribution of Radioactivity in Surface Waters of Bikini Lagoon; Baker + 2 Days

Copied/DOE
LANL, J-Div.

39

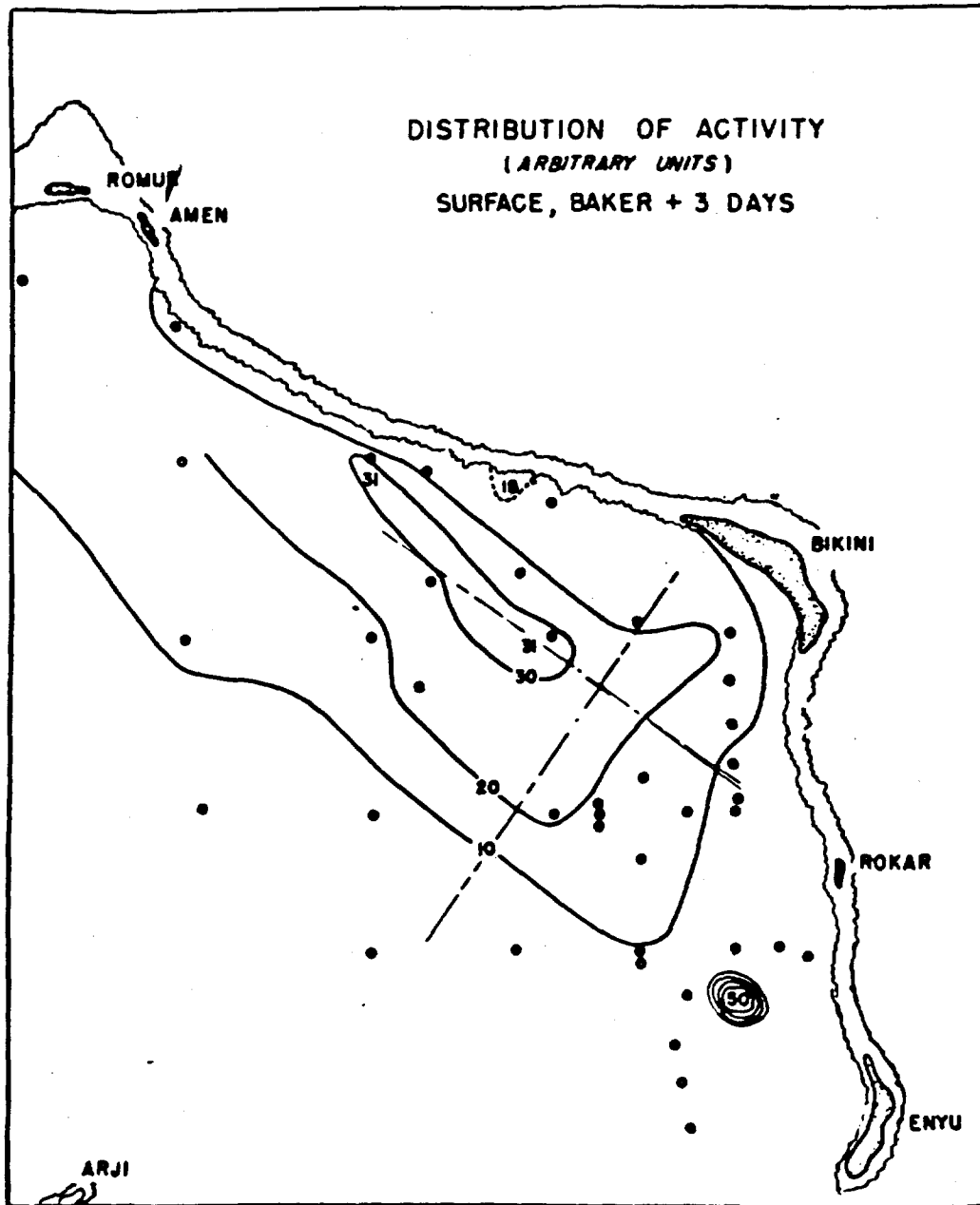


Fig. 3.28 - Distribution of Radioactivity in Surface Waters of Bikini Lagoon; Baker + 3 Days

Copied/DOE
LANL, J-DIV.

40

PAGES 237-251 WERE JUDGED
IRRELEVANT AND WERE NOT COPIED