UNCLASSIFIED

AD 409 681

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA

UNCLASSIFIED

Reproduced From
Best Available Copy

USAELRDL Technical Report 2323

NEUTRON AND GAMMA RADIATION EFFECTS ON DIELECTRICS

Erik G. Linden

Charles P. Lascaro

January 1963

UNITED STATES ARMY
ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY
FORT MONMOUTH, N.J.

U. S. ARMY ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY
FORT MONMOUTH, NEW JERSEY

January 1963

USAELRDL Technical Report 2323 has been prepared under the supervision of the Director, Electronic Components Department, and is published for the information and guidance of all concerned. Suggestions or criticisms relative to the form, contents, purpose, or use of this publication should be referred to the Commanding Officer, U. S. Army Electronics Research and Development Laboratory, Fort Monmouth, New Jersey, Attn: Chief, Reliability and Electronic Parts Branch, Electronic Parts and Materials Division.

J. M. KIMBROUGH, JR.
Colonel, Signal Corps
Commanding

OFFICIAL:
HOWARD W. KILLAM
Major, SigC
Adjutant

DISTRIBUTION:
Special

NEUTRON AND GAMMA RADIATION EFFECTS ON DIELECTRICS

Erik G. Linden

Charles P. Lascaro

DA Task No. 3A99-15-001-01

ABSTRACT

Exposure of the following materials has no significant permanent after effects on dielectric constant and dissipation factor, measured at 60 cps, 1 mcs, and 30 mcs, nor on dc volume resistivity, nor on the dc and 60 cps surface resistivity of these dielectrics: asbestos-fabric phenolic, asbestos-filled phenolic, asbestos-filled diallyl phthalate, mica-filled phenolic, alumina, forsterite, paper-phenolic laminate, polystyrene, polytetrafluoroethylene and polyethylene dielectrics to pulsed fast neutrons, ranging from 1.63×10^{12} to 2.0×10^{12} Nvt, and to gamma radiation at the rate of 2.8×10^{4} r/hr up to a total dose of 5.88×10^{5} r.

U. S. ARMY ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY
FORT MONMOUTH, NEW JERSEY

CONTENTS

TABLES

FIGURES

NEUTRON AND GAMMA RADIATION EFFECTS ON DIELECTRICS

INTRODUCTION

This investigation is part of a study of the effects of radiation on laboratory samples of dielectric materials used in electronic equipments. Considerable information is already available on the physical effect of steady-state radiation on dielectric materials. Because of lack of data, however, it was necessary to study the dielectric behavior of those materials, when exposed to a pulse type of radiation environment approximated by the Godiva-type reactor, and the effects of exposure on the dielectric properties, when exposed to a steady-state gamma radiation source. The materials were selected on the basis of their importance to the performance of military electronic equipments. The first phase of this program involving a determination of permanent aftereffects is the subject of this report. Transient effects during the actual pulse burst, the subject of the second phase of this work, are not reported here. The study includes the effects of such radiation on plastics, ceramics, and composites.

DISCUSSION

Materials

The materials studied include the following:

Code	Material
MFI	Asbestos-fabric phenolic molding compound
MFG	Asbestos-filled phenolic molding compound
MDAP	Asbestos-filled diallyl phthalate molding compound
MFE	Mica-filled phenolic molding compound
AL-576	Alumina, Al_2O_3
AL-243	Forsterite ($2mgO \cdot SiO_2$)
XXX	Paper phenolic laminate
PS	Polystyrene
PF	Polytetrafluoroethylene
PE	Polyethylene

Procedures

The above materials were exposed to the following radiation environments: One set was exposed in 2-mil thick polyethylene bags to pulsed neutrons at the Godiva Critical Assembly at the Los Alamos Scientific Laboratory, Los Alamos, New Mexico; the second set was subjected to gamma irradiation by a cobalt-60 source, located at Radiation Applications, Inc., 4042 Crescent Avenue, Long Island City, New York, for 21 hours at an intensity of 2.8×10^4 roentgens per hour, giving a total dosage of 5.88×10^5 roentgens. Table 1 lists the total Nvt to which each material was exposed at the Godiva Critical Assembly. Figures 1 and 2 show the arrangement of the test specimens at the Godiva Critical Assembly. A group of control samples was left unexposed to radiation so as to determine natural aging effects. They were stored under standard conditions here at the USAELRDL until final measurements could be made coincident with the exposed samples.

Electrical measurements were made on all samples, including unexposed controls, one month before and one month after the time of the above irradiation exposures. The elapsed time was due to shipment of material from the facilities involved to the Johns Hopkins University Dielectrics Laboratory where all measurements were made. Measurement techniques used are described in a report dated 31 December 1958, subject, "A Practical Interpretation of Dielectric Measurements up to 100 mc," by Dielectrics Laboratory, The Johns Hopkins University, Baltimore Maryland, under Signal Corps Contract DA36-039-sc-73156.

Results

The results of these measurements and irradiation exposures are listed in Tables 2 through 15. Comparison of the electrical changes of the irradiated specimens with the controls, as listed in Tables 2 through 15, shows that there are no significant permanent aftereffects other than those of natural aging on 60 cps, 1 mcs, and 30 mcs dielectric constant and dissipation factor, nor on dc volume resistivity, nor on dc and 60 cps surface resistivity, when the above materials are exposed to the irradiation environments described above.

CONCLUSIONS

It is concluded that exposure of asbestos-fabric phenolic, asbestos-filled phenolic, asbestos-filled diallyl phthalate, mica-filled phenolic, alumina, forsterite, paper-phenolic laminate, polystyrene, polytetrafluoroethylene and polyethylene dielectrics to pulsed fast neutrons, ranging from 1.63×10^{12} to 2.0×10^{12} Nvt, and to gamma radiation at the rate of 2.8×10^{4} roentgens per hour up to a total dose of 5.88×10^{5} roentgens, has no significant permanent effects on electrical properties.

ACKNOWLEDGMENTS

The valued assistance of the following persons is acknowledged in the performance of this study: Mr. Louis J. Frisco, Director of Research of Dielectrics Laboratory, Institute for Cooperative Research, Johns Hopkins University, who supervised the measurements; and Mr. Alton L. Long, Project Engineer, supervisor of the Radiation Effects Team of USAELRDL, who supervised the exposure of the samples.

TABLE I

RADIATION NEUTRON DOSAGE
(Obtained at Godiva Critical Assembly, Los Alamos Scientific Laboratory, Los Alamos, New Mexico)

Material	Nvt
MFI	1.88×10^{12}
MFG	1.88×10^{12}
MDAP	1.63×10^{12}
MFE	1.63×10^{12}
AL-576	1.97×10^{12}
AL-243	1.97×10^{12}
XXX	1.86×10^{12}
PS	1.86×10^{12}
PE	2.0×10^{12}
PF	2.0×10^{12}

TABLE 2

DIELECTRIC CONSTANT
(Before & after exposure to neutrons)

Material	60-cps		1-mc		30-mc	
	initial	irradiated	initial	irradiated	initial	irradiated
MFI	167	150	8.76	8.23	5.88	5.84
MFG	170	163	8.41	8.36	6.11	5.76
MDAP	6.82	6.19	3.87	3.86	3.50	3.42
MFE	5.30	5.17	4.28	4.27	4.20	4.20
AL-576	8.39	8.39	8.09	8.09	7.67	7.67
AL-243	6.74	6.74	6.65	6.65	6.55	6.55
XXX	5.95	5.93	4.93	4.82	4.70	4.62
PS	2.57	2.57	2.54	2.54	2.54	2.54
PF	2.10	2.10	2.10	2.10	2.09	2.09
PE	2.31	2.31	2.30	2.30	2.29	2.29

TABLE 3

DIELECTRIC CONSTANT
(Control samples unexposed to neutron irradiation)

Material	60-cps		1-mc		30-mc	
	initial	final	initial	final	initial	final
MFI	167	154	8.76	8.19	5.88	5.69
MFG	170	161	8.41	7.94	6.11	5.92
MDAP	6.82	6.21	3.87	3.84	3.50	3.41
MFE	5.30	4.89	4.28	4.19	4.20	4.16

TABLE 4

DISSIPATION FACTOR
(Before & after exposure to neutrons)

Material	60-cps		1-mc		30-mc	
	initial	irradiated	initial	irradiated	initial	irradiated
MFI	.495	.419	.495	.445	.104	.103
MFG	.494	.468	.339	.325	.102	.104
MDAP	.158	.151	.057	.052	.042	.042
MFE	.064	.061	.016	.015	.010	.010
AL-576	.002	.002	L	L	.002	.002
AL-243	.002	.002	L	L	L	L
XXX	.036	.029	.038	.039	.058	.057
PS	L	L	L	L	L	L
PF	L	L	L	L	L	L
PE	L	L	L	L	L	L

L – Less than .001.

TABLE 5

DISSIPATION FACTOR
(Control samples unexposed to neutron irradiation)

Material	60-cps		1-mc		30-mc	
	initial	final	initial	final	initial	final
MFI	.495	.465	.495	.472	.104	.104
MFG	.494	.478	.339	.322	.102	.104
MDAP	.158	.142	.057	.052	.042	.040
MFE	.064	.061	.016	.015	.010	.010

TABLE 6

VOLUME AND SURFACE RESISTIVITY
(Before & after exposure to neutrons)

Material	DC Volume Resistivity (ohm-cm)		DC Surface Resistivity (ohms per square)		60-cps Surface Resistivity (ohms per square)	
	initial	irradiated	initial	irradiated	initial	irradiated
MFI	1.5×10^{10}	2.6×10^{10}	2.5×10^{10}	9.9×10^{11}	4.9×10^{7}	2.8×10^{7}
MFG	3.4×10^{10}	5.4×10^{10}	4.8×10^{9}	1.5×10^{10}	1.9×10^{7}	1.6×10^{7}
MDAP	A	A	B	B	C	9.4×10^{10}
MFE	A	A	B	B	C	C
AL-576	A	A	B	B	C	C
AL-243	A	A	B	B	C	C
XXX	A	A	B	B	C	C
PS	A	A	B	B	C	C
PF	A	A	B	B	C	C
PE	A	A	B	B	C	C

A – Greater than 2.3×10^{13} ohm-cm

B – Greater than 9.1×10^{12} ohms per square

C – Greater than 1.0×10^{13} ohms per square

TABLE 7

VOLUME AND SURFACE RESISTIVITY
(Control samples unexposed to neutron irradiation)

Material	DC Volume Resistivity (ohm-cm)		DC Surface Resistivity (ohms per square)		60-cps Surface Resistivity (ohms per square)	
	initial	final	initial	final	initial	final
MFI	1.5×10^{10}	2.5×10^{10}	2.5×10^{10}	5.4×10^{10}	4.9×10^{7}	2.2×10^{7}
MFG	3.4×10^{10}	4.8×10^{10}	4.3×10^{9}	5.3×10^{10}	1.9×10^{7}	1.1×10^{7}
MDAP	A	A	B	B	C	C
MFE	A	A	B	B	C	C

A – Greater than 2.3×10^{13} ohm-cm
B – Greater than 9.1×10^{12} ohms per square
C – Greater than 1.0×10^{13} ohms per square

TABLE 8

PERCENTAGE DECREASE
IN DIELECTRIC CONSTANT
FOUND AFTER EXPOSURE TO NEUTRONS,
AS COMPARED TO UNEXPOSED CONTROLS

Material	60-cps		1-mc		30-mc	
	exposed	control	exposed	control	exposed	control
MFI	10.2	7.8	6.1	6.5	0.7	3.2
MFG	4.1	5.3	0.6	5.6	5.7	3.7
MDAP	9.2	8.9	0.3	0.8	2.3	2.6
MFE	2.5	9.5	0.2	2.1	0	1.0

TABLE 9

DIELECTRIC CONSTANT
(Before & after exposure to gamma irradiation)

Material	60-cps		1-mc		30-mc	
	initial	irradiated	initial	irradiated	initial	irradiated
MFI	167	162	8.76	8.53	5.88	5.78
MFG	170	170	8.41	8.09	6.11	6.07
MDAP	6.82	6.75	3.87	3.83	3.50	3.48
MFE	5.30	5.14	4.28	4.06	4.20	3.88
AL-576	8.39	8.39	8.09	8.09	7.67	7.66
AL-243	6.74	6.74	6.65	6.56	6.55	6.54
XXX	5.95	5.90	4.93	4.89	4.70	4.63
PS	2.57	2.59	2.54	2.54	2.54	2.54
PF	2.10	2.10	2.10	2.10	2.09	2.09
PE	2.31	2.31	2.30	2.30	2.29	2.20

TABLE 10

DIELECTRIC CONSTANT
(Control samples unexposed to gamma irradiation)

Material	60-cps		1-mc		30-mc	
	initial	final	initial	final	initial	final
MFI	167	144	8.76	8.37	5.88	5.68
MFG	170	161	8.41	8.02	6.11	5.83
MDAP	6.82	6.28	3.87	3.72	3.50	3.46
MFE	5.30	5.11	4.28	4.17	4.20	3.96

TABLE 11

DISSIPATION FACTOR
(Before & after exposure to gamma irradiation)

Material	60-cps		1-mc		30-mc	
	initial	irradiated	initial	irradiated	initial	irradiated
MFI	.447	.439	.438	.424	.094	.088
MFG	.429	.434	.333	.306	.094	.087
MDAP	.107	.091	.050	.048	.038	.038
MFE	.040	.038	.014	.014	.010	.009
AL-576	L	L	L	L	.001	.001
AL-243	L	L	L	L	L	L
XXX	.021	.018	.038	.039	.060	.055
PS	L	L	L	L	L	L
PF	L	L	L	L	L	L
PE	L	L	L	L	L	L

L – Less than .001

TABLE 12

DISSIPATION FACTOR
(Control samples unexposed to gamma irradiation)

Material	60-cps		1-mc		30-mc	
	initial	final	initial	final	initial	final
MFI	.447	.429	.438	.395	.094	.084
MFG	.429	.422	.333	.304	.094	.087
MDAP	.107	.104	.050	.045	.038	.041
MFE	.040	.031	.014	.013	.010	.009

TABLE 13

VOLUME AND SURFACE RESISTIVITY
(Before & after exposure to gamma irradiation)

Material	DC Volume Resistivity (ohm-cm)		DC Surface Resistivity (ohms per square)		60-cps Surface Resistivity (ohms per square)	
	initial	irradiated	initial	irradiated	initial	irradiated
MFI	3.1×10^{10}	1.0×10^{11}	7.6×10^{10}	7.7×10^{10}	9.5×10^{9}	6.7×10^{9}
MFG	6.6×10^{10}	1.1×10^{11}	2.1×10^{10}	2.4×10^{10}	3.5×10^{8}	3.4×10^{8}
MDAP	A	4.6×10^{10}	B	B	C	C
MFE	A	A	B	B	C	C
AL-576	A	A	B	B	C	C
AL-243	A	A	B	B	C	C
XXX	A	2.3×10^{12}	B	B	C	C
PS	A	A	B	B	C	C
PF	A	A	B	B	C	C
PE	A	A	B	B	C	C

A – Greater than 2.3×10^{13} ohm-cm

B – Greater than 9.1×10^{13} ohms per square

C – Greater than 1.0×10^{13} ohms per square

TABLE 14

VOLUME AND SURFACE RESISTIVITY
(Control samples unexposed to gamma irradiation)

Material	DC Volume Resistivity (ohm-cm)		DC Surface Resistivity (ohms per square)		60-cps Surface Resistivity (ohms per square)	
	initial	final	initial	final	initial	final
MFI	3.1×10^{10}	7.5×10^{11}	7.6×10^{10}	2.9×10^{10}	8.5×10^{9}	7.0×10^{9}
MFG	6.6×10^{10}	1.2×10^{11}	2.1×10^{10}	2.5×10^{10}	3.5×10^{8}	3.4×10^{8}
MDAP	A	A	B	B	C	C
MFE	A	A	B	B	C	C

A – Greater than 2.3×10^{13} ohm-cm
B – Greater than 9.1×10^{12} ohms per square
C – Greater than 1.0×10^{13} ohms per square

TABLE 15

PERCENTAGE DECREASE
IN DIELECTRIC CONSTANT
FOUND AFTER EXPOSURE TO GAMMA IRRADIATION
AS COMPARED TO UNEXPOSED CONTROLS

Material	60-cps		1-mc		30-mc	
	exposed	control	exposed	control	exposed	control
MFI	3.0	13.8	2.6	4.5	1.7	3.4
MFG	0	5.3	3.8	4.6	0.6	4.6
MDAP	1.0	7.9	1.0	3.9	0.6	1.1
MFE	3.0	3.6	5.1	2.6	8.1	5.7

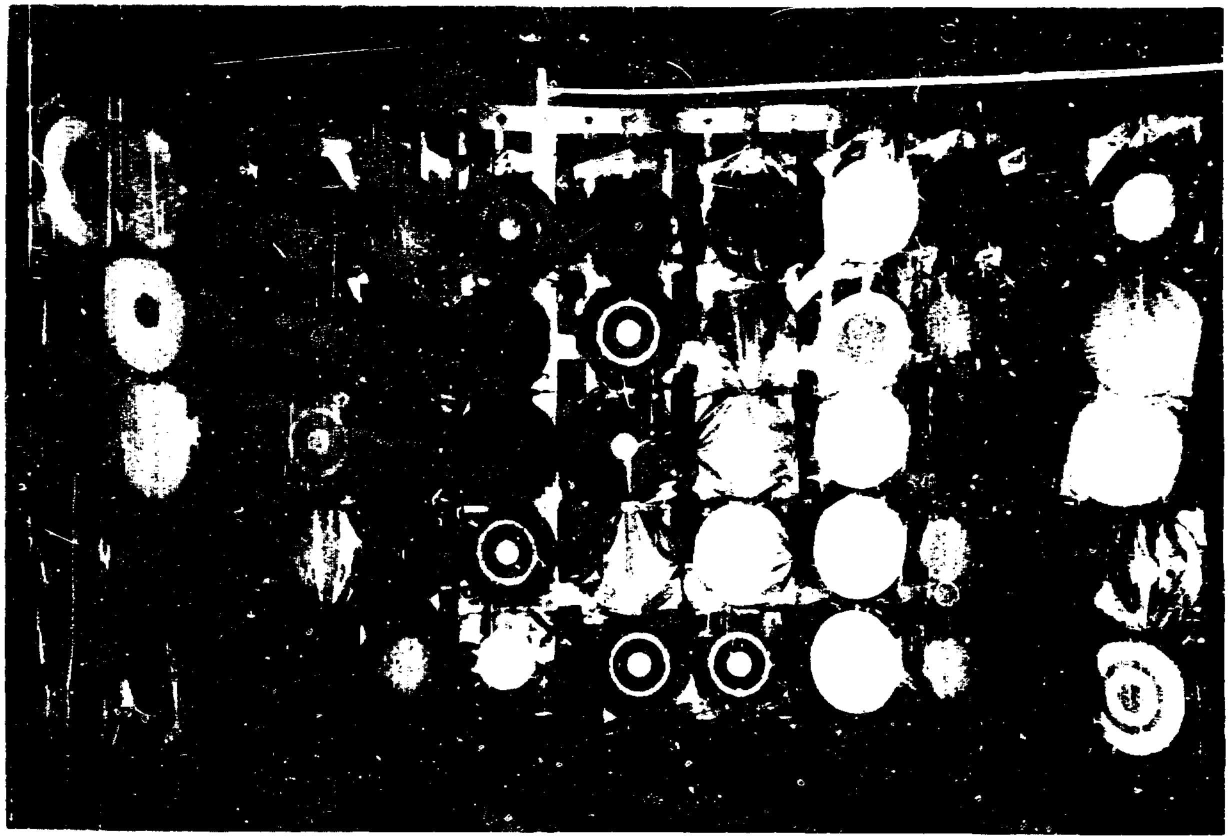

FIGURE 1 PLASTIC AND CERAMIC DIELECTRIC SPECIMENS IN 2 MILS THICK POLYETHYLENE BAGS ON CURVED MOUNTING RACK UTILIZED IN GODIVA REACTOR RADIATION EXPOSURE STUDY

USASEL-SIGFM-58-523

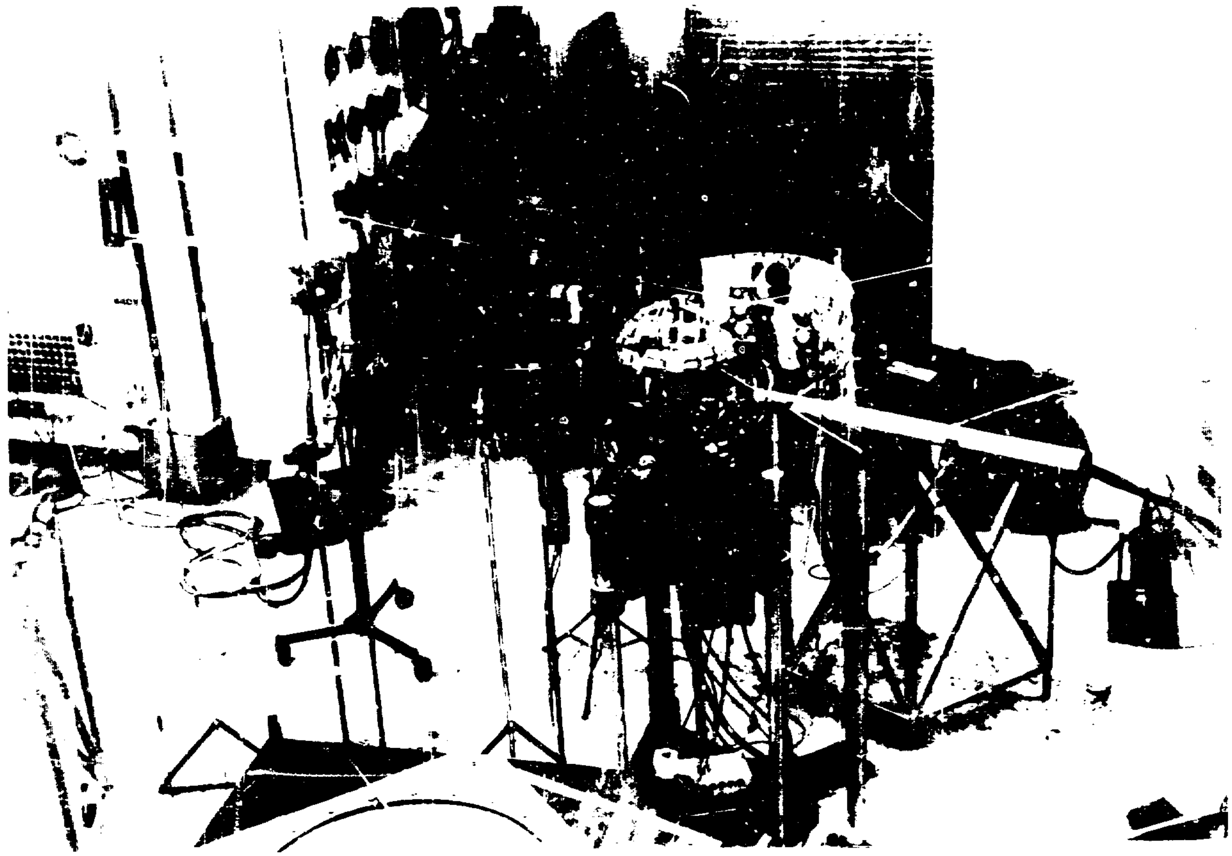

FIGURE 2 GODIVA REACTOR WITH PLASTIC AND CERAMIC DIELECTRIC SPECIMENS IN PLACE PREPARATORY TO IRRADIATION

M-9608

MATERIALS INVESTIGATED

MATERIAL	TRADE NAME	SOURCE	CODE
Asbestos-fabric phenolic molding compound	#17610 Bakelite	Molded by American Insulator Corporation, New Freedom, Pennsylvania	MFI
Asbestos-filled phenolic molding compound	#250 Brown Bakelite	Molded by American Insulator Corporation, New Freedom, Pennsylvania	MFG
Asbestos-filled diallyl phthalate molding compound	Acme 1-501A resin with asbestos filler	Molded by American Insulator Corporation, New Freedom, Pennsylvania	MDAP
Mica-filled phenolic molding compound	RESINOX #7934, Natural	Molded by American Insulator Corporation, New Freedom, Pennsylvania	MFE
Alumina, Al_2O_3	Alsimag 576	American Lava Corporation Chattanooga, Tennessee	AL-576
Forsterite (2 $MgO-SiO_2$)	Alsimag 243	American Lava Corporation, Chattanooga, Tennessee	AL-243
Paper phenolic laminate	Phenolite XXX-401	National Vulcanized Fibre Co., Kennett Square, Pennsylvania	XXX
Polystyrene	Polystyrene Unpigmented	Plax Corporation, Hartford, Connecticut	PS
Polytetrafluoroethylene	DuPont Teflon	Fabricated by United States Gasket Company, Camden, New Jersey	PF
Polyethylene	DuPont Polythene	E.I.duPont de Nemours & Co.	PE

[redacted]

DISTRIBUTION LIST

	Copies
Commanding General U. S. Army Electronics Command ATTN: AMSEL-AD Fort Monmouth, New Jersey	3
Office of the Assistant Secretary of Defense (Research and Engineering) ATTN: Technical Library Room 3E1065, The Pentagon Washington 25, D. C.	1
Chief of Research and Development Department of the Army Washington 25, D. C.	2
Chief, United States Army Security Agency ATTN: ACofS, G4 (Technical Library) Arlington Hall Station Arlington 12, Virginia	1
Commanding Officer U. S. Army Electronics Research and Development Activity ATTN: Technical Library Fort Huachuca, Arizona	1
Commanding Officer U. S. Army Electronics Research and Development Activity ATTN: SELWS-AJ White Sands, New Mexico	1
Commanding Officer U. S. Army Electronics Research Unit P. O. Box 205 Mountain View, California	1
Commanding Officer U. S. Army Electronics Materiel Support Agency ATTN: SELMS-ADJ Fort Monmouth, New Jersey	1
Commanding General U. S. Army Satellite Communications Agency ATTN: Technical Documents Center Fort Monmouth, New Jersey	1
Director U. S. Army Engineer Research and Development Laboratories ATTN: Technical Documents Center Fort Belvoir, Virginia	1
Commanding Officer U. S. Army Chemical Warfare Laboratories ATTN: Technical Library, Building 330 Army Chemical Center, Maryland	1
Commanding Officer Harry Diamond Laboratories ATTN: Library, Building 92, Room 211 Washington 25, D. C.	1
Headquarters, United States Air Force ATTN: AFCIN Washington 25, D. C.	2
Rome Air Development Center ATTN: RAALD Griffiss Air Force Base New York	1
Headquarters Ground Electronics Engineering Installation Agency ATTN: ROZMEL Griffiss Air Force Base New York	1
Commanding General U. S. Army Materiel Command ATTN: R&D Directorate Washington 25, D. C.	2

Distribution List (Cont)

	Copies
Aeronautical Systems Division ATTN: ASAPRL Wright-Patterson Air Force Base Ohio	1
U. S. Air Force Security Service ATTN: ESD San Antonio, Texas	1
Headquarters Strategic Air Command ATTN: DOCE Offutt Air Force Base, Nebraska	1
Headquarters Research & Technology Division ATTN: RTH Bolling Air Force Base Washington 25, D. C.	1
Air Proving Ground Center ATTN: PGAPI Eglin Air Force Base, Florida	1
Air Force Cambridge Research Laboratories ATTN: CRXL-R L. G. Hanscom Field Bedford, Massachusetts	2
Headquarters Electronic Systems Division ATTN: ESAT L. G. Hanscom Field Bedford, Massachusetts	2
AFSC Scientific/Technical Liaison Office U. S. Naval Air Development Center Johnsville, Pa.	1
Chief of Naval Research ATTN: Code 427 Department of the Navy Washington 25, D. C.	1
Bureau of Ships Technical Library ATTN: Code 312 Main Navy Building, Room 1528 Washington 25, D. C.	1
Chief, Bureau of Ships ATTN: Code 454 Department of the Navy Washington 25, D. C.	1
Chief, Bureau of Ships ATTN: Code 686B Department of the Navy Washington 25, D. C.	1
Director U. S. Naval Research Laboratory ATTN: Code 2027 Washington 25, D. C.	1
Commanding Officer & Director U. S. Navy Electronics Laboratory ATTN: Library San Diego 52, California	1
Commander U. S. Naval Ordnance Laboratory White Oak Silver Spring 19, Maryland	1
Commander Armed Services Technical Information Agency ATTN: TISIA Arlington Hall Station Arlington 12, Virginia	20
USAELRDL Liaison Officer U. S. Army Tank-Automotive Center Detroit Arsenal Center Line, Michigan	1
USAELRDL Liaison Officer Naval Research Laboratory ATTN: Code 1071 Washington 25, D. C.	1
USAELRDL Liaison Officer Massachusetts Institute of Technology Building 26, Room 131 77 Massachusetts Avenue Cambridge 39, Massachusetts	1

Distribution List (Cont)

	Copies
USAELRDL Liaison Office Aeronautical Systems Division ATTN: ASDL-9 Wright-Patterson Air Force Base Ohio	1
U. S. Army Research Liaison Office Lincoln Laboratory P. O. Box 73 Lexington, Massachusetts	1
USAELRDL Liaison Officer Rome Air Development Center ATTN: RAOL Griffiss Air Force Base New York	1
Commanding Officer U. S. Army Security Agency Processing Center Deal Area, Bldg. 5001	1
File Unit Nr. 1, Rm. 3D-116 Hexagon	
USAEMSA Liaison Engineer USASCAJ APO 343 San Francisco, California	1
Technical Dir., SELRA/CS Headquarters, USAELRDL	1
USAELRDA-White Sands Liaison Office SELRA/LNW, USAELRDL	1
AFSC Scientific/Technical Liaison Office SELRA/LNA, USAELRDL	1
Corps of Engineers Liaison Office SELRA/LNE, USAELRDL	1
Marine Corps Liaison Office SELRA/LNR, USAELRDL	1
USACDC Liaison Office SELRA/LNF, USAELRDL	2

	Copies
Chief, Technical Information Division Headquarters, USAELRDL	6
USAELRDL Technical Documents Center SELRA/ADT, Hexagon	1
USAELRDL Liaison Officer Hq, U. S. Army Combat Developments Command CDCLN-EL Fort Belvoir, Virginia	1
Director, Electronic Components Dept., SELRA/P	1
Director, Electronic Parts & Materials Division, SELRA/PE	1
Reliability and Electronic Parts Branch, SELRA/PEE	40

Army-Ft Monmouth,NJ-MON 1057-63

AD ______________ Div. ______________

Army Electronics Research and Devlopment Laboratory, Fort Monmouth, N. J.
NEUTRON AND GAMMA RADIATION EFFECTS ON DIELECTRICS by Erik G. Linden and Charles P. Lascaro, January 1963, 15 p. incl. illus. tables
(USAELRDL Technical Report 2323)
(DA Task Nr. 3A99-15-001-01) Unclassified Report

Exposure of the following materials has no significant permanent after effects on dielectric constant and dissipation factor, measured at 60 cps, 1 mcs, and 30 mcs, nor on dc volume resistivity, nor on dc and 60 cps surface resistivity of these dielectrics: asbestos-fabric phenolic, asbestos-filled phenolic, asbestos-filled diallyl phthalate, mica-filled phenolic, alumina, forsterite, paper-phenolic laminate, polystyrene, polytetrafluoroethylene and polyethylene dielectrics to pulsed fast neutrons, ranging from 1.63×10^{12} to 2.0×10^{12} Nvt, and to gamma radiation at the rate of 2.8×10^{4} r/hr up to a total dose of 5.88×10^{5} r.

UNCLASSIFIED

1. Neutron and Gamma Radiation Effects on Dielectrics
2. Electronic Materials -- After Effects of Gamma and Pulsed Neutron Radiation

I. Linden, Erik G.
Lascaro, Charles P.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-001-01

UNCLASSIFIED

AD ______________ Div. ______________

Army Electronics Research and Devlopment Laboratory, Fort Monmouth, N. J.
NEUTRON AND GAMMA RADIATION EFFECTS ON DIELECTRICS by Erik G. Linden and Charles P. Lascaro, January 1963, 15 p. incl. illus. tables
(USAELRDL Technical Report 2323)
(DA Task Nr. 3A99-15-001-01) Unclassified Report

Exposure of the following materials has no significant permanent after effects on dielectric constant and dissipation factor, measured at 60 cps, 1 mcs, and 30 mcs, nor on dc volume resistivity, nor on dc and 60 cps surface resistivity of these dielectrics: asbestos-fabric phenolic, asbestos-filled phenolic, asbestos-filled diallyl phthalate, mica-filled phenolic, alumina, forsterite, paper-phenolic laminate, polystyrene, polytetrafluoroethylene and polyethylene dielectrics to pulsed fast neutrons, ranging from 1.63×10^{12} to 2.0×10^{12} Nvt, and to gamma radiation at the rate of 2.8×10^{4} r/hr up to a total dose of 5.88×10^{5} r.

UNCLASSIFIED

1. Neutron and Gamma Radiation Effects on Dielectrics
2. Electronic Materials -- After Effects of Gamma and Pulsed Neutron Radiation

I. Linden, Erik G.
Lascaro, Charles P.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-001-01

UNCLASSIFIED

AD ______________ Div. ______________

Army Electronics Research and Devlopment Laboratory, Fort Monmouth, N. J.
NEUTRON AND GAMMA RADIATION EFFECTS ON DIELECTRICS by Erik G. Linden and Charles P. Lascaro, January 1963, 15 p. incl. illus. tables
(USAELRDL Technical Report 2323)
(DA Task Nr. 3A99-15-001-01) Unclassified Report

Exposure of the following materials has no significant permanent after effects on dielectric constant and dissipation factor, measured at 60 cps, 1 mcs, and 30 mcs, nor on dc volume resistivity, nor on dc and 60 cps surface resistivity of these dielectrics: asbestos-fabric phenolic, asbestos-filled phenolic, asbestos-filled diallyl phthalate, mica-filled phenolic, alumina, forsterite, paper-phenolic laminate, polystyrene, polytetrafluoroethylene and polyethylene dielectrics to pulsed fast neutrons, ranging from 1.63×10^{12} to 2.0×10^{12} Nvt, and to gamma radiation at the rate of 2.8×10^{4} r/hr up to a total dose of 5.88×10^{5} r.

UNCLASSIFIED

1. Neutron and Gamma Radiation Effects on Dielectrics
2. Electronic Materials -- After Effects of Gamma and Pulsed Neutron Radiation

I. Linden, Erik G.
Lascaro, Charles P.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-001-01

UNCLASSIFIED

AD ______________ Div. ______________

Army Electronics Research and Devlopment Laboratory, Fort Monmouth, N. J.
NEUTRON AND GAMMA RADIATION EFFECTS ON DIELECTRICS by Erik G. Linden and Charles P. Lascaro, January 1963, 15 p. incl. illus. tables
(USAELRDL Technical Report 2323)
(DA Task Nr. 3A99-15-001-01) Unclassified Report

Exposure of the following materials has no significant permanent after effects on dielectric constant and dissipation factor, measured at 60 cps, 1 mcs, and 30 mcs, nor on dc volume resistivity, nor on dc and 60 cps surface resistivity of these dielectrics: asbestos-fabric phenolic, asbestos-filled phenolic, asbestos-filled diallyl phthalate, mica-filled phenolic, alumina, forsterite, paper-phenolic laminate, polystyrene, polytetrafluoroethylene and polyethylene dielectrics to pulsed fast neutrons, ranging from 1.63×10^{12} to 2.0×10^{12} Nvt, and to gamma radiation at the rate of 2.8×10^{4} r/hr up to a total dose of 5.88×10^{5} r.

UNCLASSIFIED

1. Neutron and Gamma Radiation Effects on Dielectrics
2. Electronic Materials -- After Effects of Gamma and Pulsed Neutron Radiation

I. Linden, Erik G.
Lascaro, Charles P.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-001-01

UNCLASSIFIED