Technical Report

FC

Copy No. 106

4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE

Research and Development Technical Report USNRDL-TR-147
NS 088-001

13 January 1956

by

W. H. Shipman
J. R. Lai

U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY
SAN FRANCISCO 24 CALIFORNIA

AD 138 164

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

UNCLASSIFIED

4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE

Research and Development Technical Report USNRDL-TR-147
NS 088-001

13 January 1956

by

W.H. Shipman
J.R. Lai

Chemistry General

Technical Objective
AW-7

Analytical and Standards Branch
P.E. Zigman, Head

Chemical Technology Division
E.R. Tompkins, Head

Scientific Director
P.C. Tompkins

Commanding Officer and Director
Captain Richard S. Mandelkorn, USN

U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY
San Francisco 24, California

UNCLASSIFIED

ABSTRACT

Certain fallout samples from Operation CASTLE were retained for decay rate measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 2.03. This range of values is larger than that expected from thermal-neutron fission.

SUMMARY

The Problem

Since fallout is a heterogeneous mixture of individual nuclides each of which has its own decay rate, an experimental determination of the composite decay rate for a fallout sample is necessary. Certain fallout samples were retained from Operation CASTLE and their decay rates measured.

Findings

Most of the values found for the exponent of the usual decay equation exceeded the value normally used in describing thermal-neutron fission of U^{238}.

ADMINISTRATIVE INFORMATION

The work reported is a by-product of gross gamma measurements of certain samples made for Project 2.5a, Operation CASTLE. It was done under Bureau of Ships Project No. NS 088-001, Subtask 11, Technical Objective SR-2, DD Form 613 of 24 May 1955, and NS 081-001, Subtask 4, Technical Objective AW-7, DD Form 613 of 6 October 1955.

INTRODUCTION

During Operation CASTLE, fallout samples were collected from areas immediately adjacent to and 180 miles from the Pacific Proving Grounds. These samples were returned to this laboratory for gamma measurements in a 4-pi high-pressure ionization chamber. A number of samples were retained for periodic measurements of decay rate. This was done to evaluate the range of the exponent in the equation $A_t = A_o t^{-k}$, where A_t and A_o are the radioactivities at time t and at zero time respectively. This paper presents the data and the calculated values of the exponent for fallout samples from the first four CASTLE detonations.

EXPERIMENTAL DETAILS

The locations from which the samples were collected are shown in Figs. 1 and 2. One sample of thatch from the roof of a hut on the island of Rongelap was measured. The remainder of the samples received were of two types: gummed paper and polyethylene fallout collectors.[1]

The gummed papers were cut from their cardboard mounts and each folded to fit the bottom of a 100-ml lusteroid centrifuge tube. These tubes were then placed in the gamma ionization chamber and the decay rate measured.

The samples from the polyethylene fallout collectors were centrifuged in preweighed 100-ml lusteroid centrifuge tubes. These tubes were then placed in the gamma ionization chamber and the decay rate measured.

The samples from the polyethylene collectors were centrifuged to separate the liquid from the solid. The liquid volume was measured in a graduated cylinder, acidified with hydrochloric acid, and concentrated by evaporation to a volume of less than 75 ml. The only possible error introduced by the procedure would be the loss of any iodine that may have been present. The weight of the solid was determined on a semi-microgramatic balance.

TABLE I
Summary of Gamma Decay Data From Fallout Samples

Shot	Samples: Site Designation[a]	Samples: Type and Size	Period of Decay After Detonation (hr)	Exponent Value, k	Remarks
1	251.07	Solid, 56.08 g	382 to 870	1.34	Location shown in Fig. 2
			870 to 1395	1.16	
	Thatch from roof of hut		840 to 4873	1.4	From Rongelap Island. No slope change.
2	T_4 108-2	Gummed paper	165 to 550	1.8	Cut into 4 sections due to high level of activity.
			550 to 1077	1.3	
	A_4 49-1	Gummed paper	165 to 600	1.6	Cut into 2 sections because of high level of activity.
			600 to 1077	1.3	
	Q_4 114-5	Gummed paper	165 to 500	1.7	
			500 to 1077	1.4	
	P_4	Gummed paper	165 to 1077	1.5	No slope change
	Q_4 124-7	Gummed paper	165 to 1077	1.4	No slope change
3	250.06	Liquid, 1665 ml	221 to 821	1.54	No slope change
	250.17	Liquid, 515 ml	221 to 821	1.44	No slope change
	250.17	Solid, 2.81 g	244 to 430	2.01	
			430 to 821	1.47	
	250.17 GP	Gummed paper	315 to 821	1.67	No slope change
	250.18 GP	Gummed paper	315 to 430	1.93	
			430 to 821	1.43	
	250.18	Liquid, 560 ml	221 to 821	1.43	No slope change
	250.18 GP (buoy)	Gummed paper	315 to 430	2.03	
			430 to 821	1.40	
4	YAG 39 TC	Liquid, 365 ml	77.5 to 155	1.1	The ship was approx. 25 mi NW of Aomoen Island (Fox), Bikini Atoll.
			155 to 430	1.4	

(a) See Figs. 1 and 2.

UNCLASSIFIED

The activity of the liquid and of the solid was measured separately in the 4-pi gamma high-pressure ionization chamber.[2] The decay was plotted on appropriate log-log paper. The ionization chamber utilized argon gas under a pressure of 600 psi; the ionization current was impressed across a high resistance. The resulting voltage was measured with a vibrating reed electrometer.[2] Its calibration with respect to energy and linearity agreed closely with published values.

RESULTS AND DISCUSSION

The data have been summarized in Table 1 and the exponent values, k, computed for the decay equation. The observed decay curves are plotted in Figs. 3 through 8.

It has been noted* that these data are within a few percent of the gamma decay curves calculated from radiochemical analysis. The values of k for all the samples except two were greater than 1.2.

The range and magnitude of the exponents are greater than those reported from Operation TEAPOT.[3] The exponent values derived from the fallout collected at Operation TEAPOT ranged from 0.9 to 1.3 while the values from CASTLE ranged from 1.1 to 2.03. It is interesting to note that beta decay measurements made on rain water collected at Harvard University[4] after Operation CASTLE gave exponents of the same order of magnitude as those reported here.

Approved by:

E. R. Tompkins

E.R. TOMPKINS
Head, Chemical
Technology Division

For the Scientific Director

* Personal communication from C.F. Miller of this laboratory.

REFERENCES

1. Stetson, R.L., Schuert, E.A., Perkins, W.W., Shirasawa, T.H., and Chan, H.K. Fallout (short title). U.S. Naval Radiological Defense Laboratory, Operation CASTLE, Project 2.5a, Final Report WT-915, January 1956 (CLASSIFIED).

2. Jones, J.W., and Overman, R.T. The Use and Calibration of a 100% Geometry Ion Chamber. Oak Ridge National Laboratory, Atomic Energy Commission Document AECD-2367, 20 March 1948.

3. Stetson, R.L., Shirasawa, T.H., Sandomire, M.M., Baum, S., and Chan, H.K. Fallout (short title). U.S. Naval Radiological Defense Laboratory, Operation TEAPOT, Project 2.5.2. Final Report WT-1154, 1956 (CLASSIFIED).

4. Bell, Carlos G., Jr. Sanitary Engineering Aspects of Long-Range Fallout From Nuclear Detonations. Howard University and Atomic Energy Commission Report NYO-4654, January 1955.

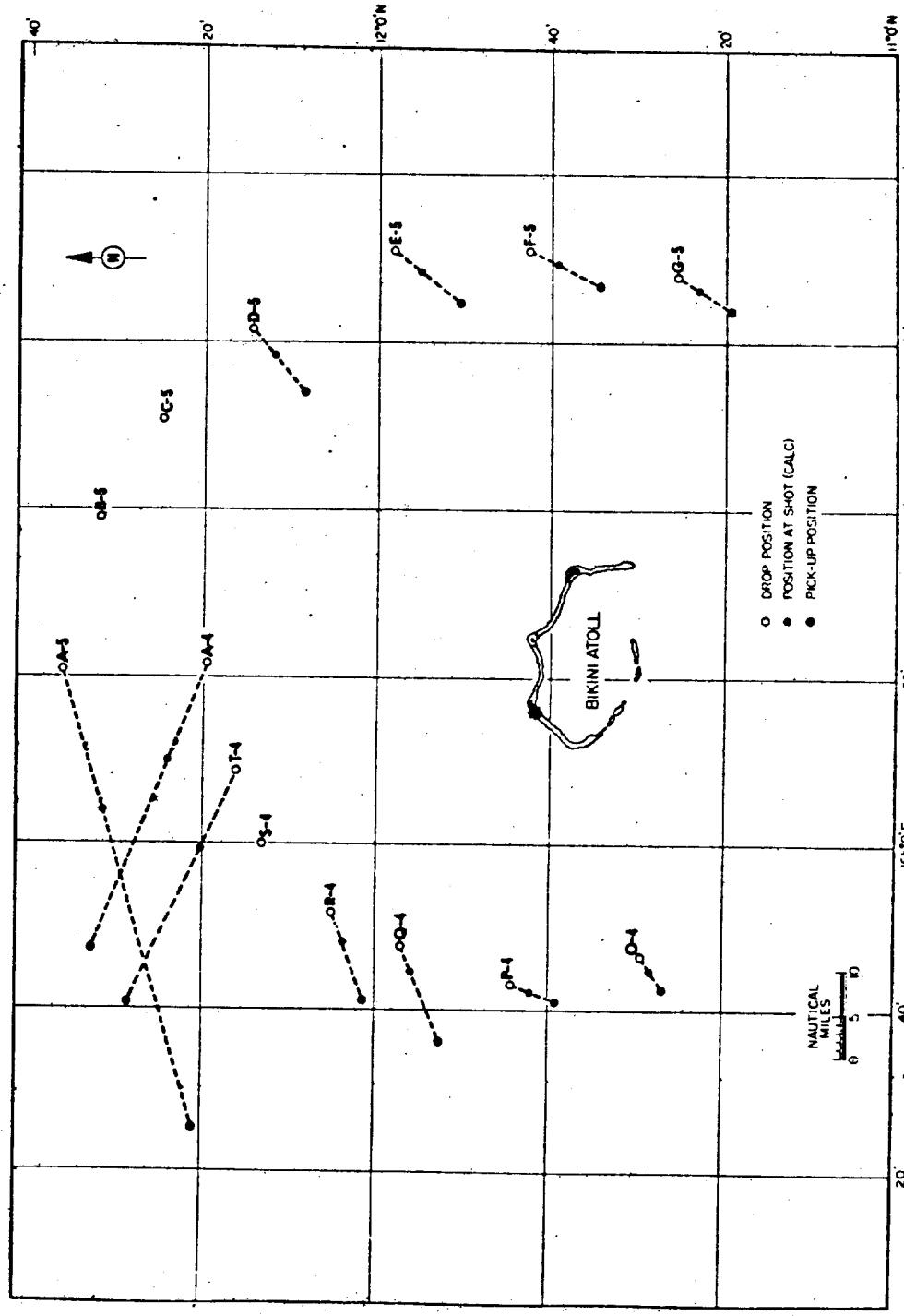

Fig. 1 Sampling Locations for Shot 2, Operation CASTLE
(the Star Marks the Point of Detonation)

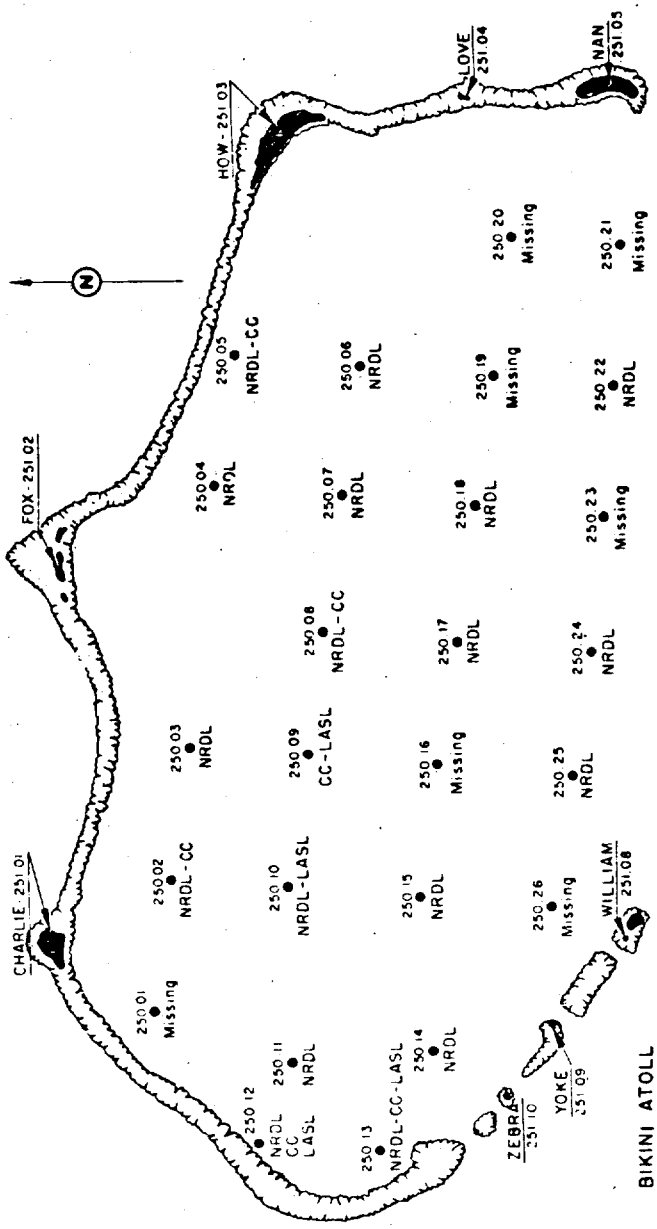

Fig. 2 Sampling Locations for Shot 3, Operation CASTLE

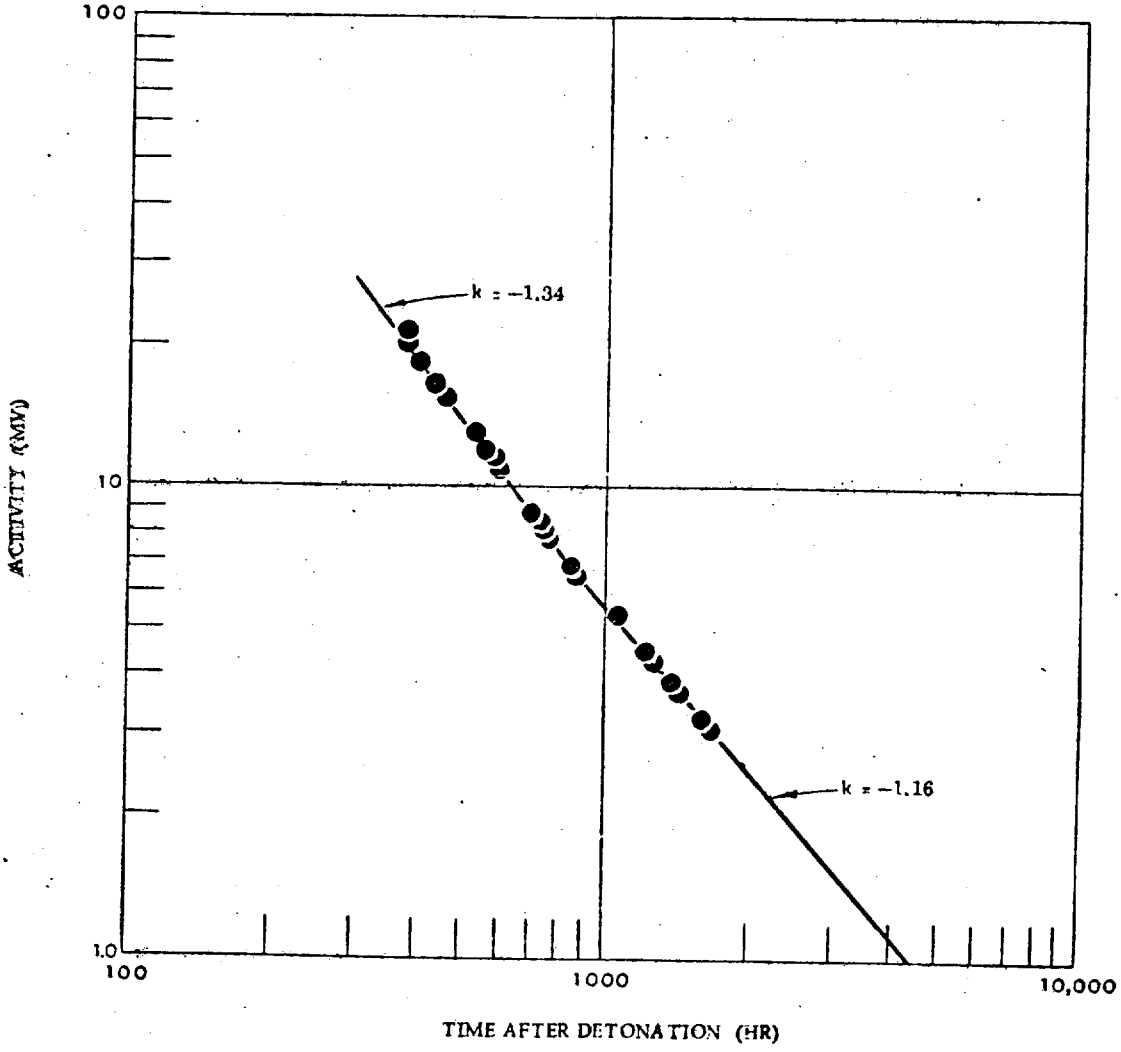

Fig. 3 Gross Decay of Sample 251.07 From Shot 1, Operation CASTLE

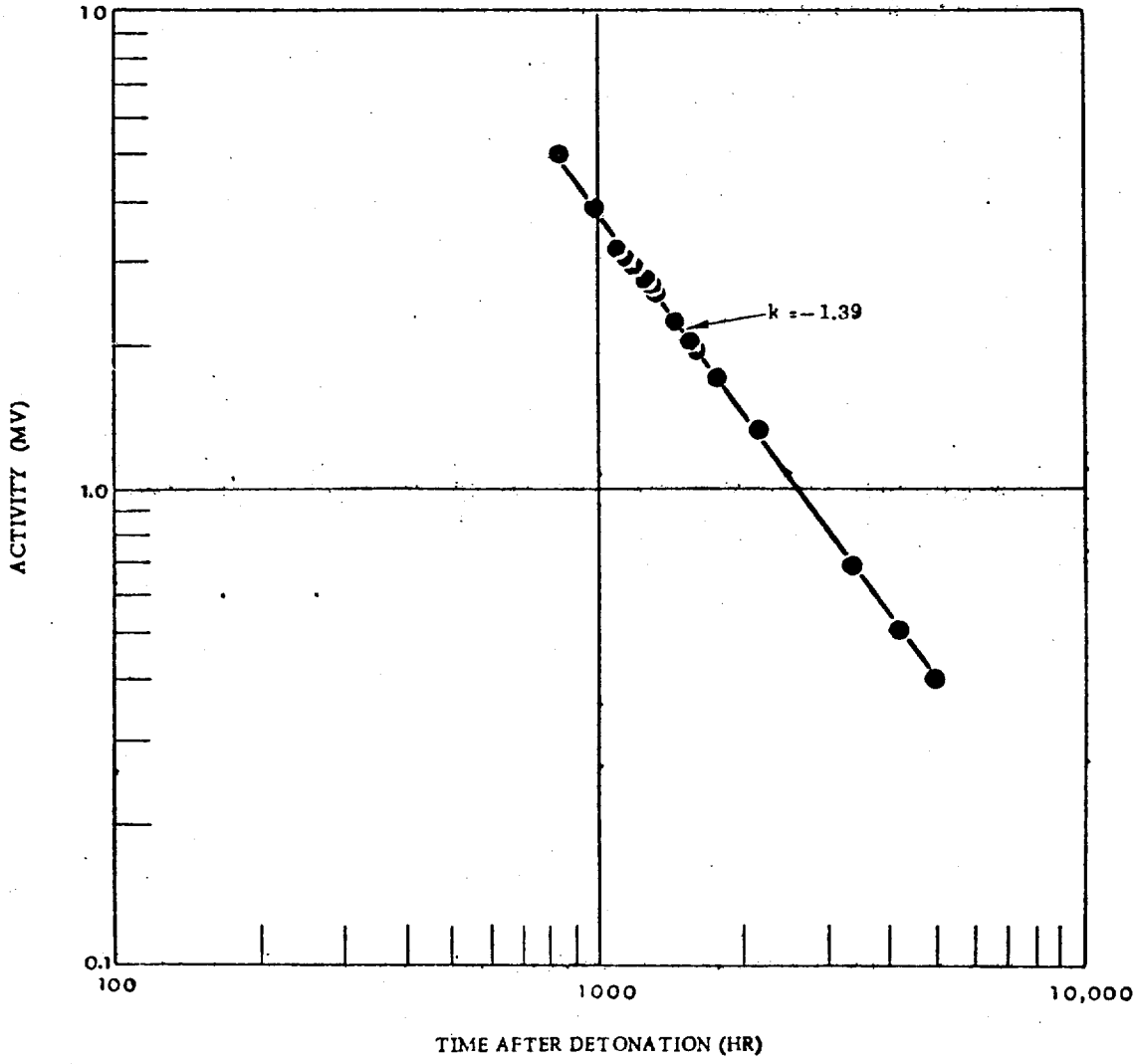

Fig. 4 Gross Decay of Thatch Sample From Shot 1, Operation CASTLE

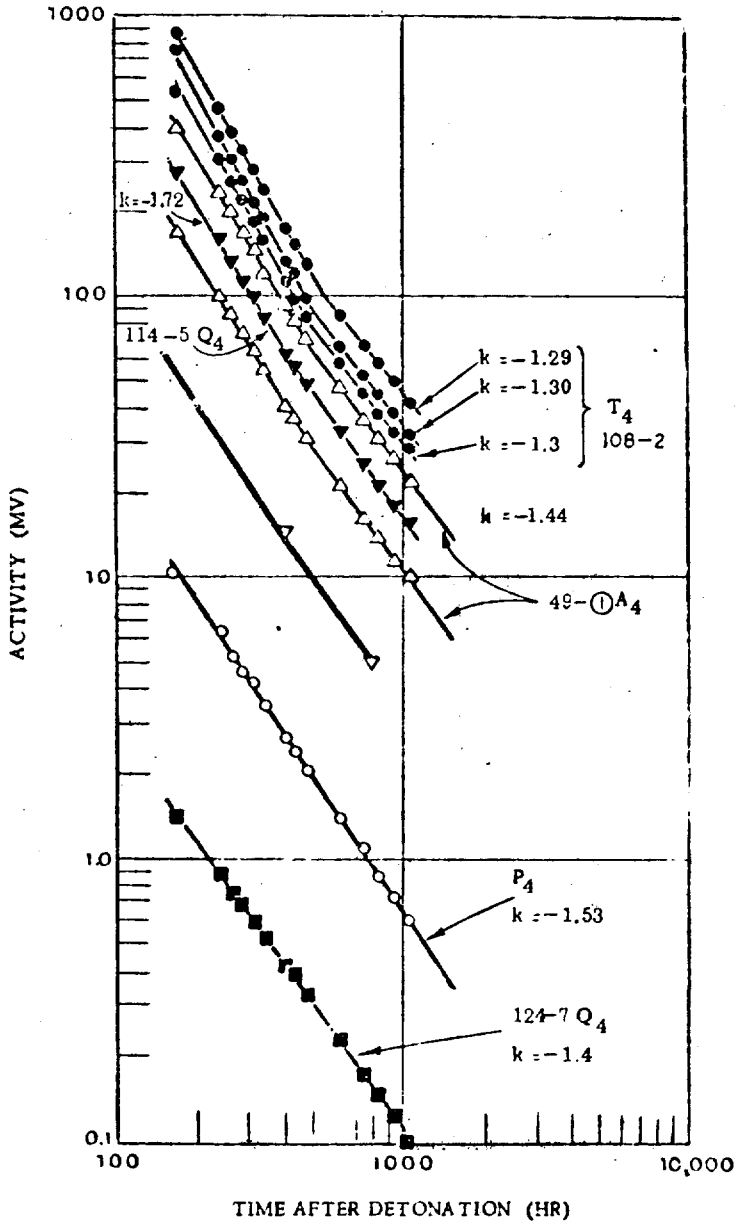

Fig. 5 Gross Decay of Gummed Paper Samples for Shot 2, Operation CASTLE

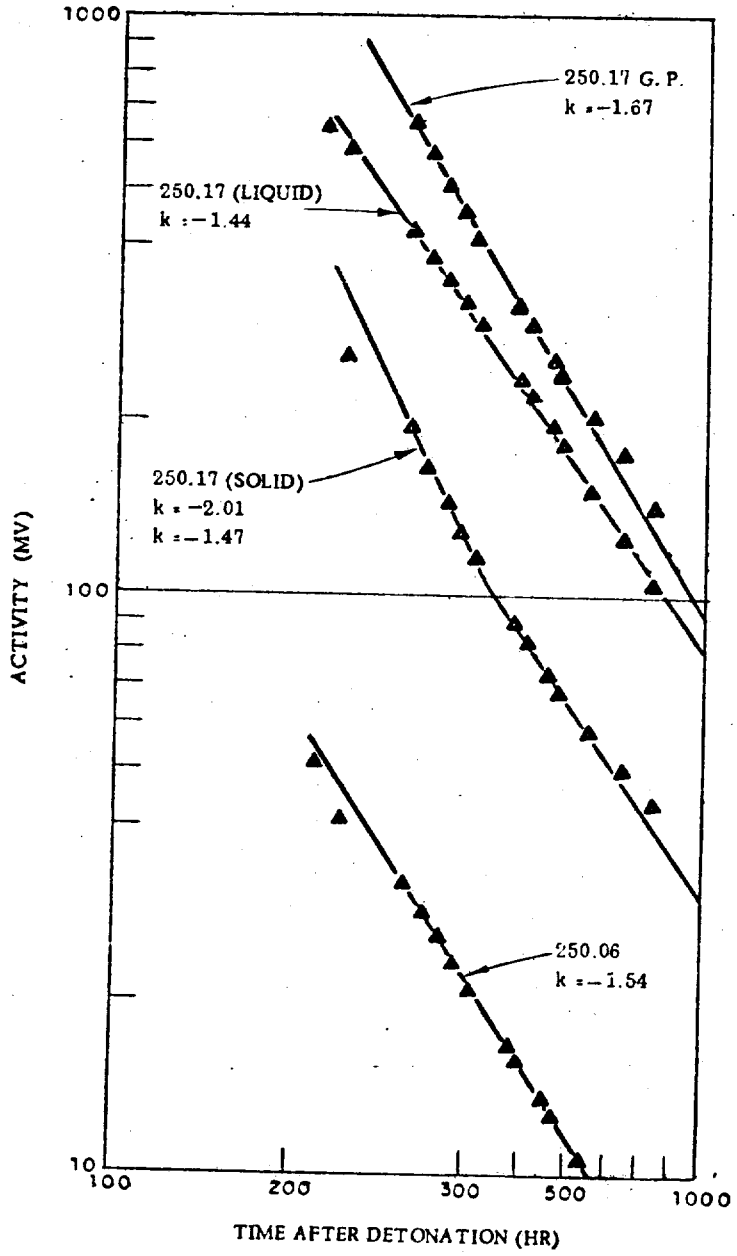

Fig. 6 Gross Decay of Samples From Shot 3, Operation CASTLE

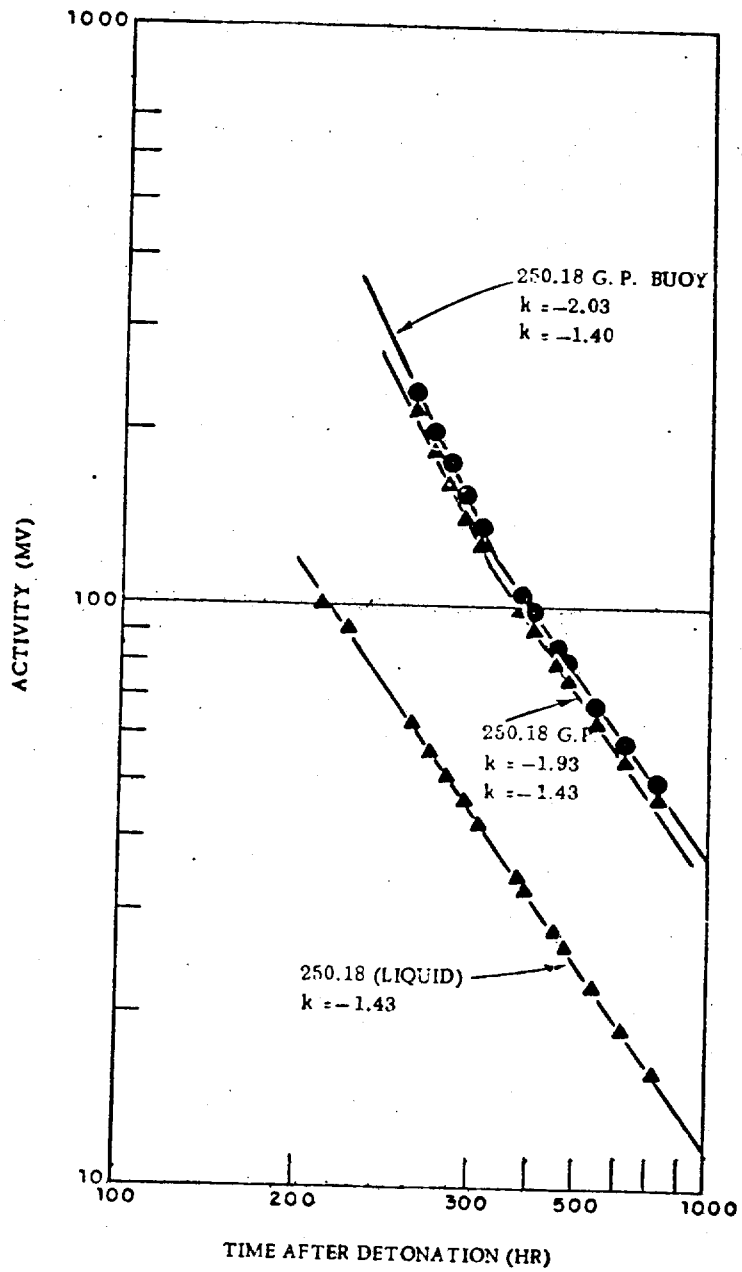

Fig. 7 Gross Decay of Samples From Shot 3, Operation CASTLE

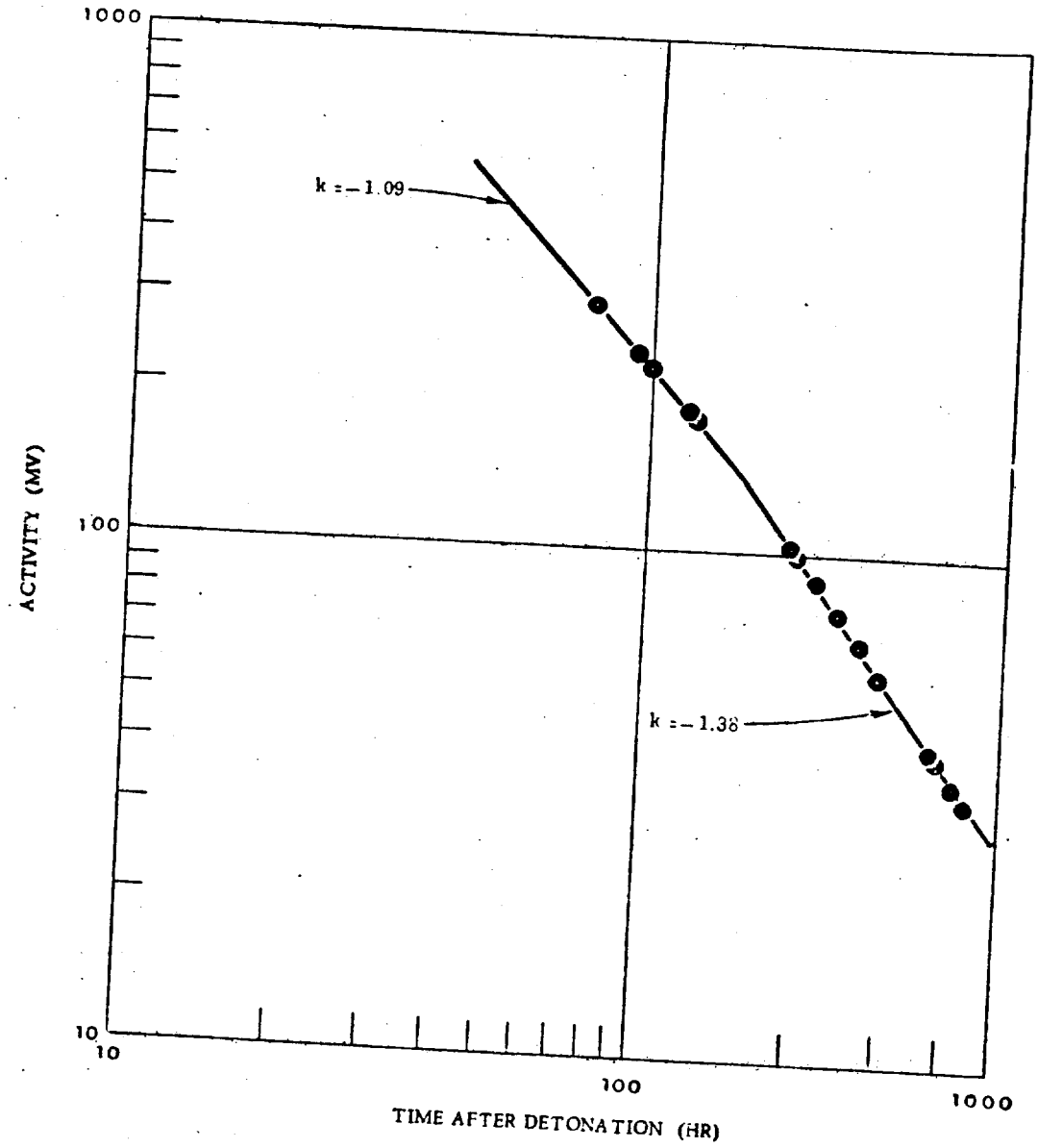

Fig. 8 Gross Decay of Sample 4 YAG-39 TC From Shot 4, Operation CASTLE

DISTRIBUTION

COPIES

NAVY

1-9	Chief, Bureau of Ships (Code 233)
10	Chief, Bureau of Medicine and Surgery
11	Chief, Bureau of Aeronautics (Code AE40)
12	Chief, Bureau of Supplies and Accounts (Code W)
13-14	Chief, Bureau of Yards and Docks (D-440)
15	Chief of Naval Operations (Op-36)
16	Commander, New York Naval Shipyard (Material Lab.)
17-19	Director, Naval Research Laboratory (Code 2021)
20-24	CO, Office of Naval Research, New York
25	Office of Naval Research (Code 422)
26	Naval Medical Research Institute
27	CO, Naval Unit, Army Chemical Center
28	CO, Naval Unit, CmlC Training Command
29	CO, U.S. Naval Civil Engineering (Res. and Eval. Lab.)
30	U.S. Naval School (CEC Officers)
31	Commander, Naval Air Material Center, Philadelphia
32	CO, Naval Schools Command, Treasure Island
33	CO, Naval Damage Control Training Center, Philadelphia
34	U.S. Naval Postgraduate School, Monterey
35	CO, Fleet Training Center, Norfolk
36-37	CO, Fleet Training Center, San Diego
38	Office of Patent Counsel, Mare Island
39	Commander Air Force, Atlantic Fleet (Code 16F)
40	CO, Fleet Airborne Electronics Training Unit Atlantic
41	Commandant, U.S. Marine Corps
42	Commandant, Marine Corps Schools, Quantico (Library)
43	Commandant, Marine Corps Schools, (Dev. Center)

ARMY

44	Chief of Engineers (ENGEB, Dhein)
45	Chief of Engineers (ENGNB)
46-47	Chief of Research and Development (Atomic Division)

48	Chief of Transportation (TC Technical Committee)
49	Chief of Ordnance (ORDTB)
50	Chief Chemical Officer
51	Deputy Chief of Staff for Military Operations
52-53	Assistant Chief of Staff, G-2
54	CG, Chemical Corps Res. and Dev. Command
55	CO, Hq., Chemical Corps Materiel Command
56-57	Aberdeen Proving Ground (Library)
58	President, Chemical Corps Board
59	CO, Chemical Corps Training Command (Library)
60	CO, Chemical Corps Field Requirements Agency
61-62	CO, Chemical Warfare Laboratories
63	Office of Chief Signal Officer (SIGRD-8B)
64	Director, Walter Reed Army Medical Center
65	CG, Continental Army Command, Fort Monroe (ATDEV-1)
66	CG, Quartermaster Res. and Dev. Command
67	Director, Operations Research Office (Librarian)
68	CO, Dugway Proving Ground
69	Director, Evans Signal Laboratory (Nucleonics Section)
70	Signal Corps Center, Fort Monmouth
71	CG, Engineer Res. and Dev. Laboratory (Library)
72	CO, Transportation Res. and Dev. Command, Fort Eustis
73	Commandant, Army Aviation School, Fort Rucker
74	President, Board No. 6, CONARC, Fort Rucker
75	NLO, CONARC, Fort Rucker
76	Director, Special Weapons Development, Fort Bliss
77	CO, Frankford Arsenal
78	CO, Ordnance Materials Research Office, Watertown
79	CO, Watertown Arsenal
80	Tokyo Army Hospital

AIR FORCE

81	Directorate of Intelligence (AFOIN-3B)
82	Commander, Air Materiel Command (MCMTM)
83	Commander, Wright Air Development Center (WCRTY)
84	Commander, Wright Air Development Center (WCRTH-1)
85	Commander, Air Res. and Dev. Command (RDTDA)
86	Director, USAF Project RAND (WEAPD)
87	Commandant, School of Aviation Medicine, Randolph AFB
88	USAF, SAM, Randolph Field (Brooks)
89	CG, Strategic Air Command, Offutt AFB (IGABD)
90	CG, Strategic Air Command (Operations Analysis Office)
91	Commander, Special Weapons Center, Kirtland AFB
92	Office of Surgeon General (AFCSG-15)
93	Director, Air University Library, Maxwell AFB
94-95	Commander, Technical Training Wing, 3415th TTG
96	CG, Cambridge Research Center (CRHTM)
97-98	CO, Air Weather Service - MATS, Langley AFB

OTHER DOD ACTIVITIES

99	Chief, Armed Forces Special Weapons Project
100	AFSWP, SWTG, Sandia Base (Library)
101-103	AFSWP, Hq., Field Command, Sandia Base
104	Assistant Secretary of Defense (Res. and Dev.)
105-109	Armed Services Technical Information Agency

AEC ACTIVITIES AND OTHERS

110	Alco Products, Inc.
111-120	Argonne National Laboratory
121	Atomic Bomb Casualty Commission
122-124	Atomic Energy Commission, Washington
125-126	Atomics International
127-128	Battelle Memorial Institute
129-130	Bettis Plant
131-134	Brookhaven National Laboratory
135	Brush Beryllium Company
136	Chicago Patent Group
137	Columbia University (Hassialis)
138	Combustion Engineering, Inc.
139-140	Consolidated Vultee Aircraft Corporation
141	Convair-General Dynamics Corporation (Helms)
142	Defense Research Member
143	Department of Food Technology, MIT
144	Division of Raw Materials, Casper
145-146	Division of Raw Materials, Denver
147	Dow Chemical Company, Pittsburg
148	Dow Chemical Company, Rocky Flats
149-151	duPont Company, Aiken
152	duPont Company, Wilmington
153-154	General Electric Company (ANPP)
155-160	General Electric Company, Richland
161-162	Goodyear Atomic Corporation
163	Hawaii Marine Laboratory
164-165	Iowa State College
166-167	Knolls Atomic Power Laboratory
168-169	Lockheed Aircraft Corporation, Marietta
170-171	Los Alamos Scientific Laboratory
172-173	Mallinckrodt Chemical Works
174	Massachusetts Institute of Technology (Hardy)
175	Mound Laboratory
176	National Advisory Committee for Aeronautics
177	National Bureau of Standards (Library)
178	National Bureau of Standards (Taylor)
179	National Lead Company, Inc., Winchester

180	National Lead Company of Ohio
181	New Brunswick Laboratory
182-183	New York Operations Office
184	Nuclear Development Corporation of America
185	Nuclear Metals, Inc.
186	Oak Ridge Institute of Nuclear Studies
187-191	Oak Ridge National Laboratory
192	Patent Branch, Washington
193-196	Phillips Petroleum Company
197-198	Public Health Service, Washington
199	RAND Corporation
200	Sandia Corporation
201	Sylvania Electric Products, Inc.
202	Technical Operations, Inc.
203	Union Carbide Nuclear Company (C-31 Plant)
204-206	Union Carbide Nuclear Company (K-25 Plant)
207-210	United Aircraft Corporation
211	U.S. Geological Survey, Denver
212	U.S. Geological Survey, Menlo Park
213	U.S. Geological Survey, Naval Gun Factory
214	U.S. Geological Survey, Washington
215	U.S. Patent Office
216	UCLA Medical Research Laboratory
217-218	University of California Radiation Laboratory, Berkeley
219-220	University of California Radiation Laboratory, Livermore
221	University of Rochester (Technical Report Unit)
222	University of Utah (Stoner)
223	Vitro Engineering Division
224	Weil, Dr. George L.
225	Westinghouse Electric Corporation
226-250	Technical Information Extension, Oak Ridge

USNRDL

251-260	USNRDL, Technical Information Division

DATE ISSUED: 19 July 1957

Naval Radiological Defense Laboratory.
USNRDL-TR-147.
4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE, by W.H. Shipman and J.R. Lai. 13 Jan. 1956. [illegible] p. illus.
UNCLASSIFIED

Certain fallout samples from Operation CASTLE were retained for measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 1.03. This range of values is larger than that expected from thermal-neutron fission.

1. Fallout
2. Gamma rays - Measurement
I. Shipman, W.H.
II. Lai, J.R.
III. Title
IV. Operation CASTLE
V. NS 088-001
VI. NS 081-001.

UNCLASSIFIED

Naval Radiological Defense Laboratory.
USNRDL-TR-147.
4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE, by W.H. Shipman and J.R. Lai. 13 Jan. 1956. [illegible] p. illus.
UNCLASSIFIED

Certain fallout samples from Operation CASTLE were retained for measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 1.03. This range of values is larger than that expected from thermal-neutron fission.

1. Fallout
2. Gamma rays - Measurement
I. Shipman, W.H.
II. Lai, J.R.
III. Title
IV. Operation CASTLE
V. NS 088-001
VI. NS 081-001.

UNCLASSIFIED

Naval Radiological Defense Laboratory.
USNRDL-TR-147.
4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE, by W.H. Shipman and J.R. Lai. 13 Jan. 1956. 16 p. illus.
UNCLASSIFIED

Certain fallout samples from Operation CASTLE were retained for measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 1.03. This range of values is larger than that expected from thermal-neutron fission.

1. Fallout
2. Gamma rays - Measurement
I. Shipman, W.H.
II. Lai, J.R.
III. Title
IV. Operation CASTLE
V. NS 088-001
VI. NS 081-001.

UNCLASSIFIED

Naval Radiological Defense Laboratory.
USNRDL-TR-147.
4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE, by W.H. Shipman and J.R. Lai. 13 Jan. 1956. [illegible] p. illus.
UNCLASSIFIED

Certain fallout samples from Operation CASTLE were retained for measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 1.03. This range of values is larger than that expected from thermal-neutron fission.

1. Fallout
2. Gamma rays - Measurement
I. Shipman, W.H.
II. Lai, J.R.
III. Title
IV. Operation CASTLE
V. NS 088-001
VI. NS 081-001.

UNCLASSIFIED

Naval Radiological Defense Laboratory.
USNRDL-TR-147.
4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE, by W.H. Shipman and J.R. Lai. 13 Jan. 1956. [illegible] p. illus.
UNCLASSIFIED

Certain fallout samples from Operation CASTLE were retained for measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 1.03. This range of values is larger than that expected from thermal-neutron fission.

1. Fallout
2. Gamma rays - Measurement
I. Shipman, W.H.
II. Lai, J.R.
III. Title
IV. Operation CASTLE
V. NS 088-001
VI. NS 081-001.

UNCLASSIFIED

Naval Radiological Defense Laboratory.
USNRDL-TR-147.
4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE, by W.H. Shipman and J.R. Lai. 13 Jan. 1956. [illegible] p. illus.
UNCLASSIFIED

Certain fallout samples from Operation CASTLE were retained for measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 1.03. This range of values is larger than that expected from thermal-neutron fission.

1. Fallout
2. Gamma rays - Measurement
I. Shipman, W.H.
II. Lai, J.R.
III. Title
IV. Operation CASTLE
V. NS 088-001
VI. NS 081-001.

UNCLASSIFIED

Naval Radiological Defense Laboratory.
USNRDL-TR-147.
4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE, by W.H. Shipman and J.R. Lai. 13 Jan. 1956. 10 p. illus.
UNCLASSIFIED

Certain fallout samples from Operation CASTLE were retained for measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 1.03. This range of values is larger than that expected from thermal-neutron fission.

1. Fallout
2. Gamma rays - Measurement
I. Shipman, W.H.
II. Lai, J.R.
III. Title
IV. Operation CASTLE
V. NS 088-001
VI. NS 081-001.

UNCLASSIFIED

Naval Radiological Defense Laboratory.
USNRDL-TR-147.
4-PI GAMMA IONIZATION CHAMBER DECAY MEASUREMENTS OF FALLOUT SAMPLES FROM OPERATION CASTLE, by W.H. Shipman and J.R. Lai. 13 Jan. 1956. [illegible] p. illus.
UNCLASSIFIED

Certain fallout samples from Operation CASTLE were retained for measurement. The exponent of the equation $A_t = A_o t^{-k}$ was evaluated from appropriate log-log plots and found to be in the range 1.1 to 1.03. This range of values is larger than that expected from thermal-neutron fission.

1. Fallout
2. Gamma rays - Measurement
I. Shipman, W.H.
II. Lai, J.R.
III. Title
IV. Operation CASTLE
V. NS 088-001
VI. NS 081-001.

UNCLASSIFIED

UNCLASSIFIED