

GE Study of 7,075 Capacitor Workers *

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***Worked for at least 3 months between
January 1, 1946 to June 15, 1977**

Other Mortality Studies in Capacitor Workers

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Reference	Workers	All Cause	All Cancer	Specific Causes
Bertazzi et al. 1987	2100 total 544 Males	Males O/E 30/27/8 SMR=108	Males O/E 14/5.5 SMR=253 95% C.I. (144-415)	Males Carcinoma GI Tract O/E 6/1.7 SMR=346 95% C.I. (141-721)
<i>(The increases in cancer were no longer observed in a recent follow up)</i>	1556 Females	Females O/E 34/16.5 SMR (local) = 206	Females O/E 12/7.7 (5.3 local) SMR=156 (N.S.) SMR (local) = 226 95% C.I. (123-385)	Females Hematological O/E (local) 4/1.1 SMR=377 95% C.I. (115-877)
Brown & Jones 1981	2567 1258 Males 1309 Females	Male and Female O/E 163/182 SMR=89 95% C.I. (76-104)	Male and Female O/E 39/44 SMR=89 95% C.I. (63-122)	Male and Female Rectal Carcinoma O/E 4/1.19 SMR=336 95% C.I. (92-860)
				Total Liver Carcinoma O/E 3/1.1 SMR=280 95% C.I. (58-820)

<u>Reference</u>	<u>Workers</u>	<u>All Cause</u>	<u>All Cancer</u>	<u>Specific Causes</u>
Brown, 1987 Follow-up of Brown & Jones	2588 1270 Males 1318 Females	Male and Female O/E 295/318 SMR=93	Male and Female O/E 62/80 SMR=78	Male and Female Rectal Carcinoma 4/1.9 SMR=211 (n.s) Total Liver O/E 5/1.9 SMR=280 (p<0.05)
Sinks, et al 1992	3588 2742 Males 846 Females	Male and Female O/E 192/283 SMR=70 (p<0.01) 95% C.I. (60-80)	Male and Female O/E 54/64 SMR=80 95% C.I. (60-110)	Total Melanocarcinoma O/E 8/2 SMR=400 (p<0.01) 95% C.I. (180-800) Total Brain, Nervous System O/E 5/2.8 SMR=180 95% C.I. (60-420)
Taylor, 1988	6292 3601 Males 2691 Females	O/E Males 355/430 SMR=83 95% C.I. (74-92) O/E Females 155/185 SMR=84 95% C.I. (71-98)	O/E Males 69/84 SMR=83 95% C.I. (64-105) O/E Females 67/61 SMR=110 95% C.I. (85-140)	None were significant

804023

**IEHR Advisory Committee on the Mortality Study of
General Electric Capacitor Workers**

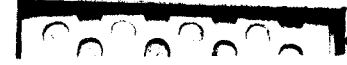
- **Arthur C. Upton, M.D.**
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(Former Director of the National Cancer Institute)
- **Gilbert W. Beebe, Ph.D.**
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State University of New York at Buffalo
- **Roy E. Shore, Ph.D.**
New York University Medical Center

Strengths of Study

- Largest cohort (7,075 workers)
- Highest number of person years (212,778)
- Only 1.3% of workers lost to follow-up
- Largest number of deaths with 1,195 death certificates
- Advisory committee of experts

Determining Death

- Equifax: Social Security mortality tapes
- National Death Index since 1979
- Obituaries tapes
- Tapes of the Veterans Administration
- Private investigator



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Completeness of Cohort

- Review of pension records
- Review of Social Security Administration 941 Forms = quarterly earning reports
- Review of GE employee profile data base

Demographic Characteristics*

<u>Characteristic</u>	<u>Hourly</u>		<u>Salary</u>		<u>TOTAL</u>
	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	
Number of workers	2984	2544	1078	469	7075
Number of deaths	586	380	177	52	1195 (17%)
Number lost to follow-up	33	52	7	3	95 (1.3%)
Mean years worked	6.2	5.8	5.7	4.8	
Number ever highly exposed	1268	352	87	10	1717
Number ever undefinably exposed	2031	133	407	9	2580
Number ever low exposed	2343	2468	831	459	6101
Mean years of follow-up	28	30	32	34	
Percent attended college	15	7	73	26	

*Inclusion criteria: must have worked for at least 3 months between 01/01/46 - 06/15/77.
Total person years 212,778

USAGE OF PCBs

1946 - 1954	Aroclor 1254
1955	Aroclor 1242
1956 - 1971	Aroclor 1254, 1242
After 1971	Aroclor 1016
June 30, 1977	All PCB Usage Discontinued

GE Data, October 1975

Area Air Survey

<u>Plant</u>	<u>H.F. Air Levels $\mu\text{g}/\text{m}^3$</u>	<u>F.E. Air Levels $\mu\text{g}/\text{m}^3$</u>
Treat area	295 - 911	270 - 570
Manifold area	260 - 1040	230 - 370
Repair area	600 - 1000	227
Heat sink	600 - 800	260
Salvage drain	400 - 800	
Bldg. 10 Inst. Lab. 2nd floor	644	
Bldg. 10 office area	260	
Carousel #1		365 - 2000
Carousel #2		170 - 675
CEB Crimp station		1000 - 1500
Washer		1000 - 1500
Refinery		500

NIOSH PERSONAL* AND AREA
AIR SAMPLE SURVEY
April 1977**

<u>Area in Plant/Type of Job</u>	<u>Air Levels $\mu\text{g}/\text{m}^3$</u>
Treat Area*	55 - 264
Soldering*	400 - 600
Moveman Sealing*	300 - 400
Moveman Testing*	170 - 180
Final Assembly**	100 - 150
Maintenance*	150
Recovery and Repair*	281 - 316
Testing, Reworking*	30 - 52
Rework Solder*	173 - 183
Salvage*	30 - 642
Rework Packer*	130 - 300
EMF Operator*	100 - 170
Winding**	3 - 54
Assembly, Shipping*	16 - 100
Storage**	19 - 94
Testing and Painting**	30 - 52
Can and Cover Manufacturer**	25 - 67

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**Deaths¹ in 2,984 Hourly Males,² 2,544 Hourly Females,³
1,078 Salaried Males⁴ and 469 Salaried Females⁵**

Cause of Death	HOURLY				SALARY			
	Males Obs/Exp	SMR (95% C.I.)	Females Obs/Exp	SMR (95% C.I.)	Males Obs/Exp	SMR (95% C.I.)	Females Obs/Exp	SMR (95% C.I.)
All Causes	586 / 699	83.8** (77-91)	380 / 420	90.4* (82-100)	177 / 328	53.9** (46-62)	52 / 75	69.0** (52-91)
All Cancers	128 / 158	81.1* (68-97)	150 / 136	109 (93-129)	56 / 81	69.1** (52-90)	19 / 25	75 (45-118)
Cancer of Tongue	1 / 0.9	103 (3-576)	2 / 0.4	483 (59-1745)	0 / 0.1	—	1 / 0.1	1346 (34-7498)
Other Cancer of Buccal Cavity	2 / 1.1	178 (22-642)	2 / 0.5	365 (44-1317)	0 / 0.5	—	1 / 0.1	1021 (26-5690)
Cancer of Pharynx	4 / 2.0	199 (54-509)	2 / 0.7	253 (31-915)	0 / 1.0	—	0 / 0.1	—
Cancer of Esophagus	5 / 3.8	131 (42-304)	1 / 1.1	87 (2-482)	1 / 2.0	49 (1-272)	0 / 0.2	—
Cancer of Stomach	4 / 5.9	68 (18-173)	4 / 3.0	132 (36-339)	1 / 2.7	36 (0.9-200)	0 / 0.5	—
Cancer of Intestine	8 / 14.0	57 (25-112)	20 / 12.7	157 (96-242)	7 / 7.1	98 (40-203)	1 / 2.2	44 (1-247)
Cancer of Rectum	3 / 3.4	87 (18-255)	4 / 2.2	169 (46-434)	3 / 1.6	185 (38-540)	0 / 0.4	—
Cancer of Biliary Passages & Liver	2 / 2.5	80 (10-289)	2 / 2.2	89 (11-321)	1 / 1.2	79 (2-439)	0 / 0.3	—
Cancer of Pancreas	9 / 7.8	115 (53-219)	7 / 5.9	117 (47-241)	6 / 3.9	150 (55-327)	0 / 1.1	—
Cancer of Larynx	3 / 2.0	147 (30-428)	1 / 0.4	215 (5-1198)	0 / 1.0	—	0 / 0.1	—

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<u>Cause of Death</u>	HOURLY					SALARY			
	<u>Males Obs/Exp</u>	<u>SMR (95% C.I.)</u>	<u>Females Obs/Exp</u>	<u>SMR (95% C.I.)</u>		<u>Males Obs/Exp</u>	<u>SMR (95% C.I.)</u>	<u>Females Obs/Exp</u>	<u>SMR (95% C.I.)</u>
Cancer of Trachea, Bronchus & Lung	42 / 54.5	77 (56-104)	32 / 25.2	127 (87-179)		12 / 29.6	40.5** (21-71)	5 / 4.7	104 (34-244)
Cancer of Breast	--	---	25 / 30	82 (53-121)		--	---	6 / 5.7	104 (38-226)
Cancer of Cervix Uteri	--	---	6 / 4.7	128 (47-277)		--	---	1 / 0.9	112 (3-622)
Cancer of Other Parts of the Uterus	--	---	5 / 3.8	131 (43-306)		--	---	0 / 0.6	---
Cancer of Ovary, Fallopian Tube, Broad Ligament	--	---	8 / 9.3	85 (37-168)		--	---	2 / 1.7	115 (14-415)
Cancer of Prostate	12 / 10.9	110 (57-192)	--	---		3 / 5.3	56 (5-136)	--	---
Cancer of Kidney	3 / 4	75 (15-219)	2 / 2.1	94 (11-341)		0 / 2.1	---	--	---
Cancer of Bladder & Other Urinary Organs	3 / 3.8	77 (16-226)	2 / 1.3	151 (18-545)		1 / 1.8	54 (1-300)	0 / 0.2	---
Cancer of Skin	5 / 3.8	130 (42-303)	3 / 2.0	144 (30-421)		4 / 1.9	210 (57-538)	0 / 0.4	---
Cancer of Brain and Nervous System	2 / 5.1	39 (5-140)	2 / 3.7	53 (6-192)		4 / 2.5	156 (42-398)	0 / 0.7	---
Lymphosarcoma	2 / 2.1	92 (11-331)	1 / 1.5	65 (2-364)		0 / 1.0	---	0 / 0.2	---
Leukemia & Aleukemia	4 / 6.3	63 (17-162)	4 / 4.3	93 (25-238)		5 / 3.1	166 (54-387)	0 / 0.8	---
Other Lymphatic & Hematopoietic Tissue	5 / 5.7	87 (28-202)	5 / 4.7	105 (34-245)		4 / 3.0	131 (36-336)	0 / 0.8	---

<u>Cause of Death</u>	HOURLY				SALARY			
	<u>Males Obs/Exp</u>	<u>SMR (95% C.I.)</u>	<u>Females Obs/Exp</u>	<u>SMR (95% C.I.)</u>	<u>Males Obs/Exp</u>	<u>SMR (95% C.I.)</u>	<u>Females Obs/Exp</u>	<u>SMR (95% C.I.)</u>
Diabetes	4 / 10.5	38* (10-97)	9 / 10.3	87 (40-165)	5 / 5.1	97 (32-226)	0 / 1.8	—
Ischemic Heart Disease	182 / 205	89 (76-103)	71 / 87	81 (64-103)	44 / 97.5	45** (33-61)	8 / 14.3	56 (24-110)
Cerebrovascular Disease	26 / 34.9	74 (49-109)	27 / 30	89 (59-130)	3 / 15.2	20** (4-58)	6 / 5	120 (44-260)
Diseases of Arteries, Veins, Pulmonary Circulation	19 / 17.0	112 (67-174)	10 / 11	95 (46-175)	4 / 8.0	50 (14-128)	1 / 1.8	56 (1-310)
Emphysema	7 / 7.3	96 (39-198)	3 / 3.1	97 (20-283)	1 / 3.3	30 (0.8-168)	0 / 0.5	—
Pneumoconioses & other Respiratory Diseases	18 / 19.6	92 (54-145)	10 / 11.9	84 (40-154)	3 / 10.2	29* (6-86)	0 / 2.1	—
Cirrhosis of the Liver	13 / 17.9	72 (39-124)	6 / 9.2	65 (24-142)	3 / 9.1	33* (7-96)	1 / 1.7	57 (1-318)
Transportation Accidents	29 / 34.7	84 (56-120)	14 / 9.1	153 (84-257)	3 / 12.6	24** (5-69)	3 / 1.9	156 (32-455)
Other Accidents	10 / 14.4	69 (33-127)	5 / 3.1	158 (51-369)	3 / 5.9	51 (11-148)	1 / 0.6	159 (4-886)
Suicide	14 / 21.3	66 (36-110)	3 / 2	44 (9-128)	2 / 8.6	23* (3-84)	2 / 1.4	140 (17-507)
Homicide	3 / 8.4	36 (7-104)	2 / 2	96 (12-345)	0 / 3.0	—	0 / 0.4	—

* Significant at $p < 0.05$; ** significant at $P < 0.01$

¹ Expected numbers based on age-sex-race and time specific United States rates coded according to the rules of the International Classification of Diseases coding in force at the time of death.

² 85, 991 person-years of observation

³ 75, 674 person-years of observation

⁴ 34, 755 person-years of observation

⁵ 16, 358 person-years of observation

Observed and Expected¹ Deaths in
1268 Ever Highly Exposed, 584 Only Low Exposed and
2037 Ever Undefinably Exposed Hourly Male Workers

Cause of Death ⁴	High ¹	SMR ⁵ (95% C.I.)	Low ²	SMR (95% C.I.)	Undefinable ³	SMR (95% C.I.)
	Obs/Exp		Obs/Exp		Obs/Exp	
All Causes	244 / 299	82** (72-93)	135 / 144	94 (79-111)	389/469	82.9** (75-92)
All Cancers	52 / 68	77 (57-100.5)	25 / 32	79 (51-116)	93/107	86.7 (70-106)
Cancer of Tongue	1 / 0.4	241 (6-1345)	0 / 0.2	---	0 / 0.66	---
Other Cancer of Buccal Cavity	1 / 0.5	207 (5-1151)	0 / 0.2	---	2 / 0.77	261 (32-944)
Cancer of the Pharynx	1 / 0.9	115 (3-642)	3 / 0.4	742* (153-2168)	1 / 1.4	73 (2-404)
Cancer of Esophagus	2 / 1.7	121 (15-435)	2 / 0.7	259 (31-936)	2 / 2.6	76 (9-276)
Cancer of Stomach	2 / 2.5	80 (10-290)	0 / 1.3	---	4 / 3.9	102 (28-261)
Cancer of Intestine	1 / 6	17* (0.4-93)	2 / 2.8	70 (9-252)	6 / 9.4	63 (23-138)
Cancer of Rectum	1 / 1.4	69 (2-386)	0 / 0.7	---	3 / 2.3	131 (27-383)
Cancer of the Biliary Passages and Liver	2 / 1	187 (23-676)	0 / 0.5	---	1 / 1.7	59 (2-329)
Cancer of Liver not Specified	1 / 0.4	228 (6-1268)	0 / 0.2	---	1 / 0.7	143 (4-799)
Cancer of Pancreas	3 / 3.3	90 (19-263)	3 / 1.6	188 (39-549)	5 / 5.2	95 (31-221)

<u>Cause of Death</u>	<u>High¹ Obs/Exp</u>	<u>SMR⁵ (95% C.I.)</u>	<u>Low² Obs/Exp</u>	<u>SMR (95% C.I.)</u>	<u>Undefinable³ Obs/Exp</u>	<u>SMR (95% C.I.)</u>
Cancer of the Peritoneum	0 / 0.3	---	0 / 0.1	---	0 / 0.5	---
Cancer of the Larynx	3 / 0.9	342 (71-999)	0 / 0.4	---	2 / 1.4	143 (17-517)
Cancer of the Trachea, Bronchus, & Lung	16 / 24	68 (39-110)	5 / 11	46 (15-108)	35 / 37	93 (65-130)
Other Respiratory Cancer	1 / 0.3	353 (9-1967)	0 / 0.1	---	0 / 0.45	---
Cancer of the Prostrate	3 / 4.7	65 (13-190)	2 / 2.2	88 (11-316)	10 / 7.1	139 (67-256)
Other Male Genital Cancers	0 / 0.4	---	0 / 0.1	---	0 / 0.8	---
Cancer of the Kidney	2 / 1.7	115 (14-416)	1 / 0.8	125 (3-695)	2 / 2.7	73 (9-264)
Bladder & Other Urinary Cancers	3 / 1.6	184 (38-538)	0 / 0.8	---	3 / 2.6	117 (24-341)
Cancer of the Skin	4 / 1.7	236 (64-605)	0 / 0.7	---	4 / 2.7	152 (41-388)
Cancer of the Brain and Nervous System	1 / 2.3	44 (1-247)	1 / 1	100 (3-557)	1 / 3.6	28 (0.7-156)
Cancer of Other & Unspecified Sites	1 / 4.5	22 (0.6-124)	2 / 2	97 (12-350)	4 / 7.1	57 (15-145)
Lymphosarcoma & Reticulosarcoma	0 / 0.9	---	1 / 0.5	221 (6-1230)	1 / 1.5	68 (2-378)
Hodgkin's Disease	0 / 0.7	---	0 / 0.3	---	0 / 1.1	---
Leukemia & Aleukemia	0 / 2.7	---	2 / 1.3	157 (19-567)	2 / 4.3	47 (6-168)
Other Lymphatic & Hematopoietic Tumors	3 / 2.6	119 (25-349)	1 / 1.1	90 (2-500)	3 / 3.9	76 (16-221)
Ischemic Disease	71 / 87	82 (64-103)	48 / 44	110 (81-146)	116 / 136	85 (70-102)
Chronic Disease of Endocardium	3 / 0.9	326 (67-952)	0 / 0.4	---	1 / 1.45	69 (2-386)

<u>Cause of Death</u>	<u>High¹ Obs/Exp</u>	<u>SMR⁵ (95% C.I.)</u>	<u>Low² Obs/Exp</u>	<u>SMR (95% C.I.)</u>	<u>Undefinable³ Obs/Exp</u>	<u>SMR (95% C.I.)</u>
Hypertension with Heart Disease	1 / 2.4	42 (1-232)	0 / 1.3	—	5/3.8	134 (43-312)
Other Diseases of the Heart	16 / 15	105 (60-171)	7 / 6.8	104 (42-215)	25/23	107 (69-157)
Hypertension without Heart Disease	1 / 0.8	125 (3-698)	0 / 0.4	—	2/1.2	163 (20-589)
Cerebrovascular Disease	12 / 14.7	82 (42-143)	6 / 7.9	76 (28-166)	14/22	62 (34-105)
Diseases of Arteries, Veins, Pulmonary Circulation	11 / 7.2	152 (76-272)	3 / 3.7	82 (17-241)	15/11	134 (75-221)
Transportation Accidents	12 / 15	79 (41-138)	11 / 6.6	167 (83-299)	16/23	67 (38-109)
Accidental Poisonings	2 / 1.4	146 (18-527)	0 / 0.6	—	3/3.2	93 (19-272)
Other Accidents	4 / 6.3	63 (17-162)	3 / 2.8	108 (22-315)	6/9.9	61 (22-132)
Medical Complications	2 / 0.4	532 (64-1921)	0 / 0.1	—	1/0.6	169 (4-941)

*Significant at $p < 0.05$; **significant at $p < 0.01$

¹ 37,739 Person-years of exposure

² 16,249 Person-years of exposure

³ 59,226 Person-years of exposure

⁴ Expected numbers based on age-sex-race and time specific United States rates coded according to the rules of the International Classification of Diseases coding in force at the time of death.

⁵ SMR equals deaths observed divided by deaths expected based on United States rates and multiplied by 100. Values in parentheses are the 95 percent confidence intervals.