County of Monroe, Michigan
Board of Commissioners
106 EAST FIRST STREET, MONROE, MICHIGAN 48161
Telephone: (313) 243-7081

RICHARD E. PETTICREW,
Chairman

DOCKET NUMBER
PROPOSED RULE PR-140 (3)
(50 FR 13978)

DOCKETED
USNRC

'85 JUN -3 A11:25

May 21, 1985

OFFICE OF SECRETARY
DOCKETING & SERVICE
BRANCH

Secretary Nuclear Regulatory Commission
Washington, D.C. 20555
Att: Docketing and Service Branch

Dear Sir:

The Monroe County Board of Commissioners, would like to go on record in opposition to your written comments on proposed Amendments to Part 140.

We feel the present rule is much more adequate for the protection of the general public.

Sincerely,

Richard E. Petticrew

Richard E. Petticrew
Chairman

REP/jfu
Attachments

cc: Sen. Carl Levin
Sen. Donald Riegle
Rep. John Dingell

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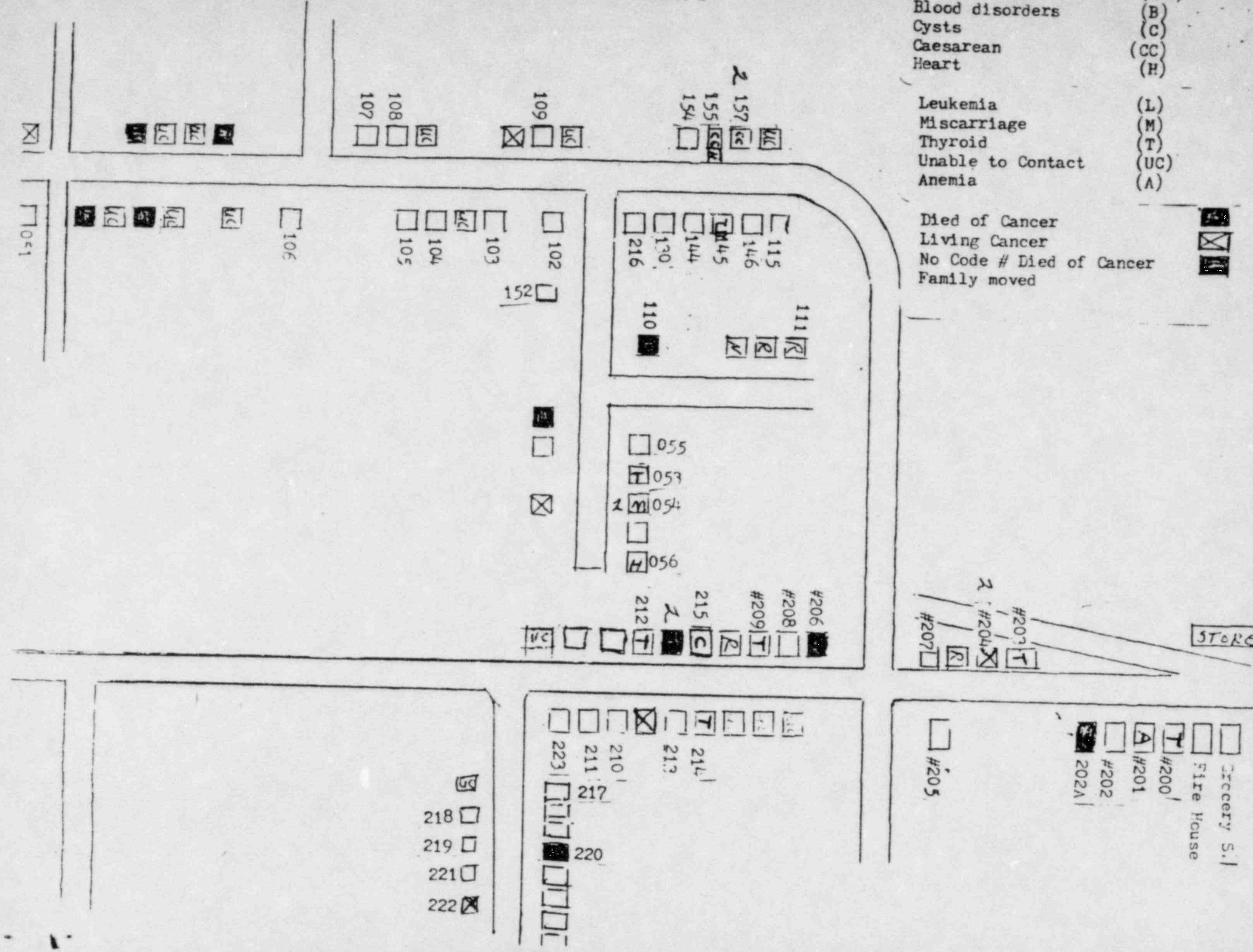
PDR PR
140 50FR13978 PDR

DS10
add: H.T. Peterson
1130SS

Acknowledged by card JUN 3 1985

AREA 2


Animal Cancer (AA)
Blood disorders (B)
Cysts (C)
Caesarean (CC)
Heart (H)
Leukemia (L)
Miscarriage (M)
Thyroid (T)
Unable to Contact (UC)
Anemia (A)
Died of Cancer
Living Cancer
No Code # Died of Cancer
Family moved
Grocery S.
Fire House
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#201
#202
202A
#203
#204
#205
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AREA # 2 APPROX. Two½ Air MILES South WEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	Health Dept. Pa Survey
051	Husband	1931					Grandson/age 6/developed diabetes	
	Beverly	1931		yes			White powder on patio/dead birds	Yes
056	Husband	1918				heart condt.		NO
	Wife	1923						
05[illegible]	Husband	1945						
	Wife	1949					Thyroidism nausea, severe headaches/dizziness	Yes
	Son	1974						
	Daughter	1971					" " " "	
054	Husband	1947						
	Wife	1957					Two miscarriages since accident	
	Daughter	1973						
055	Husband	1932						
	Wife	1936						NO
102	Husband	1947						
	Wife	1945						
103	Husband	1930						
	Wife	1930		odor when venting				
104	Husband	19						NO
	Wife	19				heart palpa.	Vomiting/nausea/unable to retain food	Yes
	Daughter	24 yrs						
	Daughter	30 yrs.						
	Son	11 yrs.						
	Son	4 yrs.						
106	Husband							
	Wife							

*Resident moved. Information obtained from other sources

**New Resident since accident.

***Residents unavailable or refused to participate

Case # Represents a single household.

AREA # 2 APPROX. TWO½ air MILES SOUTH WEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	Health Dept. Pa Survey
108	Husband	1945						NO
	Wife	1942						
	Son	1969					Psychological damage	
	Daughter	1972						
109	Husband	1942						
	Wife	1938						
	son	17 yrs.						
	Son	11 yrs.						
	Daughter	12 yrs.						
	Son	9 yrs.						
107	Wife			yes	yes		No birds for a long time. Aunt/lived grandview dr. died cancer	NO
	Husband			yes				
	Daughter	3 yrs.			like sunburn sore throats			
110	Husband	1923	cancer breast				First wife who lived here prior to accident/ cancer/ mastectomy	NO
	Wife	1921			burning yes			
	Wife's 1st husband also died from cancer							
115	Husband	1945						NO
	Wife	1946						
	Daughter	1969						
	Daughter	1974						
	Daughter	1982						
130	Husband	1931						NO
	Wife	1931						
111	refused	4 family members						Yes

*Resident moved. Information obtained from other sources

**New Resident since accident.

**Residents unavailable or refused to participate

Case # Represents a single household.

AREA # 2 APPROX. Two½ air MILES SOUTHWEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	Health Dept. Pa Survey
144	Husband	1940						
	Wife	1945	large Tumor				Large tumor under right upper arm/no injury: no biopsy/since 82	?
	Son	1967						
	Son							
	Daughter	1968						
	Son	1970						
145	Husband	1939						
	Wife	1941	breast cysts	yes	face/hands/arms		removed 1980 Felt funny in the head(dizzy)	Yes
	Daughter	1964						
	Son	1966						
	Daughter	1962					NOTE: One daughter breast cyst removed 83	
46	Husband	1941						?
	Wife	1939						
	Daughter	1967						
	Daughter	1961						
	Daughter	1962						
	Daughter	1965					Has had thyroidism since age 3	
	Son	1967						
	Son	1970						
52	Husband	1917						
	Wife	1922						
	Jeff	1960					Pro-nuclear/PPL employee	NO
53**	Husband	1923						
	Wife	1948						
	Son	1967						
	Son	1974						

*Resident moved. Information obtained from other sources

**New Resident since accident.

**Residents unavailable or refused to participate

Case # Represents a single household.

AREA # 2 APPROX. TWO air MILES/SOUTHWEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	Health Dept. Pa Survey
154	Husband	1928		yes				NO
	Wife	1928		yes	yes		detects white silvery powder	
	Susan	21 yrs.						
	Jere	23 yrs.						
155	Husband	1949						YES
	Wife	1951						
	Son	1980				Red cell 5,500,000/cumm	Wife's red blood count 4.2 -5.4 mill/cumm	
157	Husband	1955						NO
	Wife	1956						
	Son	1979						
	Son	1982					two caesarean sections	
200	Husband	1922				Heart	Heart by-pass/deceased 1982	NO
	Wife	1919					Thyroid problem/takes medicine	
201	Husband	1922						NO
	Wife	1925					anemia severe arthritis	
202	Husband	1919						NO
	Wife	1922						
203	Husband	1943						NO
	Wife	1945					Thyroid disorder/Dr.'s care	
	Son	1973						
204	Husband	1920	colon cancer				clostomy	NO
	Wife	1918	lymph cancer				chemotherapy/began 1983	
205	Widow	1923					Opened door to outside patio heard something like rain/not raining	NO
	Son	1962						
	Son	1952						

*Resident moved. Information obtained from other sources

**New Resident since accident.

***Residents unavailable or refused to participate

Case # Represents a single household.

AREA # 2 APPROX. TWO 1/4 air MILES SOUTH WEST OF TMI

se #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	Health Dept. Pa Survey
06	Husband	1910						
	Wife	1911	Breast Cancer				onset 1979/suddenly/died 81	NO
07	refused							
08	Husband	1923		yes	yes			NO
	Wife	1927						
09	Husband	1914		yes	yes	heart failure 1983		NO
	Wife	1919		yes			thyroidism problem	
10	Father	1914					TMI worker (construction)	NO
	Son	1941					employee of HBG Hospital	
11	Widow	1912			Yes			yes
12	Husband	1906			Yes			NO
	Wife	1914			Yes		Ankels severely discolored Red spots under skin	
	Grandaughter	1955						
3	Husband	1941						NO
	Wife	1936		Yes			Hear hissing sound eve. saw yellow cloud helicopters following cloud.	
	Son	1962						
	daughter	1963						
	Gr.father	1901					excellent health/sound mind	
4	Husband	1945						NO
	Wife	1947					enlarged thyroid/medication	
	Son	1977						
	Daughter	1980						
	H's father	65 yrs					stroke/died 1979	
5	Husband	1948					cyst-like eruptions a month after accident	NO
	Wife	1950					have since disappeared	
	Daughter	1984						

*Resident moved. Information obtained from other sources

**New Resident since accident.

**Residents unavailable or refused to participate

Case # Represents a single household.

AREA # 2 APPROX. TWO½ air MILES/SOUTHWEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	Health Dept Pa Survey
17	Husband	1947						
	Wife	1952						NO
	Daughter	1977						
	Son	1975						
18	Single parent (f)	1940	fiberous tumor				Dog died from muscle cancer	
	Daughter	1971					Miscarriage four & half years ago. outside of uterus	NO
	Son	1961						
19	Husband	1945						
	Wife	1946						NO
	Daughter	1975						
	Daughter	1977					Dog died from skin cancer discovered white powder in dogs dish/and b.r.	
20	Single parent (f)	1953						
	Daughter	1971					anemia/premature birth(82)	NO
	Son	1982						
	D's Father		myeloma mutiple				onset of illness 7/81 died 82	
21	Husband	1945						
	Wife	1948						NO
	Son	1970					Did not live here attime of accident " " " " " " " "	
22	Husband	1917	Throat spleen				cancer	NO
	Wife	1909	Nose face				cancer	
6	Husband	1924						
	Wife	1924	psychological damage from accident				strong taste of iodine/gritty in mouth 3/28/79	NO
3	Husband	1930					Pro-restart/plan to move to Fla.	Yes
	Wife	1930						

*Resident moved. Information obtained from other sources

**New Resident since accident.

***Residents unavailable or refused to participate

Case # Represents a single household.

AREA # 2 APPROX. TWO$\frac{1}{2}$ air MILES SOUTHWEST OF TMI

ne #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	Pa Survey
	Not interviewed		cancer				died	
	" "		cancer				died	
	" "		skin cancer				living	
	" "		cancer				died	
	" "		cancer				died	
	" "		cancer				?	
	" "		cancer				?	
	" "		cancer				died	
5	Husband	19						
	Wife	19						
	Son	21 yrs.						
	Son	17 yrs.						
•								

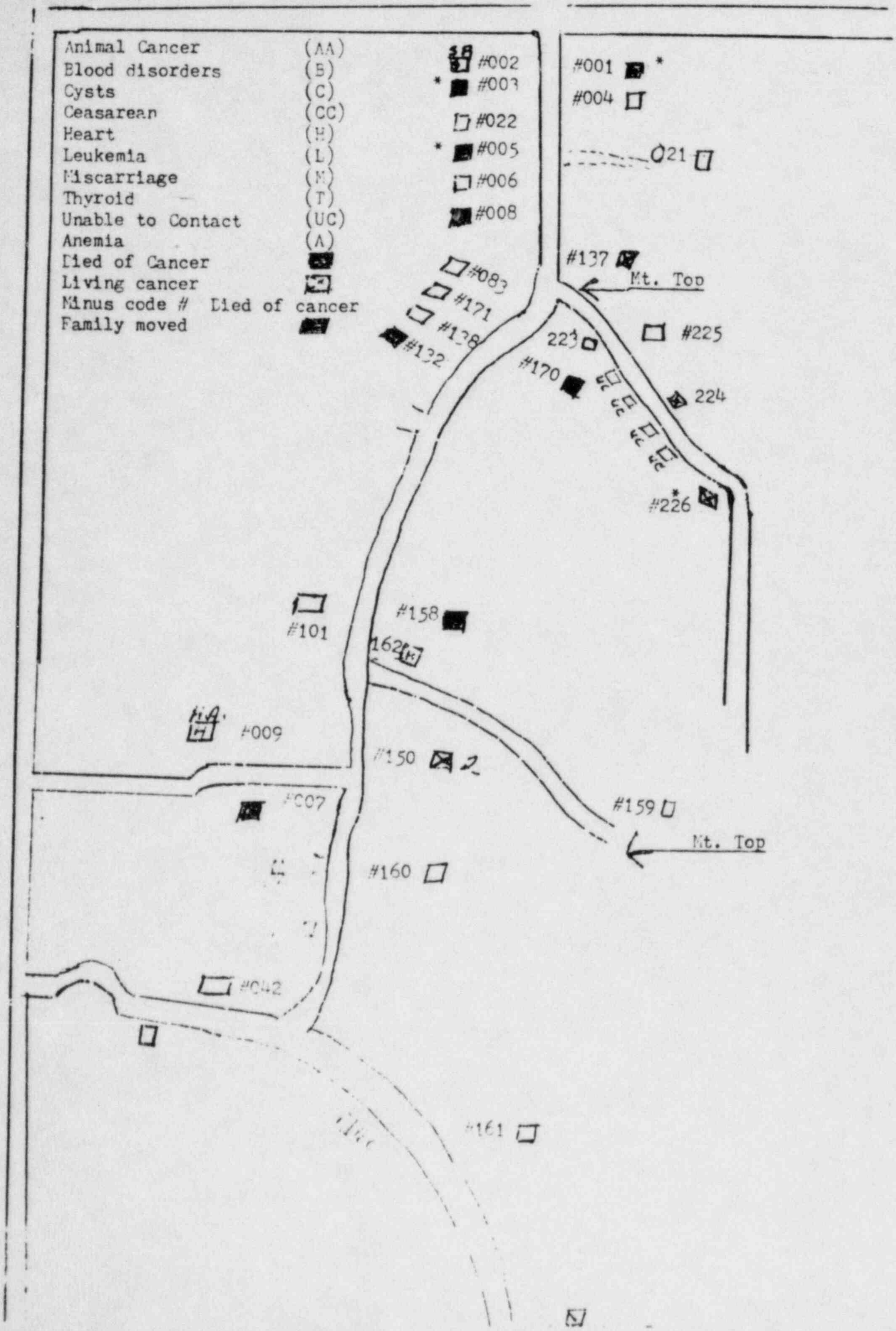
*Resident moved. Information obtained from other sources

**New Resident since accident.

**Residents unavailable or refused to participate

Case # Represents a single household.

A. EA # 1



Animal Cancer (AA)
Blood disorders (B)
Cysts (C)
Ceasarean (CC)
Heart (H)
Leukemia (L)
Miscarriage (M)
Thyroid (T)
Unable to Contact (UC)
Anemia (A)
Died of Cancer
Living cancer
Minus code # Died of cancer
Family moved
#002
* #003
#022
* #005
#006
#008
#001 *
#004
021
#137
Mt. Top
#083
#171
#138
#132
223
#225
#170
224
#226
#101
#158
162
#009
#150
#159
#007
Mt. Top
#160
#042
#161

AREA # 1 APPROX. SIX MILES NORTHWEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	In Survey
042	Mother	191?					Repeated chest colds	NC
	Son	1937						
043	Husband	1916					former TMI worker	C
	Wife	1919	Breast				Breast cancer/masdectomy/chemotherapy	
161	Husband	1943						
	Wife	1939						
160	Husband	1943					Lt. evacuated at 7:00 A.M. 7/28/79	
	Wife	1943						
	Son	1963						
	Daughter	1968						
	Son	1971						
162 **	Refused information		Former residents		Burns (male/heart attack)		New Resident	
170 **	Owner/Male						New Resident	
Previous	Owner/Male	?	Lung Cancer				Former resident died 198[illegible]	
171	Husband	1937		Yes	Yes	Open heart surgery	See affidavit	C
	Wife	1941		Yes			Hypothyroidism	
	Son	1957						
08?	Husband	1959						
	Wife	1959						
	Daughter	1980						
	Son	1980		Crossing Turnpike			Unusual order	C
150	Husband	1907	Colon Cancer					
	Wife	1910	Colon Cancer				Daughter from Shiremanstown, [illegible] Birth...Downs syndrome/cancer (Re[illegible]	
	Daughter	1945						

*Resident moved. Information obtained from other sources

**New Resident since accident.

***Residents unavailable or refused to participate

Case # Represents a single household.

AREA # 1 APPROX. six MILES NorthWEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	'a urvc
009	Sister	1918						
	Brother	1912				heart attack	Sudden death/no history of health problem	
101	Husband	1946						
	Wife	1952						
	Son	1976						
	Daughter	1979						
158	Husband	1918						
	Wife	1928						
	Son	1966						
	Son	1950						
	Mother						Died 1980 leukemia	
159	Husband	1924						
	Wife	1924		Yes				
132	Husband		colon cancer				colostomy -	
	Wife	1954						
021	Husband	1922						
	Wife	1925						
008	Single Male	1940						
	Mother	1909	Cancer Kidneys				Died 2-1-81	
137	Husband	1940	Cancer colon				Operated on 198?	
	Wife	1941						
	Daughter	1964						
	Daughter	1961						
	Daughter	1962	Breast Cancer				operated/4/8?	
135**	Number of people unknown						no information	

*Resident moved. Information obtained from other sources

**New Resident since accident.

***Residents unavailable or refused to participate

Case # Represents a single household.

AREA # 1 APPROX. SIX MILES North WEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	In Survey
022	Husband	1931						
	Wife	1932						
	Daughter	8 yrs.						
	Daughter	12 yrs.						
004	Single Male	1933						
001	Single Male	54 yrs.	muscle cancer				died 1980	[illegible]
002	Husband	1933						[illegible]
	Wife	1931						
	Daughter	1957						
	Grandaughter	1972				Heart Condition		
003**	Husband	1951						
	Wife	1952						
	Son	1976						
	Daughter	1980						
	Former Resident	33 yrs.	muscle cancer				Died 1980 Female	
005**	Husband	1947						[illegible]
	Wife	1953					Two miscarriages 1981 & 82	
	Son	1983						
	Former Resident	68 yrs.	muscle cancer				Female died 1980	
006**	Husband	1934						
	Wife	1936						
	Daughter	1960						
	Daughter	1963						
	Son	1966						
007	Husband		prostate cancer				Died 1981 diagnosed 1978	
	Wife	1915	colostomy				colostomy 1974	

*Resident moved. Information obtained from other sources

**New Resident since accident.

***Residents unavailable or refused to participate

Case # Represents a single household.

AREA #1 APPROX. six MILES NORTHWEST OF TMI

Case #	Residents	Yr. Birth	Tumors	Metallic Taste	Skin/Eye Irritations	Circulatory	Other Indications	[illegible]
223	Husband	5-11-42						
	Wife	2-22-48						
	Son	12-17-71						
	Son	8- 3-75					Pet dog unable to deliver 4th litter	[illegible]
224	Husband	1-23-21						
	Wife	8-24-06	eye	yes			This resident had eye removed/cancer Also skin cancer. Withold information	
225	Husband	7-24-42						
	Wife	12-17-46						
	Son	9- 5-65						
	Son	8- 1-71						
	Son	12- 3-75						
226	Husband							
	Wife							
	Daughter							
	Son							

*Resident moved. Information obtained from other sources.

**New resident since accident.

***Residents unavailable or refused to participate.

Case # represents a single household.

1978-714 * 1980-477 * 1982-501

GOLDSBORO

XXXXXXX

Code #		AGE	DECEASED	LIVING	DIAGNOSIS	CANCER
300	Bailets, Martha				Masdectomy/chemotherapy	X
301	Bamberger, Carrie	96	12-14-81		Old age	
302	Drawbaugh, Alda Mae	64	1-24-82			
303	Derrick, Robert	60	9- -82		Lung	X
304	Ensminger,	80's		X	Pancreas	X
305	Gross, Athea	53		X	Benign Breast Tumor/ovary removal	
306	Gross,	53		X	Spinal Stignosis/disabled	
307	George, Eva	53		X		X
308	Haring, Walter	65	83		Stomach/liver	X
309	Henry, Forothy	51		X	Chemotherapy	X
310	Hillman, Anne	70		X	Colon	X
311	King, Francis	61	81		Admitted to hospital for operation Died from heart attack during Hosp.stay	
312	King, Irene	60's		X	Masdectomy	X
313	Krone, Rena	65		X	Masdectomy	X
314	Kunkle, Paul Dr.	70's	82		Leukemia(several types of cancer)	X
315	Lehman, Henry	62	11-15-81		Heart Attack	
316	Miller, Harry	76	6-27-80		Liver/stroke	X
317	Miller, Preston	60's	80		Leukemia	X
318	Park, Frank Jr.	63	6- 2-81		Heart Attack	
319	Shuler, Cora	78	12-18-80		Throat	X

14 * 1980-477 * 1982-501

AREA #3

Code #	AGE	DECEASED	LIVING	DIAGNOSIS	CANCER
320 Speece, William Mrs.	45		X	Colon/Breast/Colestomy	X
321 Speece, William	46			Heart Attack	
322 Rosinski, Frank	57	6- 81		Lung/Met Ed. employee	X
323 Sweitzer, Raymond	44		X	Aug., 1981 Leukemia/Met Ed employee	X
324 Toomey, Daniel R.	44	10- 4-81			
325 Tusing, Rebecca	65	[illegible]		Uterine/Bone	X
326 Yinger, Eva	74	4-6-81		Colon	X
327 Yinger, Henry	80's	4-24-82		colon/liver	X
328 Seigler, Alvin	84	11-18-79		Old age	
329 Staub, Melvin, Mrs. (Mt. Wolf)	64	1-24-82			X
330 Staub, Melvin	71	2-27-82			X
331 Richards, Dorothy	59	6-13-82			

PRELIMINARY CANCER SURVEYS NEAR TMI (as of June 1984)

Molholt

Introduction

In an effort to assess potential chronic health effects from the TMI-2 accident, several citizens groups have been conducting door-to-door surveys on the west bank of the Susquehanna River between 0.5 and 5 miles from TMI. An effort was made to select subdivisions which are high in elevation. Many of the people remember metallic taste or odor 28-30 March 1979 and some had more acute symptoms. Three such areas are reported here:

AReA (1) [redacted]
AReA (2)
AReA (3)

In each case over half the households were surveyed. Sometimes data was collected for other homes from neighbors. Total populations were estimated for each area assuming 3 persons per uncontacted household.

The population mean age for all three groups was 35-39, not atypical for an average U.S. population. Hence, the reported cancer mortality rates have not been age adjusted, although this procedure is recommended for any subsequent followup studies. Followup is urged. Although the state reports it has surveyed 95 percent of persons residing within a 5 mile radius of TMI, only 11 out of 62 responding to this question upon survey (18 percent) said they had been contacted.

Expected cancer mortality

The southeastern Pennsylvania cancer mortality rate is 183 per 100,000 per year. Of these 183 cases, 40 will be lung, 28 breast, 8.5 leukemia, 6 lymphoma, 5 brain and 1.3 muscle (tissues of origin). These baselines of expected cases will be compared with those found during the surveys. If anything such survey results represent minimal cancer mortality frequencies, since many households were not queried and in some of those queried there was reticence to discuss cancer.

Area 1 [redacted]

84 persons were surveyed in 28 homes. For the 7 homes uncontacted, if one assumes 3 per household, the population base of this area is 105. This is an elevated section [redacted] 5 miles northwest of TMI. Cancer mortalities are shown in Table 1 and a map of these fatalities in Area #1. In addition to the 5 confirmed cancers, a previous owner of house #170 died of lung cancer in 1981 and the mother in house #158 (80 years old) died of leukemia in 1980. Five additional residents have cancer diagnosed between 1979 and 1984, including one additional muscle cancer.

Area 2 [redacted]

145 persons were surveyed in 49 homes. It is estimated that 127 live in homes not surveyed (43) for a total population of 272. This section [redacted] is 2.5 miles southwest of TMI. Cancer mortalities

mortalities for [redacted] are shown in Table 2 and a map of these fatalities in Area #2. In addition to these 5 confirmed cases, 6 other cancer deaths have been reported between 1979-84 for a total of 11 cancer deaths in this neighborhood.

Area 3 [redacted]

This area is approximately 6 miles northwest of TMI. Fourteen households with 52 residents were questionned. One case of lymphoma is living. Of the three reported cancer deaths 1979-84, one was leukemia (death in 1982) and two others were in a father (41) and his son (21). The lymphoma and leukemia occurred in individuals 53 and 54 years of age, respectively. Since information is less complete than for the other two areas, no table or map is shown for Schuey Road.

Epidemiology of cancer mortalities

Table 3 summarizes the cancer mortalites found in each of the three areas surveyed compared with those expected for the five year period mid-1979 to mid-1984. It may be seen that Area 1 would be expected to incur one cancer fatality in its population of 105 over the five year period, but 7 cancer fatalities were found. Similarly 2.5 cancer fatalities were expected along Area 2 , but 11 cancer deaths were found. Along Area 3 the story was the same with 0.5 cancer fatalities expected (e.g., a 50 percent chance that there would be one fatality) but 3 cancer fatalities were found.

Overall, in these three areas which reported signs of contamination by TMI during the 1979 accident (metallic taste, skin burns, etc.), whereas 4 cancer fatalites would have been expected in the five years since the accident, 21 cancer deaths have actually occurred. This five-fold increase over expected cancer mortality rate is statistically significant at the 95 percent confidence level and indicates that some carcinogenic insult may have occurred as a result of the TMI accident.

Table 1

Cancer Mortalities 1979-84

- 4Res. [redacted]

Case	Age	Date	Type of cancer
A	40	?	colon
B	72	1981	renal
C	54	1980	muscle
D	33	1980	muscle
E	68	1980	muscle

Table 2

Cancer Mortalities 1979-84

Area 2 [redacted]

Case	Age	Date	Type of cancer
A	31	7/81	multiple myeloma
B	70	1979	breast
C	48	1981	brain
D	48	1981	lung
E	60	?	breast

Table 3

Expected v. Actual Cancer Mortalities

in Communities near TMI (1979-84)

Community	Cancer Mortalities		Actual/ Expected	Excess Deaths
	Expected	Actual		
Area 1	1.0	7.0	7.0	6.0
Area 2	2.5	11.0	4.4	8.5
Area 3	0.5	3.0	6.0	2.5
TOTAL	4.0	21.0	5.2	17.0

UNITED STATES NUCLEAR REGULATORY COMMISSION

Office of Public Affairs
Washington, D.C. 20555

NUREG/BR-0032

Vol. 4, No. 14

WEEK ENDING April 9, 1985

NEWS RELEASES

No. 85-55
Tel. 301/492-7715

FOR IMMEDIATE RELEASE
(MOnday, April 8, 1985)

NRC CONSIDERS REGULATIONS ON WELL LOGGING OPERATIONS

The Nuclear Regulatory Commission is considering amending its regulations to include specific safety requirements for the use of radioactive materials in well-logging operations.

The oil and gas industry uses well-logging techniques to obtain information on the properties of underground formations--such as the type of rock, porosity, hydrocarbon content and density--in new and existing wells. One technique involves lowering a sealed radioactive source, with an associated radiation detector, into a well on a wire line. Information collected by the detector is sent to the surface through the wireline while the radioactive source and detector are slowly raised from the bottom. The log of the well is produced by recording the way in which radiation emitted by the source interacts with the underground formation.

Americium and cesium are the radioactive materials most commonly used for this purpose. Similar use of the materials is made in coal and other mineral exploration.

As of November 1984, 173 NRC licensees were authorized to use radioactive materials in well-logging operations. In addition, 27 states have reached an agreement with the NRC under which they regulate well-logging (as well as certain other activities involving commercial use of radioactive materials). These Agreement States have about 400 well-logging licensees.

Current NRC regulations do not contain radiation safety requirements specifically related to the use of nuclear materials in well-logging operations. Instead these operations are regulated through the general safety requirements for use of nuclear materials and through conditions of each individual license imposed on a case-by-case basis. The proposed rule would provide comprehensive and consistent regulations in this area and is designed to reduce the risk of an accident involving radioactive material.

Specific requirements of the proposed rule would include:

(1) The licensee (well-logging company) would be required to enter into a written agreement with the well owner or operator in which the owner or operator commits to make a reasonable effort to recover any radioactive source that gets stuck in the well. The owner or operator would also agree not to release contaminated equipment or property surrounding the well for unrestricted use until the equipment or property has been decontaminated. This agreement is needed because the well-logging company itself might not have the legal authority or resources to recover a radioactive source that gets lost in a well.

(2) Licensees would be prohibited from forcing a stuck sealed radioactive source out of its holder in a manner that could endanger the sealed source's integrity unless the action was specifically authorized by the NRC. Rupture of the sealed source could cause radioactive contamination of the facility, personnel and environment.

(3) Performance criteria would be established for the sealed radioactive sources. After a phase-in period, the sealed sources used by well-logging licensees would have to be doubly encapsulated, contain nuclear material that is relatively insoluble and nondispersible and either have individually passed a pressure test or be similar to a prototype that has passed tests complying with standards of the American National Standards Institute.

Interested persons are invited to submit written comments on the proposed rule, which would be contained in a new Part 39 of the Commission's regulations. Comments should be sent to the Secretary, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, Attention: Docketing and Services Branch, by July 8, 1985 (90 days after publication in the Federal Register on April 8, 1985).

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FOR IMMEDIATE RELEASE
(Monday, April 8, 1985)

NRC PROPOSES TO REVISE EXTRAORDINARY NUCLEAR OCCURRENCE CRITERIA

The Nuclear Regulatory Commission is proposing to revise its criteria for determining that a nuclear accident at a licensed nuclear power plant, or certain other licensed facilities, is an "extraordinary nuclear occurrence" (ENO).

The test for an ENO, as defined in the Atomic Energy Act of 1954, as amended, is whether there was substantial release or dispersal of radioactive materials offsite and whether there was substantial personal injuries or property damage offsite. The existing criteria are:

1. "That one or more persons offsite were, could have been, or might be exposed to radiation or to radioactive material, resulting in a dose or in a projected dose in excess of... 20 rems to the whole body or corresponding doses to specific organs; or specified levels of surface contamination have occurred.

2. "The event has resulted in the death or hospitalization, within 30 days of the event, of five or more people located offsite showing objective clinical evidence of physical injury..." from exposure to radiation; or

"$2,500,000 or more of damage offsite has been or will probably be sustained by any one person or $5 million or more of such damage in total has bee or will probably be sustained..."; or

"$5,000 or more of damage offsite has been or will probably be sustained by each of 50 or more persons, provided that $1 million or more of such damage in the aggregate has been or will probably be sustained, as the result of such events."

If the Commission determines that a nuclear accident was an ENO, persons with claims for injuries would not need to prove that the licensee was negligent. However, those persons would have to prove that there was injury or damage, the amount of monetary loss and the link between the loss and the radioactive material released during the accident.

After the March 1979 accident at the Three Mile Island nuclear power station, the Commission encountered problems in applying existing ENO criteria. One of the problems was that it was difficult to determine monetary damages, other than those directly related to evacuation, and, in some cases, these damages were resolved only after extended litigation. This difficulty did not affect the Three Mile Island ENO determination as it was clear that the existing criteria for substantial releases or offsite doses were not met or exceeded.

Three options for amending the present criteria are being proposed. Like the present criteria, the proposed criteria set forth in any of the three options would be used by the Commission in making a legal decision which would affect procedures for handling claims for damages or injuries. They would not represent allowable or safe limits for use by NRC licensees.

Option 1. The first criterion--for determining that there has been a substantial release of radiation offsite--would be a Commission determination "...that one or more of the persons...has been or probably will be..." exposed to a whole body dose of radiation in excess of five rems with corresponding doses for specific organs. Specified levels of surface contamination would n be changed from those currently contained in the NRC's regulations.

The second criterion--for making a finding of substantial personal injur to persons or damage to property offsite--would require a Commission determin tion that one or more of the following conditions are satisfied:

(a) "Five or more people have received a radiation dose...to the whole body or any organ..." which is in excess of 100 rads.

(b) "Offsite property having a value of $2,500,000 is contaminated with radioactive materials..." in excess of specified levels.

Finance Committee

(c) "Employment loss of at least 25,000 person-days has occurred."

(d) "Evacuation of at least 100,000 person-days has occurred as a result of an evacuation ordered by a State or local official with the authority to make such an order."

Option 2. The first criterion would require a Commission determination that "...a person or persons located on or near any site boundary throughout the duration of the accident" could have received a whole body dose of radiation in excess of five rems with corresponding doses for specific organs. Specified levels of surface contamination would remain the same, as in Option 1 and the existing criteria.

The second criterion would require a Commission determination that one or more of the following conditions are satisfied:

(a) "A calculated dose of 100,000 person-rem has been delivered within a 50-mile radius during the course of the accident."

(b, c, d) Same as Option 1.

Option 3. This option would not use two separate criteria for substantial releases and substantial damages. A Commission determination would be required "...that there has been a substantial release of radioactive material offsite, or that there have been substantial levels of radiation offsite such that substantial injuries or substantial damages have resulted or will probably result when radioactive material is released...and, as a result of the event, any of the following conditions is satisfied:"

(a) "Real and personal property is rendered unfit for its normal use as a result of contamination with radioactive materials at..." a specified exposure rate.

(b) The radiation dose "...which could be received by an individual, over any 24-hour period, exceeds 10 rads..."

(c) "Real and personal property is rendered unfit for its normal use as a result of contamination for each square meter of any 100 square meters (as a minimum)..." in excess of specified levels.

Written comments on the proposed amendments to Part 140 of the Commission's regulations should be received by August 7, 1985. They should be addressed to the Secretary of the Commission, Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch.

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Special Report

QUARANTINED MEDICINE

There's only one drug in the world known to block radiation's effect on the thyroid—and the U.S. government has been trying to keep it under wraps. Why?

By John Grossmann

THREE DAYS AFTER THE WARNING WAS SOUNDED AT THE CRIPPLED THREE MILE ISLAND PLANT IN PENNSYLVANIA, AIR FORCE JETS FLEW IN EMERGENCY SUPPLIES OF A DRUG THAT CAN OFFER SIGNIFICANT PROTECTION IN THE EVENT OF A SERIOUS ACCIDENT AT A NUCLEAR POWER PLANT. THE DRUG IS INEXPENSIVE. IT HAD BEEN DEEMED SAFE AND EFFECTIVE BY THE U.S. FOOD AND DRUG ADMINISTRATION AND APPROVED FOR SALE WITHOUT A PRESCRIPTION. IN ALL, SOME 236,000 BOTTLES WERE DELIVERED TO A WAREHOUSE IN HARRISBURG, WHERE THEY SAT UNDER ARMED GUARD.

THE DRUG WAS NEVER DISTRIBUTED.

MANY EXPERTS SAY THE DRUG COULD BE NEEDED UPWARD OF 100 MILES FROM A RUPTURED NUCLEAR REACTOR. ALTHOUGH AS MANY AS THREE-FOURTHS OF ALL AMERICANS LIVE THIS CLOSE TO ONE OR MORE OF THE NATION'S 53 OPERATING NUCLEAR POWER PLANTS, ONLY A FEW THOUSAND AMERICANS CURRENTLY HAVE THE DRUG IN THEIR HOMES, AND ONLY LIMITED SUPPLIES ARE NOW ON HAND AROUND THE COUNTRY. WHY?

The drug is called *potassium iodide*, or KI for short, and the first question Alan Morris asked was: Where could he get some? Morris, then a 36-year-old marketing specialist for Publishers' Clearinghouse, first read about the drug in newspaper accounts of the Three Mile Island accident. He read that KI could be especially important in safeguarding young children and unborn babies. Morris looked at his 1-year-old son and at his wife, who was still well within her childbearing years. Morris lived in Manhattan, some 160 miles from the accident site, but he knew that the Indian Point nuclear power plant was only about 30 miles away. Unlike most Americans who heard about KI, Morris did not forget about the drug when Three Mile Island faded from front-page news. By virtue of his job, he had subscriptions to numerous magazines. One of them was Science News, which told him enough about the drug to propel him to the library to do more research. What he learned was this:

A major accident at a nuclear power plant could release several kinds of radioactive particles into the air. Among these would be radioactive iodine, one of the most abundant fission products in a reactor, and additionally worrisome because of the peculiar workings of the body's thyroid, a tiny gland weighing less than an ounce. The thyroid is responsible for secreting important growth hormones. It is also very efficient at absorbing iodine from the blood—and would gather radioactive iodine just as proficiently. Acting like a sponge, the thyroid would concentrate the body's exposure to radioactive

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John Grossmann is a contributing editor of HEALTH.

ILLUSTRATION BY THOMAS WOODRUFF

iodine; in only a few hours the concentration might be 1,000 times the level elsewhere in the body. The effects of radioactive iodine on the thyroid range from mild inflammation of the gland to *hypothyroidism* (a loss of function) to benign thyroid nodules and thyroid cancer. Because of their small body size, infants would be especially at risk of developing thyroid-related problems. And a baby in its mother's womb would run an increased risk of *cretinism*, severe congenital retardation.

You could guard against these effects, Morris learned, by taking potassium iodide, a so-called blocking agent. If swallowed immediately before or within 30 minutes of exposure to radioactive iodine, the thyroid gland would become saturated with the drug and have little room left to absorb the harmful radioactivity. Timing was important, though: If taken at the time of a radioactive release, KI could block approximately 90 percent of the radioactive iodine; if taken only a few hours later, the drug's effectiveness would be cut in half. Potassium iodide was no magic bullet. It offered no protection against other radioactive particles such as *cesium* and *tellurium*. It did not shield the body from the effects of radiation; it protected only one small gland. But it appeared likely to do that well. Noting these caveats, the FDA had given the green light to non-prescription sale of KI and had granted marketing approval to the pharmaceutical firm of Carter-Wallace.

Morris had soon read enough. He decided he wanted the drug to protect his family and himself. He tried several pharmacies, but none stocked the Carter-Wallace product. No pharmacist he visited had even heard about a drug that might offer radiation protection. He was asked if he had a prescription, which seemed strange, since he knew KI was approved for non-prescription sale. Baffled, Morris decided to call Carter-Wallace and order the drug directly from them. He asked for the product by name—Thyro-Block—and was told the company did make the drug, but could not sell it to him. "It has been approved for over-the-counter sale, hasn't it?" Morris inquired. "Yes," he was told, but it was company policy not to sell it directly to the public. He was directed to call his local utility, Con Edison; they would have a supply.

Morris happened to live just around the corner from Con Edison's Manhattan headquarters. He walked over and [illegible] potassium iodide. He got [illegible] in frustration, he raised his voice. That got him the name and the Brooklyn telephone number of Con Ed's chief medical officer. Morris tried to call him, but ended up speaking with someone else in the department. "At first he denied they had the drug," Morris recalls. "Finally he admitted they had it." But Morris wouldn't be needing any KI, he remembers the Con Ed employee saying—there would never be an accident at Indian Point (the nuclear plant in upstate New York owned by the utility). "If I don't need it, then why do you have it?" asked Morris. The employee's reply, says Morris, made reference to the "image" of Con Ed. Every day, he said, Morris and others who kept the drug in their medicine cabinets would

"I think it's pretty clear a lot of people are afraid that widespread distribution of KI would make people believe that nuclear accidents are much more likely than we've been told in the past."

be reminded that nuclear power plants can be dangerous. (When a Con Ed spokesman was later presented with this conversation, he said that it seemed "unrealistic that a Con Ed person would talk like that.")

Morris was furious. He fairly shouted: "You're more concerned about your image than the safety of my one year old! Nuclear accidents *are* possible. We had Three Mile Island only a few months ago." Not long after he hung up, Morris made a remarkable decision: He vowed to manufacture the drug himself.

With that vow, Alan Morris became an unlikely player and, indeed, a catalyst, in a health debate of national importance: Should KI be made available to the general public? And if it is, when? How? The debate is crisscrossed by scientific uncertainties and controversies; seemingly biased by deeply rooted pro and con nuclear sentiments, and thus highly political; and bogged down by bureaucratic inertia and indecision at both the federal and the state levels. More than a year ago, Representative Edward Markey, a Democrat from Massachusetts, called Congressional hearings to try to speed up the debate on KI. Near the end of those March 1982 hearings he asked representatives of the U.S. Food and Drug Administration (FDA), the Federal Emergency Management Agency (FEMA) and the Nuclear Regulatory Commission (NRC) how much longer they thought it would take to fully coordinate a federal policy on KI. All said six months. Some three weeks later came the third anniversary of Three Mile Island.

A fourth anniversary has now passed—still without a coordinated federal policy. This indecision has affected state health officials, who have been confused by conflicting federal signals. To date, only one state has distributed KI to residents living close to a nuclear power plant. For the most part, the medical community has remained strangely silent. Neither of the nation's most prestigious medical journals, The New England Journal of Medicine and The Journal of the American Medical Association, has published a single editorial or article on the subject. Most Americans remain woefully uninformed—and perhaps disastrously deprived—of what may be an important nuclear antidote.

HEALTH has learned that if a severe nuclear accident were to occur today—more than four years after Three Mile Island supposedly shocked the country into a more thorough appraisal of nuclear power—it is doubtful that officials could amass a supply of KI as large as was rushed to Harrisburg. Again, the question: Why?

Alan Morris probably brushed very near the heart of the KI debate in his exchange with Con Edison, but to appreciate this requires some backtracking. Nuclear bomb testing in the South Pacific first spotlighted radiation damage to the thyroid. Years after a 1954 blast over the island of Bikini, thyroid tumors began appearing among people exposed to radioactive fallout on islands some 100 miles away. From study and treatment of these tumors came the notion of employing potassium iodide, used for decades in bronchial medications, as a blocking agent. A quick KI chronology:

1975. The NRC receives a recommendation from a study group of the American Physical Society that "a national policy of stockpiling thyroid-blocking chemicals for possible emergency distribution should be established."

1977. A nonprofit organization chartered by Congress, the National Committee on Radiation Protection, advocates KI as "a major protective action to be considered after a serious accident at a nuclear power facility involving the release of radioiodine."

1978. The FDA asks drug companies to submit "new drug applications" for KI

SCIENTIFIC CONTROVERSIES BLUR THE KI PICTURE

"Source term" is nuclear jargon for the amount of radioactive release from a damaged power plant. The current debate about it is highly technical, but hinges on recent reports (from the Electric Power Research Institute and the Oak Ridge National Laboratory—both with strong ties to the nuclear industry) about the small release of radioactive iodine at Three Mile Island and suggesting that estimates of such release in other accident scenarios should be scaled down considerably, perhaps to the point where KI would hardly be necessary. Counterarguments concede the small radioactive release at TMI, but point out it was a "slow, wet accident" in which radiation was contained by virtue of the cooling water present. What about a "fast, dry accident" or other catastrophic event, they ask, that could lead to a meltdown and breach of the containment structure?

The NRC and indeed the nuclear industry have taken the stance that catastrophic nuclear accidents are virtually impossible—a probability of one major release of radioactivity every 1,000 years. Nuclear critics put very little faith in such estimates. Low probabilities weigh heavily in estimates prepared for the NRC that place the cost/benefit ratio of KI in a range of a few hundred thousand dollars to $10 million for each thyroid nodule prevented. Frank von Hippel terms such estimates "a misuse of science," and in a memo to the NRC commissioners explained that his calculations reduced those figures substantially—to $1,000 to $30,000 per thyroid tumor.

Another insight into costs comes from Leonard Solon, MD, director of the New York City bureau of radiation control. Speaking for himself, not in an official capacity, Dr. Solon feels "KI is cost-effective." An intense nuclear plume, say from a crippled reactor at Indian Point, that swept over the nation's largest city, might, in the absence of KI distribution, cause some 40,000 thyroid nodules. Of these, he says, 26,000 would be benign; 14,000 cancerous. Just the resulting health care—to say nothing of the pain and anxiety suffered—might cost some $128 million to remove the 14,000 cancerous thyroid glands; $163 million to remove the benign nodules; and upward of $9 billion to monitor the city's eight million residents over a span of some 40 years.

There is another way of considering the question of costs, concludes von Hippel. The safety costs associated with a single, multi-billion-dollar reactor, he explains, can run from $200 million to $800 million dollars. Supplying potassium iodide, even to everyone in the country (using an NRC figure of 20¢ per person per year), would come to only about $48 million dollars.

These controversies follow previous ones, now cooled for the most part, centering on fears of side effects from the drug and disagreement about at what exposure level KI should be administered.

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to spur manufacture of the drug.

1979. The accident at Three Mile Island occurs before any companies have approval to make the drug, and so a frantic effort, complete with middle-of-the-night telephone calls to drug company officials, is necessary to hastily arrange for manufacturing the 236,000 bottles of KI then flown to Harrisburg.

Following Three Mile Island. The official investigation of the Three Mile Island accident, the Kemeny Commission report, advocates a KI strategy. Similar recommendations emerge from a study done for the President's Council on Environmental Quality. Calculations done at Princeton University's Center for Energy and Environmental Studies underscore these recommendations. Princeton's investigators, headed by Frank von Hippel, PhD, predict that had there been a large release of radioactive iodine at Three Mile Island, depending on the wind direction at the time, between 3,500 to 450,000 people—some living well in excess of 100 miles away—might later have suffered thyroid damage.

Concurrent with this growing belief in the value of a nationwide KI policy, countervailing voices and studies began emerging, challenging the likelihood the drug would ever be needed and dismissing the value of KI strategies with cost/benefit analyses that suggested potential costs of $10 million per thyroid nodule prevented. Before plunging headlong into the [illegible] KI debate, it is important to first sketch the emerging policies of the three federal agencies most responsible for framing national policy regarding KI.

THE FDA. The FDA's position is for the most part clear. It recommends that state and local public health officials should consider advocating KI in radiation emergencies for people likely to receive radiation exposure of 25 rems or greater. (A *rem* is a measurement of radiation exposure.) A year ago, by the time the FDA finalized its position on KI, two manufacturers—Carter-Wallace and Roxane Laboratories, Inc.—had FDA approval to sell the drug.

But then things become a bit murky, in part due to the unusual reason for taking the drug. In order to make distribution of the drug practical, especially in time of an emergency, the FDA had to give it non-prescription status. But the FDA did not want the drug to be directly available to the public. Officially, the FDA's stand is that Carter-Wallace and Roxane "agreed to voluntarily limit sale of the drug to state and local officials and nuclear plant operators." This, of course, is why Alan Morris was unable to purchase the drug. Asked about this paradox—the public unavailability of a drug with OTC status—one FDA official seemingly inadvertently exposed what may be the agency's true feelings when he said, "We requested—no, I wouldn't say that—they voluntarily agreed to limit sales of the drug."

Last November, Alan Morris's newly formed New York-based company, Anbex, Inc., made this distinction moot. Soon after receiving FDA approval to sell the drug, Morris, who had made no limiting agreement with the FDA, began a public sales campaign with newspaper ads in the Harrisburg area. The ad pictured his company's product, IOSAT, beside this heading: "If You Live in Harrisburg This Could Save Your Life. It's True. A Tablet That Could Save Your Life in a Nuclear Accident."

With that ad, announcing mail-order distribution of the drug, Morris angered FDA officials. Some charged him with "hucksterism." Then, too, the agency was obliged to free the two other companies from their earlier promise not to sell the drug directly to the public. Since then, Roxane has begun trial distribution of its Potassium Iodide Oral Solution to a limited number of Pennsylvania pharmacies. Carter-Wallace has also considered OTC marketing of KI, but has as yet given no [illegible] it intends to do so.

continued on page [illegible]

Quarantined Medicine

continued from page 54

FEMA. While the FDA was proclaiming KI safe and effective and providing threshold exposure limits suggesting when the drug be taken, a second federal agency, FEMA, was mapping policies for emergency preparedness around nuclear reactors. As with FDA recommendations, FEMA's policies would serve to guide the decision-making of state and local health officials—those ultimately responsible for the public welfare. In addition to such protective measures in a nuclear accident as evacuation and sheltering indoors, FEMA pointed strongly, at least initially, to the value of KI. Amid some concern that people might misunderstand the drug's limited application to the thyroid and "develop a false sense of security," FEMA nevertheless budgeted some $100,000 in 1980 to purchase potassium iodide destined for states interested in stockpiling the drug. Another $350,000 was projected for sup- ...ental purchases.

...icture clouds again, for nei- ...mounts was spent on KI. "somewhat of a reversal," ...mm, an administrator of the agency's Office of Natural Technological Hazards, explained the change in policy by restating concerns about the "false sense of security" and by hinting at an admission stated more bluntly by another agency official: Namely, that to purchase KI and then make it available to the states implied too much of a federal endorsement for a drug still considered quite controversial.

THE NRC. Who considered it controversial? Not insignificantly, a third federal agency, the NRC, which is responsible for licensing and ensuring the safety of the nation's nuclear plants. It is also largely responsible for the lack of a unified federal KI policy, for it has delayed signing such a policy statement drafted by a FEMA-chaired group known as the Federal Radiological Preparedness Coordinating Committee. The statement mirrors the gradual federal distancing from potassium iodide. It says little beyond calling KI "an effective ancillary protective action" and leaving all decisions pertaining to public distribution of the drug to state and local officials. The NRC, however, presently refuses to sign even this watered-down policy statement.

In Congressional hearings, Brian Grimes, then director of NRC's Division of Emergency Preparedness, stated there seemed "no compelling reasons to recommend potassium iodide for the general public" (this despite agency requirements that all nuclear plants consider stockpiling KI for their workers; most, if not all, plants do). Apparently this sentiment underlies the NRC's position. Repeated attempts by *HEALTH* to secure an agency policy from officials proved unsuccessful. From recent studies prepared for the agency, it appears that the NRC's rationale is tied to a dual skepticism: that not only are serious nuclear accidents highly unlikely, but a significant release of radioactive iodine would also be highly unlikely. (See box, "Scientific Controversies Blur the KI Picture.") But many observers discern other motives at work.

"Basically the NRC has been extremely negative about off-site preparedness. I think they have been very effective at talking states out of this," says Frank von Hippel, the Princeton University physicist who has long advocated that KI be widely available. Three years ago The Bulletin of the Atomic Scientists printed a paper of his, entitled "The NRC and thyroid protec-

tion—one excuse after another." A former colleague of von Hippel's, Jan Beyea, PhD, now a senior staff scientist with the Audubon Society, feels the KI debate boils down, in essence, to nuclear politics: "I think it's pretty clear a lot of people are afraid that widespread distribution of the drug would make people believe that nuclear accidents are much more likely than we've been told in the past. But the important thing here is not to protect the nuclear industry but to protect people."

That sentiment, relayed to a FEMA official privy to the vacillating federal rumblings on KI, prompted these words: "I think that's pretty close to it. There is a feeling that the NRC is being strongly pressured by the utilities." The NRC, he said, "is a real powerful bunch, and people over here [FEMA] are very leery of putting any pressure on them. They were here first, so to speak."

J. Gordon MacLeod, MD, Pennsylvania's commissioner of health at the time of the Three Mile Island accident, worries that "the whole issue of health has been lost. The decisions are being made in too many cases by nuclear engineers and nuclear physicists." The NRC, he complains correctly, cannot point to a single physician among its commissioners or staff.

Just as the anti-KI camp has had pronuclear leanings attributed to it, so have many of those favoring KI distribution been called anti-nuclear. Along the way, von Hippel has been accused of "joining the mass hysteria [illegible] the Jane Fondas of the world." Says A.P. Mal-

WHERE TO BUY KI

For now, unless you happen to live near one of the Pennsylvania pharmacies stocking Roxane's product—Potassium Iodide Oral Solution—the only way to get a supply of the drug is through the mail by writing to Alan Morris's company: Anbex, Inc., Box 861H, Cooper Station, New York, NY 10276. Each bottle contains 14 tablets, the recommended two-week supply per person. Package labeling and instructions list potential side effects, and explain that the pills should be taken only in a nuclear emergency and only if so directed by local health authorities."

Some outfits have begun to sell KI illegally through the mail, without FDA approval. Their ads often offer 100-tablet bottles—a clear tipoff, since the FDA has not approved selling the pills in this type of package.

inauskas, co-author of a recent report revising downward the likelihood of harm from nuclear accidents: "The whole KI issue is really sort of a snow job to undermine the public's confidence in nuclear power."

Such sniping, the recurring scientific disagreements and the confusing signals out of Washington are reflected, coast to coast, in widely diverging state policies. Ohio is one of a few states that has decided it wants nothing to do with KI. The state has no written explanation of this policy, but former state director of health John Ackerman, MD, accounted for Ohio's decision by saying, "At the time we made the decision there was still a great deal of controversy at the national level...We took our lead largely from the federal government." California officials simply haven't made up their minds yet. In New York, limited supplies of the drug are stored at police and fire stations near nuclear power plants. The supplies are to be used by emergency workers who would remain in the area supervising the evacuation of everyone else. Pennsylvania has stockpiled supplies at local civil defense centers—again for emergency personnel only—and at half a dozen hospitals located within 10 miles of the state's four operating nuclear plants. The latter supplies are earmarked for patients too sick to be evacuated in case of an emergency and for a skeleton hospital staff who would also remain.

The policy in Illinois is similar: KI only for emergency workers and a limited "immobile" population. Officials there say the state's decision not to make KI available to the general public was influenced by intertwining ethical and legal questions about whether the state should in effect be prescribing and distributing medicine.

Alabama has readied a plan that includes distributing KI "to any individual who might be exposed to a potentially harmful dose." County health departments in five strategically located cities have from 500 to 950 bottles of KI tablets. Noting that "the wind can only blow one way," James McNees, director of the division of Environmental Monitoring and Emergency Planning in the Alabama Bureau of Radiological Health, explained: If it appears there's going to be iodine in the air, emergency workers would transfer the KI from the local stockpiles to the predesignated evacuation centers—located at least 17 miles from a reactor. The drug would then be offered, complete with informed consent forms, to those individuals whose evacuation path may have exposed them to radioactive iodine above the FDA standard of 25 rems.

To date, only one state has adopted the protective planning that is nationwide policy in Sweden: predistributing the drug to nearby residents of a nuclear plant. The state is Tennessee. In addition to stockpiling KI for emergency workers and for possible distribution, as in Alabama, at mass care centers, Tennessee health officials went door to door within a five-mile radius of the Sequoyah plant in the fall of 1981, explaining about the drug and supplying KI to those residents who wanted it. Only a handful of residents decided not to accept the drug. State officials term the program highly successful and report they are likely to repeat it when a second nuclear plant comes on line next year.

Tennessee's policy came largely at the urging of Eugene Fowinkle, MD, the former state commissioner of health, now an associate vice chancellor for medical affairs at Vanderbilt University. Dr. Fowinkle served on the Kemeny Commission and heard, firsthand, much of the early discussion on the pro-

five-mile radius was chosen "not very scientifically," but has clear thoughts on the need for predistributing the drug. "We did three evacuation drills testing emergency planning, as the NRC requires, and found there is really no practical way to distribute the drug after the fact. Unless you predistribute KI you do not have the option to use it." Tennessee's supplies of KI came from the Tennessee Valley Authority (TVA), the local utility—at first reluctantly. Fowinkle says the "initial position of the TVA was that potassium iodide would frighten people. My response was, 'I'm not frightened when an airplane stewardess tells me how to use an oxygen mask.' I think there's a tendency to underestimate the intelligence of people. All these arguments about a false sense of security—in fact, every objection I've heard—have rational answers. A lot remains to be worked out, though. This

To date, only one state has distributed KI to residents living close to a nuclear power plant. For the most part, the medical community has remained strangely silent.

process is now going on around the country."

Indeed it is, albeit in fits and starts marked by controversy, confusion, delay—and a rather striking irony. The Illinois policy, for instance, suggests the general public, unprovided for in state plans, consult their family doctor. "We're gingerly handing it off to the medical profession," admitted Philip Gustafson, PhD, until recently the director of the Illinois Department of Nuclear Safety. In so doing, a non-prescription drug returns, in effect, to prescription status. An already confusing situation thus becomes even more tangled, especially when it seems clear that the medical profession and the general public are both misinformed.

"In part," notes Audubon Society scientist Jan Beyea, "this shows how difficult it is to get a novel public health measure started. There was tremendous opposition to covering open sewers in the nineteenth century." He fears, as do many others, that potassium iodide may not be earnestly considered or widely distributed until after we've had another, perhaps far more serious, nuclear accident. ■

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Senior Research Scientists, Accord Research and Educational Associates, Inc.

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INTRODUCTION

Nuclear power plants release radioactive materials into the environment in the course of normal operations. Federal regulations require the licensee to monitor all such releases at the point of discharge and to limit these releases so that the total dose delivered to individuals off-site through all exposure pathways is kept as low as reasonably achievable.(1)* This dose, which includes both external and internal contributions, is not measured. Instead, it is calculated from the measured release rates using an approved set of formulas that model the dispersion of plant effluent in the environment. Large uncertainties inherent in such modeling may cause significant discrepancies between the actual and the calculated dose.(2)

The licensee is also required to carry out an approved off-site environmental monitoring program for the purpose of checking the model used to calculate off-site dose. Such a program usually consists of a fixed array of thermoluminescent dosimeters and a set of sampling stations from which environmental samples are collected for laboratory analysis. The typical environmental monitoring program is not designed to provide prompt discovery of significant changes in off-site dose rates.(3) Excessive off-site dose rates due to plant effluent could therefore persist for weeks without being detected.

An even greater lag exists between the time monitoring results are obtained and the time they are made available to the public. The results of environmental monitoring by the licensee may not be available for a year or more after the monitoring was performed. The results of on-site monitoring of releases at point of discharge are also available only after a similar delay. Then only the total amount of each isotope released during a three month period is reported. Data on specific releases, including time of release, are published only in the case of unplanned releases. Detailed data on routine releases are not available. Therefore, reliance on the licensee's monitoring program for protection against excessive doses is unwarranted. Independent monitoring is needed both as a check during routing operation and for early warning at the onset of a radiological emergency.

One form of independent off-site monitoring carried out by a group of concerned citizens living near the Maine Yankee nuclear power plant in Wicasset, Maine, was to manufacture and deploy a network of continuously recording electronic radiation monitors.(4) Another method is to actively track and measure the plume of airborne effluent using a mobile radiological monitoring unit. This type of monitoring was carried out by AREA researchers at TMI during the venting of the Unit 2 containment atmosphere during the summer of 1980(5) and in routine monitoring of several nuclear power plants.

In this paper the equipment and procedures developed by AREA for mobile monitorig are described and the results of monitoring in the vicinity of the Oyster Creek Nuclear Generating Station in Tom's River, New Jersy are reported. The monitoring method was designed to determine the external dose rate due to gamma radiation from the plume, to measure the short-lived air particulate activity in the field, and to sample airborne particulates for laboratory analysis for long-lived radionuclides. A novel and important feature of the method employed in this study is the ability to detect the radioactive plume without prior background measurement by observing fluctuations in the environmental radiation field caused by the meandering motion of the plume.

THE OYSTER CREEK NGS

The Oyster Creek plant is a boiling water reactor (BWR) manufactured by the General Electric Company for the Jersey Central Power and Light Company. The station began operating in 1969 and reached its present maximum power level of 1930 megawatts thermal in 1971. The station is located in a relatively flat marshland area of Ocean County, New Jersey, about 3.2 km inland from the shore of Barnegat Bay. The site is situated 14.5 km south of Tom's River, New Jersey, and 56 km north of Atlantic City. It is bounded on the east by US Route 9, on the west by the Garden State Parkway, on the north by the south branch of Forked River, and on the south by Oyster Creek. The station is located approximately 100 km south of New York City. Figure 1 is a map of the Oyster Creek vicinity showing 43 numbered locations where measurements were made.

Several pathways exist for the discharge of airborne effluent from the Oyster Creek plant.(6) The main sources of gaseous waste are: 1. offgas from the main steam condensers, 2. leakage from the turbine gland seals, 3. building ventilation air, and 4. exhaust from the mechanical vacuum pump.

The mechanical pump is used during reactor startup to remove offgas from the main condenser. The offgas is vented through a short (1.75 minute) delay line to the plant stack without filtration. Building ventilation air from the reactor building, the radwaste building, the turbine building, and the offgas building is vented to the stack without delay or filtration. The turbine, radwaste, and offgas buildings are also ventilated through rooftop vents. In a 1971-73 study of the Oyster Creek plant by the United States Environmental Protection Agency (USEPA), it was found that the turbine building was the second largest source of airborne emissions, due to leaks in the steam systems.(7) The steam leakage rate was found to be substantially greater than the 770 kg/hr value assumed in the plant Environmental Statement(8); Xenon-133 and Xenon-135 emission release rates from the turbine building were measured at 31 and 94 microcuries per second, 25 times greater than the rate predicted in the Environmental Statement. The main condenser offgas is the largest source of radioactive gas. Prior to 1977 the main condenser offgas was passed through a 30-minute delay line,

* Refer to references at end of text.

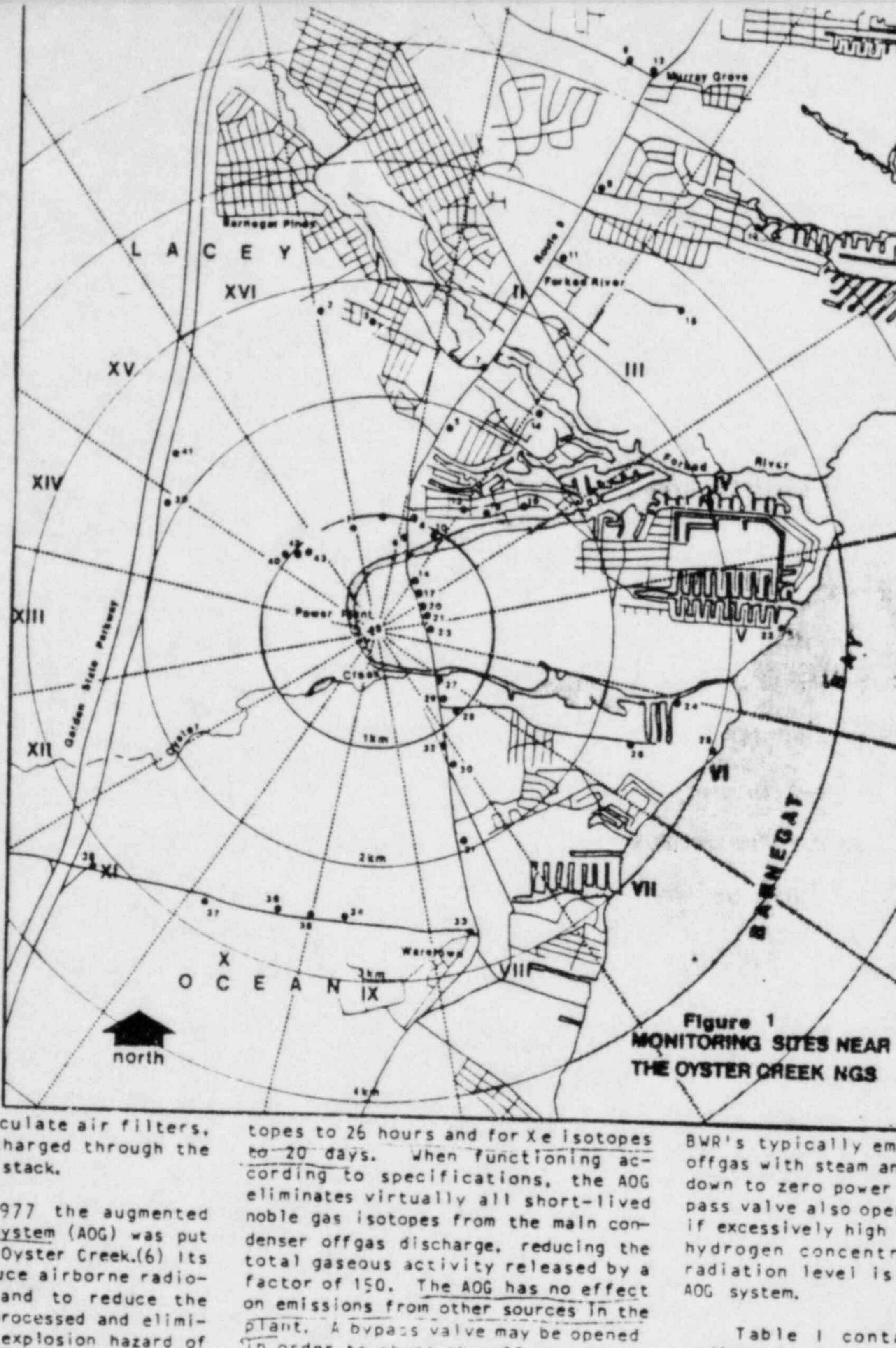


Figure 1
MONITORING SITES NEAR THE OYSTER CREEK NGS

followed by particulate air filters, before being discharged through the 112 m. high plant stack.

In August 1977 the augmented offgas treatment system (AOG) was put into operation at Oyster Creek.(6) Its purpose is to reduce airborne radioactive releases and to reduce the volume of offgas processed and eliminate the possible explosion hazard of hydrogen and oxygen formed by the radiolytic decomposition of the reactor water. The AOG system consists of a series of subsystems: hydrogen recombiner subsystem, water removal subsystem, charcoal absorber subsystem, and high efficiency particulate air filters. Offgas from the main condenser is diluted with air, passed through the AOG, and then vented through the plant stack. The charcoal absorption system, which consists of a series of four six-ton beds of activated charcoal, is designed to increase the delay time for Kr isotopes to 26 hours and for Xe isotopes to 20 days. When functioning according to specifications, the AOG eliminates virtually all short-lived noble gas isotopes from the main condenser offgas discharge, reducing the total gaseous activity released by a factor of 150. The AOG has no effect on emissions from other sources in the plant. A bypass valve may be opened in order to shunt the offgas waste stream around the AOG. During start-up the bypass valve is kept open until the power level gets above 50% of the rated capacity. When the power level decreases, the bypass valve is opened when the power level goes below 45%. The AOG cannot be operated at low power level because of the difficulty in controlling water level flow in the recombiner condenser. This problem is specific to the design of the AOG at Oyster Creek in which the condenser offgas [illegible] prior to passage through the [illegible] AOG's at other BWR's typically employ dilution of offgas with steam and may be operated down to zero power level.) The bypass valve also opens automatically if excessively high temperature, high hydrogen concentration, or high radiation level is detected in the AOG system.

Table I contains a list of radionuclides reported released in the airborne effluent from the Oyster Creek plant during the third and fourth quarters of 1979.(9) During most of this period the reactor was operating at nearly maximum power and it may be assumed that the AOG was functioning most of the time.

METHOD

A specially modified Volkswagen Rabbit containing radiation detectors, a high-rate portable vacuum pump, and other equipment carried a two man crew.

energy gamma scintillation probe (HEGSP)*(Ludlum Measurements, Sweetwater, Tx., Model No. 44-2) connected to a portable digital ratemeter/scaler (Ludlum Model No. 2200). The probe was sealed inside a foam rubber-lined Lucite housing that was mounted on the roof of the monitoring vehicle.

Air particulate samples were collected on 47 mm membrane filters (Millipore Corporation, Bedford, MA, Cat. No. HAWP-047-00) having a pore size of 0.45 microns. Filters were held in "Sterifil" filter holders (Millipore No. XX11-047-02, -04, and -07). Tygon tubing was used to connect the outlets of three filter assemblies in parallel to three "rotamer" flow meters graduated to 120 standard cubic feet per hour (scfh) (Matheson Instruments, Horsham, PA) and then to the intake ports of a portable high-volume constant displacement air pump (Gast Mfg. Col, Benton Harbor, MI, Model No. 12x2440-101A) driven by a 3 horsepower gasoline engine (Briggs and Stratton, Milwaukee, WI). The pump was capable of maintaining 120 scfh through each filter.

One of the filter holders was modified to clamp onto the front face of a Geiger-Muller 'pancake' probe (GMP) (Victoreen, Cleveland, OH, Model No. 489-110) with a thin mica window (1.4-2.0 mg/cm2 thickness, 4.45 cm diameter). Holes were cut in the sides of the filter holder to allow unimpeded air flow as shown in Figure 2. The distance between the filter and the probe window was 2.7 cm. A similar filter holder assembly, not connected to the air pump, was clamped to a second identical reference 'pancake' probe.

Each GM probe was connected to a separate portable ratemeter (Victoreen, Model No. 490, Thyac III) coupled to digital accumulator/timer. The counts accumulated by the reference probe were subtracted from the counts accumulated by the probe facing the pumped filter in order to determine the net activity due to particulate radioactive material accumulating on the filter.

The following procedure was used to detect the radioactive plume. Small helium-filled balloons were released near the plant to determine local wind direction. Using the roof-mounted gamma detector, a search for the plume was made downwind from the plant. If the presence of the plume at a particular location was suspected 5 consecutive 2 minute readings were taken. The mean, $\bar{X}$, of these reading x_i (i=1,5) was calculated according to:

$$\bar{x} = \frac{1}{5}\sum_{i=1}^{5} x_i$$

[illegible] airborne radionuclides released from Oyster Creek Nuclear Generating Station during the third and fourth quarters of 1979.

Nuclides Released	Half-Life*	Third Quarter (Curies)	Fourth Quarter (Curies)
Noble Gases:			
krypton-85m	4.4h	1.07×10^{4}	9.04×10^{3}
krypton-87	76.0m	3.60×10^{4}	3.34×10^{4}
krypton-88	2.8h	3.56×10^{4}	3.13×10^{4}
xenon-133	5.27d	1.15×10^{4}	8.54×10^{3}
xenon-135	9.2h	6.10×10^{4}	5.45×10^{4}
xenon-135m	15.6m	2.70×10^{4}	2.28×10^{4}
xenon-138	17.0m	9.03×10^{4}	7.59×10^{4}
krypton-89	3.2m	8.16	5.65
xenon-133m	2.26d	$<1.47\times10^{-8}$	$<1.47\times10^{-8}$
xenon-137	3.9m	1.78×10^{2}	1.33×10^{2}
Total for period:		2.72×10^{5}	2.36×10^{5}
Iodines:			
iodine-131	8.05d	2.67	1.44
iodine-133	21.0h	9.26	4.46
iodine-135	6.7h	1.31×10^{1}	5.55
Total for period:		2.50×10^{1}	1.15×10^{1}
Particulates:			
strontium-89	50.4d	1.08×10^{-2}	1.52×10^{-2}
strontium-90	28.2y	5.22×10^{-2}	5.25×10^{-5}
cesium-134	2.19y	$<1.32\times10^{-10}$	3.20×10^{-5}
cesium-137	30.0y	8.77×10^{-4}	5.43×10^{-4}
barium-140	12.8d	8.89×10^{-2}	4.40×10^{-2}
lanthanum-140	40.2h	7.08×10^{-2}	3.56×10^{-2}
chromium-51	27.8d	4.59×10^{-4}	$<7.14\times10^{-10}$
manganese-54	291.0d	2.91×10^{-3}	4.03×10^{-4}
cobalt-58	71.0d	4.96×10^{-3}	$<1.67\times10^{-10}$
iron-59	45.0d	$<3.65\times10^{-10}$	2.98×10^{-4}
cobalt-60	5.27y	2.15×10^{-3}	2.93×10^{-3}
strontium-91	9.7h	6.22×10^{-1}	2.61×10^{-1}
niobium-95	35.0d	6.65×10^{-4}	$<2.07\times10^{-10}$
molybdenum-99	66.0h	$<5.99\times10^{-10}$	1.19×10^{-3}
technetium-99m	6.0h	6.16×10^{-2}	4.73×10^{-2}
ruthenium-103	40.0d	1.27×10^{-4}	$<6.05\times10^{-11}$
iodine-131	8.05d	7.81×10^{-3}	7.97×10^{-3}
iodine-133	21.0h	6.66×10^{-2}	6.49×10^{-2}
iodine-135	6.7h	1.49×10^{-1}	9.82×10^{-2}
cerium-141	32.5d	1.82×10^{-4}	1.24×10^{-4}
cerium-144	285.0d	4.64×10^{-4}	1.38×10^{-4}
protactinium-233	27.4d	$<1.38\times10^{-10}$	1.55×10^{-3}
neptunium-239	35.0m	1.01×10^{-3}	1.33×10^{-3}
Total for period:		1.14	5.93×10^{-1}

*y=years, d=days, h=hours, m=minutes.

and the standard deviation, S, of the five reading about the mean was calculated using

$$S^2 = \frac{1}{5}\sum_{i=1}^{5}(x_i - \bar{x})^2$$

The ratio of the standard deviation to the square root of the mean was calculated. This ratio is known as the reliability factor,

$$RF = S/\sqrt{\bar{x}}$$

The counts recorded by a properly functioning radiation detector exposed to a constant source of radioactivity obey Poisson statistics and the expected standard deviation of a series of readings equals the square root of the mean. The meandering motion of the radioactive plume causes a variation in the radiation itensity at the detector on a time scale of minutes, while changes in background radiation intensity occur on a time scale of hours.(10) Thus the motion of the plume tends to increase the standard deviation of the series of 2-minute readings above the expected value predicted by Poisson statistics. This is reflected in an R which is significantly greater than 1. As a practical criterion adopted in this study an RF greater than 2 was taken as indication of the presence of the radioactive plume.

The gamma detector count rate was measured in several plumes while simultaneous measurements were made with a calibrated high-pressured argon-filled ionization chamber, (Reuter/Stokes, Cleveland, Ohio, Model RS-111) on loan from the New Jersey Department of Environmental Protection. It was found that the excess gamma dose rate in the plume could be estimated using:

$$DR = 2.7\times10^{-3}\,T$$

where T is the count rate above background in counts per minute (cpm), and DR is the dose rate in microroentgens per hour (R/h).(11)

Routine verification of the response of the GMP and HEGSP probes was performed using low-intensity, depleted uranium and [illegible] microcurie cobalt-60 check sources, respectively.

filtration system was set up to draw air though three membrane filters. In order to measure short-lived particulates present in the plume, one of the filters was monitored with a GMP, using the modified filter holder described above, while simultaneous readings were made with the reference GMP. The number of counts accumulated on each GMP was recorded in consecutive two-minute intervals for at least ten minutes before starting the pump in order to check the relative response of the two probes. Then counts accumulated by the HEGSP and both GMP's were recorded every two minutes during the pumping. If significant particulate activity was measured on the monitored filter, the monitored filter was disconnected from the pump. Readings of both GMP's were continued for at least one hour in order to determine the rate of decay of the short-lived particulates. During the measurement, wind direction was periodically observed and recorded by release of a helium-filled balloon. Flow rates through each filter were recorded, and start and finish times of pumping were noted. When the HEGSP count rate indicated that the plume had moved, pumping was discontinued, and the search for the plume began again.

Except for five upwind reference samples, all samples were collected in the plume in order to increase the possibility of detecting long-lived particulates in the plant effluent. All the downwind samples were combined and subjected to gamma-ray emission spectroscopy. The composited sample was also subjected to a radiochemical analysis for strontium-89 and -90. Laboratory analyses were performed by Teledyne Isotopes, Westwood, NJ.

RESULTS

Figure 3 shows two series of two-minute HEGSP readings taken in the early morning of 25 June 1981 on Haines Road near Route 9 about three miles north of the plant. In the first series taken at site 12 the first five readings averaged 2378 cpm with an RF of 13.8. Then as the wind shifted to a few degrees to the west carrying the plume away, the readings decreased. The average of the last five readings was 861 cpm with an RF of 3.6. At 0340 the monitoring vehicle moved along Haines Road and the plume was found again at site 8. By 0450 the plume had again drifted out of range of the detector.

Table II contains a record of radiation measurements taken at each of the sites shown in Figure 1. The date and time of each measurement are given along with the average HEGSP and GMP count rates for a selected ten minute period. The HEGSP readings were recorded as a series of five two-minute readings, and the RF for this series is also entered in

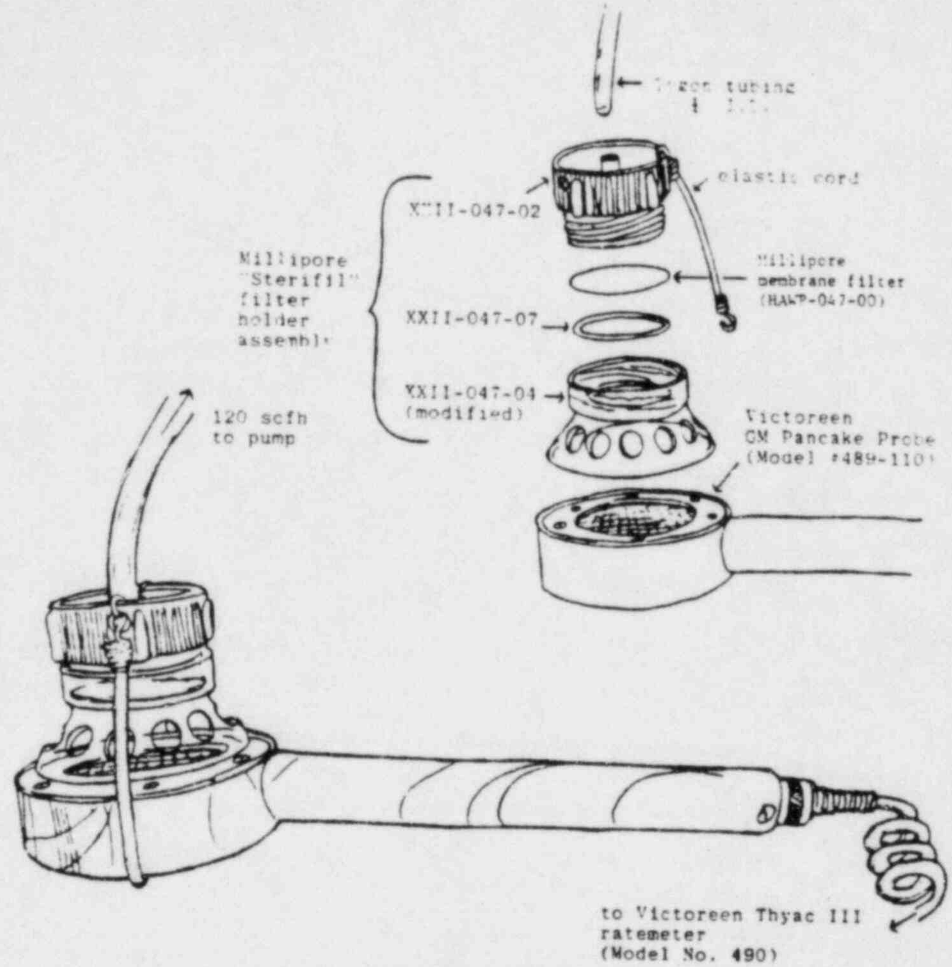
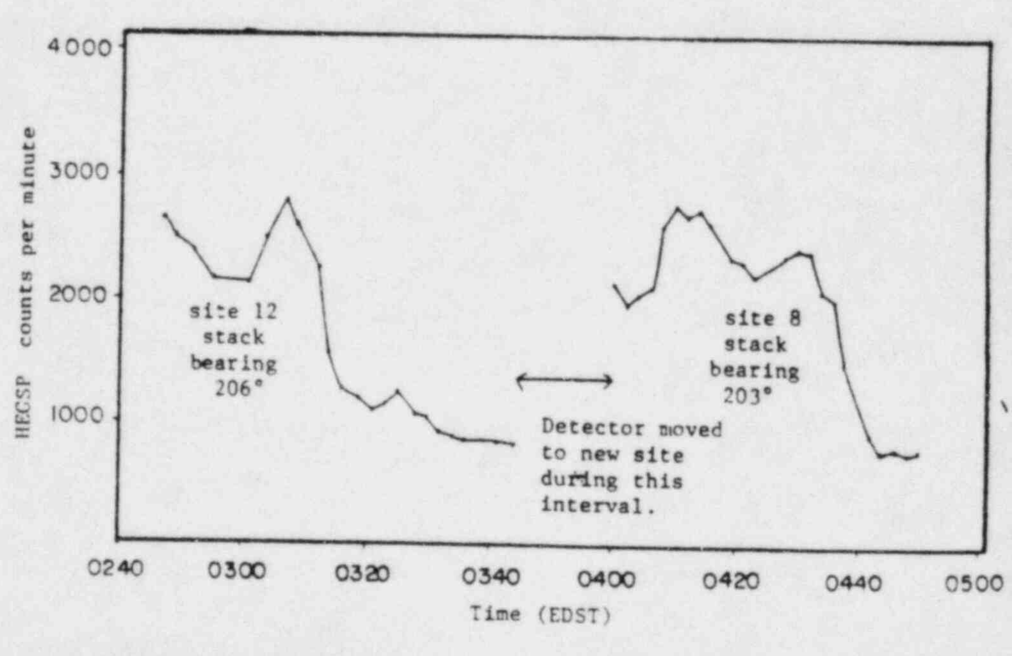


Figure 3

Gamma radiation levels at two locations along Haines Road near Route 9 on 25 June 1981, measured with HEGSP (1"x1" NaI) detector. Distance to Oyster Creek stack is 5.2 km.

During this period the wind shifted so that first site 12 and then site 8 was downwind from the reactor.



radiation field proved to be an effective means of detecting the plume when prior knowledge of background radiation was not available.

Using the conversion factor obtained by comparison of the scintillation detector with the calibrated ionization chamber (Methods), it is possible to convert scintillation detector count rates to external gamma dose rates. The lower limit of detection for radiation from the plume corresponded to a dose rate of 1uR/hr. A maximum ten minute dose rate above background of 21uR/hr was observed 1 km northwest of the plant (site 40, 7/18/82, Table II). An average dose rate of 11uR/hr above background over a period of 46 minutes was observed in a populated area 1.9 km from the plant (site 31, 7/19/82).

Using the air filtration system with filter and reference GM probes, it was possible to observe the buildup and decay of radioactive airborne particulate on the air filters. The effective half-lives for the upwind particulate samples are about one hour for pumping times of approximately 1.5 hours. The effective half-lives of the two highest activity particulate samples collected in the plume (37 minutes and 25 minutes) are significantly shorter and indicate that a significant portion of the effluent airborne particulate radioactivity is probably a mixture of rubidium-88 (half-life 17.2 minutes) and cesium-138 (half-life 32.2 minutes). These isotopes are produced in abundance by the decay of krypton-89 and xenon-138. Krypton-89 and xenon-138 constitute a significant fraction of gaseous releases that have been reported (see Table I). Because of the half-lives of the krypton-88 and xenon-138 parents of the observed particulates are only 2.80 hours and 14.2 minutes, utilization of the AOG with design hold up times of 26 hours for krypton and 20 days for xenon, would eliminate these isotopes from the effluent stream. Thus, the results reported here indicate that a significant portion of the Oyster Creek gaseous effluent was not being processed through the AOG. On the day these results were obtained the plant was operating at between 50% and 60% of its rated capacity.(12) The low power level suggests that the AOG had been bypassed, accounting for the presence of short-lived noble gases and their particulate daughters in the plume.

By positioning the air filtration system in the plume, effluent airborne particulates were collected at a maximum rate along with a minimum quantity of background particulates. This method yields a sample with the best plume volume to

Measurement of shortlived air particulate activity.

Date	Site No.	Start of Pumping (EDST)	Duration of Pumping+ (min)	Average HEGSP (cpm)	Maximum Excess Filter Activity (cpm)	Effective Half-life First ½ Hr. of Decay (min)
7/11	31	0520	201	802	51.2	--
7/11	42	1637	58	636	36.9	--
7/18	4	0143	92	2360	80.6	--
7/18	4	0430	161	1278	92.9	--
7/18	40	1144	67	5989	433.4	37.0
7/18	1	1633	75	4038	92.9	--
7/19	20(231°)	2353	97	2985	39.3	--
7/19	31	0827	46	4874	595.5	25.3
7/19	31	1623	100	683	49.3	55.7*
7/19	43	2116	92	641	67.3	62.4*

+Flow rate was 120 scfh for all samples.

*Upwind sample.

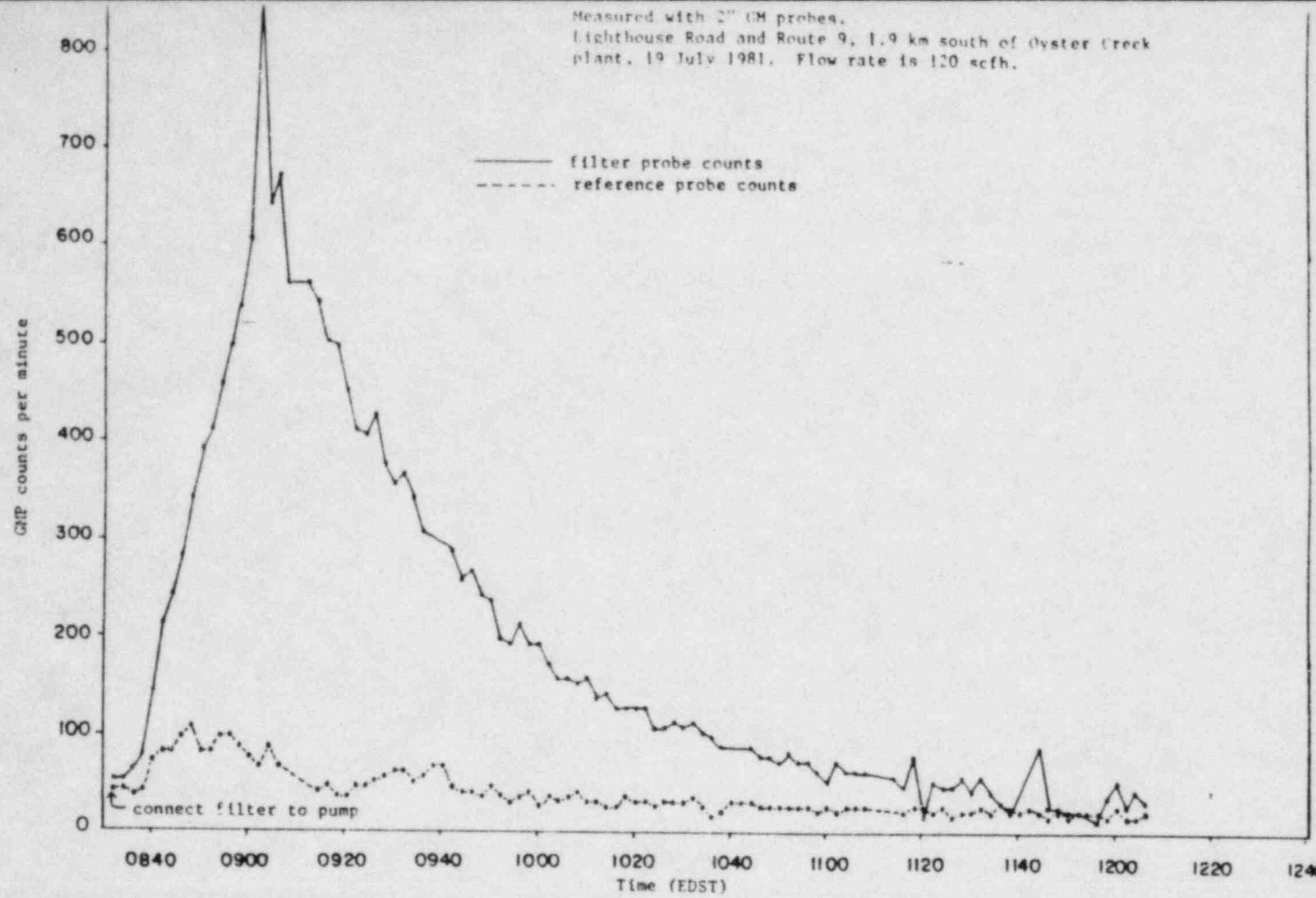
TABLE IV

Long-lived nuclides in air particulate samples collected downwind of Oyster Creek Nuclear Generating Station

	Half-Life	Measured Activity (pCi)	Average air concentration** (fCi/m^3)
Gamma ray emission Ge(Li) spectrascopy:*			
beryllium-7	53.6d	10	58
potassium-40	1.3×10^9y	40	110
manganese-54	291d	1	3.1
cobalt-58	71d	1	4.8
iron-59	45d	3	20
cobalt-60	5.27y	2	5.5
zinc-65	245d	3	9.6
zirconium-95	65d	2	10
ruthenium-103	40d	2	15
ruthenium-106	1.0y	10	30
iodine-131	8.0d	2	470
cesium-134	2.19y	2	5.7
cesium-137	30y	2	5.4
barium-140	12.8d	2	103
cerium-141	32.5d	2	19
cerium-144	285d	9	28
radium-226	1622y	30	81
thorium-228	1.91y	3	86
Radiochemical analysis:*			
strontium-89	50.4d	1.9±1.0	17.5±9.2
strontium-90	28y	0.7	19

*Measurements performed by Teledyne Isotopes, Inc., Westwood, New Jersey.

**[illegible] air concentration for each nuclide [illegible] measurement [illegible] see text for details.



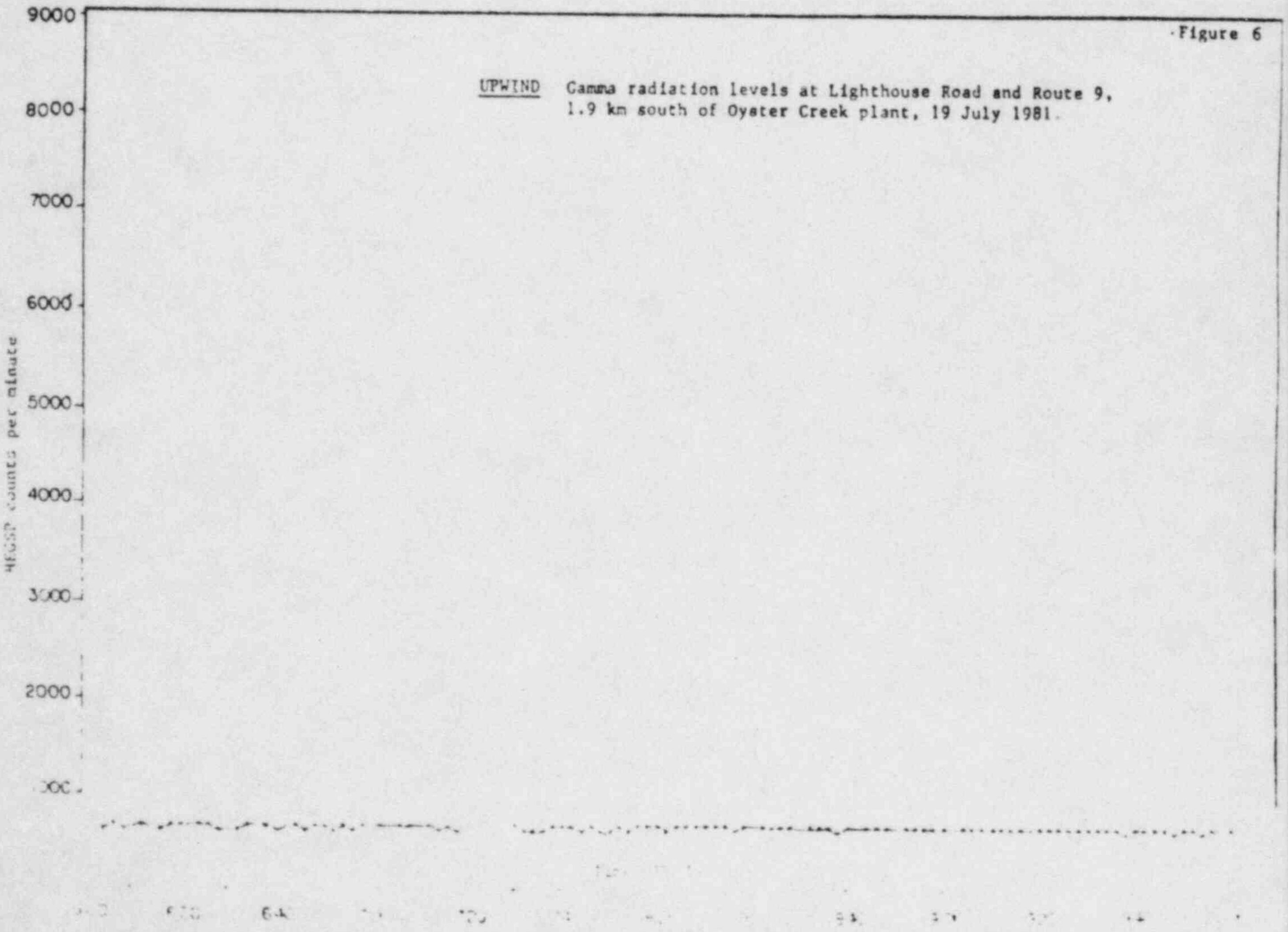
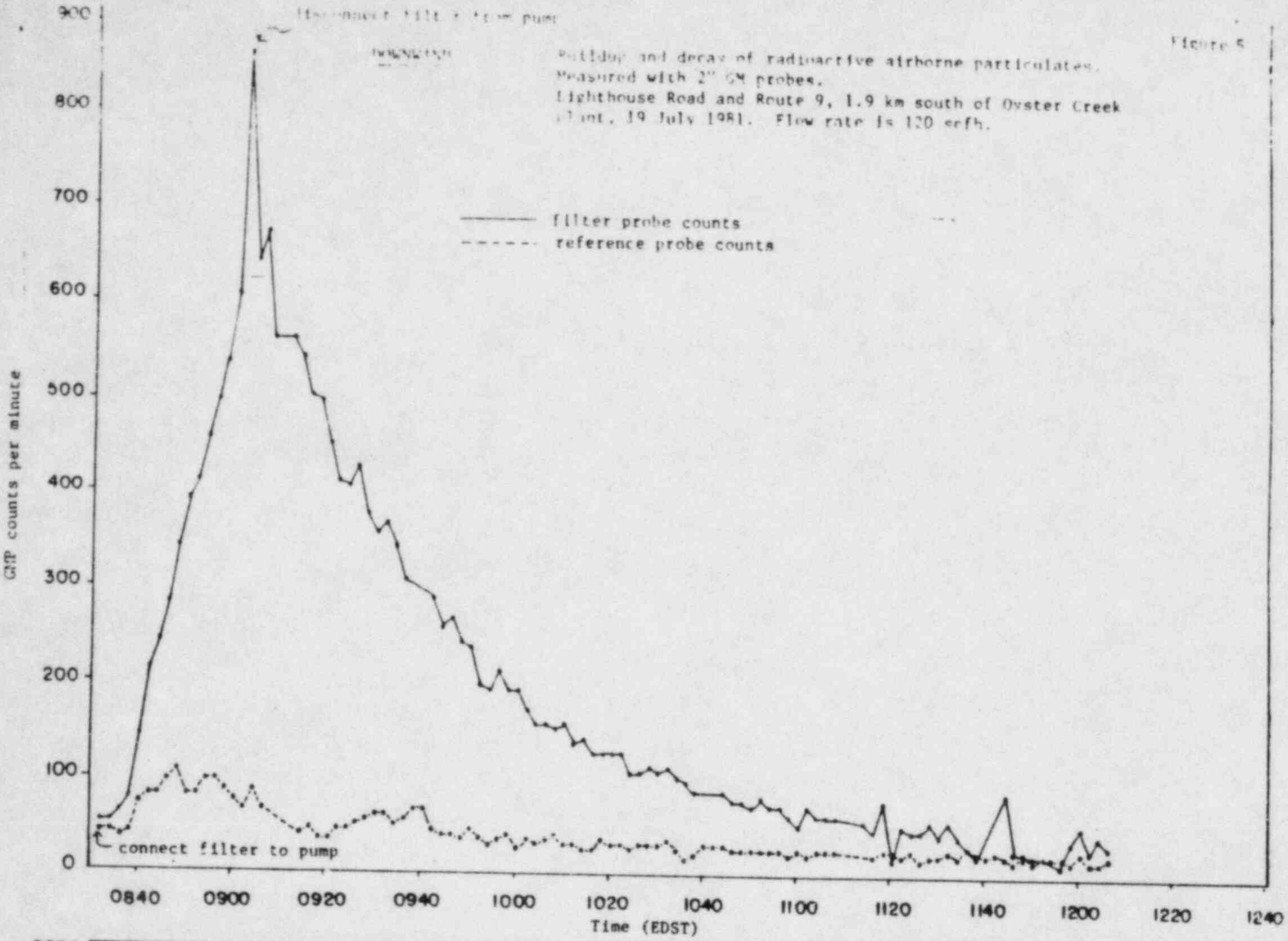


Figure 6

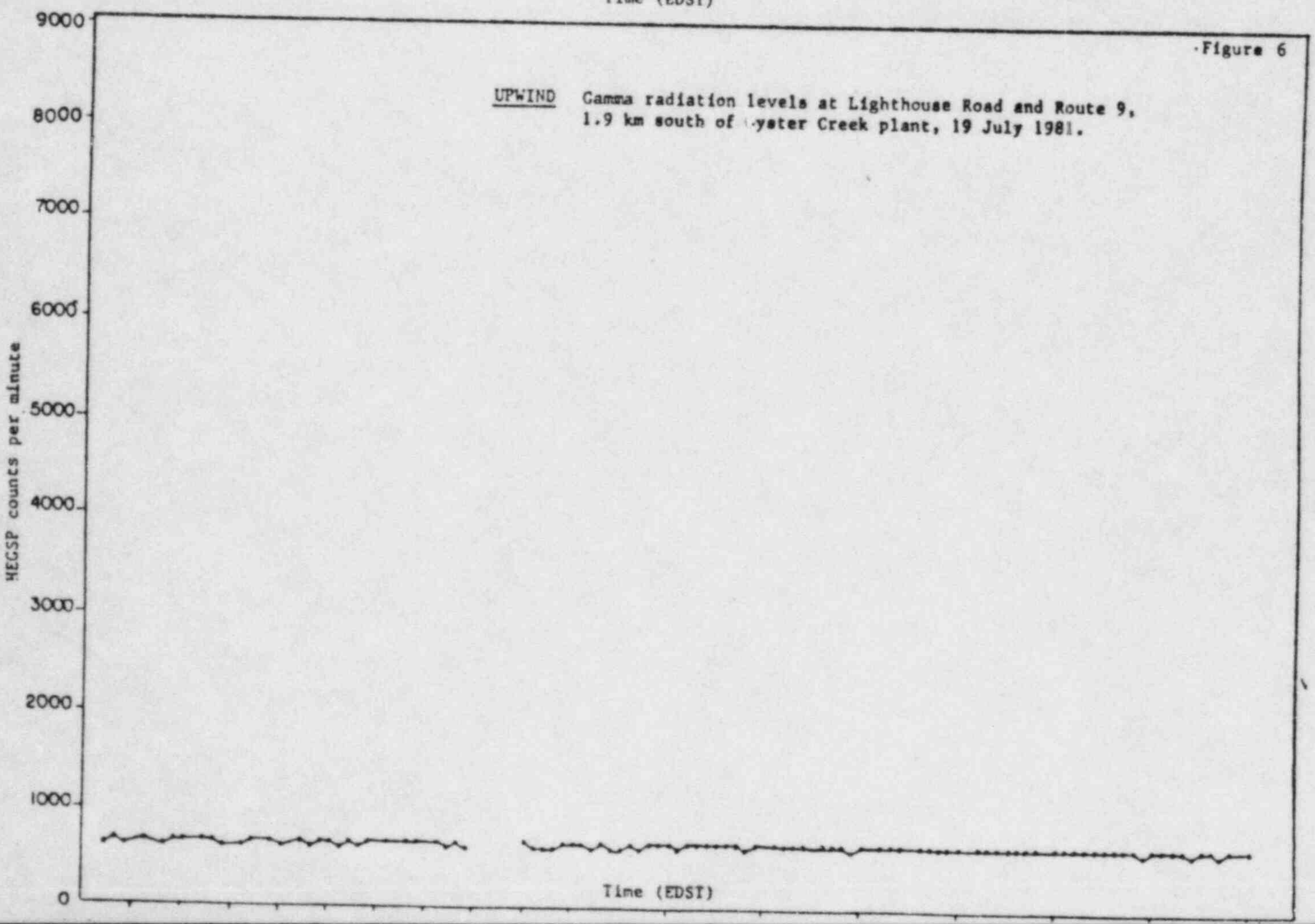
UPWIND Gamma radiation levels at Lighthouse Road and Route 9, 1.9 km south of Oyster Creek plant, 19 July 1981.

Figure 5



Buildup and decay of radioactive airborne particulates. Measured with 2" GM probes. Lighthouse Road and Route 9, 1.9 km south of Oyster Creek plant, 19 July 1981. Flow rate is 120 scfh.

Figure 6



UPWIND Gamma radiation levels at Lighthouse Road and Route 9, 1.9 km south of Oyster Creek plant, 19 July 1981.

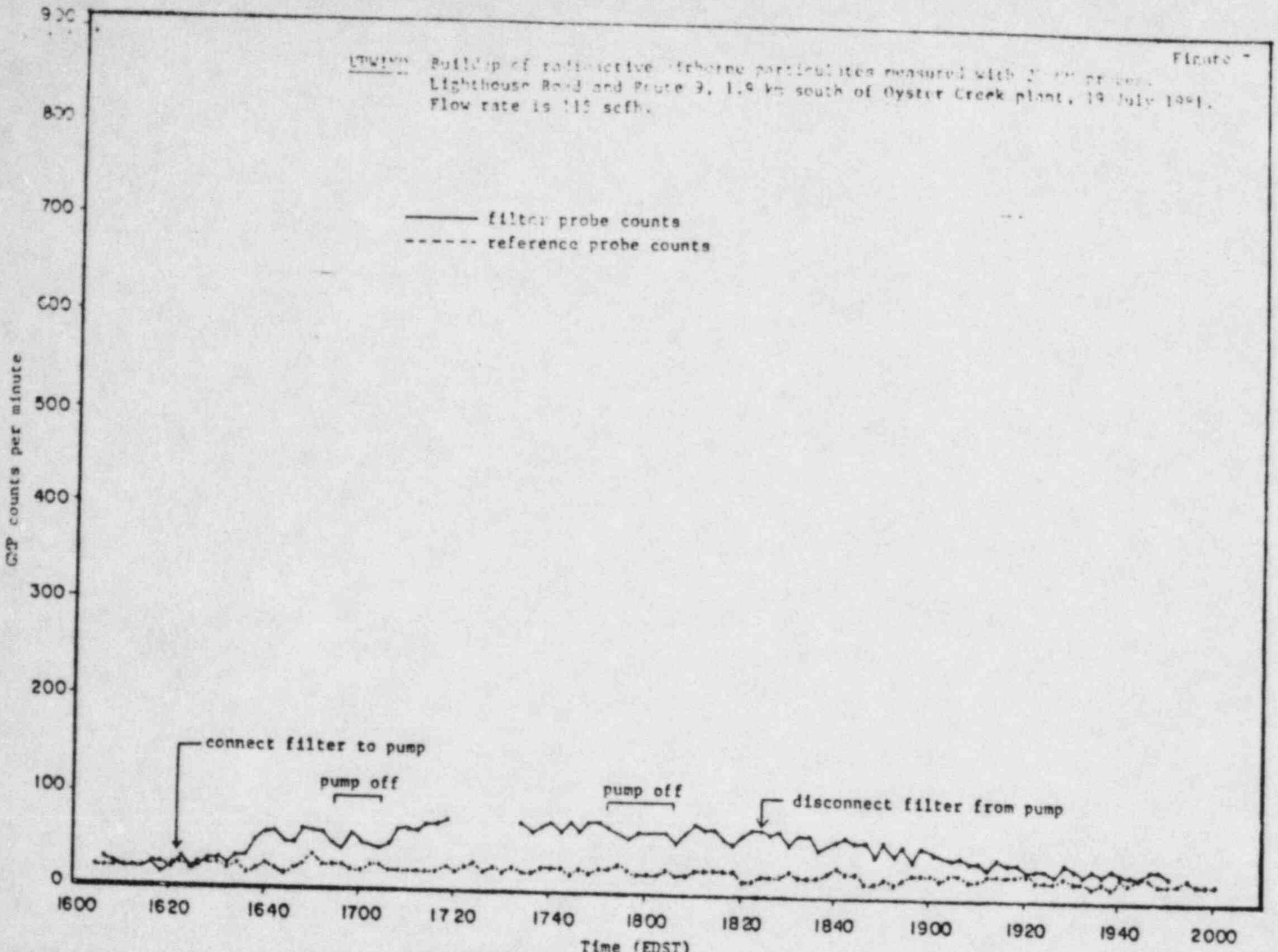


Figure [illegible] Buildup of radioactive airborne particulates measured with [illegible] probes. Lighthouse Road and Route 9, 1.9 km south of Oyster Creek plant, 19 July 1981. Flow rate is 115 scfh.

ackground air volume ratio in the hortest possible time. The con entration of strontium-89 in air easured by the New Jersey Department f Environmental Protection at everal locations in the state, uring the same period, was omparable to the value reported ere. This background con centration f strontium-89 is due to an tmospheric nuclear bomb test carried ut by the People's Republic of China n October 1980. Thus, the trontium-89 in the sample could not e attributed to plant effluent.

In conclusion, mobile radiologi-al monitoring units can be used ef-ectively to monitor routine dis-harges of radioactive airborne ef-luent from nuclear facilities. Such nits can also be used to monitor ossible offsite releases of airborne adioactivity during an emergency. etection of the radioactive plume an be accomplished without prior urvey of background radiation levels n the plant vicinity. The results f such measurements can reveal hanges in the operating status of he plant such as changes in power evel or abnormal occurrences. They an also provide the fastest way for community to discover a gradual in-ease in released, long-lived radio-tivity from a nuclear facility.

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FRED WILLIAMS RADIO INTERVIEW (19 July 84)

Bradley

(1) Planning on removing head Aug. 6th (39th anniv. Hiroshima).

Head & possibly plenum (upper core support) warped from H explosion (30 Mar 79?).

That means will be very difficult to remove & then can't get back on.

Inside, 100 tons disintegrated fuel rods, crumbled uranium fuel.

- Don't know configuration of last 4 feet of rubble.
- Very dangerous material - 350 lbs. plutonium, 180 other kinds radionuclides.
- Since 1 µg plutonium = carcinogenic dose, enough for 150B cancers (30 Earths)

Think of reactor as giant cookie tin

- Originally contained 100 tons of chocolate chip cookies
- But somebody dropped the cookie tin, bending its lid
- Inside all the cookies crumbled - 100 tons of cookie crumbs
- What's worse, a few cockroaches slipped into bent top, multiplied for 5 year
- Now you're going to pry open that lid ...

Point of no return - once get head off can't recap (Saran wrap?)

(2) NRC regulations allow each worker to receive 3 rem/quarter or 5 rem/year.

Revised EIS says maximal radiation during cleanup 46K rem to workers.

- Gofman says 1 cancer/268 person-rems, hence = 170 cancers.
- 1 birth defect/134 person-rems, = 340 birth defects.

Workers paid by hour (ave. $5.50, not much for hazardous duty)

- Often inadequately monitored
- After receive 3 rem, sit out rest of quarter?
- Leave badges outside/switch badges
- Internal vs. external dose

Brainwashed by industry to minimize radiation risks + Macho image

Accidents during TMI cleanup

- James Rogers (15 Oct 79)
- TMI make-up filter (15 Apr 80)

(3) They say it's in the best interest of the public "to preserve public health"

This is the only real NRC mandate (not to be advocates of nuclear industry!)

Yes, we've heard this before

Containment building still held 43K Ci Kr-85 year after accident

NRC said had to get it out - it might endanger public if leaked out

Studied 5 options for cleanup - Resolution? Leaked it all out in 2 weeks!

Now we're hearing it again

The core contains dangerous elements which might contaminate the public

We've got to get in there and clean it up

But the greatest danger to the public is <u>during</u> the cleanup (core stable)

Where are they going to put 100 tons highly radioactive debris?

Real reason for rushing the cleanup?

NRC afraid GPU Nuclear will go bankrupt & fed will be stuck with the bill

(4) First of all, should wait until have high level nuclear waste repository.

NRC commissioners recently approved search for national site (not in PA)

Until then most spent fuel (30 tons/year from each of 70 reactors)

stored in spent fuel pools adjacent to reactors (on-site).

So I recommend not getting the crumbled fuel out of there until some place to put it.

Secondly, many experts (Bob Pollard UCS, Tom Cochran NRDC) recommend entombment

Does the utility seriously consider restart of TMI-2??

Containment as secure as any proposed high level waste site.

Technology exists for neutron adsorbers in concrete.

Compromise (third alternative) - remove fuel, entomb rest.

(5) Yes, new knowledge of extent of core damage increased max. 13K → 46K person-rems.

As mentioned, increases potential number cancer cases in workers 50 → 170.

But still don't know condition of bottom 4' of core or its supporting elements

Will there be another increase in person-rem estimates when get inside?

(6) There is every reason to believe that the TMI management team was directly responsible for the accident 5 years ago which came within 30-60 mins of complete do me

They rushed to get TMI-2 up to full power before 31 Dec 78 (tax deduction)

They falsified PORV release rates into Susquehanna to prevent shutdown

It was that PORV which led to LOCA which led to near meltdown (no intact r

Even after accident started management refused to close PORV!

Now - who was that management team who directed the TMI operation?

Utility changed name after accident Met-Ed --> GPU Nuclear

But still Kuhns & Diekamp #s 1 & 2 in co. with Bob Arnold #3.

6 months ago, with much fanfare, announced NEW MANAGEMENT

But still Kuhns & Diekamp #s 1 & 2

Who'd they replace? Bob Arnold (Sacrifial Lamb)

See Bob Arnold living in his trailer on the island -

See Bob Arnold drinking water cleaned by EPICOR-II -

See Bob run, from Middletown to Parsnippinay NJ (HQ)

Who replaced #3? Phil Clark (yes man from Parsnippinay)

Shellgame.

Same day they announced NEW MANAGEMENT were indicted for leak rate falsifications not-in-the-old-days but in Aug. 1983!

(7) 100 tons rubble in core. If only one ounce evenly distributed to 36,000 persons who reside within 5 miles of TMI, all would develop lung cancer from plutonium alone.

But in addition to 150K Ci Pu:

745K Ci	cesium-137 (muscle ca.?)
679K Ci	Strontium-90 (bone ca, leuk.)
180K Ci	cerium-144
744K Ci	promethium-147

All-in-all over 4M Ci of over 150 radionuclides each with their own tissue specificity & carcinogenic potentia

8) TMI-1, like TMI-2, contains about 31K steam generator tubes. Inside these tubes circulates primary coolant - highly radioactive superheated water under pressure. Outside these tubes circulates cool water which will be heated into steam to drive the turbines for making electricity. So the steam generator tubes have to withstand thermal stress and pressure, and to accomplish this reliably over the long haul, they are made of special carbon steel. Two things are wrong about the design at TMI-1: 1) as in other reactors, this carbon steel begins to granulate under constant radiation bombardment from primary coolant (granulations are weakening of structure, the beginnings of cracks) and 2) specifically at TMI-1, these tubes have been idle for 5 years during which time they have corroded. When GPU tested these 31K tubes last year, they discovered that 8K of them leaked. If you or I had been running the show, we probably would have ordered a new steam generator - but not this management. GPU management decided to try a new method of repairing defective steam generator tubes en masse called "kinetic expansion," which means setting off an explosion inside the tubes causing them to suddenly balloon and fuse small cracks on the inside.

Lots of money and time has been spent arguing about the merits or deficits of using kinetic expansion to repair defective steam generator tubes. It seems a little bit to me like pouring Stopleak into the radiator of an aging car to see if you can't get a few more miles out of it without spending too much money (and this car hasn't been driven for 5 years). The difference between a car and a nuclear reactor is that if the radiator repair fails in your old car, you might get stranded on the expressway, but if a steam generator tube fails - as it did at the Ginna plant in Rochester, NY, causing the worst nuclear power accident since TMI - then you're endangering thousands of people. It doesn't seem to have worked too well. In a recent test, one tube failed badly (like Ginna) and was plugged. Seven more leaky tubes were left damaged.

9) No. The 100 tons of fuel contain only about 3 tons of uranium-235 (3%) which has to be over 90% to explode in a flash as in a nuclear weapon. But there is a danger of two other types of explosions:

1) A steam explosion if complete meltdown occurs and molten fuel falls through the bottom of containment intercepting groundwater beneath the Susquehanna. ("China Syndrome")

2) A hydrogen explosion from hydrogen generated when the zirconium cladding of fuel rods corrodes to become zirconium oxide which then can generate hydrogen when reacting with water in the primary coolant. (Zirconium is used to encase fuel rods, despite this liability, because it is transparent to neutrons which sustain the fission reaction in the core.)

We came within 30-60 mins of a steam explosion at TMI in 1979. If 100 tons of molten fuel had intercepted the Susquehanna River bed, highly radioactive debris would have been thrown up in huge clouds of steam carrying particles and dissolved gasses for hundreds of miles downwind. Thousands of persons would be killed by such a steam explosion.

A hydrogen explosion did occur during the TMI-2 accident. It severly damaged reactor superstructure, but, as far as is known, did not breech containment. Its worst effect is probably to interfere with cooling water access to the core, potentiating the more serious steam explosion mentioned above.

10) This often repeated conclusion has little basis in fact. Inadequate radiation monitoring during the initial and most dangerous stages of the accident coupled with lost records and misinterpretation of what little data has survived have all conspired to underestimate actual doses from the accident.

The following considerations lead me to conclude that official estimates of radiation exposure from the TMI accident have been much too low:

1) At least 17 radiation monitors in the plant went off-scale high during the accident. For these monitors, then, all we know is the minimal amount of radiation released, with no idea at all of maxima.

2) Radioiodine filters became quickly clogged since they were never designed to entrap so much iodine. They were then bypassed. Some even burned due to the intense radioactivity on the filters. Normally much of the iodine becomes dissolved in primary coolant, but during peak iodine releases much of the core was uncovered and iodines were carried upward by rising steam and hydrogen. It should also be mentioned that radioiodine isotopes such as iodine-132 released during the early hours of the accident (4-7 a.m. on 28 March 1979) were by far the most dangerous. Later iodine measurements could only detect iodine-131 (of which officially 24 Ci escaped). Many nearby residents tasted iodine throughout the two weeks of the accident. One woman three miles west of the reactor, at 6:30 a.m. on the 28th, said the iodine taste was "as if she had stuck her finger in a bottle of iodine and put ~~it~~ a drop on her tongue."

3) Met-Ed has "lost" all records of radiation monitoring from 28 March 1979, when the majority of the radiation releases occurred.

4) Helicopter readings over Goldsboro prior to 8 a.m. on March 28th showed 40 rem/hr. This reading was later changed to 10 rem/hr and then eventually discounted as altogether too high by the NRC.

5) Containment dome readings of 300 rem/hr on the morning of March 28th 'were later interpreted by the NRC as having been 400 millirem/hr." (NUREG-0600) What was the basis for this interpretation 750 times lower than initial readout?

So I think there is every reason to assume that less than 100 mrem maximal exposure from the TMI accident is much too low a figure. Assume, for example that the 40 rem/hr figure at Goldsboro was correct. Anyone outside during that period for two and one-half hours would have received 100 rems (more than 1000 times official estimates).

11) Yes, of course. And people all over the region did experience ~~other~~ sensations ~~than~~ in addition to just metallic and iodine taste and smell. Some of the acute radiation effects reported by many persons during the first days of the accident were:

These acute radiation effects require about 50 rem exposure

a) skin rashes (sometimes through pants or in one case father and son mechanics who spent all day in their garage).

b) nausea (sometimes accompanied by vomiting)

c) diarrhea

d) eye and mucous membrane burns (sometimes accompanied by blistering) Many of these people did not know about the TMI accident until after their symptoms.

Many of the severe radiation health effects cannot be measured until many years after radiation exposure, such as cancers or birth defects. However, there is one type of genetic effect seen within 9 months of radiation exposure. That is the so-called teratogenic effect of radiation on the developing human fetus. So also we saw two immediate effects of TMI on the newborn:

1) infant mortality rates doubled within 10 miles of TMI

2) neonatal hypothyroidism increased 4 → 14 in counties

I should also mention one other possibility as to how so much radiation got out into the environment. Dave Campbell, a nuclear engineer at Oak Ridge National Laboratory, calculates that as much as 1 ton of nuclear fuel left the core during the accident. How much of this fuel entered the atmosphere or the Susquehanna as particulates? Some persons who smelled or tasted iodine strongly also reported a grittiness in their teeth. Grittiness indicates the presence of particulate matter.

(12) As I mentioned earlier, you would expect cancers and birth defects to increase in the exposed population. It is only 5 years since the accident, so any study now is still premature. But in a preliminary study by Marjorie Aamodt, Jane Lee, Francine Taylor and some of their friends, asking questions of over 100 families in areas which experienced some of the acute radiation symptoms mentioned above, indeed there has been a five-fold increase in cancer mortalities following the TMI accident.

(13) Among these cancers are those you'd expect earliest, such as leukemias and lymphomas. The worker I mentioned earlier who got trapped in the auxiliary building during the cleanup operation was diagnosed as having acute leukemia within a few months and died 2.5 years later. After the atomic bombing of Hiroshima, leukemia incidence rose after the first year and peaked eleven years later. So if these statistics are correct, we should see increases in cancer incidence over the next six years.

One statistic found in the preliminary cancer surveys was very interesting: three deaths due to muscle cancers within a half-block area. These sarcomas are extremely rare, normally in only 0.7% of cancer cases reported. They are similar to Kaposi's sarcoma in AIDS patients, and like sarcomas in AIDS, developed very quickly. Perhaps radiation exposure has also weakened immune defenses against cancer as occurs in AIDS patients.

(14) At least 17 studies reported stress not only during 1979 around TMI but lingering through 1980 (containment atmosphere venting) and subsequent years (further radiation leaks). Everyone agrees that the TMI community was severly stressed. Unfortunately, as the only officially recognized health effect from the accident, this pronouncement tends to shift blame to the victims of the accident ("It's all in your head." Or the patronizing "We understand that you're upset, but if you'd just pay attention to the data, you would know there is no health risk.")

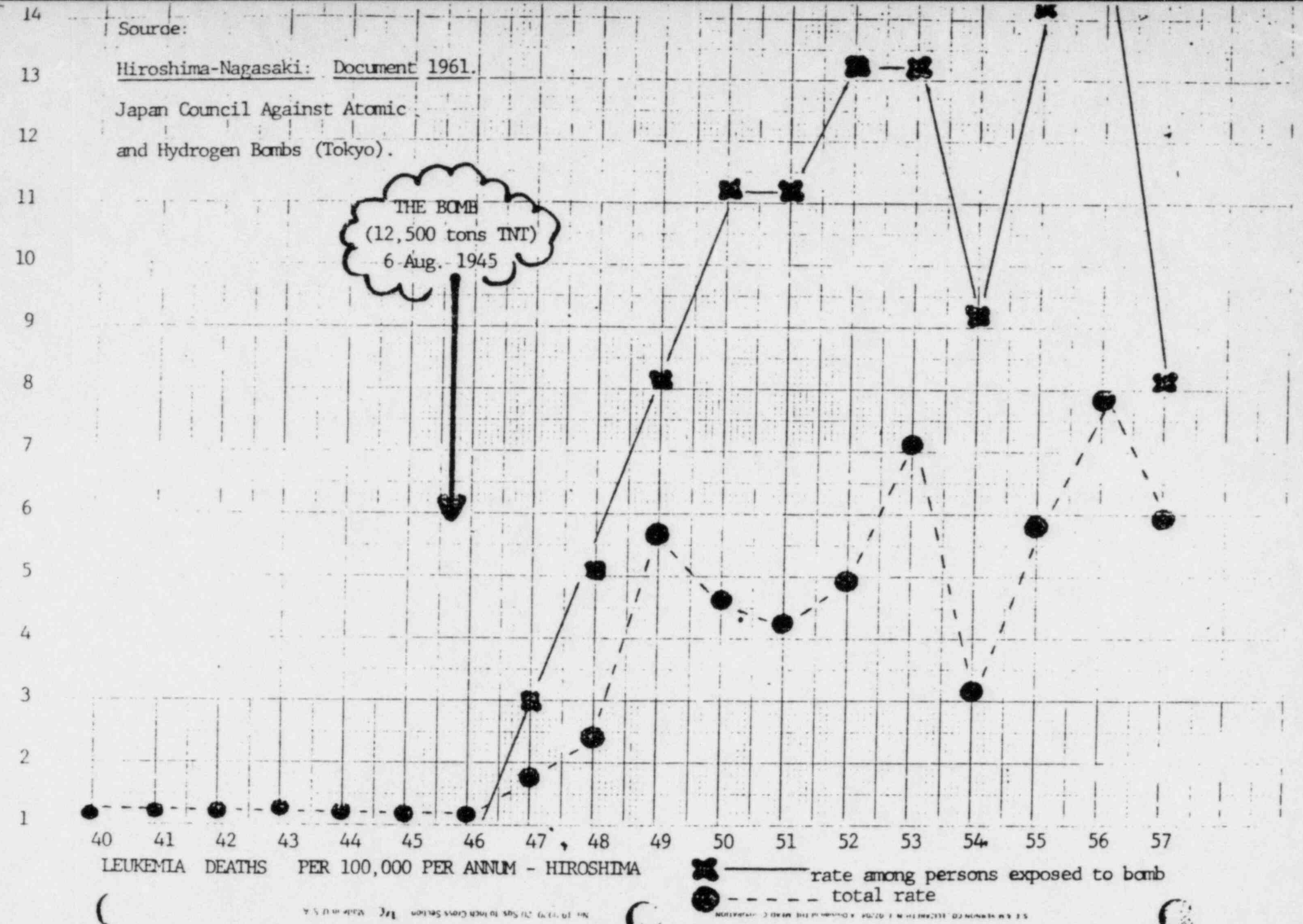
Stress has many harmful medical effects, including hypertension which exacerbates cardiovascular diseases and reduced immunological competence. The latter is especially pernicious for the TMI community since the immune system also is sensitive to radiation injury and has the responsibility, among other things, of rejecting cancerous cells as they pop up. (You can see this in organ transplant recipients who must be immunosuppressed and wind up with 10-100 times the cancer frequency as the normal population). So this aspect may help explain higher cancer incidence in such a short time - the combination of radiation carcinogenesis, radiation-induced immunosuppression and stress-induced immunosuppression.

(15) Virtually everyone knows how poorly nuclear power is faring in the U.S. It's been downhill ever since the TMI accident, which may go down in history as the deathnell of the industry. Projections of energy demands in the early 70's turned out to be way to optimistic (6% per annum increase, when the actual rate has been more like 2%). This coupled with long delays in construction and concomitant enormous cost overruns have conspired to kill the future of the nuclear power industry. In our capitalistic, democratic society two forces control decision-making: profit and public opinion. Nuclear power has failed dismally in both arenas.

16) I think Reagan's recent trip to China was one of the most incredible activities for a U.S. President of all time. He was virtually acting as an ambassador for Bechtel Power Corp., that giant U.S. company which builds most nuclear facilities in the world. Of course, it is no wonder that Reagan ~~will~~ would go abroad on behalf of Bechtel. A huge portion of his cabinet are ex-Bechtel executives (Schultz, Weinberger, Clark). Should the U.S. taxpayers sponsor his trip to China to sell Bechtel reactors? It will probably come out to be no sale anyway, not because of poor salesmanship (the Chinese were clearly flattered and had money-in-hand) but due to technicalities of the nuclear arms proliferation treaty.

17) Again, we have to realize that our growing demands for electrical power have not been increasing as fast as anticipated. It may well be that we can reach an energy plateau in this country, especially if we practice more energy conservation. On the other hand, power stations wear out (especially nuclear power stations which have a life expectancy of only 30 years). I suggest replacing these with coal-fired generators. Obviously, burning coal has its own environmental problems, mainly, exacerbating acid rain pollution due to sulfur emissions. For low sulfur coal, limestone scrubbers can be added which reduce sulfur emissions by 90% and only increase the price of coal energy by 30%. For high sulfur coal, there is a novel technique utilizing microwaves in alkaline slurries which removes 95% of the sulfur and doubles the price of coal. Even at double the price, coal is competitive with nuclear fuel as practiced by the industry today.

18) When Eisenhower launched Atoms-for-Peace 30 years ago, nuclear energy seemed almost too good to be true. 1 million times as much energy from each atom of uraniu as from each atom of carbon! Energy produced so cheaply, it won't be metered! I think this was a public relations exercise which has suddenly gone very sour. It was originally designed to get our minds off atomic weapons, Hiroshima and mutually assured destruction. Unfortunately for the Defense Dept. and the nuclear industry, due to TMI and other accidents, the awareness of dangers in nuclear power have alerted the country to greater dangers in nuclear weapons: a PR disaster of unpre-


Source:
Hiroshima-Nagasaki: Document 1961.
Japan Council Against Atomic
and Hydrogen Bombs (Tokyo).
THE BOMB
(12,500 tons TNT)
6 Aug. 1945
14
13
12
11
10
9
8
7
6
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LEUKEMIA DEATHS PER 100,000 PER ANNUM - HIROSHIMA
rate among persons exposed to bomb
total rate

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSIONERS:
Nunzio J. Palladino, Chairman
Victor Gilinsky
James Asselstine
Thomas Roberts
Frederick Bernthal

In the Matter of

METROPOLITAN EDISON COMPANY — Docket 50-289

Three Mile Island Nuclear
Generating Station, Unit 1

AAMODT MOTIONS FOR INVESTIGATION
OF LICENSEE'S REPORTS OF RADIOACTIVE RELEASES
DURING THE INITIAL DAYS OF THE TMI-2 ACCIDENT
AND POSTPONEMENT OF RESTART DECISION
PENDING RESOLUTION OF THIS INVESTIGATION

151 ABSTRACT

Interviews with residents in two areas which were in the path of radioactive releases from TMI-2 March 28, 29 and 30, 1979 demonstrate cancer deaths seven times greater than the Pennsylvania average.

Interviews with residents in these areas reveal that radiation-related health effects were experienced on March 28, 29, 30 and April 2, 1979 which could have resulted from exposures of 5 to 100 rems or more.

Analysis of flora growth abnormalities observed in the same geographic area are demonstrably the result of severe radiation exposure.

These three sets of observations are compelling evidence of release of airborne radioactive materials during the accident at TMI-2 orders of magnitude greater than have been acknowledged by the Licensee, the NRC Staff or the Commonwealth of Pennsylvania.

The significance of this conclusion, in the context of the Restart Proceeding, is that:

1. the records of airborne releases of radioactive materials during the early hours of the accident, which the Licensee asserts were "lost", were more likely intentionally destroyed to prevent disclosure of the hazard the accident posed to the health of the residents of the region.

2. the estimates of core damage and resultant source terms were intentionally minimized on March 31, 1979 to similarly deceive the public, and

3. although residents have attempted to raise the issue of serious health effects which occurred during the early days of the accident as well as illnesses which have subsequently developed, the Licensee has maintained its posture of deception to this day, asserting as recently as April 1984 in a newsletter to stockholders that no human injury has been caused by the TMI-2 accident.

Therefore, we herein motion the Commission to stay its decision in rendering a judgement as to this licensee's fitnes to operate the TMI-Unit 1 until these allegations are fully examined.

2.0 INTRODUCTION

Restart of TMI-1 is pendant upon a judgement that the Licensee's management possesses the integrity needed to safeguard the public from the potential dangers of plant operation. We herein present evidence that, in the early days of the accident, people who lived at high elevations in a generally northwesterly direction from the plant were subjected to radiation exposures of 100 rems or more. The significance of this evidence lies in the fact that the Licensee, as well as the NRC and the Commonwealth of Pennsylvania, holds a publicly stated position that raadiation releases at the time of the accident were negligible and that this position is supported by the willful withholding of data by Licensee which would prove this position false.

Licensee asserts that missing radiation records from the first day of the accident and the missing vent filters were "lost". We believe that they were intentionally destroyed.

Beyond this, we believe that the subsequent venting - with helicopter measurements of 1200 mr directly over the plant on March 30, 1979 - demonstrate the presence of hazardous doses to the population. These measurements were grossly optimistic for two reasons: First, the helicopter blades forced the plume away from the measuring instrument and, secondly, the measuring device did not measure beta and alpha emissions from particulates, which, we believe, comprised a significant portion of the releases.

Finally, no dosimetry was on the ground in the areas we have surveyed where we found severe health effects. Yet, despite repeated assertions by residents of the areas over which plumes passed that significant radiation effects were experienced by them, not a single evaluation of these claims has appeared on the record of the Restart Proceeding.

Following is a summary of the results of only a few weeks of surveying the population in areas where several plumes passed in the early days.

3.0 THE HEALTH SURVEY

3.1 METHOD

A group of women*, several of whom had expertise in conducting survey, went from door-to-door. A form, organized on the basis of information provided by Dr. Carl Johson of Denver, Colorado was used. (See Attachment 1.)

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*The primary interviewers were Francine Taylor, Norma Ritterspach, Jane Lee and Marjorie Aamodt. Assisting were Joyce Corradi, Linda Barash, Sally Stephenson, Drenda Witmer, Marie Inslee, Paula Kinney, Susan Folta, Helen Hocker, Mary Osborn, and Erma Weaver. Also interviewing were Austin Ritterspach and Cory Folta.

The areas selected were ones where residents had experienced erythema and metallic taste during the early days of the accident. One of these areas was six miles northwest of the plant(Area 1)and the other, three and one-half miles southwest (Area 2). A third area, seven miles northwest of the plants, was chosen because of its high elevation (Area 3) and clear view of the TMI plants. Figure 1 summarizes these area characteristics as well as age distribution of the residents.

Amost every household was willing to provide the information solicited. There were no refusals in Area 1, four in Area 2 and 2 in Area 3. The interviewers represented themselves as a group of citizens interested in health issues.

Several other residents of the TMI area, not in the precise areas surveyed, but residing or working in the area northwest of the plants were also interviewed because we learned of their unique experiences.

While the questionnaire did 'suggest' symptoms, the interviewers found, without exception that this did not more than remind the participant. All interviewers were of the opinion that the residents were conservative in their provision of information and that what was obtained was less than actually existed. For instance, a woman with an obvious lump in her arm did not mention it until the interviewer questioned her about it.

Figure 1 - DESCRIPTION OF AREA STUDIES

	CATION	MEDIAN 5 YEAR AGE RANGE	POPULATION AGE RANGE
Area 1	Elevated area N6 miles Northwest of TMI	35-39	1-80+
Area 2	Elevated area N3½ miles Southwest of TMI	35-39	1-80+
Area 3	Short road high elevation N7 miles Northwest of TMI	35-39	1-80+

3.2 RESULTS OF SURVEY

The survey produced the following significant information:

a. a cancer death rate for each area from six to over eight times greater than expected,

b. a large number of cancers and other tumors diagnosed after 1979,

c. a number of other serious health effects, and

d. first-hand accounts by residents of exposure to plumes in each of the areas surveyed.

3.21 CANCER DEATH RATE

Figure 2 presents the cancer death rate analysis. Based on data obtained concerning only those 313 persons about which information was obtained, the overall cancer mortality rate for the five year period since the accident was 6.5 times higher than expected. Even if it were assumed that there were no cancer deaths among the 144 persons about whom no information was obtained, the mortality rate is 5.2 times higher than expected. The highest rates were in Areas 1 and 3. These areas also provide the most reliable data since essentially the entire populations were surveyed.

FIGURE 2 - CANCER DEATH RATE ANALYSIS

AREA	1	2	3	ALL
Number of houses in Area	35	93	15	143
Total Number of households 1979 - 1984	42	-	17	
Number of Household about which Information was obtained	40	56	14	110
Number of Persons about which Information was obtained	112	156	45	313
Estimated Number of Persons in all Households 1979 - 1984	118*	288*	51*	457*
Expected Cancer Deaths[1,2] based on All Persons in All Households	1.27	3.10	0.55	4.93
Persons about which Information was obtained	1.21	1.68	0.48	3.37
Actual Cancer Deaths	7	9	4	20
Ratio of Actual to Expected				
Based on All Persons	5.51	2.90	7.26	5.22
Based on Persons Surveyed	5.79	5.36	8.33	6.47

* Estimated on basis of 3.1 persons/family not surveyed

1 215.6/100,000/yr. - Monthly Vital Statistics Report, Table 21, Vol. 31, No. 6, Supplement 9/30/82

2 For five year period 1979 - 1984

3.22 OTHER HEALTH EFFECTS - DIAGNOSED CANCERS AND TUMORS

Shown below are the number of diagnosed cancers and other tumors among living persons in each of the three areas. These data would suggest a continuing cancer mortality rate far in excess of that expected.

FIGURE 3 - CANCERS AND TUMORS DIAGNOSED - PERSONS LIVING

AREA	NUMBER
1	6
2	10
3	3
ALL	19

3.23 OTHER HEALTH EFFECTS

Other health effects picked up by the survey were most notably five cases of anemia, four cases of spontaneously ruptured or collapsed organs, seven persistent rashes and eleven birthing abnormalities in nineteen pregnancies.

Three of the four cases of ruptured or collapsed organs occurred in Area 3; the fourth case was in Area 1. A fifth case (subject of Affidavit 6) occurred out of the areas surveyed but in a northwesterly direction from TMI and to an individual who was subjected to fallout from a plume on Friday, March 30, 1979.

FIGURE 4-COLLAPSED AND RUPTURED ORGANS

Effect	Year	Age
Lung Collapsed	1980	19
Aortic Valve Ruptured	1981	43
Spleen Ruptured	1983	53
Kidney Collapsed	1983	55 (Approx.)
Artery to Heart 90% Blocked	1984	29

The eleven birthing abnormalities were as follows: one birth defect, miscarriage (fetus outside of uterus), four other miscarriages, one stillbirth, three Caesarean Sections and one premature. The dates of these occurrences were not identified in all cases, however all occurred since March 1979. The birth defect and the pregnancy outside the uterus occured in 1979.

3.24 STATEMENTS OF RESIDENTS WHO EXPERIENCED A RADIOACTIVE PLUME DURING THE INITIAL DAYS OF THE ACCIDENT

Affidavits 1 through 7 present first-hand accounts of the touchdown of plumes. The individuals supporting Affidavits 1 through 4 reside in the three areas surveyed. Affidavit 5 presents additional evidence of plume touchdown near Area 3. Affidavit 6 presents the account of a resident' insult from a plume several miles beyond Area 1 on a northwesterly line from TMI. Affidavit 7 presents an individual's experience with a plume six and one-half miles north northwest of TMI before 8 a.m. March 28, 1979.

Figure 5 summarizes the date, location and extent of each individual's experience.

4.0 RADIATION EFFECTS ON PLANTS

Affidavit 8 was provided by Dr. James E. Gunckel, the world authority on radiation effects on plants. Dr. Gunckel's affidavit provides an explanation for the numerous abnormalities observed in a variety of plants by local residents.

Dr. Gunckel examined plants and leaves provided by Mary Osborn of Swatara. The flora were gathered in the area of her home, approximately six and one-half miles north northwest of TMI. Other specimens were provided by Helen Hocker from her yard which is approximately three miles northwest of TMI. Also considered was Affidavit 9 of a farmer located two miles west of the plant.

5.0 DISCUSSION

The suggestion that the cancers present in the areas surveyed were initiated by radioactive releases from the TMI accident defies the generally accepted theory of a period of considerable latency following exposure. We suggest that this theory is not viable in the present case. We believe that the critical exposure was to beta and alpha particulates and that the general biological effects of this irradiation were similar to that described by Dr. Gunckel as effective in plants. (See Affidavit 8.)

The hypothesis of particulate exposure is supported by Affidavits 1, 2, and 6. The reddening of skin occurred on exposed areas. According to Dr. Edward Branigan of the NRC, the dose would be in excess of 100 rems. (Verbal communication with Mary Osborn)

Although we present no baseline for cancer deaths for the selected areas for the five years prior to the accident, we believe that the residents reached back to recall 'recent' cancer deaths. In Area 2 two cancer deaths prior to 1979 were reported. We conclude that there were few cancer deaths (as would be expected in a population of this size), possibly only the two reported in these areas in the five year pre-accident period. This conclusion is supported by the frequently-expressed opinion of the residents as well as a medical doctor, a paramedic and two nurses we met in the area that, since the TMI accident, the ocurrence of cancer has increased enormously on the west shore and that life is terminated in a more rapid fashion than would be expected.

Although no data is available for expectations of cancer and other tumor diagnoses, as well as the other health effects, the numbers of ocurrences of serious health problems in a population of this size is alarming. Particularly so, when according to the residents, all of these effects ocurred after March 1979.

We attempted to have soil samples from the areas analyzed. A spectral analysis has not been completed. EPA soil sampling since the accident was recently published, however we have not had an opportunity to view the data. This information has not been provided in the Restart Proceeding. The only information concerning soil sampling that we have found in the studies of the accident is an assertion in the Rogovin Report (Vol. II. Part 2, p. 389) that although several radionuclides were detected in some samples, they could not be attributed to the accident. Alpha particulate comtamination was not determined since it was assumed that uranium

and plutonium isotopes had not escaped in view of the Licensee's representation of only one to two percent core damage. These positions are no longer tenable in view of the more recent recognition of extensive core damage. Alpha emitters, if ingested or inhaled, can produce severe health effects. (See Attachment 2.)

Aside from the failure of NRC or the Licensee to survey for alpha particulate contamination, we have little confidence in any official data so far provided. An independent dose assessment study commissioned by the Burger Fund about two years ago and conducted by Jan Beyea may soon provide some more reliable information. This study has been completed and has received peer review, however it is, unfortunately, languishing in the court in Harrisburg.

Although the Beyea study may provide conclusive evidence to support our position that the the serious health effects on the west shore are related to radioactive releases during the initial days of the accident, consideration of our motion need not await its publication. The personal affidavits provide clear evidence of high radiation dose to residents of the west shore. The health data shows severe effects on the health of the residents in the areas studied. According to an authority (See Attachment 2, p. 151) "Whereas the effects of radiation are nonspecific, i.e., other agents or diseases can cause the same damage...where the effects of radiation are being studied, conclusions can (only) be drawn on the basis of in cidence of a particular type of damage above that normally occurring in a comparable poulation." Clearly the incidence of cancer deaths in the areas studied far exceeds the expected, and this high incidence is clearly tied to the TMI-2 accident by the personal experiences of the residents with high radiation exposure.

It is a fact that the Licensee, the NRC and the Commonwealth of Pennsylvania have no data in their possession which can define the quantity of radioactive materials emitted over the areas of this study during the early days of the accident. On the other hand, the record is replete with evidence of radiation release records being "lost", filters being "lost" and calculations and measurements of high dose rates being explained away or denegrated. (See NUREG-0600,II-397; II-3-18; II-3-77; NUREG-0760 at 31-33.)

6.0 CONCLUSIONS

The evidence is here. A grossly high cancer mortality rate is present exactly where plumes traveled in the early days of the accident. The fact that radiation monitoring data and TMI plant records have been "lost" or misconstrued only emphasizes the point that the Licensee conspired to hide the seriousness of the accident. The Licensee alone monitored radiation releases during the initial days of the accident.

7.0 MOTIONS

1. We move that the Commission act immediately to investigate the circumstances surrounding the falsification of radiation emission information in the early days of the accident and during subsequent investigations of the accident. We move that the Commission take a prime role in this investigation.

2. We move that the Commission postpone any decision relative to restart of Unit 1 until the matter of Motion 1 has been fully resolved.

Respectfully submitted,

Marjorie M. Aamodt

Norman O. Aamodt

June 21, 1984

AFFIDAVIT 1

On April 24, 1984, I, [redacted], [redacted] provided the following information in response to a questionnaire presented by Francine Taylor of Lancaster, Pa. and to Marjorie Aamodt in a subsequent interview that same day. I also provided Ms. Aamodt with a letter which was addressed to Governor Thornburgh and is dated November 19, 1981. I never received an answer to this letter. The letter is attached to this affidavit and is to be considered a part of it.

At the time of the TMI accident, I was living at [redacted], not far from my present home. This area is approximately four miles northwest of TMI Concerning my experiences following the accident at TMI: On Thrusday, March 29, 1979, I was working all day with my son in our garage The garage doors were open. That night when I took a shower, my face, neck and hands looked like I was at the seashore and got burned real bad. I felt nauseous. My eyes were red and burning. I felt like I was looking through water. Friday morning when I got out of bed, my lips and nose were blistered, and my throat and inside my chest felt like fire. It tasted like burning galvanized steel. My son had similar experiences He was 22 years old at the time. On Friday we decided to evacuate. While packing our truck, a township police officer, in a closed car, shouted over his loudspeaker system, "Bill, don't breath this air Get inside'" We spent the first night in Mechanicsburg with relatives. We convinced other family members to go with us and traveled to Front Royal, Va on Saturday. We stayed at a camp ground in Front Royal for about one week During this time I experienced severe diarrhea which caused rectal bleeding We took one of our dogs with us, a German Shepherd, female. Following our arrival in Virginia, the dog passed only blood from the rectum and bleed from the nose and mouth. Since I felt that these conditions may have been caused by nervousness due to our flight, I gave her a sedative When we returned home, we went in the garage first and found our male German Shepherd had died. His eyes were milky white. We had provided about 100 lb. of food and 50 gallons of water, however, he had only drunk water, about five gallons. It appeared that he had thrown up some of this water before he died. We had five cats that lived in a box on the back porch. All but one was dead. All cats had milky white eyes. The one living cat had one eye that was milky white: skin grew over this eye during the following weeks. This cat lived for about six months after the accident. She had kittens prior to her death. The kittens were born dead and hairless I should also note that we noted a metallic taste when we entered our hm home after the evacuation.

My son and I have both experienced hair loss; mine was on my head, arms, legs and torso This hair has regrown. My son lost hair on his arms and torso, which has also regrown. In 1981 a sore developed on my leg. The sore remained for two years, healing after we moved to Florida The effected area is still detectable as a faint discoloring. The skin was inflammed, open, and raised: the doctor's diagnosis was uncertain. Also in 1981 my wife, [redacted], was diagnosed as having paroxysmal tachycardia and in 1982 as having a underactive thyroid. I have also experienced problems with my heart. Although I had had a slight mummer prior to the accident, I had passed a physical required for racing cars. However, in December 1980 I needed to undergo an aortic valve replacement. I was 43 years old at the time.

The spring following the accident, our walnut trees did not produce any leaves, and there were no walnuts. There were no flies or other flying insects until July 1979. There were no birds, squirrels or pheasants

The spring following the accident, our walnut trees did not produce any leaves, and there were no walnuts. There were no flies or other flying insects until July 1979 There were no birds, squirrels or pheasants for about a year and one-half following the accident. I found a number of dead birds. A number of neighbors died of cancer.

In 1983, I felt that I could not continue to live in this neighborhood, so close to the TMI plants. I sold my home and business at considerably less than its appraised value and moved to Florida. However, we returned this year and are living in a new home at [redacted], near our previous home. We got homesick. My daughter and grandchildren live in this area, as well as other relatives, and telephone communication with them was not sufficient contact. My son left with us for Florida and has stayed there.

I had been in business in Fairview Township, York County, for twenty-two years. I operated an automobile sales and service shop. I was involved in community affairs as a justice of the peace and in politics as a committeeman.

All of the above information was provided voluntarily, and I attest to its truthfulness.

[redacted]

AFFIDAVIT 2

On May 5, 1984, I, [redacted], provided the following information to Marjorie Aamodt at my place of residence on [redacted]. My residence is approximately 2-3 miles south west of TMI and is at a high elevation,

On Monday evening, April 2, 1979, after returning from West Virginia where I had evacuated with my family, I worked outside on my camper from approximately 6 until 7 p. m. My family stayed inside. When my wife called me in for supper, my skin was burning. My face, arms and hands were reddened and remained that way for about 12 hours. I had a metallic taste. I felt nauseous. I felt "funny in the head". I took a shower that evening before going to bed. Since I had a head cold, I went to the doctor's the next day. I told my doctor about my experiences the following evening. He read from a book what symptoms are related to radiation exposure. We noted that these symptoms matched what I had experienced, however the doctor reassured me that nothing had come out of the plant. Concerning the weather conditions on the Monday evening, April 2, 1979, I remember that there was a light mist over the area.

[redacted]

____

Date Sworn________________________

AFFIDAVIT 3

I, [redacted] provided the following information to Marjorie Aamodt in a telephone conversation on June 18, 1984. I was ill with the flu at the time of the TMI accident. I was in bed most of the time. However, one day, which I believe was Friday, March 30, 1979, I was out of bed and decided to shake out a throw rug. I went out on the porch. It sounded as if it was raining. The sound appeared to be in the trees. I could not see any rain so I reached out beyond the porch roof to try to feel it. I did not feel any rain on my hands or arms. I was extremely puzzled, I was impressed by the stillness except for the sound of rain. There were no sounds of birds or other sounds to which we are accustomed. This all seemed very strange, however I was too sick at the time to pursue the matter further, so I returned to bed. My certainty in dating this event on March 30, 1979 is tied to a telephone call I received later that same day. A neighbor called to tell me that my son had been taken from his school to Dillsburg because of the TMI accident, and she volunteered to pick him up.

I could never get the experience of the silence and the rain-like sound out of my mind. Subsequently, several of my friends told me about similar experiences at the same time. One of these friends is [redacted]

I and my sons remained during the accident. We would have chosen to leave, however I am a widow, and I did not have suffiencient financial resources to leave.

[redacted]

Date----------------1

AFFIDAVIT 4

On April 28, 1984, at my home, [redacted], I related the following experiences that I had at the time of the accident at TMI. On Wednesday evening, March 28, 1979, unaware of any problems at the TMI plants, my wife and I were outside in the evening to take a walk on our street. The walk lasted approximately ten minutes. That evening, my eyes began to water and burn. My eyes watered throughout the entire night.

In the fall of 1982, I began to have problems with my eyes. My eyes felt like they were burning. About three months after this occurred, I decided to see a doctor. At this time the skin around my eyes was irritated and red, and there was a distinct red mark on the innerside of my nose. Although the redness around my eyes has disappeared, the mark on my nose has remained.

The first doctor appeared unable to help, and since I was troubled about my eye condition, unique to me during my lifetime, I saw a second doctor. I also had a rash on my forearms which had come and gone since shortly after March 1979. This rash is particularlynoticeable after showering and in warm weather. The dermatologist prescribed Prednizone.

In 1981, my wife [redacted] was diagnosed as having fibroid tumors in her uterus. These tumors were large, but were successfully removed in September of 1982.

I believe that my skin conditions and possibly my wife's tumors are related to some exposure we may have gotten from the accident at TMI. We were unaware of the problems there or any dangers to ourselves until several days after the accident. Actually, it was a TMI worker who is a neighbor and who evacuated early on the first day of the accident who returned on the weekend to warn his neighbors to evacuate.

[redacted]

Dated----------------------

AFFIDAVIT 5

On Friday, April 27, 1984, I provided the following information to Marjorie Aamodt in my dental office in [redacted], located at [redacted]. This information concerned my experiences on Wednesday and Thrusday, March 28 and 29, 1979. On those days, I discovered that the X-ray films in my dental office in [redacted] were fogged. This office is located on the corner of [redacted] and [redacted] in a stone building 5 miles north west of TMI. The film fogging can be described as alternately light and dark banding across the entire film. Approximately 75 films were "fogged". These films had been placed in a little container for easy access in the X-ray room The X-ray room has an outwall of cinderblock and gypsum board. The film is #2 oral film, fast D film, 0.2 mr exposure. The machine is marked as 70 KV, 7.5 m.amps, 3/10 sec., for jaw exposure On Friday following, March 30, 1979, I posted new film outside the building each day for an entire week, however these films were not exposed. On Wednesday and Thrusday, March 28 and 29, 1979, I experienced a metalish taste and a queasy stomach. I felt "funny" and expressed this feeling to my receptionist. At that time I had no knowledge of the accident at TMI.

[redacted] 5/7/84

____

Date Sworn ____________________

AFFIDAVIT 6

I, [redacted] provided the following information to Jane Lee and Marjorie Aamodt on May 11, 1984.

On Friday evening, March 30, 1979, I was standing on the front porch of my home. My home faces south. It was raining, and the wind was blowing. All of a sudden the cat that had been let out began to howl in a most unusual way. I had never heard a sound like that from this or any other cat. I called the cat by name, however it did not come home. From the direction of the howling, I could tell that the cat was under the porch. I went over to the bannister and leaned over to call the cat again. While standing in this position at the east side of the porch, I experienced a most unusual sequence of events. Suddenly, the wind stopped; there was a movement in the limbs of the trees next to the porch, and a wave of heat engulfed me. The gust of heat brought the rain over me. Then the wind started again. This all happened in about one minute. I was so startled that I went in, taking the cat, who had by now come up on the porch. I wiped the cat's wet coat and then washed my hands and face. My face felt tingly. About an hour later, I washed My face again and wiped my arms and legs with the towel. I noticed that my arms and face were pink. I applied a lotion because my skin felt tingly.

On Saturday morning, my skin was a darker pink, and there was an itch at the front of my scalp. This was the only part of my scalp that was not covered by a scarf. When I went to church on Sunday, my friends commented that I looked healthy and sunburned. On this day, hard little lumps, a little bigger than a pinhead appeared on my forehead and into the hairline.

On Tuesday, my scalp felt prickly and tingly, so I washed my hair again, shampooing it three times which is more than I customarily do. (I generally wash my hair once a week.) About three weeks later, I noticed that a lot of gray hairs had appeared across the front of my hair. When I washed my hair that week, my comb was full of hair. The next week, the loss of hair increased. I called my hairdresser, [redacted] who subsequently applied treatments which he believed would arrest the loss of hair. The hair loss did appear to stop. The gray hairs have also disappeared, and my hair is now uniformly brown as it was before the events described.

In the subsequent weeks, the skin on my forearms and neck turned darker and was scaly. This condition lasted for several years. There is however some permanent discoloration however it not prominent. My forearms were, and continue to be, very sensitive to the sun, becoming itchy with exposure. I try to avoid sunlight. I have also noticed that if my arms are injured, the bruise will last longer than was normal for me prior to the events described above.

A number of spots have appeared on my face and chest. These appeared after the tiny hard bumps went away. Six of these spots, or pimples, remain. Some of the pimples have yellow centers. The size of these pimples appears to have diminished somewhat, and they are not sensitive, however I am uncomfortable with this condition of my skin, unlike its condition prior to the events described above.

Of greatest concern to me presently is the loss of the function of a kidney. Toward the end of November 1983, I was in renal failure. My doctor described my condition as an unusual case. He stated that one of my kidneys had died. I was in Holy Spirit Hospital under the care of Drs. Bean and Eaton. I have not fully recovered, and I have not been able to resume my customary social and household activities.

I live on a farm with my husband. We were not able to evacuate during the accident, although I wanted to leave, because my husand would not ask anyone else to stay to do his job of caring for the animals. Despite our continual attention to the cattle, we experienced the first deformed calves ever born on our farm the following spring. The calves' heads hung to one side until they were six months old. Their necks appeared twisted. I also noted that the Norway maple by our home had deformed leaves which were curled at the edges.

[redacted]

Date------------------------

AFFIVADIT 7

I, [redacted] reside at [redacted], six and one-half miles north northwest of TMI. This was also my residence at the time of the TMI accident as well as that of my husband, son and daughter.

On the morning of March 28, 1979, my husband was putting his tools into his truck. It was six o'clock in the morning when he came in to ask me to go out and smell the air. I wondered to myself whether it would be the Hershey chocolate smell or the aroma of Capitol Bakers' bread. This time the air was different. The air smelled like metal. It was overwhelming. I could taste metal in my mouth. It seemed as though as every taste bud in my mouth could sense this metal. We were very puzzled.

Later that morning, at 8 o'clock, my son and I walked my daughter to the bus stop. There was no metallic smell in the air.

[redacted]

Date--------------------

AFFIDAVIT 8

I, [redacted] of [redacted] provided the following information to Jane Lee, a neighbor, and Marjorie Aamodt at my [redacted] home on [redacted] on Monday, May 7, 1984. I provided this information voluntarily and attest to its truthfulness.

My home is approximately 2 miles from the TMI plants. My house faces in that direction and is north west of TMI. I have several trees in my frontyard. One of these, a maple at the south corner of the yard next to a wooden fence appeared to be affected by the accident at TMI. This tree is about 30 years old and is still living, however it has undergone considerable changes. About a week after the accident, I noticed that the leaves in the center of the tree were turning brown. The leaves then dropped off leaving a circle of defoliation about twelve feet in diameter. The next year the barked dropped off many branches. This caused these branches to die. About one-fourth of the limbs are now gone. The top of the tree, which was the area that was affected after the accident, now has few leaves. Two pear trees, one a Keifer and the other a Harvest, both planted in the late 1920's, have died. Six trees had been good bearing trees prior to the accident, however they all produced dwarfed pears after the accident. The number of pears decreased also. Since the accident, I can no longer grow clover seed. because the clover yields so few seeds. In 1981, the last year I grew clover, there were only 0-10 seeds per stem, whereas I got about 75-125 seeds per stem before the accident. This problem has affected other farmers in my area, but is not a problem on a farm in this area but at a greater distance from the TMI plants, approximately 12-15 miles. I attribute the decrease in seed production to the disappearance of bumble bees that pollinate clover. Last year we had no apples from our 3 trees. One apple tree, in the yard, started 'going back' after the accident. Last year, it only had a couple of leaves, three blossoms and no apples. The only crop that 'does good' is potatoes. We have had a number of problems with livestock including sows that did not come into heat. These sows were not born on my farm, but were purchased from a farm near here.

I was inside my house on the day of the accident and stayed in most of the time. I have a rash 'back of my ear' and down on the side of my face' ever since the Krypton venting began.

I have lived in this area all of my life and have farmed since 1912.

[redacted]

Addendum - the leaves on my garlic plants curled tightly, and the plants died. this happened in 1979 after the accident.

The Bulletin
of the Torrey Botanical Club

Editor-in-Chief: James E. Gunckel

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May 11, 1984

AFFIDAVIT 9

I have carefully examined a few specimens of common plants collected shortly after the accident at TMI and compared them with specimens collected more recently. The current abnormalities are probably carried forward by induced chromosomal aberrations. There were a number of anomalies entirely comparable to those induced by ionizing radiation -- stem fasciations, growth stimulation, induction of extra vegetative buds and stem tumors.

Most of the stem abnormalities described in the literature, and in my own experience, are induced by relatively high doses of X or gamma rays extending over a period of usually 2-3 months. Notable exceptions, however, are similar responses to beta ray exposure from radioisotopes (P^{32}, Zn^{65}, Ca^{45}) and for only 24 hours. In other words, it would have been possible for the types of plant abnormalities observed to have been induced by radioactive fallout on March 29, 1979.

In discussing the general biological effects of irradiation, some clarification may be helpful. In plants, the dose rate (e.g., mr/hr) is much more important than total dose (e.g., mr/yr) in inducing abnormalities. Further, the "quality factor" for gamma and beta radiation is not the same as generally assumed. In fact, I have incontrovertible experimental results to show that beta rays are at least a quality factor of two in plants.

I am the world authority on modifications of plant growth and development induced by ionizing radiations, having researched this area for 34 years at the Brookhaven National Laboratory and at Rutgers University. The three review papers appended attest to my expertise.

James E. Gunckel

James E. Gunckel

ATTACHMENT #1

Case number 190

A VOLUNTARY COMMUNITY HEALTH SURVEY

Date: ________

Location: ____________

1. Have you been contacted by the Pa. Dept. of Health survey on TMI?___When?____

2. Family name ________ ________ Willing to participate? yes______ no______

3. Family members: (doctor)

name	status	sex	birth-date	3/28/79	Location 3/29/79	3/30/79

If deceased, when?_______ Onset of illness__________ Diagnosis________ Dr.______

4. Current address and phone no.: ______________________
Address on 3/28/1979: ______________________

5. Persons outdoors?

name	3/28-hours	3/29-hours	3/30-hours

6. If vacated the area:

who	to where	when left--when returned

7. Did anyone notice (indicate date, time, who)

a. unusual atmospheric conditions________
b. metallic taste, smell________
c. eye irritation, burning________
d. skin irritation, ", reddening________
e. irritation of nose, throat, chest________
f. experience nausea________
g. experience vomiting________
h. experience diarrhea________
i. experience headaches________
j. develop hypothyroidism________ hyperthroidism________
k. within 2-4 wks unusual hair loss or color change________
l. red spots under skin________ bleeding gums________
m. unusual bleeding________
n. cancer________ form________ treatment________ doctor________
o. later was there confirmed (doctor) anemia________ blood or thyroid disorder________

8 women: If pregnant, date of last menstrual period before 3/28/79________
Complications with pregnancy?______ stillbirth________ miscarriage________
premature birth________ Date of birth________ Wt. at birth________
health of child since birth________
caesarean section ________ Date of birth ________ wt. at birth____
health of child since birth ________ crib death________

9 History of disorders in family tree (leukemia, cancers, thyroid, etc.) ________

10. Animals.

name	age in 3/79	inside/outside	alive/dead	health problems

11. Additional comments________

FIGURE 5 INDIVIDUALS' RADIATION EXPOSURE

AFFIDAVIT	AREA	DATE	SYMPTOMS
1	1	3/29/79	Erythemia Metallic Taste Burning Throat Hair Loss Rashes
2	2	4/2/79	Erythemia Metallic Taste Nausea
4	3	3/28/79 (evening)	Tearing Eyes
5	Near 3	3/28, 29/79	Nausea Metallic Taste Exposed Film
6	Beyond 1	3/30/79	Erythemia Tingling Skin Hair Greying and Loss Discoloration of Skin Skin Cysts

Attachment 2

Dangerous Properties of Industrial Materials

Fifth Edition

N. IRVING SAX

Assisted by:

Marilyn C. Bracken/Robert D. Bruce/William F. Durham/Benjamin Feiner/
Edward G. Fitzgerald/Joseph J. Fitzgerald/Barbara J. Goldsmith/John H. Harley/
Robert Herrick/Richard J. Lewis/James R. Mahoney/John F. Schmutz/
E. June Thompson/Elizabeth K. Weisburger/David Gordon Wilson

VAN NOSTRAND REINHOLD COMPANY
NEW YORK CINCINNATI ATLANTA DALLAS SAN FRANCISCO
LONDON TORONTO MELBOURNE

TABLE 5A.3 Summary of Effects Resulting from Acute Whole Body External Exposure to Radiation

0–25 rems	25–100 rems	100–200 rems	200–300 rems	300–600 rems	600 or more
No detectable clinical effects. Delayed effects may occur	Slight transient reductions in lymphocytes and neutrophils.	Nausea and fatigue, with possible vomiting about 125 rems.	Nausea and vomiting on first day.	Nausea, vomiting and diarrhea in first few hours.	Nausea, vomiting and diarrhea in first few hours
	Disabling sickness not common, exposed individuals should be able to proceed with usual duties.	Reduction in lymphocytes and neutrophils with delayed recovery	Latent period up to 2 weeks or perhaps longer.	Latent period with no definite symptoms, perhaps as long as 1 week.	Short latent period with no definite symptoms in some cases during first week.
	Delayed effects possible, but serious effects on average individual very improbable	Delayed effects may shorten life expectancy in the order of 1 percent.	Following latent period symptoms appear but are not severe: loss of appetite, and general malaise, sore throat, pallor, petechiae, diarrhea, moderate emaciation.	Epilation, loss of appetite, general malaise, and fever during second week, followed by hemorrhage, purpura, petechiae, inflammation of mouth and throat, diarrhea, and emaciation in the third week.	Diarrhea, hemorrhage, purpura, inflammation of mouth and throat, fever toward end of first week
			Recovery likely in about 3 months unless complicated by poor previous health, superimposed injuries or infections.	Some deaths in 2 to 6 weeks. Possible eventual death to 20 percent of the exposed individuals for about 450 rems.	Rapid emaciation and death as early as the second week with possible eventual death of up to 100 percent of exposed individuals

would be completely absorbed by 1.1 g cm² of aluminum; it would also be absorbed by 1.1 g cm² of air. However the absorber thickness would be only about 0.25 inch for the aluminum and over 30 feet for air.

The result of ionization is merely a conversion of the radiation energy into another form of energy within the absorber, and it is these secondary effects which are of the greatest importance in radiation protection work.

The primary effects of ionization and the distribution of this ionization over various path lengths in different absorbers have been mentioned previously. The different types of radiation also show different degrees of absorption and these differences also are biologically significant. Alpha particles are heavy, slow moving, and expend their energy in a relatively short path. They are, therefore, spoken of as showing high specific ionization, i.e., a large number of ions are formed per unit length of path in the absorber. Gamma and x-radiations, on the other hand, require a great thickness of absorber for complete absorption. Gamma rays and x-rays have a low specific ionization, i.e., the ionization is spread out over the relatively long path required for complete absorption. Beta particles are intermediate in their specific ionization.

Biological Effects

The biological effects of radiation are considered here only in sufficient detail to be of assistance in problems of radiation protection. Some of the information is also required for an understanding of the concepts that have gone into the formulation of permissible levels.

X-rays or γ rays, because of their penetrating nature, may dissipate only a fraction of their energy in passing through the body. This is particularly true of high-energy rays. The energy dissipated is, of course, the absorbed dose delivered to the body or portion of the body.

Radioisotopes, in contrast, may present a further hazard when the material is taken into the body where it irradiates the tissues or organs internally. The most serious effects from this standpoint are produced by the α emitters such as Ra, U, and Pu. They are particularly marked because α emitters outside the body expend their energy either in penetrating the clothing or the dead cells of the epidermis; usually the radiation cannot penetrate to living cells. Once they are taken into the body via ingestion or inhalation, this same property of short-range and high specific ionization increases their relative effect considerably. Emitters located in a small section of tissue will irradiate that small section very heavily.

Beta emitters can be both an internal and an external hazard. The range of most external β radiation is great enough that the outer tissues, at least, will be penetrated. The most common external effects have been radiation burns and malignancies of the skin. Internally, they may

produce a considerable effect. Their specific ionization is high although not as great as that for α radiation.

The preceding paragraphs have emphasized the ionization effects, particularly specific ionization. Many secondary effects can be caused by the ionization process. It may disrupt molecules, it may destroy body cells, or the energy may merely appear in final form as heat released within the absorber. Depending on the location of the absorbing atom within the molecule, the ionization may or may not disrupt the molecule. If this molecule is in a critical place within the cell, the cell, its function, or its ability to reproduce itself may be destroyed. Many of these processes are reversible; that is, damage caused by molecule disruption or cell destruction can be reversed by the usual reparative mechanism of the body. This is confirmed by experimental data which show that a fixed total dose spread out over a period of weeks produces a smaller effect than the same dose delivered in a few minutes. However, in the case of a large acute dose or continued chronic overexposure, there is the possibility that non-reversible damage will occur.

Another type of cell change which is possible is that the regulative functions of a tissue may be destroyed. In this case a carcinoma (cancer) may be produced. Although the mechanism is not fully understood, there is direct evidence that continued insult to a tissue may produce this result. The high rates of leukemia among radiologists, bone cancer among Ra dial painters, and lung cancer among miners of the Czechoslovakian, German, and U.S. uranium mines all point to radiation as the causative agent. This irreversible damage in chronic radiation exposure was apparently cumulative and the cumulative effects led to the illnesses.

Internal Emitters. The biological effects of radiation from radioisotopes in the body are complicated by several factors. In any determination of radiation effects, whether in working populations or in animal experiments, the following factors must be considered: (1) the location of specific isotopes in the body, and (2) the relative sensitivity of different tissues to radiation.

The general effects of external radiation have been previously described but there are certain modifications in the consideration of radiation from internal sources. The first is that different elements tend to localize in different organs of the body, e.g., calcium or strontium in bone, iron in the red blood cells, and iodine in the thyroid. This is true for any material which is metabolized following either inhalation or ingestion. Of course, many not readily soluble substances will remain in the lungs for long periods after inhalation. This means that the total amount of such a radioactive material is not distributing its dose uniformly but rather is concentrating its effect on a relatively small fraction of the body.

Most of the heavy metals tend to be deposited in the bone structure. After deposition, there is usually a continuous excretion of the isotope which gradually reduces the amount present. The excretion rate of such materials has been considered to follow much the same pattern as the radioactive decay of an isotope. The time required by the body to eliminate one-half the total quantity it contains is thus referred to as "biological half-life." Most of the experimental data on excretion seem to fit a power function which is the resultant of a number of exponentials rather than a simple exponential function, but the concept of biological half-life is still used in deriving permissible levels.

Such body deposits may depend on many physiological factors both in the process of deposition and of excretion. For many years a high calcium diet was recommended for radium workers, as it was supposed that a large excess of calcium entering the body would reduce the amount of Ra deposition. Actually, the relative radium deposition is a function of the ratio of radium to calcium in the blood stream. Unless the calcium level of the blood is maintained at a very high value there will still be deposition of radium. The increase in the blood calcium required to cut the radium deposition by even a factor of three would be impossible to attain.

Besides the bone structure, common sites of deposition are the lungs and lymph nodes for inhaled particles, and specific organs for certain isotopes, such as the thyroid for iodine and spleen for iron.

A second consideration is that certain organs or tissues are more radiosensitive than others. The membranes lining the bronchi are supposedly quite sensitive to radiation and this is the primary site of many lung cancers attributed to inhaled radioactive material. The spleen is also sensitive to radiation and relatively small doses have produced more irreversible damage in that organ than in other parts of the body.

The organ most likely to be damaged because of the combined effects of concentration and radiosensitivity is known as the critical organ for a particular isotope. In general, any cell in the process of division (mitosis) is radiosensitive and for that reason a person is more sensitive to radiation during his growing period than as an adult.

Radiation Injury. The effects of radiation are nonspecific; i.e., other agents or diseases can cause the same damage. For example, it is impossible to distinguish between radiation-induced anemia and normally incident anemia. Other possible effects such as lung cancer, leukemia, and bone cancer present similar difficulties.

In any case, where the effects of radiation are being studied, conclusions can only be drawn on the basis of incidence of a particular type of damage above that normally occurring in a comparable population. If tabulations are made of incidence in a particular group, such as chemical operators exposed to radiation in a process

Attachment 3

State Represetative Stephen Reed's Letter to the NRC

August 8, 1979

Honorable Joseph M. Hendrie, Chairman
U.S. Nuclear Regulatory Commission
Washington, District of Columbia

Dear Chairman Hendrie,

I am entirely baffled by the apparent refusal of the U.S. Nuclear Regulatory Commission to have extensively reviewed the reports by hundreds of Three Mile Island area residents who, during March 28-31, 1979 primarily, and at times subsequent, experienced:

(a) metallic taste in their mouth
(b) metallic or Iodine-like odor in the air
(c) irritated and watery eyes
(d) moderate or severe respiratory inflammation
(e) gastro-intestinal dysfunction and diarrhea
(f) disruption of the menstral cycle in females
(g) skin rashes (some appearing as radiation burns)
(h) sharp, abnormal pains in joints.

The U.S. Public Health Service and Pennsylvania State Dept. of Health are jointly conducting a survey of TMI area residents to record medical histories so that the full health consequences of TMI' radiation releases in the next 25 years will be documented. That is all fine and should be done. But why is there a complete dismissal by the NRC of any immediate indications of exposure to levels of radiation higher than what were immediately thought the first dates of the accident? Psychosomatically induced ailments are possible with some, but not with hundreds or even more persons and I suggest this matter has been conveniently laid aside.

The NRC is charged with ascertaining full details about the TMI accident. You are further charged with knowing the full effects of even low level radiation on populations near to nuclear reactors. Failure to pursue the aforementioned reports from TMI area residents is a dismal failure of your most important safety responsibilities to the tens of millions of people living near reactors, not to mention the people around TMI.

I therefore recommend that all available expertise be applied to ascertaining the cause of these physical ailments associated with the TMI accident and a completely accurate public disclosure made of its cause and the level of radiation or contamination that people may have been exposed to. The inability of both Metropolitan Edison and the NRC to know even to this day (or at least to have disclosed if you actually do know) the levels of exposure is in itself a major, most serious failing of pre-TMI accident obligations by both parties. And if it is determined that the exact cause of these physical ailments cannot be determined due to the lack of adequate research on the subject pre-TMI, then the public should know the extent to which we indeed are unprepared to deal with nuclear plant emissions.

Yours sincerely,

STEPHEN R. REED
State Representative