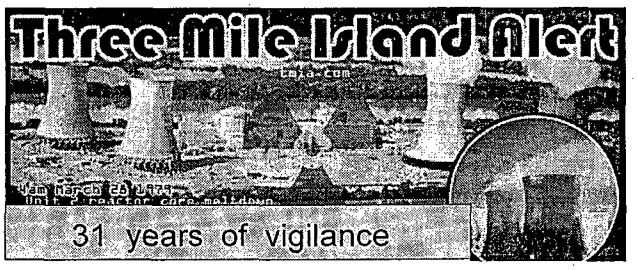


NRC Public Meeting May 1, 2008

Environmental Impact TMI re-Licensing Application

Comments of Scott D. Portzline

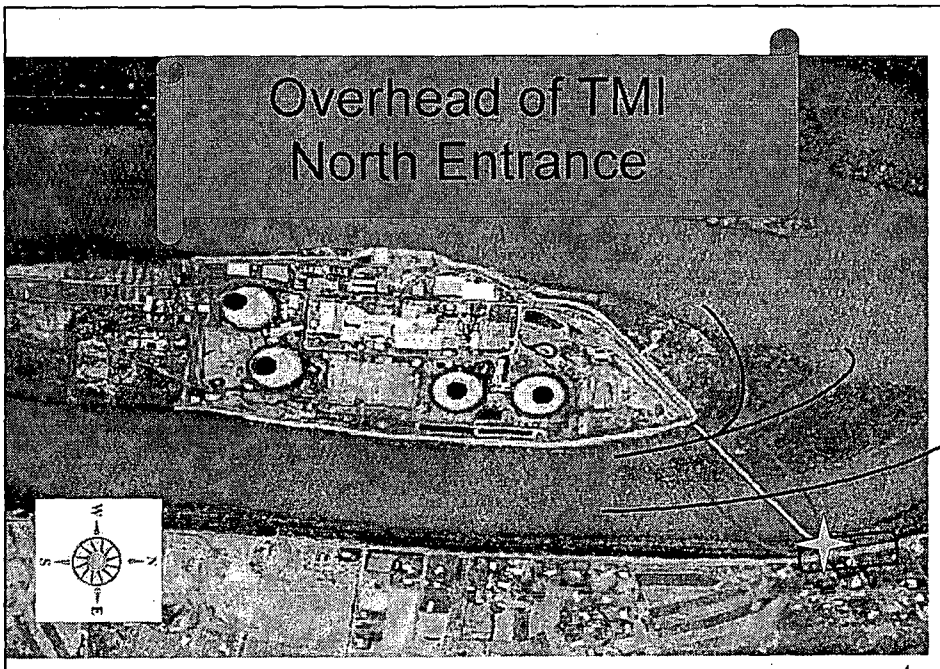
Harrisburg PA

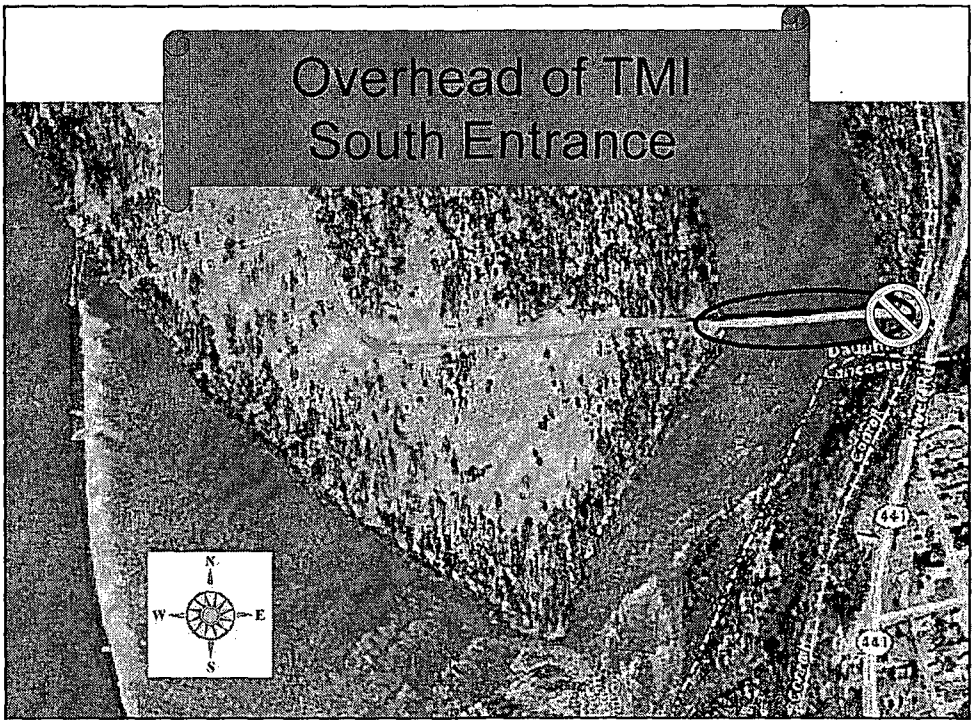
- The new proposed security requirements have potential impact on the environment.
- This is especially true at TMI which has unique geographical features and will require special attention by the NRC.
- This issue must be included in the environmental impact assessment.

Power Reactor Security Requirements
(RIN 3150-AG63)

"Licensees shall describe the site-specific factors affecting contingency planning and shall develop plans for actions to be taken in response to postulated threats."

"The safeguards contingency plan must include a site description, to include maps and drawings, of the physical structures and their locations."





Power Reactor Security Requirements
(RIN 3150-AG63)

"The site description must address the site location in relation to nearby towns, transportation routes (e.g., rail, water, air, roads), pipelines, hazardous material facilities, onsite independent spent fuel, storage installations, and pertinent environmental features that may have an effect upon coordination of response operations."

Power Reactor Security Requirements
(RIN 3150-AG63)

"Owner controlled area. The licensee shall establish and maintain physical barriers in the owner controlled area to deter, delay, or prevent unauthorized access, facilitate the early detection of unauthorized activities, and control approach routes to the facility."

7

"Licensees shall describe the site-specific factors affecting contingency planning and shall develop plans for actions to be taken in response to postulated threats. The following topics must be addressed:

Approaches: Particular emphasis must be placed on main and alternate entry routes for law-enforcement or other offsite support agencies and the location of control points for marshaling and coordinating response activities."

"Limit and control all approach routes."

8

To meet these Regulations

- TMI must control the entrances and pathways which emergency responders are planning to utilize.
- TMI has only two entrance points since it resides on an island surrounded by water.
- Methods to control pathways would include closed vehicle barriers, watercraft barriers, and other denials systems to prevent the loss of usage of each bridge.
- NRC must assess what effects these denial systems will have on the environment.

Aircraft Crash

The NRC must re-evaluate the effect of aircraft crashes at TMI as promised by the Atomic Safety and Licensing Appeal Board in its ruling at the original licensing process (9/15/1978).

TMI is less than 3 miles from the Harrisburg International Airport.

NRC Commissioner Ivan Selin stated that a small airplane can do "a lot of damage" and that "you probably would not even have to put explosives on it."

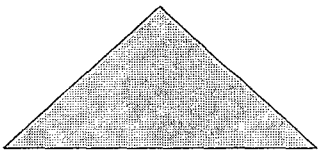
Spent Fuel Repository

- It is totally unconscionable to continue making more high level nuclear wastes without a working solution for the waste or a fiscal accounting of the future costs.
- The industry has promised a solution for nearly 50 years with little results.
- Even if Yucca Mountain ever opens, it is already out of storage space.
- The NRC must include the economic impact of spent fuel issues in its re-licensing assessments.

Spent Fuel Economics

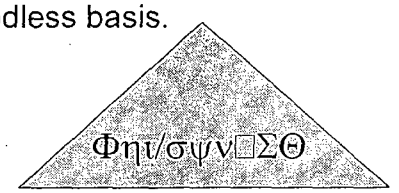
- The single greatest issue; second to none other, paramount too all, surpassing any short or long term issue, is the problem of generating even more highly radioactive spent fuel which will require utmost care and protection for longer than all of recorded history.
- To exclude this factor from the re-licensing process would be one of mankind's greatest follies whereby....

- Future generations will curse our generation for saddling it with the costs of a perpetual waste bill. The price will far exceed the benefits of the electrical power we consumed from nuclear plants.
- Imagine how we would view the ancient Egyptians if they had created a waste and stored it in the pyramids, causing mankind to ceaselessly foot the bill - just so they had some long-forgotten benefits for five decades.
  (~ 50 years the period of nuclear power generation)



13

- Imagine translating ancient manuscripts where the Pharaoh's team of scientific experts and rulers decided that the controversy of creating this waste was not part of the decision making process.
- Imagine the problems of having to rebuild the Egyptian's repository and stopping the leakage of the waste, and having to guard against the terrorists' threat or theft of fissionable materials on and endless basis.



14

200,000 Years

- Now do the math and realize that if this were actually the case for the last 5000 years, if the generations prior to ours had paid all of those bills until right now, then we would still not have paid 1 / 10,000th of a percent of the price of maintaining such a site.
- How can generating more waste be considered fiscally responsible, or "thoughtful" planning, or morally acceptable?

1st 5000 Years

- PA reactors received more than $11 billion dollars in bailouts known as "stranded costs."
- For decades, nuclear generated electricity has been the most expensive of all the conventional electrical providers in PA..
- Nuclear power has no effect on gasoline prices.
- Nuclear power does not relieve our dependency on foreign sources.

  Reactor vessels and components – Japan
  Reactor and head retrofitting and milling - France
  Pebble Bed nuclear fuel – United Kingdom

- Nuclear Utilities have sued and are suing the US Dept. of Energy to receive more than a billion dollars yearly (of taxpayer money) to maintain the spent fuel stored onsite at the plants.
- Amergen Claims to save Pennsylvanians $288 million in electrical charges each year.

$288 million / 13 million PA citizens = $1.85 per month saved

TMI has cost PA citizens at minimum $1.92 dollars per month in bailouts and governmental subsidies (taxpayer dollars).

- Capitalism and nuclear power are incompatible. Nuclear power has always been an economic failure in the free market, and has been and always will be subsidized by the government.
- Forbes Magazine has called nuclear power "the largest managerial disaster in business history, a disaster on a monumental scale."
- Nuclear power is a corporate welfare fiasco with risks, dangers, costs and consequences unlike any other industry.

end

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17

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end

18

TO NRC: 5-1-08

Re: TMI-1 Relicensing

The public concern versus the NRC's concern for environmental impact unfortunately are not the same - as we have experienced first hand, 29 years ago!

I have environmental issues:
(see doc's that follow)

Cost/Benefit - no one has the right to kill someone for profit!

Q: When will the NRC protect the people + our environment - instead of continuing to assist the nuclear industry to keep on running just a little bit longer - like they did at TMI?

You've failed us still & we don't want TMI-1 to be relicensed!

Mary Osborn (Ms.)
4951 Highland St.
Hbg PA 17111
c/o N.N.N.

Toronto, Canada
July 18, 1986

In May, 1983, my father-in-law, Admiral Hyman G. Rickover, told me that at the time of the Three Mile Island nuclear reactor accident, a full report was commissioned by President Jimmy Carter. He (my father-in-law) said that the report, if published in its entirety, would have destroyed the civilian nuclear power industry, because the accident at Three Mile Island was infinitely more dangerous than was ever made public. He told me that he had used his enormous personal influence with President Carter to persuade him to publish the report only in a highly "diluted" form. The President himself had originally wished the full report to be made public.

In November, 1985, my father-in-law told me that he had come to deeply regret his action in persuading President Carter to suppress the most alarming aspects of that report.

Jane Rickover
Jane Rickover

JANE RICKOVER appeared before me and swore as to the truth of the above statement.

Dated at Toronto this 18th day of July A.D. 1986

William F. Lamson Q.C.
Notary Public for the
Province of Ontario

"THE"
Jimmy Carter COVER-UP!

See last part for THI "cover-up". R.

From: "The Talk of the Town," The New Yorker, November 12, 1979:-

"According to Dr. Theodore Taylor, a nuclear physicist and one of the twelve members of the President's Commission on the Accident at Three Mile Island, a commercial nuclear plant routinely produces, among other biologically hazardous substances, 'two particularly troublesome' materials, cesium 137 and strontium 90. The quantity of these two life-threatening radioactive elements contained inside a typical nuclear power plant, Dr. Taylor explains, is about equal to the amount that would be released by the detonation of twenty-five megatons of nuclear-fission bombs. 'This is larger than the fission yield of any single thermonuclear weapon that's ever been exploded,' he adds. Should large amounts of strontium 90 and cesium 137 leak out of an accident-damaged nuclear power plant -- and such a leak, rather than a nuclear explosion, was the threat that developed during the accident at Three Mile Island -- terrible harm might be inflicted on people living downwind of the plant. The potential consequences include cancers, genetic defects, and other radiation-induced injuries. The number of casualties could mount, under the most adverse circumstances, into tens or even hundreds of thousands. Dr. Taylor believes, therefore, that nuclear power plants should not be built near densely populated areas. Several dozen, unfortunately, already have been, and they have federal licenses permitting them to operate in the midst of millions of our fellow-citizens.

"The over-all safety of the seventy-two currently licensed nuclear power plants in the United States -- a worrisome question in the aftermath of the Three Mile Island event -- was curiously sidestepped in the report just released by the Commission, which was chartered by President Carter last April to review the causes and implications of that accident, and was chaired by John Kemeny, the president of Dartmouth College. The Commission's report, which is a hundred and seventy-nine pages, provides a fascinating compendium of details about the accident and about the federal government's nuclear-power-plant licensing process. The document is harshly critical of the United States Regulatory Commission -- the federal authority responsible for the safety and licensing of nuclear power plants -- for allowing the plant to disregard the nominal safety precautions required. Because the N.R.C. requires so little discipline of the industry, the report concludes, the Three Mile Island plant was not equipped with adequate safety apparatus, its operators were poorly trained, its emergency procedures were defective, and its control room was simply not set up to cope with a major emergency. Metropolitan Edison, the company to which the N.R.C. awarded a license to operate the plant, lacked the basic competence to do so safely. The President's Commission also concluded that the N.R.C. itself, when it was called upon to provide crisis management, performed with marked ineptitude. The Commission's summary judgment was 'With its present organization, staff and attitudes, the N.R.C. is unable to fulfill its responsibility for providing an acceptable level of safety for nuclear power plants.'

"The Commission, with unimpeachable common sense, recommended a variety

of general reforms aimed at achieving, at some unspecified future date, a competent federal program for regulating the nuclear power industry. Given the pathetic disarray of the present federal nuclear-safety programs, as the new report describes them, the sweeping reforms that are necessary cannot be expected to occur overnight. The N.R.C. does not have a satisfactory set of basic safety standards, and these will have to be written. The N.R.C. is operating in an ambience of confusion about a wide variety of unresolved technological and safety issues, and research to resolve them will have to be carried out over a period of years. The N.R.C., which has left many key nuclear-power-plant safety features unreviewed, will have to carry out laborious investigations to determine the scope of needed safety improvement. The Commission's recommendation for a 'totally restructured' N.R.C. will obviously take several years to carry out -- perhaps, even with a high federal priority, the better part of a decade.

"What is to be done in the meantime with the seventy-two existing United States nuclear power plants? The President's Commission, in a promisingly forthright paragraph on page 24 of its report, states that it 'had to face the issue of what should be done in the interim with plants that are currently operating and those that are going through the licensing process.' Immediately after raising this urgent question, however, the Commission turns away from it. Nowhere on page 24 or elsewhere in the report does it again, except in passing, discuss the problems posed by the continued operation of these seventy-two facilities, some of which are uncomfortably close to New York, Boston, Chicago, Sacramento, and other metropolitan areas. The burden of the Commission's recommendations -- most of which are mild, pro-forma exhortations for the N.R.C.'s long-term self-improvement -- relates to the licensing of future nuclear plants. Present nuclear plants, the relics of over twenty years of impetuous and ineffectively regulated nuclear power expansion, pose safety problems that the Commission decided not to explore. Its silence on this sensitive subject was determined, it would appear, from its inception. President Carter, by means of Executive Order 12,130, signed on April 11th, sharply restricted the work of the group. Within the Executive Order, a delicately worded set of instructions to the Commission limited its investigation as narrowly as possible to the Three Mile Island accident. The panel was explicitly told to evaluate the N.R.C.'s performance 'as applied to this facility.' The Administration, strongly committed to nuclear power as a part of the President's 'comprehensive energy policy,' evidently had no desire to ask the pertinent larger questions about the over-all safety of the existing plants and about whether there really was a basic necessity for a major commitment to nuclear power, or any other questions that could conceivably bring the Commission's conclusions into conflict with established federal policies. Mr. Carter, having some technical background in nuclear power as well as some political sophistication, knew what questions not to ask."

(717) 939-2890 → U. of Pitt's studies did find increases in cancers in spite of their use of gamma dosimetry ignoring the predominate BEIR V

NIRS - TMI 25th - Rayburn Building *Mary Stamos Ouassiai 6 ½ miles NNW*

Congressional Briefing
Wednesday, 24 of March, 2004

5/1/08 Mothy

During the first days of the accident we didn't know the solid reactor fuel was melting into liquid, flowing like "hot olive oil" or that TMI was burping, venting and dumping unfiltered radioactivity into our communities, our river and our bodies. [via atmospheric dumps; when losing vacuum; & venting the hydrogen bubble]

But our bodies knew, and the animals knew. Our bodies reacted by displaying symptoms & effects: the metallic taste or smell, burning or reddening of skin, burning in nose or throat, itching or tearing of eyes, the nausea, vomiting, the subsequent diarrhea and hair loss. Birds died. Many of our pets & farm animals died & many were born deformed. Flowers & leaves started growing deformed or mutated and many trees died. They continue to do so.

The human suffering includes a neo-natal mortality rate that doubled following the accident and increases in cancers and cancer deaths. Every TMI health study I have read clearly show increases in cancers.

HEALTH STUDIES

Volunteer health studies and surveys

- Local residents, realizing there were many cancers and other ills in their communities, repeatedly asked the health department to investigate, but they refused. Not only were they refused by Dr. George Tokuhata of the health department, he bragged about refusing to help (minutes). So, out of necessity, volunteers went door-to-door, collecting data on health effects.

- In 1984, the first "Voluntary Community Health Survey" was undertaken by a group of local residents led by Marjorie Aamodt; it showed a 600% cancer death rate increase for three

the NRC ought to be ashamed! profits - lies - deaths

locations west of the plant. This was independently verified by members of the TMI Public Health Fund experts.

- In 1985, six years after the accident, Jane Lee surveyed 409 families in a development within five miles of TMI. Lee documented 23 cancer deaths, 45 living cancers, 53 benign tumors, 31 miscarriages, stillbirths & deformities, and 204 cases of respiratory problems. The "metallic taste" was reported by 98 people interviewed.

Columbia University Study on Cancers

- Columbia University Study, Maureen C. Hatch, et al, reported, "Non-Hodgkin's lymphoma showed raised risks relative to both accident and routine emissions; lung cancer... showed raised risks relative to accident emissions, routine emissions, and background gamma radiation." Then goes on to say, "Overall, the pattern of results does not provide convincing evidence that radiation releases from the Three Mile Island nuclear facility influenced cancer risk...," and increases in lung cancer, Non-Hodgkin's lymphoma, and childhood leukemia were not caused by TMI. [because not enough radiation escaped]

- Dr. Rosalie Bertell criticized Hatch's study, saying, her "...fundamental error in assuming a two year latency for childhood cancer clearly invalidates the whole study." Renowned epidemiologist, Dr. Alice Stewart commented, "She [Hatch] actually has a positive finding."

University of North Carolina Study on Cancer

- Steve Wing of The University of North Carolina verified increased cancer incidence around TMI and ties them to radiation. The UNC study found, "Accident doses were positively associated with cancer incidence. Associations were largest for leukemia, intermediate for lung cancer, and smallest for all cancers combined" and "Inhaled radionuclide contamination could differentially impact lung cancers, which show a clear dose-related increase." Wing states in his re-analysis of the Columbia Study that positive results were found but Columbia interpreted them as negative.

- Wing also reported that Federal District Judge Rambo issued a Court Order prohibiting Columbia to use "upper limit or worst case estimates of releases of radioactivity or population doses... [unless] such estimate would lead to a mathematical projection of less than 0.01 health effects." In essence, the Judge "Ordered" the finding of no adverse health effects from the TMI accident. The Judge also "Ordered" the data collected by Columbia be destroyed "some time" after publication.

- In the AJPH article of June 1991, Columbia actually shows there was more than a doubling of all observed new cancers after the accident at TMI - including lymphoma, leukemia, lung, colon and the hormonal category of breast, endometrium, ovary, prostate and testis. And for leukemia and lung cancers in the 6-12 km distance, the numbers of observed was almost four times greater and in the 0-6 km distance colon cancer was exactly four times greater. This journal article finds "a statistically significant relationship between incidence rates after the accident and residential proximity to the plant." [So now, stress can be blamed for cancer but radiation can not.]

Millersville University Study on Cancer

- "Number of cancer cases increasing here" Flannery, Intelligencer Journal, Lancaster, 4/30/98. According to James Fenwick, of Millersville University, he found statistically significant increases of prostate & urinary/bladder cancers in men; increases in kidney/renal, pelvis & ovarian cancers in women; and small increases in the rate of thyroid cancers in both men & women.

Richard E. Webb, Ph.D., Report on Infant Deaths

- Dr. Richard E. Webb found a "...clear statistically significant increase of infant deaths in Dauphin County" in 1979 following the TMI accident, using the Health Department's own vital statistics.

Penn State Study on Infant Mortality and Cancers

- Penn State professor, Dr. Winston Richards, reported, "Infant mortality for Dauphin County while average in 1978 becomes significantly above average in 1980. Death from leukemia while average in 1979 is very close to above average in 1980, and deaths from cancer for ages 45-64 while average for 1978 become decidedly significantly above average for 1980."

Pennsylvania Department of Health Studies

- The PADoH studies were based on the "TMI Census Registry," a special census of those living within five miles of the reactor, and for women who were pregnant living within ten miles.

- An important fact to consider in all TMI health studies is that 50% of the population living within five miles of TMI moved within the five years following the accident.

- The health dept. shamelessly admitted that "...much of the collected data have never been analyzed." One follow-back was attempted, with only "ten percent" of the TMI census registry contacted in 1985-1986 (with a 30% response), and fifty percent of the mother/child registry participants were contacted.

- The health department's official cancer study was released in the fall of 1985 claiming they found no increases in incidences of cancer within a 20 mile radius of TMI. Shortly thereafter, the Sunday Patriot-News exposed the Health Dept. had "included 28,610 people" who lived beyond the five mile radius of the plant as living within five miles, and, "Another 122,000 people who live farther than 10 miles from the plant were included in the population of those living 'within' 10 miles," which substantially diluted any cancer rates. (Frank Lynch, " TMI Survey Method Doubts" Sunday Patriot News, 10/6/85)

- Independent experts have charged the PA Health Dept. with using "statistical fraud and deceit," [Dr. Irwin Bross ltr to Jane Lee 1/26/89] and of lacing its studies with, "errors, inconsistencies and mathematical impossibilities." [Former PA Sec. of Health, Gordon MacLeod, "TMI & the Politics of Public Health" 11/22/80.]

- The PA Vital Statistics, which had included "Induced Abortions" under the "Fetal Death" column prior to 1979, had excluded them following the accident, thus showing lower than

normal results and making yearly statistical comparisons almost impossible. AND, the PADoH admitted to only one occurrence of neo-natal hypothyroidism within 10 miles of the plant, but discounted the other 19 cases concentrated further downwind.

Government and industry still insist "that not enough radiation escaped to cause any of the effects people reported," therefore TMI didn't do it. The fact is, people died as a result of the TMI accident. Those of us exposed to the fallout were the true dosimeters. ~~If TMI didn't do it, what did?~~

To this day, the symptoms have never been investigated. To this day, the nuclear industry prostitutes continue to deny that TMI caused harm to any living thing. If Three Mile Island didn't do it - what did? Nothing else happened in Central Pennsylvania during those days; actually, nothing has ever happened to cause the effects experienced, except for the accident at Three Mile Island!

- Dr. Rosalie Bertell, GNSH, said that former President Carter, by his continued silence on the evidence withheld from his own President's Commission Report has been "complicit in keeping the true facts of the Three Mile Island accident from the American and world public." Dr. Bertell was a member of the Citizen's Advisory Council to the Blue Ribbon Panel of the Kemeny Commission. The entire panel was dismissed when she asked about the implications of having a staff cleared for security and a Blue Ribbon Panel which was not cleared, except for Dr. Kemeny, and that the, ".. staff was able to withhold any information they wanted from the Panel under the guise of 'classified under national security.'"


$1.00 NOVEMBER 15, 1976
TIME
EXCLUSIVE:
'WHAT I'LL DO'
SE 77 060 9906JR99T 51 71 11
MRS RAY E OSBORN
RD 5 BOX 122
HARRISBURG PA 17111
SPECIAL ELECTION SECTION

A. Let me speak more in a generic sense rather than specifics. I hope to establish, as best I can, a position where our country is the leader of the world, based not on military might or economic pressure or political persuasion but on the fact that we are right and decent; that we take a position with every nation as best we can according to what is best for the people who live there. I strongly favor majority rule in Rhodesia and South Africa. I plan to let that be known to the world.

Second, I plan to appoint diplomatic officials who have superb credentials, strictly on the basis of merit, not reward people for political favors. And that's a commitment that I've made on my word of honor. I'm not going to break it.

Another thing is to treat developing nations as individuals, not as a bloc. And this would apply not only to the African nations but also to those in Latin America and in Eastern Europe as well. I'd like to try to cement, as much as I can, a good relationship on trade, cultural exchange, student exchange, tourism and foreign aid; using myself, the members of my Cabinet, maybe Governors on occasion, as special emissaries, and members of my own family, I hope to get what we call "world order" instead of power politics. World order means to me to try to establish peace.

Q. ***That sounds like Kissinger's policy by a different name.***

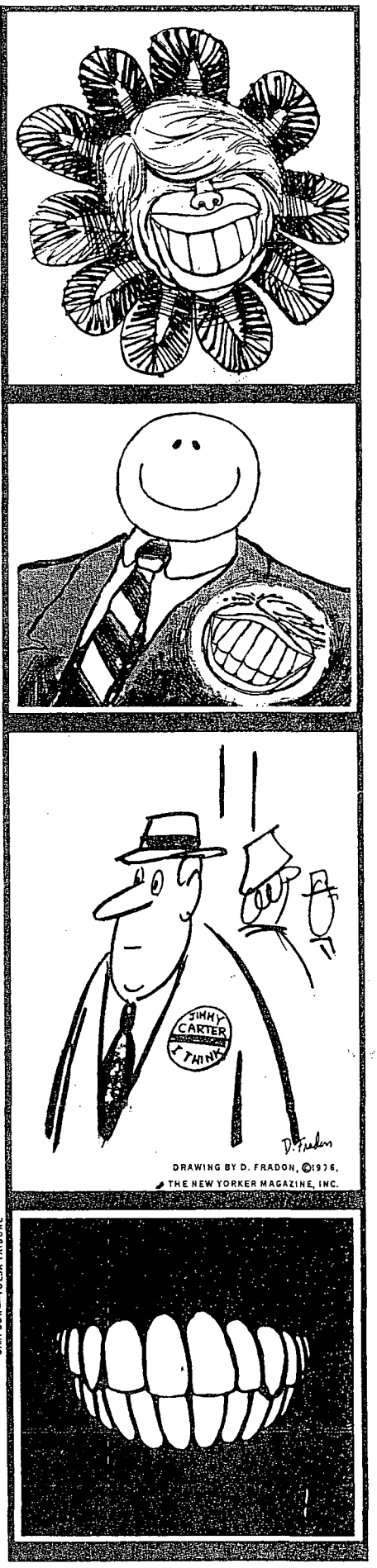
A. I haven't detected any aspect of what I've just described to you that would be compatible with what Kissinger said.

Q. ***Keeping the peace by making countries see that peace is in their own best interests—isn't that just about what Kissinger says?***

A. I think there has been in Kissinger's foreign policy an inclination to divide the world into two major power blocs and almost force nations to take a stand: "I'm for the U.S., I'm against the Soviet Union." "I'm for the Soviet Union, I'm against the U.S." I think that that is a permanently divisive attitude to take in world affairs, and what I'll do is try to get away from that position and deal with nations on an individual basis as far as what is best for their own people. Not force them to choose between us [and the Soviet Union] but let them choose our country because our system works best and because their trade with us and their open feeling for us would be in their best interest.

Q. ***You will need to make personal contact with foreign leaders?***

A. Yes, I will, immediately, particularly with the leaders of the major nations. I've had invitations from many of them to either come to their countries or to let them—the leaders—come to see me. But I've deliberately waited until after the election for that. I think it is best that I do this. But I will make contact with the Soviet Union, the People's Republic of China, the major European nations, Canada, Mexico.



Q. ***You've repeatedly said that you would issue a blanket pardon for all Viet Nam draft resisters in your first week in office. Is that a promise you intend to keep?***

A. I intend to keep all my promises.

Q. ***That presumably is something that will have very high priority right after you take office?***

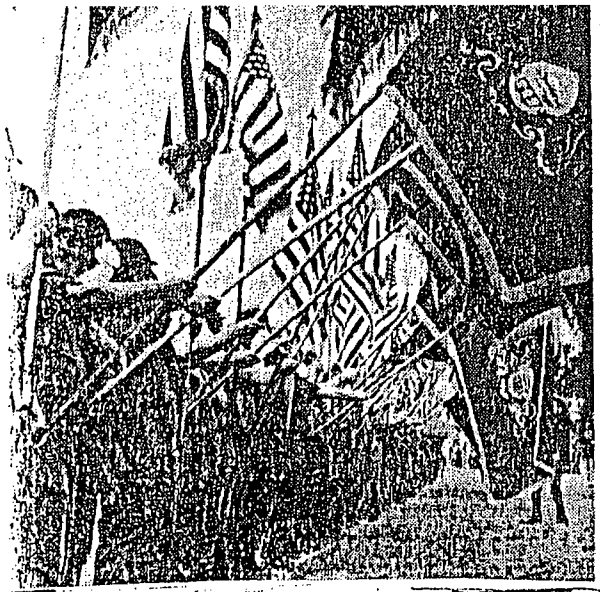
A. That's right.

Q. ***Some people have expressed concern about what they see in your political philosophy as a move toward egalitarianism. How do you feel about the question of equality versus individual initiative?***

A. I have no inclination to want a homogeneous society in which someone who is strong or able or brilliant or even fortunate is punished, and his substance —speaking about his financial substance, now—is taken away from him and distributed among those who are less highly motivated. I would not have a punitive tax rate at the upper levels, but I will continue to explore ways to make sure that those who are downtrodden, who are chronically unemployed, whose families have been required to suffer from past discriminations, are involved in the processes of Government and private life.

The ones who make decisions in Government and those that have been blessed with influence—I think they very seldom suffer when the Government makes a mistake. I want to make sure that we get away from that, and I believe that the powerful are eager to see that done as well. It is not a deliberate thing: that the big-shot crooks go free—they never go to jail—and that the average American who violates a law has a much greater chance of going to jail. That's not right. It is not fair, and it is not decent.

Unfair differences still exist. They still exist in the tax structure. They still exist in job opportunities, in employment opportunities, in housing opportunities. Even when the Congress passes a law that is designed specifically to help the poor, quite often those tax monies tend to move out toward the more wealthy people; the ones who are better organized, more articulate, who understand the complexities of the laws more fully, who are versed in grantsmanship. I want to make sure that that kind of trend is reversed. I believe I can evoke my concerns adequately to the American people with fireside chats and so forth, and there would be a broad support for a change.



Residents Near TMI Tell Probers of Horror, Fears

By MARY O. BRADLEY
Staff Writer

Before 4 a.m. on March 28 they were ordinary citizens who lived, worked and reared children under the shadow of the four gigantic cooling towers at the Three Mile Island Nuclear Generating Station.

Today, they are survivors.

They lived through the worst nuclear accident in U.S. history, and Saturday they told the Kemeny Commission how.

In a public hearing that stretched into the evening hours, a parade of citizens filed in and out of the witness box in the gymnasium-turned-hearing room at the Capitol Campus of Pennsylvania State University in Middletown.

More than 40 residents had made reservations to address the President's Commission on Three Mile Island — dubbed the Kemeny Commission after its chairman, Dartmouth President John G. Kemeny. Saturday's hearing was the first time since the accident that ordinary citizens had an opportunity to tell their stories to an official TMI investigatory body.

But, for a time Thursday it appeared that opportunity might be taken from them when the commission aborted the first days of testimony because the witnesses could not be sworn in. However, the commission ruled to proceed with the public testimony without placing the citizen witnesses under oath.

In emotional, sometimes tear-filled voices, the citizens talked about the fear of radiation, the horror of a meltdown, the frustration over misleading information, the unfairness of the economic burdens they carry and the anxiety over the future adverse effects on their health, their homes and their lives.

And, on the heels of their distress was a desperate plea to the commission to recommend that TMI be closed permanently to prove that the residents of the TMI area aren't expendable in the search for energy.

"Have you ever faced the thought of losing everything and

See CITIZENS—Page A20

From Page A1

er being able to go back?"
sewife and mother of three San-
Rineer of Londonderry Twp.
d the nine commissioners pres-

When her family evacuated dur-
the crisis, "We had to face the
ibility we were left with noth-
but our lives," she said. I'm an-
(and) outraged. We were led to
ve nuclear energy is safe. I
accept that anymore," Mrs.
er said.

She told the commission that the
s of an uncontrolled release of
ation on the morning of March
struck terror in me. It hit me
een the eyes for some reason. I
know why. I wish, if I could
d it, we'd just pack up and
out," she added.

A round of applause from the
citizens in the audience fol-
d her statement that Metropoli-
Edison Co., which operates TMI
holds 50 percent interest in it,
ld have its license revoked for
recklessly endangering the lives"
area's citizens.

Jill Peffer of Newberrytown
he didn't want to testify on the
ological effects of the Unit 2
nt in Middletown but on the
dent in Poughkeepsie, N.Y.
didn't see it on the 11 o'clock

Harry Machita

news," he said.

Peffer told a story of his family's panic-striken evacuation to stay with relatives in Poughkeepsie on March 28, followed by several days of poring over maps, plotting wind direction and planning a further evacuation to Canada.

Breaking into tears, he said that as a result of tension his wife suffered "traumatic shock" and had to be rushed to the emergency room in a Poughkeepsie hospital the morning of April 2.

On Easter Sunday she left the country for her native Sweden for further rest and has since returned with her health improved — "now she only wakes up in a cold sweat two nights a week instead of every night. I suggest to you that accidents like Poughkeepsie happened in the thousands," Peffer said.

"I challenge you, the commissioners, to uncover the real perpetrators — the people who designed and built (TMI) but didn't tell us the risks."

Peffer called on the commission to "shine the light of truth through the darkness of misrepresentation."

Angela Herrder of Middletown said, "What's the use of telling my (two) children to be careful when they cross the street when I can't let them go out and breathe the air?

"We're afraid," she said, adding, "Please, let it (TMI) shut down. Let us relax for a while."

Harry Machita of Middletown RD 1, who lives ½-mile from the plant, said his problems with TMI go back to before the accident. He said when plans for the plant were first announced, "I didn't see any reason to move or to get alarmed at that time."

But, he said, since Unit 1 opened, "I realized what would be considered normal for the (nuclear) industry was not normal for citizens who live a ½-mile from the area."

Angela Herder

He said the "normal" operating noises "scare the daylights out of me." Because of the these noises and the effects of the accident, "my home is not a home anymore."

He said, "President (Jimmy) Carter talks about human rights. What happened to human rights in Middletown?"

Sue Fegan, also a resident of the TMI area, said before the accident "I had never given much thought to nuclear energy" but the "crisis that began" on March 28 "changed my life and the lives of thousands of people in Central Pennsylvania."

She said because of the uncontrolled release of radiation on March 30 "it didn't take long to realize the people of the surrounding area were expendable."

The release came when most children were on their way to school. "No one knew about the release until it was too late. No one except those running the plant."

"My faith in Met-Ed and the experts from the NRC (Nuclear Regulatory Commission) is totally shattered," Fegan said.

She labeled as an "unforgiveable outrage" the suggestions from NRC staff to "break a pipe (or) start a a fire" to put the damaged reactor in an "accident mode" the equipment could handle.

"Thank God, I didn't know until April 14" about those considerations, she said. "Why are these men allowed to continue in their positions?"

Fegan said the operation of nuclear plants should be stopped until all investigations are completed. "No one anywhere in the world should go through the living hell we were subjected to for eight days."

Dr. John F. Barnoski of Middletown, a family practice physician told the commission that "as a physician the last six weeks have been both enlightening and frightening."

He said that since the accident he has seen "four or five patients per day with emotional problems directly related to the events which have occurred."

He added, "I have had responsible husbands and fathers in my office unable to cope with everyday problems. I have seen fear and frustration in the eyes of young couples as they bring their babies in for checkups. I have had pregant women contemplating abortion because of their fear of unknown effects on their unborn fetus."

But, Barnoski said, "my biggest problem lies in the future, for if the nuclear plant continues to operate these anxieties and fears will remain and probably increase."

Jacqueline Reigle said she has been through "two floods, a tornado and two car accidents, but I cannot co-exist with this monster in my backyard."

She said property values have dropped sharply in the area. "I can't give my home away at this time."

Fran Cain of Middletown said "property has gone down but I presume our taxes will stay up."

5/20/79

5-18-94

Harvey Wasserman did talk w/ J. Carter & he said: "look there wasn't anything that got out of the plant."

Birthday card sent Oct. 1, a few years ago.

ANOTHER VOICE

Hypocrite of the Year?

Pro-nuclear admiral exploited, son says

By Rosie DiManno Toronto Star

The American hero they called the father of the nuclear navy was, in fact, "a clinically senile" old man who was exploited by opportunists and profiteers in the nuclear industry, according to his son and daughter-in-law.

Admiral Hyman G. Rickover was "cynically exploited because he was old, weak, vulnerable and senile," said Robert Rickover, an economist who has been living in Toronto for the past 14 years.

Rickover charges that his father, buried at Arlington National Cemetery yesterday, was mentally incapable when he wrote favorable safety reports for the company that operates the Three Mile Island nuclear power plant.

He wrote the reports for General Public Utilities following a 1979 accident at the plant, near Harrisburg, Pa.

$380,000 donation

In an interview with The Star yesterday, Rickover said his late father was induced to write reports which supported restarting a reactor at the closed plant.

In return, General Public Utilities gave donations totalling $380,000 to an educational foundation the admiral had formed.

"Absolutely, he was clinically senile at that time," Rickover said.

Rickover said his father, a longtime supporter of nuclear energy, had reversed his position completely in later years, and said so in Congress in 1982.

"He said he was not proud of the part he had played (in the development of a nuclear navy) and that he wished he could sink all those nuclear ships."

Rickover

Rickover and his wife Jane, a writer, said the admiral realized too late "how incompetent people could be."

"He also didn't realize that people and companies were prepared, for gain, to deliberately endanger the lives of other people," Jane said.

She said the admiral had told her in 1983 that a report commissioned by then President Jimmy Carter on the accident had been partially squelched at the urging of the president's advisers to protect the industry.

"He said the report showed that (the accident) had come much closer to a nuclear meltdown than anybody realized."

And the Rickovers said that it was "crucial" for the utility company to get the admiral's support because of the tremendous prestige and clout that he carried.

Want answers

The Rickovers say they want answers concerning the $380,000 that was paid to the admiral's foundation.

William G. Kuhns, chairman of General Public Utilities, told The Star in an interview last night from the company's executive offices in Parsippany, N.J., that it was the company which approached Rickover to compile the report.

"We saw the admiral as probably the single most knowledgeable man in nuclear energy in this country," he said.

Kuhns insists that Rickover did not change his opinion about the merits of nuclear energy. And he was equally adamant that Rickover was not senile at the time he wrote his reports.

But he said the admiral had "occasional lapses" in memory, usually late in the day when he was tired.

Toronto Star
page 3,
July 12, 1986

Statement by President Carter on the Kemeny Commission Report

I have reviewed the report of the Commission I established to investigate the accident at Three Mile Island nuclear power plant. The Commission, chaired by Dr. John Kemeny, found very serious shortcomings in the way that both the government and the utility industry regulate and manage nuclear power.

The steps I am taking today will help ensure that nuclear power plants are operated safely. Safety has always been, and will remain, my top priority.

As I have stated before, in this country, nuclear power is an energy source of last resort. By this I meant that as we reach our goals for conservation, direct use of coal, development of solar power and synthetic fuels and enhanced production of American oil and natural gas, we can minimize our reliance on nuclear power.

Many of our foreign allies must place greater reliance than do we on nuclear power, because thay do not have the vast natural resources that give us many alternatives. We must get on with the job of developing alternative energy sources—by passing the legislation I proposed to the Congress, and by making an effort at every level of society to conserve energy.

We cannot shut the door on nuclear energy.

The recent events in Iran have shown us the clear, stark dangers that excessive dependence on imported oil holds for our Nation. We must make every effort to lead this country to energy security.

Every domestic energy source, including nuclear power, is critical if we are to free our country from its overdependence on unstable sources of high-priced foreign oil. We do not have the luxury of abandoning nuclear power or imposing a lengthy moratorium on its further use. A nuclear plant can displace up to 35,000 barrels per day.

We must take every possible step to increase the safety of nuclear power production. I agree fully with the spirit and intent of the Kemeny Commission's recommendations, some of which are within my power to implement, others of which rely on the Nuclear Regulatory Commission or the utility industry itself.

To get the government's own house in order I will take several steps. First, I will send to Congress a reorganization plan to strengthen the role of the Chairman of the NRC and provide this person with the power to act on a daily basis as the chief executive officer, with authority to put needed safety requirements and procedures in place. The Chairman must be able to select key personnel, and act on behalf of the commission during an emergency.

Second, I will appoint a new Chairman of the NRC—someone from outside that agency, in the spirit of the Kemeny Commission's recommendation. In the meantime, I have asked Commissioner Ahearne, now on the NRC, to serve as Chairman. Dr. Ahearne will stress safety and the prompt implementation of the needed reforms. In addition, I will establish an independent advisory committee to help keep me informed of the progress the NRC and the industry are achieving in making nuclear energy safer.

Third, I am directing the Federal Emergency Management Agency to head up all off-site emergency activities, and complete a thorough review of emergency plans in all states with operating reactors by June.

Fourth, I have directed NRC and other agencies to accelerate our program to place a resident federal inspector at every reactor site.

Fifth, I am asking all relevant government agencies to implement virtually all of the other recommendations of the Kemeny Commission.

A detailed fact sheet is being issued to the public, and a more extended briefing will be given to the press.

With clear leadership and improved organization, the Executive branch and the NRC will be better able to act quickly on the critical issues of improved training and standards, safety procedures, and the other Kemeny Commission recommendations.

But responsibility to make nuclear power safer does not stop with the federal government. In fact, the primary day-to-day responsibility for safety rests with utility company management and suppliers of nuclear equipment. There is no substitute for technically qualified and committed people working on the construction, operation and inspection of nuclear power plants. Personal reponsibility must be charged both at the corporate level and at the plant site. The industry owes it to the American people to strengthen its commitment to safety.

I call on the utilities to implement the following changes:

First, building on the steps already taken, the industry must organize itself to develop enhanced standards for safe design, operation, and construction of plants.

Second, the nuclear industry must work together to develop and to maintain in operation a comprehensive training, examination and evaluation program for operators and supervisors. This training program must pass muster with the NRC through accreditation of training programs.

Third, control rooms must be modernized, standardized and simplified as much as possible to permit better informed decision-making during an emergency.

I challenge our utility companies to bend every effort to improve the safety of nuclear power.

Finally, I would like to discuss how we manage the transition period during which the Kemeny recommendations are being implemented. There are a number of new nuclear plants now awaiting operating licenses or construction permits.

Licensing decisions rest with the NRC and, as the Kemeny Commission noted, it has the authority to proceed with licensing these plants on a case-by-case basis, which may be used as circumstances surrounding a plant dictate. The NRC has indicated, however, that it will pause in issuing new licenses and construction permits in order to devote its full attention to putting its house in order. I endorse the approach the NRC has adopted, but I urge the NRC to complete its work as quickly as possible, and in any event no latter than six months from today.

Once we have instituted the necessary reforms to assure safety, we must resume the licensing process promptly so that the new plants which we need to reduce our dependence on foreign oil can be built and operated.

The steps I am announcing today will help assure our country of the safety of nuclear plants. Nuclear power has a future in the United States—it is an option that we must keep open. I call on the utilities and their suppliers, the NRC, the executive Departments and agencies, and the State and local governments to assure that the future is a safe one.

'rom: Rosalie Bertell,
>To: Jimmy Carter, INTERNET:library@carter.nara.gov
>
>Date: 2/10/98 11:29 AM
>
>RE: Rickover Report on TMI
>
>Former President Jimmy Carter
>Dear Former President Carter,
>
>Many of us have been impressed with your activities on behalf of
Habitat for Humanity and for Conflict Resolution since leaving the presidency.

>There is only one large blot on your record, which distresses those of
>us who respect you, and that is the cover up of the Three Mile Island
>accident, and in particular the serious health damage done to the
>people who lived nearby. I was on the Citizen's Advisory Council to the Blue
>Ribbon Panel which you established to look into the accident. I, and
>indeed the whole advisory council, were dismissed when I asked the implications of
>having a staff cleared by the FBI for security and a Blue Ribbon Panel which was not
>cleared, with the exception of Dr. Kemmeny who had worked on the Manhattan
>Project. The staff was able to withhold any information they wanted from
>the Panel under the guise of "classified for national security". Another
>Advisory Council member asked who was in charge during the accident. These
>two questions were enough to cause the dissolution of the entire advisory council. In
>fact, Dr. Kemmeny even stated publically that we had never been invited to
>Washington (although the Panel paid our air fare).
>
>You were especially trust by the people because of your own nuclear
>background. You failed to deserve that trust. Can you not make it up now
>by joining with those of us who want the true documents released to the
>public? The nuclear industry has frustrated all of the serious health
>claims of the people, in spite of the Supreme Court's ruling. Their
>lawyers are gloating that they are "invincible" before the Courts because
>of their dirty tactics. Other countries find it hard to believe that in
>America the people cannot get justice after their experience!
>
>Please put your moral authority to work to make the truth finally known!
>
>Sincerely,
>Dr. Rosalie Bertell, President Dr. Rosalie Bertell
>International Institute of Concern for Public Health
>Toronto, Canada
>

HEPFORD
SWARTZ &
MORGAN

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PLEASE RESPOND TO HARRISBURG OFFICE.

H. JOSEPH HEPFORD, P.C
LEE C. SWARTZ
JAMES G. MORGAN, JR.
SANDRA L. MEILTON
STEPHEN M. GREECHER, JR.
DENNIS R. SHEAFFER
RICHARD A. ESTACIO
ANNE M. RIEGLE
SUSAN M. SEIGHMAN
STANLEY H. SIEGEL
OF COUNSEL

*CERTIFIED AS A CIVIL TRIAL ADVOCATE BY THE NATIONAL BOARD OF TRIAL ADVOCACY

**ADMITTED ONLY IN ILLINOIS

March 6, 1998

SENT VIA FACSIMILE TO 516/421-0818

Mr. Bill Smirnow

Dear Mr. Smirnow:

We are one of the firms that represent over 1,000 Three Mile Island personal injury clients. Steve Wing sent me some information which you had provided to him concerning the Rickover statement of which we are familiar. However, your reference to "President Carter's suppressed 1979 report" has peaked my interest. Is this the "Kemeny" report or some other document?

Would you please call me at 800-257-4121 in order that I can get more complete information as to exactly what I want to request through my congressman or at the 202-224-3121 telephone number. If I am not here, kindly leave your telephone number and I will return the call.

Thank you for your kind consideration.

Sincerely yours,

HEPFORD, SWARTZ & MORGAN

Lee C. Swartz

LCS:pjg

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LEWISTOWN, PA 17044-0867
TELEPHONE 717-248-3913

INTERNATIONAL INSTITUTE OF CONCERN FOR PUBLIC HEALTH
710-264 Queens Quay West Toronto ON M5J 1B5 CANADA
Tel: 416-260-0575/Fax: 416-260-3404/ Email: IICPH@compuserve.com

April 16, 1998

Affidavit of Dr. Rosalie Bertell, President, International Institute of Concern for Public Health, and by Profession an Epidemiologist and expert in the health effects of low level radiation exposure:

I feel that former President Jimmy Carter should come forth with all of the facts surrounding the Three Mile Island (TMI) Accident, especially those which involved the radiation release and the dose to the public. This disclosure should moreover, be in language which can be easily and correctly understood by the public, and not massaged to hide the truth. After the accident, for example, I found that the dose officially assigned to the public, was called: "measured dose to the public from the accident" - where "measured" meant it only included the dose after the rate metres were in place the third day after the accident began; "accident" meant only the first eight days, after which it was called "clean up"; and "from the accident" meant that the radiation dose received during the same time period in 1978 when the TMI reactors were all operating and there was Chinese nuclear test fallout, could be subtracted.

President Carter was and continues to be by his silence, complicit in keeping the true facts of the Three Mile Island Accident from the American and world public. While it may have been legally, although not morally, permissible to withhold this information in 1979 under the guise of national security needs, now that the Cold War is over it is no longer credible that the US government protect the nuclear industry at the cost of the lives and health of its citizens.

As I, Dr. Rosalie Bertell, President of the International Institute of Concern for Public Health, stated in my E-mail to President Carter of February 10, 1998 (enclosed), President Carter was and is involved in the cover up of the Three Mile Accident, and in particular the serious health damage to the people who lived nearby. I was on the Citizen's Advisory Council to the Blue Ribbon Panel set up by President Carter to investigate the TMI accident. The members of this public panel did not have FBI clearance, with the possible exception of Dr. Kemmeny who had worked on the Manhattan Project. The staff, selected from those who worked for the NRC or DOE, did have such security clearance, and therefore they were able to withhold any information they or their superiors wanted to declare "classified", from the Panel. The nuclear weapon program demanded that workers and the military personnel handle this radioactive material and the nuclear ordnance, therefore health effects of radiation could be classified for national security to prevent rebellion.

At the first meeting of the Citizen's Advisory Council to the Kemmeny Commission, I brought up this potential problem and asked what provisions had been made for the Commission members to have security clearance so that they might have full access to the truth about the accident. Another Advisory Council Member asked who was in charge of reactor operations during the accident . These two questions were never answered, and they were enough to cause the dissolution of the entire advisory panel. In fact, Dr. Kemmeny even stated publicly to the press that we had never been invited to Washington [although the Commission paid our air fare and hotel bills]. The Industry Advisory Council to the Kemmeny Commission continued to function during the investigation.

The nuclear industry has frustrated the litigation of all of the serious health claims of the TMI exposed people, in spite of the Supreme Court's ruling in 1997 that these claims must be heard. Lawyers for the nuclear industry are gloating that they are "invincible" before the Courts. Using dirty tactics, they have managed to eliminate all of the expert witnesses which the victims had engaged to bring their cause before the Court, subsequently causing the cases to be dismissed for lack of witnesses. There may be as many as 2,000 people who have not had their grievances heard by the courts. This dismissal, after the Supreme Court ruling, was accomplished through a judge's ruling, not through the court hearing which the people had been promised. The people have still, almost 20 years after the accident, not had their day in court!

It is my opinion that former President Carter should come forth and make the truth known so that the court cases for the victims can be reopened. I believe that it should also be made a court ruling that defendants, such as the nuclear industry, should not be allowed to declare their own witnesses the official spokespersons for a branch of knowledge, able to define for the court the methodologies which they accept and practice as the only legitimate ones! It was such a ploy that was used to dismiss the TMI plaintiffs witnesses. This is blatant violation of justice and of the human rights of the victims. It is especially abhorrent in the questions of health effects of radiation, a field of public health which was usurped by the nuclear physicists under the exigencies of potential nuclear war after World War II. Professional Health Physicists are not required to have any training in biology, public health or any medical discipline. Their methodologies are very limited and unacceptable to many professionals in the fields of epidemiology, occupational and public health.

Dr. Rosalie Bertell, Ph. D., GNSH
President, International Institute of Concern for Public Health
710-264 Queens Quay West
Toronto ON M5J 1B5 CANADA

Dr. Rosalie Bertell

Michael D. Sayg

July 10th, 1998

Three Mile Island Cover

President Carter Was Persuaded to Release "Dil

By Robert Smirnow

Nuclear power is an extraordinarily dangerous technology, which here in the United States has already killed 9 million people, according to Dr. Ernest Sternglass, professor emeritus of radiological physics at the University of Pittsburgh and Dr. Jay Gould, with the Environmental Protection Agency under President Jimmy Carter, in their book *Deadly Deceit: Low-Level Radiation, High Level Cover-Up* (published by 4 Walls, 8 Windows, New York).

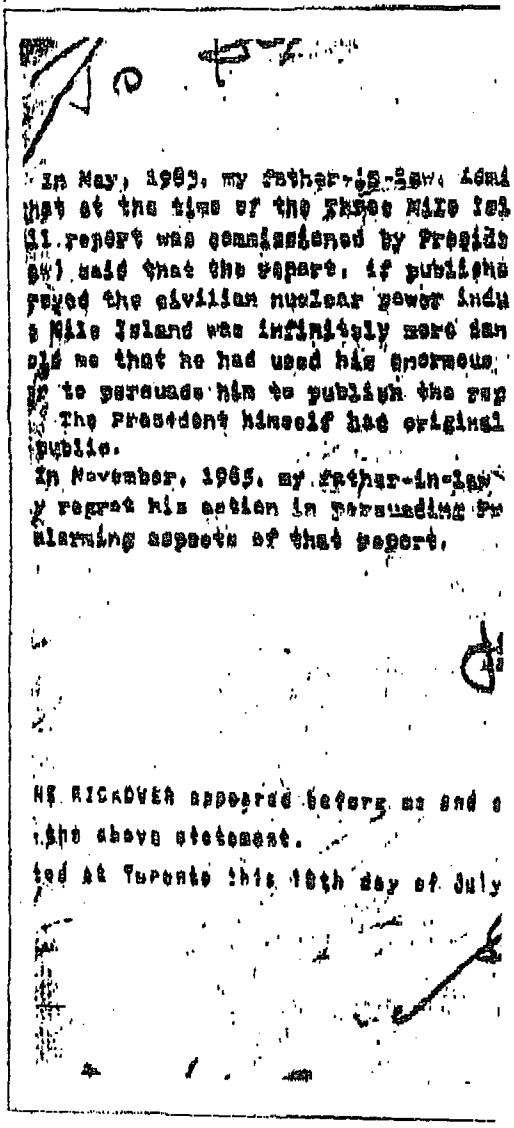
Since nuclear power is so deadly here, it is deadly wherever it exists—be that Japan, China, Indonesia, France, etc. Clearly it must be abolished: In addition to its inherently murderous nature, the waste problem and the possibility of meltdown or excursion due to human error, earthquake (particularly relevant in Japan and Indonesia), war, or storm—nuclear power is felt to be so dangerous that the heart of the accident at Three Mile Island in 1979 has been and continues to be covered up and lied about to both the American public and world public. Here are the basic facts; recommendations for citizens' public action are provided at the end of this article.

The basic cover-up is described by Jane Rickover, Admiral Hyman G. Rickover's daughter-in-law in this signed, notarized statement:

"In May, 1983, my father-in-law, Admiral Hyman G. Rickover, told me that at the time of the Three Mile Island nuclear reactor accident, a full report was commissioned by President Jimmy Carter. He/my father-in-law] said that the report, if published in its entirety, would have destroyed the civilian nuclear power industry because the accident at Three Mile Island was infinitely more dangerous than was ever made public. He told me that he had used his enormous personal influence with President Carter to persuade him to publish the report only in a highly 'diluted' form. The President himself had originally wished the full report to be made public.

"In November, 1985, my father-in-law told me that he had come to deeply regret his action in persuading President Carter to suppress the most alarming aspects of that report."

[Signed] Jane Rickover



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alarming aspects of that report.

[illegible] RICKOVER appeared before me and s
the above statement.
ted at Toronto this 10th day of July

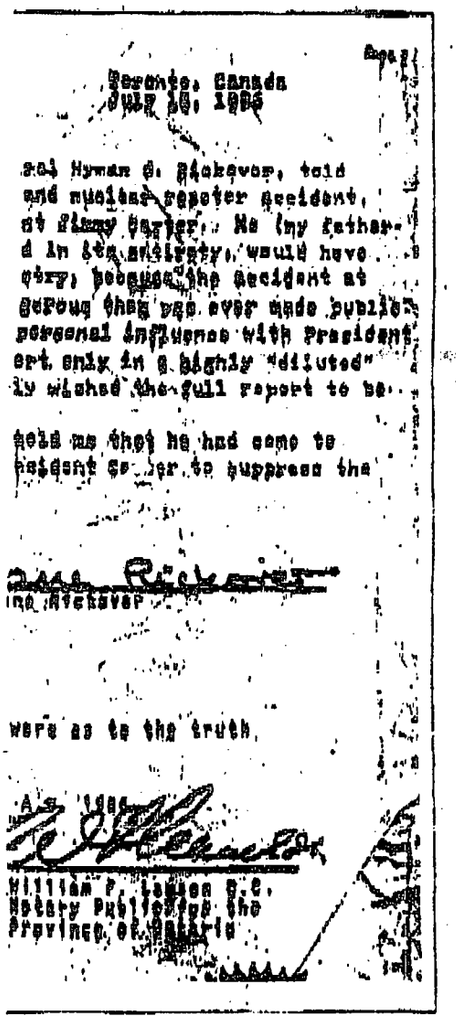
May 1998

up Hides True Disaster

Ited' Report, says Admiral's Daughter-in-Law

"Jane Rickover appeared before me and swore as to the truth of the above statement. Dated at Toronto this 18th day of July A.D. 1986.
[Signed] William F. Lamson, Q.C.
Notary Public for the Province of Ontario

I spoke with Jane Rickover twice in depth. She verified the absolute truthfulness of this signed, notarized statement. She also told me



Toronto, Canada
July 18, 1986

...al Hyman G. Rickover, told
... and nuclear reactor accident,
... at Three Mile ...r. He (my father-
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... were as to the truth.

... 1986.

William F. Lamson Q.C.
Notary Public for the
Province of Ontario

that Dan Rather, the CBS-TV news anchor for many years and then with the famous American TV show "60 Minutes" called her and her husband and sounded VERY interested in looking into this story. They never heard from him again. Obviously, Rather was told by his corporate masters just how far serious investigative journalism was allowed to go.

Another alarming piece of evidence in this cover-up was sent to me and President Carter recently by Dr. Rosalie Bertell, president of the International Institute of Concern for Public Health in Toronto. Dr. Bertell states in her February 10, 1998 e-mail to President Carter:

"There is only one large blot on your record, which distresses those of us who respect you, and that is the cover up of the Three Mile Island Accident, and in particular the serious health damage done to the people who lived nearby. I was on the Citizen's Advisory Council to the Blue Ribbon Panel which you [President Carter] established to look into the accident. I, and indeed the whole panel, was dismissed when I asked the implications of having a staff cleared for security and a Blue Ribbon Panel which was not cleared, with the exception of Dr. Kemmeny who had worked on the Manhattan Project. The staff was able to withold any information they wanted from the Panel under the guise of "classified for national security." Another Advisory Council Member asked who was in charge during the accident. These two questions were enough to cause the dissolution of the entire panel. In fact, Dr. Kemmeny even stated publicly that we had never been invited to Washington [although the Panel paid our air fare]."

I also spoke recently with Dr. Bertell, who verified the validity of her e-mail to President Carter. She has not heard from President Carter. The only way she or the rest of the world will is by having innumerable individual citizens e-mail, fax, call, write President Carter at:

E-mail: library@carter.nara.gov
Fax: 404-730-2215
Phone: 404-331-3942
Address: Carter Library, 441 Freedom Parkway, Atlanta, Georgia 30307-1498 U.S.A.

March 28th, 1998 marked marked the 19th anniversary of the Three Mile Island disaster. (Anyone wanting a copy of the signed, notarized statement by Jane Rickover can get it by faxing to: 516-421-0818.)

Concerned citizens are urged to act. Call your local TV, radio and newspaper outlets and demand that they investigate and write/tell the truth. Also, call, write, fax, & E-mail former President Jimmy Carter and demand that he finally tell the world the truth about the accident and cover-up at 3 Mile Island.

THYROID

National Program of Cancer Registries

Data Collection and Surveillance

2001 Geographic area by sex and site

Thyroid cancers Pa is Highest in county!

Chester County Wellness Coalition CONTROL GROUP FOR THIS...

<< back to data selection menu

Select desired criteria and click "go."

Year: 2001
Sex: Males and Females
Site: Cancer of the Thyroid
Rate: Age-adjusted
(•) Incidence ( ) Mortality
Go

Geographic area by sex and site: 2001, Males and Females, Cancer of the Thyroid, Age-adjusted, Incidence (Table 2.21.1.1MF) *†‡

PA = 11.3 11.5 8.9

Case counts | Population | Download data | Printer-friendly format

	All Races	White	Black	Hispanic §‖
United States	7.5 (7.4-7.6)	7.8 (7.7-7.9)	4.7 (4.4-5.0)	7.1 (6.7-7.4)
Northeast	9.5 (9.2-9.8)	9.7 (9.4-10.0)	5.8 (5.2-6.4)	8.2 (7.3-9.2)
New England	8.4 (7.9-8.9)	8.4 (7.9-8.9)	4.5 (3.1-6.6)	8.8 (6.6-12.0)
Connecticut	9.3 (8.3-10.4)	9.8 (8.7-11.0)	~	10.4 (6.9-17.0)
Maine	7.5 (6.1-9.1)	7.6 (6.2-9.3)	~	~
Massachusetts	8.6 (7.9-9.3)	8.3 (7.6-9.0)	5.3 (3.3-8.8)	-
New Hampshire	6.7 (5.4-8.3)	6.7 (5.4-8.3)	~	-
Rhode Island	9.0 (7.3-10.9)	9.3 (7.5-11.5)	~	~
Vermont	5.9 (4.1-8.2)	6.0 (4.2-8.4)	~	~
Middle Atlantic	9.9 (9.6-10.2)	10.3 (9.9-10.6)	5.9 (5.3-6.6)	8.0 (7.1-9.1)

All Races White Black Hispanic

New Jersey	9.7 (9.0-10.3)	10.0 (9.3-10.8)	6.0 (4.6-7.8)	9.2 (7.2-11.7)
New York	9.0 (8.6-9.5)	9.5 (9.0-10.0)	4.8 (4.1-5.7)	7.4 (6.3-8.6)
Pennsylvania	11.3 (10.7-11.9)	11.5 (10.9-12.1)	8.9 (7.2-10.8)	-
Midwest	7.1 (6.9-7.3)	7.3 (7.0-7.5)	4.3 (3.8-4.9)	5.7 (4.6-7.1)
East North Central	7.0 (6.7-7.2)	7.3 (7.0-7.5)	4.3 (3.7-4.9)	5.9 (4.7-7.6)
Illinois	7.3 (6.8-7.7)	7.6 (7.1-8.2)	4.9 (3.9-6.2)	-
Indiana	6.3 (5.7-7.0)	6.6 (5.9-7.3)	~	~
Michigan	7.6 (7.1-8.2)	8.1 (7.5-8.7)	4.9 (3.7-6.4)	~
Detroit	8.0 (7.2-8.9)	9.0 (7.9-10.1)	5.3 (3.8-7.1)	-
Ohio	6.5 (6.0-6.9)	6.6 (6.1-7.1)	3.3 (2.3-4.6)	~
Wisconsin	7.1 (6.4-7.9)	7.3 (6.5-8.1)	~	~
West North Central	7.2 (6.9-7.6)	7.3 (6.9-7.7)	4.3 (3.1-6.0)	4.7 (2.9-8.3)
Iowa	7.9 (6.9-9.0)	7.8 (6.8-8.9)	~	~
Kansas	7.8 (6.8-9.0)	7.7 (6.7-8.9)	~	~
Minnesota	7.3 (6.6-8.1)	7.2 (6.4-8.0)	~	-
Missouri	6.4 (5.8-7.1)	6.8 (6.1-7.5)	3.5 (2.1-5.6)	~
Nebraska	7.7 (6.5-9.2)	7.8 (6.4-9.3)	~	~
North Dakota				
South Dakota				
South				
South Atlantic				
Delaware				
District of Columbia	8.7 (6.4-11.5)	9.7 (5.7-16.5)	7.4 (4.9-10.9)	~
Florida	7.4 (7.0-7.9)	7.8 (7.4-8.3)	4.7 (3.9-5.8)	-
Georgia	6.0 (5.5-6.6)	6.7 (6.0-7.4)	4.3 (3.4-5.3)	10.4 (6.2-18.9)
Atlanta	6.7 (5.7-7.7)	8.1 (6.9-9.6)	3.9 (2.7-5.7)	~
Maryland				
North Carolina	5.6 (5.1-6.2)	5.8 (5.3-6.5)	4.7 (3.7-6.0)	~
South Carolina	5.8 (5.1-6.6)	6.5 (5.6-7.5)	3.8 (2.7-5.2)	-
Virginia				
West Virginia	7.7 (6.5-9.1)	7.6 (6.4-9.0)	~	~

East South Central				
Alabama	5.1 (4.5-5.9)	5.4 (4.6-6.2)	4.6 (3.4-6.1)	~
Kentucky	7.1 (6.3-7.9)	7.4 (6.6-8.3)	~	-
Mississippi				
Tennessee				
West South Central	6.3 (6.0-6.6)	6.5 (6.2-6.8)	4.3 (3.6-5.0)	6.5 (5.8-7.2)
Arkansas	4.7 (3.9-5.6)	4.9 (4.0-5.9)	~	~
Louisiana	6.6 (5.8-7.4)	7.2 (6.3-8.2)	5.5 (4.2-7.0)	-
Oklahoma	5.1 (4.4-5.9)	5.4 (4.6-6.4)	~	~
Texas	6.6 (6.3-7.0)	6.8 (6.4-7.2)	3.9 (3.1-4.9)	6.5 (5.8-7.3)
West	7.7 (7.5-7.9)	7.8 (7.6-8.0)	4.1 (3.4-5.0)	7.2 (6.6-7.8)
Mountain	9.1 (8.6-9.5)	9.3 (8.8-9.8)	3.5 (2.0-6.1)	8.1 (6.9-9.4)
Arizona	8.2 (7.4-9.0)	8.5 (7.7-9.4)	~	7.3 (5.4-9.8)
Colorado	8.8 (7.9-9.7)	8.8 (7.9-9.8)	~	8.5 (5.9-12.2)
Idaho	9.5 (7.9-11.4)	9.6 (7.9-11.5)	~	~
Montana	10.5 (8.5-12.9)	10.7 (8.6-13.2)	~	-
Nevada	10.5 (9.2-12.1)	10.9 (9.4-12.6)	~	-
New Mexico	10.5 (9.0-12.1)	11.2 (9.6-13.0)	~	10.0 (7.7-12.9)
Utah	8.7 (7.5-10.2)	8.9 (7.6-10.4)	~	~
Wyoming	8.1 (5.7-11.1)	8.2 (5.8-11.3)	~	~
Pacific	7.1 (6.9-7.4)	7.1 (6.8-7.4)	4.2 (3.4-5.2)	6.9 (6.3-7.6)
Alaska	7.2 (5.2-10.3)	7.7 (5.4-11.6)	~	-
California	6.8 (6.5-7.1)	7.0 (6.6-7.3)	4.2 (3.4-5.3)	6.7 (6.1-7.4)
San Francisco-Oakland	5.7 (5.0-6.4)	5.5 (4.7-6.4)	~	5.4 (3.5-8.2)
San Jose-Monterey	6.0 (5.1-7.1)	5.8 (4.8-7.1)	~	4.3 (2.5-7.6)
Los Angeles	8.2 (7.6-8.8)	8.9 (8.2-9.6)	4.2 (2.9-5.8)	7.5 (6.4-8.7)
Hawaii	10.7 (8.9-12.6)	6.1 (3.8-9.7)	~	-
Oregon	7.0 (6.2-8.0)	6.8 (6.0-7.8)	~	~
Washington	8.4 (7.7-9.2)	8.1 (7.4-8.9)	~	12.6 (7.2-21.7)
	8.1	8.1		

Seattle-Puget Sound	(7.3-9.1)	(7.2-9.1)	~	~

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Table 2.21.1.1MF. Cancer of the Thyroid. Age-Adjusted Invasive Cancer Incidence Rates* and 95% Confidence Intervals by U.S. Census Region and Division, State and Metropolitan Area, and Race and Ethnicity, United States†‡

Footnotes

* Rates are per 100,000 persons and are age-adjusted to the 2000 U.S. standard population.

† Data are from selected statewide and metropolitan area cancer registries that meet the data quality criteria for all invasive cancer sites combined. See Appendix J for registry-specific data quality information. Rates cover approximately 92% of the U.S. population.

‡ Invasive cancers only

§ Data for specified race/ethnic groups other than white and black should be interpreted with caution. See technical notes.

|| Hispanic origin is not mutually exclusive from race categories (white, black).

~ Rates are suppressed if fewer than 16 cases were reported in the specific area-race-ethnic category.

- Rates are suppressed at state's request. See technical notes.

Notes: Cases from suppressed rates are included in the U.S. and region/division rates. Observed region/division age-adjusted incidence rates are presented for regions/divisions with >= 80% of the population covered by registries that meet the data quality criteria specified above, and if the 95% confidence intervals around the observed region/division rates for each of four major cancers include "bias-corrected" estimated region/division rates (see technical notes) for each of those cancers. U.S rates are as presented in Table 1.1.1.1MF. Michigan, Georgia, California, and Washington state rates each include cases from the SEER metropolitan areas.

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Rosalie Bertell, Ph.D., G.N.S.H.
President

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October 10, 1990

Columbia did find increases in cancers — but said not enough got out of TMI to be the cause —

Miles Hoye
Midway Road
Shelter Island, NY 11964
USA

Dear Miles,

Thank you for sending the TMI study. It certainly did nothing to follow up or elucidate the serious study conducted by the Aamodt's. It was my understanding that, that was the task given to Dr. Hatch by the TMI fund.

My comments are enclosed. Your further reflection and comments would be welcome.

Sincerely,

Rosalie Bertell

Rosalie Bertell, Ph.D.,GNSH

Copy: Mr and Mrs Aamodt

(Correspo\Hoye.Oct.10/90)

Re: Cancer Near the TMI Nuclear Plant
by Maureen C. Hatch, J. Beyea, J.W. Nieves
and M. Susser (Columbia Univ. Study)

Perhaps Dr. Hatch is unfamiliar with the etiology of radiogenic cancers in children, the focus of her study around TMI. These leukemias and cancers are thought to originate from in utero exposure. Dr. Hatch made no attempt to trace women who were pregnant and who resided around TMI at the time of the accident. The Hatch study was based on place of residence at diagnosis. Therefore, in addition to cases lost to follow-up, she included cases without knowing the place of birth or pregnancy.

This same error permeates all of her cancer cases. For example, a nine year old diagnosed with leukemia in 1985 was most likely carrying the malignancy since 1976. However a five year old diagnosed with leukemia in 1984 may be related to the 1979 accident. She has so many irrelevant cases in the study that it would be impossible or at least highly improbable that she would observe a statistical relationship.

On page 406, Hatch clearly indicates her belief that radiogenic childhood leukemia has a two year latency period. This error colors her entire analysis.

There are several other sources of error in the paper:

1. Page 403, Hatch assumes the median exposure in the study tract to be 0.4 mSv due to the accident and 0.001 mSv due to the routine emissions. The mathematics and sources of these estimates are of doubtful accuracy. Hatch apparently was not acquainted with Bernd Franke's study of the accuracy of dose measurements, also done for the T.M.I. Fund.

2. Page 400, Hatch demonstrated ignorance of the variety of radiochemicals released in the accident, their radioactive decay products, and the high likelihood of internal contamination.

3. Hatch assumes an absense of alpha radiation, a highly unlikely scenario given the flooding of the reactor floor and auxiliary building and unfiltered escape of radionuclides. Again, Bernd Franke's research would have helped. *

4. Hatch states (p 400) that no data was available on routine emissions at TMI. Such data must be filed with the Nuclear Regulatory Commission and should have been available to her.

5. Hatch failed to deal with strontium 90 (decay product of krypton 90) and cesium 137 (decay product of xenon 137). These fission gases were released at TMI.

6. Hatch assumed that all releases were from the vent stack, neglecting liquid releases and releases from the flooded auxiliary building.

7. Out-migration and in-migration was completely ignored, although it was known to be widespread. **

It is regretable that the State of Pennsylvania allowed so many nuclear facilities to be built and operated with no proper base line data on cancer, no tumor registry and no audit of their health effect forcast. A base line would have been of assistance to Dr. Hatch. However her fundamental error in assuming a 2 year latency for childhood cancer clearly invalidates the whole study.

Rosalie Bertell, Ph.D.,GNSH

* they told us the alpha radiation that was found was unexplained

** 50% of the 5 mile radius population moved away following the 5 years after the TMI accident

DOSE-RATE CONVERSION FACTORS FOR EXTERNAL EXPOSURE TO PHOTON AND ELECTRON RADIATION FROM RADIONUCLIDES OCCURRING IN ROUTINE RELEASES FROM NUCLEAR FUEL CYCLE FACILITIES*

D. C. KOCHER
Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830

(*Received* 21 *March* 1979; *accepted* 24 *July* 1979)

Abstract—Dose-rate conversion factors for external exposure to photon and electron radiation are calculated for 240 radionuclides of potential importance in routine releases from nuclear fuel cycle facilities. Exposure modes considered are immersion in contaminated air, immersion in contaminated water, and irradiation from a contaminated ground surface. For each exposure mode, dose-rate conversion factors for photons and electrons are calculated for tissue-equivalent material at the body surface of an exposed individual. Dose-rate conversion factors for photons only are calculated for 22 body organs.

INTRODUCTION

IN ASSESSING radiation dose to an individual or to the population from external exposure to a radionuclide dispersed in the environment, a dose-equivalent rate at a given location at time t, denoted by $R(t)$, can be written in the general form $R(t) = Q(t) \times D$, where $Q(t)$ is a radionuclide concentration at the particular location and time and D is a quantity called the external dose-rate conversion factor. From the general equation, the quantity D, which we also call the dose-rate factor, can be regarded as a dose-equivalent rate per unit radionuclide concentration.

In general, estimation of the concentration $Q(t)$ requires detailed consideration of the rate and manner of release of the radionuclide of interest, its transport in the environment, and radioactive decay including build-up and decay of any radioactive daughter products. Such considerations are beyond the scope of this work. We are concerned instead with the determination of the external dose-rate factor D.

For a given radionuclide, the dose-rate factors are constants which are determined by the particular radiation type of interest (usually photons or electrons) and the energies and intensities of the emitted radiations of that type, the mode of exposure (e.g. immersion in contaminated air), and the organ of the exposed individual or population for which the dose-equivalent rate is desired. Dose-rate factors are thus independent of the dynamic behavior of radionuclides in the environment. These factors are clearly useful in radiological assessments, since multiplication of an assumed radionuclide concentration in the environment by a dose-rate factor gives an external dose-equivalent rate.

This paper presents a tabulation of dose-rate factors for external exposure to photons and electrons for 240 radionuclides of potential importance in routine releases from nuclear fuel cycle facilities. The exposure modes considered are immersion in contaminated air, immersion in contaminated water, and irradiation from a contaminated ground surface. For each radionuclide, radiation type, and exposure mode, dose-rate factors are calculated for tissue-equivalent material at the body surface of an exposed individual. In addition, dose-rate factors for photons only are calculated for 22 body organs.

The dose-rate factors are calculated by assuming that the contaminated air, water, and ground surface are infinite in extent and that the radionuclide concentration is uniform throughout the medium. For immersion in contaminated air and water, the calculations are based on the requirement that all of the

*Research sponsored by Division of Safeguards, Fuel Cycle and Environmental Research, U.S. Nuclear Regulatory Commission under Interagency Agreement DOE 40-550-75 with the U.S. Dept. of Energy under Contract W-7405-ENG-26 with Union Carbide Corp.

Photons, water immer

$$D'_{w\gamma} = 1(1.87 \times 10^7)\frac{1}{\rho_w}$$

Electrons, water imme

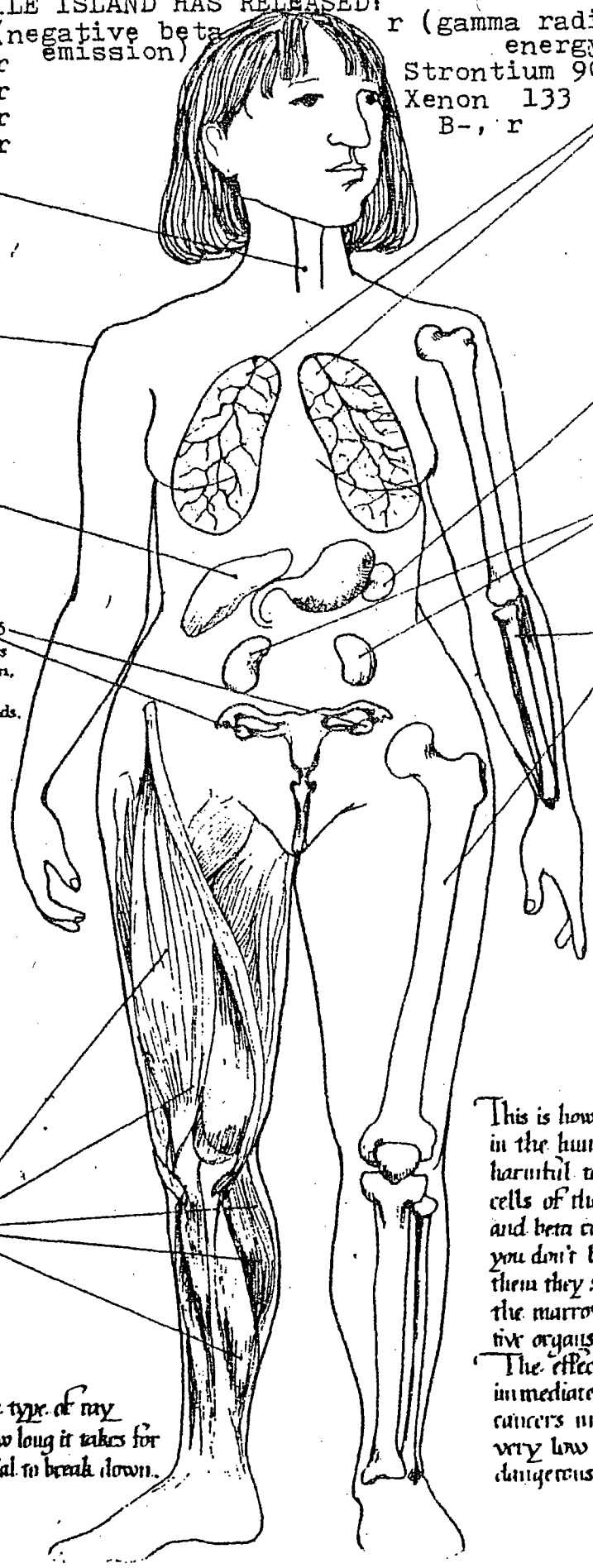
$$D'_{w\beta} = \frac{1}{2}(1.87 \times 10^7)\frac{1}{\rho_w}$$

In these equations, the
denote air, water and tis
subscripts γ and β deno
trons, respectively, ar
denotes a particular pho

IONIZING RADIATION

MATERIALS THREE MILE ISLAND HAS RELEASED:

Cesium 137	B- (negative beta emission)	r (gamma radiation-an intense energy wave)
Cobalt 60	B-,r	
Iodine 131	B-,r	
Krypton 85	B-,r	
Rubidium88	B-,r	
Strontium 90	B-	no r
Xenon 133	B-, r	



THYROID
IODINE-131
beta (gamma), 8 days

SKIN
SULFUR-35
beta, 87 days

LIVER
COBALT-60
beta (gamma), 5 yrs.

OVARIES
THE REPRODUCTIVE ORGANS are attacked by all radioactive isotopes emitting gamma radiation. In addition, the deadly PLUTONIUM-239 is known to concentrate in the gonads. The radiation it emits can cause birth defects, mutations and miscarriages in the first generation after exposure and or successive generations.

IODINE-131
gamma, 8 days
COBALT-60
gamma, 5 yrs.
KRYPTON-85
gamma, 10 yrs.
RUTHENIUM-106
gamma, 1 yr.
ZINC-65
gamma 245 days
BARIUM-140
gamma, 13 days
POTASSIUM-42
gamma, 12 hrs.
CESIUM-137
gamma, 30 yrs.
PLUTONIUM-239
alpha, 24,000 yrs.

MUSCLE
POTASSIUM-42
beta, (gamma), 12 hrs.
CESIUM-137 (and gonads)
beta (gamma), 30 yrs.

LUNGS
RADON-222 (and whole body)
alpha, 3.6 days
URANIUM-238 (and bone)
alpha, 162,000 yrs.
PLUTONIUM-239 (and bone)
alpha, 24,000 yrs.
KRYPTON-85 (and?)
beta (gamma), 10 yrs.

SPLEEN
POLONIUM-210
alpha, 138 days

KIDNEYS
RUTHENIUM-106
gamma (beta), 1 yr.

BONE
RADIUM-226
alpha, 1,620 yrs.
ZINC-65
beta (gamma), 245 days
STRONTIUM-90
beta, 28 yrs.
YTIRIUM-90
beta, 64 hours
PROMETHEUM-147
beta, 2 yrs.
BARIUM-140
beta (gamma), 13 days
THORIUM-234
beta, 24.1 days
PHOSPHORUS-32
beta, 14 days
CARBON-14 (and fat)
beta, 5,600 years

The times listed next to the type of ray emitted are the half-lives: how long it takes for half of the radioactive material to break down.

This is how ionizing radiation is concentrated in the human body. All this radiation is harmful to normal tissue, because it damages cells of the body. Generally speaking, alpha and beta rays are harmless to you as long as you don't breathe or eat them, but if you inhale them they set up permanent business near the marrow of your bones, in your reproductive organs or vital parts.

The effects of ionizing radiation are not immediate. Exposure to radiation can cause cancers many years later. Exposure to very low levels of radiation can be equally dangerous over time.

CLAMSHELL ALLIANCE

State Represetative Stephen Reed's Letter to the NRC

August 8, 1979

symptoms never investigated!

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

currently Mayor of Harrisburg

... and the NRC's Response (SEP 20, 1979)

of the Three Mile Island Nuclear Power Plant. Technical staff members of the Nuclear Regulatory Commission (NRC), the Department of Health, Education and Welfare (HEW) and the Environmental Protection Agency (EPA), who constituted an Ad Hoc Dose Assessment Group, prepared the report. The report concludes that the offsite doses associated with the accident during the period March 28 to April 7, 1979, represents minimal risks of additional health effects to the offsite population. The projected number of additional fatal cancers due to the accident that could occur over the remaining lifetime of the population within 50 miles is less than one. This report, of course, did not address the immediate physiological reactions addressed in your letter. However, we have consulted with Dr. Marvin Goldman, a medical consultant for NRC and he has stated that at the radiation dose rates involved, as described in the report, none of the effects identified in items (a) thru (h) above can be expected to be caused by radiation.

If we can be of further assistance to you, please do not hesitate to write us.

Sincerely,

Original Signed by
H. R. Denton

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

The above is a part of the NRC's reply to Stephen Reed which was written by Harold Denton on behalf of Chairman Hendrie. It stated that,"The only knowledge that we have of a large number of people experiencing physiological reactions to the accident comes through Mr. Arnold of ParaScience Internationl." Enclosed with the reply was a copy of Larry Arnold's letter to the NRC in which literally the same eight kinds of symptoms Mr. Reed had listed can be found. It is apparent that Mr. Reed's letter was based on Larry Arnold's report.

It is as though the 'information' went round that closed circuit: after spending much time and energy, one throws one's results in front of those bureaucrats only to receive in return, if anything at all, the empty echo of one's own voice. No, it is worse than empty——it echoes maliciously.

Thus, this was the NRC's only response to the question of the strange experiences people had had at the time of the accident. One can't help but ask, even if, for example, the metallic taste in the mouth had nothing to do with the radioactive materials from the nuclear power plant, how the NRC can justify its failure to ascertain what caused it?

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 19 1984

Mr. Albert Manik
919 Hoffer Street
Middletown, PA 17057

Dear Mr. Manik:

Your letter to Commissioner Bernthal (postmarked January 31, 1984) has been referred to me for response.

Your letter requests the type and amount of radioactivity released during the Three Mile Island Unit 2 (TMI-2) accident and the reason for the metallic taste reported by area residents during the first few days of the accident.

I understand that at the February 9, 1984 TMI-2 Advisory Panel Meeting in Harrisburg, PA, you raised the same issues. As you remember Mr. Lake Barrett, Deputy Program Director of the Three Mile Island Program Office, responded to both issues at that time and promised to forward to you specific information. On February 17, 1984, Mr. Barrett forwarded to you a letter detailing the type and amount of radioactivity released during the accident. Enclosed is a copy of the letter.

I simply do not have a definitive answer for the reasons why some individuals experienced a metallic taste in the early days of the accident. However, from the types and quantities of radioactive materials released during the accident and the concentrations of radionuclides that could be present in the offsite environment, I have determined that these relatively low accident concentrations could not have caused a metallic taste.

In conclusion I would like to add that official inquiries into the TMI-2 accident (the NRC's Rogovin Report and President Carter's Kemeny Report) found that there would be no, or very minimum, adverse public health effects caused by the accident. I trust that this information responds to the issues you raised in your letter.

Sincerely,

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosure: As stated

Recently GPU and the NRC acknowledged that the core of Unit 2 at TMI reached a temperature of 5,100°F and that transuranic materials were released into the enviroment. Below is a statement that was part of the May 28 press conference in Washington D.C. sponsored by the SVA

May 21, 1985

TRANSURANICS AND THE IMPACT ON HEALTH
Carl J. Johnson, MD, MPH*

A typical nuclear reactor like TMI-2 has about 97 tons of uranium 238 and 3 tons of U-235. Although some reactors are also fueled with plutonium, all operating reactors make large amounts of plutonium.

A typical reactor in a year will produce 100,000 to 600,000 curies of alpha-radiation emitting plutonium, 7,000 to 110,000 curies of americium, and 400,000 to over one million curies of curium.

Each curie will exceed the Department of Energy's (DOE) maximum permissible body burden for 24 million nuclear workers, or 2.4 billion people. This DOE exposure standard does not protect workers, however. At Rocky Flats, nuclear workers with less plutonium in their bodies than permitted by DOE had sharply increased rates of chromosome damage, even at only 1% to 10% of the permitted dosage of plutonium.

Put another way, a teaspoon of plutonium 238 would exceed the DOE exposure limit for 40 billion nuclear workers, or 4 trillion people, and even a small fraction of this maximum permissible dosage will cause severe chromosome damage.

There are about 40 tansuranics of importance, like plutonium 238, produced in all nuclear reactors. Some are somewhat less toxic, some are more toxic. Plutonium and similar radionuclides occur in all tissues in the body in man, and become a permanent resident in the body. The excretion rate is very slow, about one-half would be excreted every 200 years.

In animals, plutonium causes cancer of the lung, bone, kidney, mammary gland, lymph nodes, nesothelium, and ten types of soft tissue cancer. In one animal study, plutonium caused a cancer rate of 114% with a mean induction period of about one year. Many animals has two different types of cancer.

Excess cancer incidence has been reported in Rocky Flats workers and in the population living downwind in Denver. The children and young adults in Arvada and the area near the plant in 1957, when an explosion blew out the filters at the plant, had a greater than four-fold excess of leukemia in 1969-1971 at the time of the National Cancer Institute's Third National Survey of Cancer Incidence. I estimate that the Rocky Flats exposures will cause more than 12,000 excess cases of leukemia and cancer in the Denver area between 1960 and 1990, and a somewhat greater number will be affected by birth defects and non-specific effects on health. This was the only Federally-supported study of cancer incidence around a Federal nuclear facility.

An Environmental Protection Agency (EPA) report states that a nuclear reactor can routinely release over a million curies of fission products in the exhaust each year. These routine releases include 6.8 curies of neptunium, a transuranic. I asked an EPA regional radiation officer why the release of the other 40 plus transuranics were not reported, and he said "that would not be self-serving to the industry."

* 42 Hillside Drive, Denver, CO 80215 (303) 232-2328

CONTINUED TO NEXT PAGE

CONTINUED FROM PREVIOUS PAGE

Nuclear fuel, uranium and plutonium, are contained in a reactor in rods. The rods quickly deteriorate under the heavy bombardment of countless neutrons, and the heat and increasing pressure, as these very heavy metals fission into some 1,800 different lighter isotopes, many of them gases. The rods quickly develop more and more leaks, which permit fission products and transuranics to escape. An operating reactor like TMI-2 produces as much fallout fission products and transuranics as the Hiroshima bomb every 4 hours.

There is evidence that there was a large release of nuclear fuel, of uranium, plutonium, of the 40+ transuranics, along with the release of huge amounts of fission products from the core. At a core temperature of 5,100° F, or 2816° C, all of the nuclear fuel can melt, and many of the transuranics, like americium, will boil, producing large volumes of metal fumes. Iodine boils at 184° C, cesium boils at 678°, polonium at 962°, radium at 1,140°, strontium at 1,384°, and americium at 2,607°.

Contrast a teaspoon of plutonium to the 3 to 11 tons of nuclear material missing from the TMI-2 reactor vessel. I am certain that a large amount of plutonium, curium, and other transuranics have been dessiminated offsite.

These releases in the exhaust fumes from TMI would be in the form of metallic fumes and gases, and extremely fime particles of radionuclides. Such exhaust plumes have been called "dry fallout" and are much less likely to be deposited on the ground than "wet fallout" brought down by rain or snow. However, it is very important that a survey of contamination of surface respirable dust be carried out, to a distance of 20 miles at least, around the plant. The survey should look at all of the important isotopes of curium, plutonium, americium, neptunium and uranium.

After the TMI-2 accident, I asked the NRC and the DOE to do such a survey around TMI, using a surface respirable dust method I developed in collaboration with the U.S. Geological Survey that was published in Science. The Department of Energy itself has used and recommended a very similar approach around the Savannah River Plant.

However, the DOE refused to do this survey around TMI. They did soil tests to a depth of 15". This approach guarantees negative results. A later study by the EPA to a depth of 1 centimeter is not much better.

A large lawsuit brought by landowners against Dow, Rockwell and DOE for the contamination of their land with plutonium by Rocky Flats was recently settled in favor of the plaintiffs, based in large part on the sort of evidence I present here. I was the health officer for the county involved in this issue. The federal judge in this case ruled that the plant was guilty of conducting an ultrahazardous operation, according to the reports in local newspapers. Similarly, I believe that both TMI-1 and TMI-2 have been conducting an ultrahazardous operation, and must not be permitted to resume operations.

surface respirable dust study never done!

udge OKs $3.9 million for TMI su

Patriot-News
HARRISBURG, PA., THURSDAY, FEB. 7, 1985
FINAL

By MARY WARNER
Staff Writer

A Dauphin County Court judge has approved more than $3.9 million in settlements of injury claims resulting from the 1979 accident at Three Mile Island.

The largest — in a claim filed for a Down's syndrome child — was for $1,095,000.

The settlements, all reached out of court, had to be approved by a judge because they involved claims on behalf of children or of the estates of adults who have died since the accident.

A statement issued yesterday by the insurance companies representing the nuclear plant's operators indicated the claims were being settled without regard to the evidence, strictly to avoid the expense of trials.

"These settlements represent an economic decision arrived at by the insurance companies and do not constitute an admission of liability by the companies involved, General Public Utilities Corp. and Metropolitan Edison Co.," the statement said.

"In exchange for payments to the claimants by the insurance companies, all of the defendants in the settled cases are being given general releases from claims of liability."

It could not be learned how much money was involved in the settlements that did not require court approval. Plaintiffs and defendants have agreed not to discuss the settlements, the statement said.

In all, the statement said, "the great majority of 300 personal injury claims" were being settled out of court.

Doug Bedell, a spokesman for TMI operator GPU Nuclear Corp., released the statement. He had no other comment.

The settlements approved by Judge William W. Lipsitt closed claims by 70 children and three estates.

A group of 19 settlements approved yesterday included $855,000 for Gabriella Elsen of Harrisburg, an infant born since the accident who suffered cerebral palsy, and $1,095,000 for 5-year-old Bradley R. Baker of New Cumberland, a Down's syndrome child.

Court documents said Bradley, born just over nine months after the accident, suffered the disorder, which includes mental retardation.

His parents Blaine and Deborah Baker were among 62 plaintiffs in a 1981 suit that sought damages for injuries allegedly linked to the March 28, 1979, accident at the Londonderry Twp. nuclear plant.

The suit said the plaintiffs "most probably came into physical contact with some radioactive debris," which "was dispersed throughout a large area."

Defendants in the suit were General Public Utilities Corp.; its subsidiaries, Metropolitan Edison Co., Jersey Central Power & Light Co., and Pennsylvania Electric Co.; plant designer Babcock and Wil-

See TMI — Page A8

From Page A1

cox and its parent company J. Ray McDermott & Co.; and engineer Burns & Roe.

"Based on the extreme difficulty in establishing the connection between low level radiation and Bradley's illnesses, the petitioners believe the offer of settlement is fair and equitable," plaintiff's attorney Lee Schwartz said in his petition seeking Lipsitt's approval of the $1,095,000 settlement.

The Bakers also entered a claim for their daughter Jennifer, now 6, for physical damage and emotional and mental suffering. The settlement in her case was $28,500.

The settlements approved by Lipsitt were in two groups. One group, approved yesterday, included 19 settlements totalling $3.3 million.

One-third of the money will go for contingency fees for the law firms of Hepford, Schwartz, Menaker & Morgan and Levin & Fishbein and, in some cases, attorney Richard Jameson and the firm Friedman and Friedman.

It was not always clear from court documents whether the addresses listed for the plaintiffs were for the time of the accident, the time of the suit or now.

Besides the Baker and Eisen cases, the settlements yesterday were:

- $47,500 for Maryella Durborow, 17, daughter of William and Catherine Durborow, claiming physical damage and emotional pain.
- $47,500 for Rennie Crossman, 16, child of Kenneth and Barbara Crossman of Richmond, Va., claiming physical and genetic damage.
- $264,000 for the estate of Joseph Dowden, who died of cancer at age 53 in September 1981. The address of the executor of the estate was Glen Cove, N.Y.
- $116,500 for the estate of Evelyn Gordon of Harrisburg, who died of a heart attack in November 1980 at the age of 64.
- $170,000 for the estate of Gilbert Mounall of Harrisburg, who died of a heart attack at the age of 66 in 1979.
- $123,500 for the estate of Carl Hess, who died of a heart attack last year at age 56.
- $415,000 for Samantha Ylengst, 5, daughter of Richard and Kathleen Ylengst of Duncannon, claiming congenital heart defects and other physical and genetic damage.
- $9,500 for Jennifer L. Ylengst, 7, also the daughter of Richard and Kathleen Ylengst, claiming emotional trauma and physical and genetic damages.
- $15,200 for Stacey Schuchman, 5, daughter of Donald and Judith Schuchman of York Haven, claiming emotional trauma and physical and genetic damage.
- $5,700 for Greg M. Schasse, 5, son of Terryl Schasse of Salem, Ore., claiming emotional trauma and physical and genetic damage.
- $19,000 for Barbara Martin, 13, daughter of Robert and Marie Martin of Etters, claiming emotional trauma and physical and genetic damage.
- $20,900 for Elizabeth Malestestinic, 15, daughter of Mark and Kathleen Malestestinic of Steelton, claiming emotional trauma and physical and genetic damage.
- $15,200 for Matthew Malestestinic, 9, also son of Mark and Kathleen Malestestinic, claiming emotional trauma and physical and genetic damage.
- $15,200 for Charles Malestestinic, 17, also son of Mark and Kathleen Malestestinic, claiming emotional trauma and physical and genetic damage.
- $9,500 for Kelly E. Hare, 14, daughter of Ellen Hare of Penbrook, claiming emotional trauma and physical and genetic damage.
- $9,500 for Joshua Chubb, 9, son of Julia Chubb of Middletown, claiming emotional trauma and physical and genetic damage.

Another group of settlements approved Jan. 25, were presented to the court by the Pittsburgh firm of Trasi, Tighe, Tierney & Johnson, which will receive 33 percent contingency fees.

Each petition said the parents of the children involved had engaged the firm "with respect to possible emotional and other injuries" resulting from the accident.

None of the children had "provable" physical injuries or emotional injuries that required medical treatment, the petitions said.

Therefore, the petitions said, the plaintiffs' attorneys found the offered settlement to be a "fair and reasonable" compromise.

Receiving $10,000 apiece through those settlements were:

- Joseph Moody, 7, and Christine Moody, 6, children of James and Kathleen Moody of Dillsburg.
- Craig Beible, 13, and Melissa Beible, 8, children of Paul and Wendy Beible of York Haven.
- Nathan Bare, 11, and Natalie Bare, 9, children of Terry Bare of Columbia.
- Michael Halterman Jr., 16, and Paul Halterman, 14, sons of Michael Halterman of Mount Joy.
- Jennifer Petrone and Jessica Petrone of Dillsburg, daughters of Roger Petrone of Dillsburg.
- Lisa H. Brody, 15, and Amy Brody, 13, of Tampa, Fla.
- Joseph Geltz Jr., 9, son of Joseph and Marylou Geltz of Columbia.
- Ruth Hoover, 16, Joy Hoover, 15 and Lamar Hoover, 14, of Columbia.
- Gerard W. Ingold, 8, son of Gerard and Donna Ingold of Verona.
- James R. Klinedinst Jr., son of James R. and Carla Klinedinst of York Haven.
- Gina Metzgar, 16, daughter of Lewis and Sally Metzgar of Mount Joy.
- Elizabeth Ropka, 17, Thomas Ropka, 12, and Richard Ropka, 6, children of Richard V. and Connie Ropka of Bainbridge.
- Edrige Sardi, 14, and Marco Sardi, 14, children of Marchillo and Donna Sardi of Columbia.
- John T. Meison, 17, and Melissa Meison, 15, children of Sharon Wettrau of Columbia.
- Nicole Glenny, 16, Lee Glenny, 14, and Lori Glenny, 7, children of William and Connie Glenny of York Springs.
- Angela Lovell, 9, and Adam Lovell, 14, children of Duane and Cindy Lovell of Lewisburg.
- Paul Fletcher, 15, children of Marling and Louise Fletcher.
- Sandeep Thakrar, 15, and Monica Thakrar, 10, children of Avil and Neema Thakrar of Camp Hill.
- Andrea Bratic, 7, and Kelly Bratic, 5, children of Kathleen Bratic of Grantham.
- Marc Worona, 17, and Stephanie Worona, 14, children of Valentin and Lesia Worona of Harrisburg.
- Robert S. Aquino, 17, and Deborah Aquino, 14, children of Edward and Peggy Aquino of York Haven.
- Dean Laughman, 13, Dayne Laughman, 7, and Donald Laughman, 5, children of Craig and Joan Laughman.
- Michelle Davis, 12, daughter of Barbara Cetera of Dover.
- Jesse Minnich, 15, and Michael Minnich, 17, sons of Howard and Vickie Minnich of Etters.
- Nicole Linsey, 13, and Jill Linsey, 8, daughters of Dennis and Rosemary Linsey of Tampa, Fla.

The remaining settlements were:

- $21,700 for Amy Shoop, 6, daughter of Edward and Sydney Shoop of Bainbridge.
- $42,000 apiece for Robert Thomas Jr., 13, Mathew Thomas, 12, and Deanna Thomas, 10, children of Robert and Mary Thomas of Lemoyne.
- $24,000 apiece for James Hartsfield Jr., 17, and Robert Hartsfield, 14, sons of James and Marian Hartsfield of Burnt, N.C.

Sunday Patriot-News
HARRISBURG, PA., OCTOBER 6, 1985

State's TMI study clouded by survey method doubts

fabricating data!

By Frank Lynch
Sunday Patriot-News

The state's recently released study of health effects of the 1979 Three Mile Island accident may have been flawed by expanding the survey areas beyond the prescribed five- and 10-mile zones.

According to 1980 census figures, the state Department of Health included 28,610 people who live farther than five miles from the Londonderry Twp. plant in the population listed for those who live within five miles.

Another 122,000 people who live farther than 10 miles from the plant were included in the population of those living "within" 10 miles.

THE RESULT, according to epidemiologists and statisticians contacted by the Sunday Patriot-News, is that if there actually were adverse health effects such as increased cancer cases among those living close to the plant, the figures would be diluted by expanding the base population.

"It seems like a strange thing to do," said Dr. Robert A. Hultquist, Pennsylvania State University professor of statistics. "I think you would substantially dilute [assumed cancer rates] to get even a few miles away."

Dr. George Hutchison, Harvard professor of epidemiology, concurred.

"Let's suppose there is an excess cancer rate [in the five-mile zone], and not excess rate beyond the five-mile zone," he said. "The larger population would dilute the overall cancer rate."

THE STUDY, released a month ago, concluded that no adverse health effects had been found so far in people who live around TMI, site of the nation's worst commercial nuclear accident on March 28, 1979.

Comparing census figures with the totals listed by the Health Department, 44 percent of the population figured in the five-mile statistics live outside that zone, while 42 percent of those said to be

See STATE'S—Page A10

State's TMI study clouded

From Page A1

"within" the 10-mile zone actually live farther away.

For example, all of Lower Paxton Twp.'s 34,830 residents were included in the 10-mile figures, although only 2,000 of them live in the sliver of the township inside the 10-mile radius. Some Lower Paxton Twp. residents live as far as 16 miles from the plant.

Health Department officials defend the way they gathered their data. They say the data were not diluted by the excess population included, and that the study could not have been conducted had they attempted to stay close to the imaginary 5- and 10-mile zones.

"IT WOULD be a tremendous job, almost humanly impossible" to conduct such a study, said Edward Digon, principal author of the report and chief of the department's special studies section, division of epidemiology research.

Digon said the report should have noted that some of the people included in the study live outside the zones. Such a notation had been included in an early draft that he wrote, but was deleted during the editing process. Leaving the explanation out, he said, was an "error."

But Digon stressed that there was not an increase in cancer. He said the four communities entirely within the five-mile zone had about the same number of cancer deaths as would have been expected.

Health Department spokesman Bill Lindeberg said, "We think we have a pretty solid report, and we stand on it."

TMI'S UNIT 2 reactor overheated and released some radioactivity into the environment in March 1979. Government experts and scientists have said not enough radiation escaped to trigger any significant health problems.

But doubts have persisted over the last six years.

Norman and Marjorie Aamodt, formerly of Chester County, and now of Lake Placid, N.Y., conducted a study last year that concluded the number of local people dying from cancer increased sevenfold since the accident.

Meanwhile, the Columbia (N.Y.) University Department of Epidemiology is conducting a two-year, $420,000 study of pregnancy outcomes and cancer rates since the accident.

And the Health Department will continue to monitor cancer cases in the area for future studies.

THE MOST recent study was made to find out what, if any, health effects were suffered by residents living certain distances from the plant. Five- and 10-mile zones were selected for comparison purposes.

Digon noted that death certificates and cancer incidence information from the state's Cancer Registry are available according to "minor civil division" — or by township and borough.

Since the minor civil divisions do not align with the five- and 10-mile circles, officials included all of a division in the study even if only part of it is within the described zone.

Digon said it was decided to use the divisions — even though their use inflates the population numbers — because it will be easier to conduct follow-up studies.

"YOU COULD do it [try to divide the divisions to stay close to the zone circles]. But you can't do that for too many years because the reference books [needed to keep track of residents] would fill up a room," he said.

Therefore, he said future comparison studies also will include those living outside the zones.

Harvard's Hutchison said that to do a study expeditiously, "there is a good argument for using townships and boroughs rather than using areas defining a circle around Three Mile Island."

But he said that that study method should have been described in the report. "If there is not any footnote [explaining that some areas are actually not within the described zones], then you have a problem."

Anti-nuclear protests spread

PARIS (AP) — About 3,000 people, chanting to the strains of accordion music, marched through Paris on Monday to protest France's resumption of nuclear test blasts in the South Pacific.

Several hundred anti-nuclear protesters also demonstrated Monday in Orleans in central France, Rennes in the west, and Poitiers and Agen in the southwest.

The protests were small by French standards, involving far fewer people than the typical union, student or other anti-government demonstration. But they were still one of the largest shows of opposition yet in France to nuclear testing.

9-12-85 Orrtell Lane

AND-PA DOH already had a 5 mile population base study.

A LISTING OF SOME OF THE SEVERE SYMPTOMS AND HEALTH EFFECTS DURING AND AFTER THE THREE MILE ISLAND ACCIDENT

1 - Zions View: blue fog, earthquake, animal deaths, plant abnormalities, cancers, thyroid disorders, birth defects.

2 - Lisburn, Goldsboro: metallic taste, skin burns, hair loss, plant effects, defoliation, animal deformities, cancers, birth defects, film fogging. Goldsboro received the official high dose of radiation for the west shore area during accident. Lisburn is on the 10 mile radius evacuation line. NRC wants to have a two mile evacuation zone.

3 - Rural areas: 5 cancers in 6 homes, metallic taste, skin burns, plant mutations, tree damage. Area of 75 dental films fogged.

Between 3 & 4: On Thursday 3/29/79 I was driving on Rt 15, and experienced eye burning and difficulty seeing - almost like snowblindness.

4 - Rural area: Skin and eye burns, metallic taste, blisters, nausea, diarrhea, animal deaths, plant mutations, cancers, hair loss, tree defoliation, tree tops died, miscarriages.

5 - Enola, South Bridge: Metallic taste, cancer cluster, plant effects. On South bridge, many people reported orangey-pinkinsh haze, metallic taste.

6- Summerdale: Cancers, hair falling out in clumps. Harrisburg-metallic taste all over downtown, 2 bone marrow supression cases, plant abnormalities. Enhaut- cancer cluster, plant effects.

7 - Dauphin, Highspire: birth defects. Pa DoH even acknowledged high cancers in Highspire.

8 - Host Inn plume line (see Nureg 0600): Osborn home-metallic taste, skin burns, hair loss, plant mutations. AMP builing on Fulling Mill Road-gardener got sick during accident, eventually died of Leukemia. Kunkle School-official high radiation dose for east shore during accident, plant effects. Corradi's home- plant abnormalities, rashes, "fifths disease" in neighborhood, cataracts.

9 - Rt 441 at Nissly: High body radiation count, plant effects, miscarriage, cataracts, cancer.

0 - Colonial Park: Metallic taste all over, burning sensation, menstrual problems in young women.

1 - Linglestown: cancer cases, birthing problems. Rutherford- metallic taste, plant abnormalities, cancer cluster. + Penn State Capitol Campus.

2 - Pineford Village: Eye burns, hair loss all over body, cancers.

3 - Across street from TMI: Animal deformities, deaths, metallic taste.

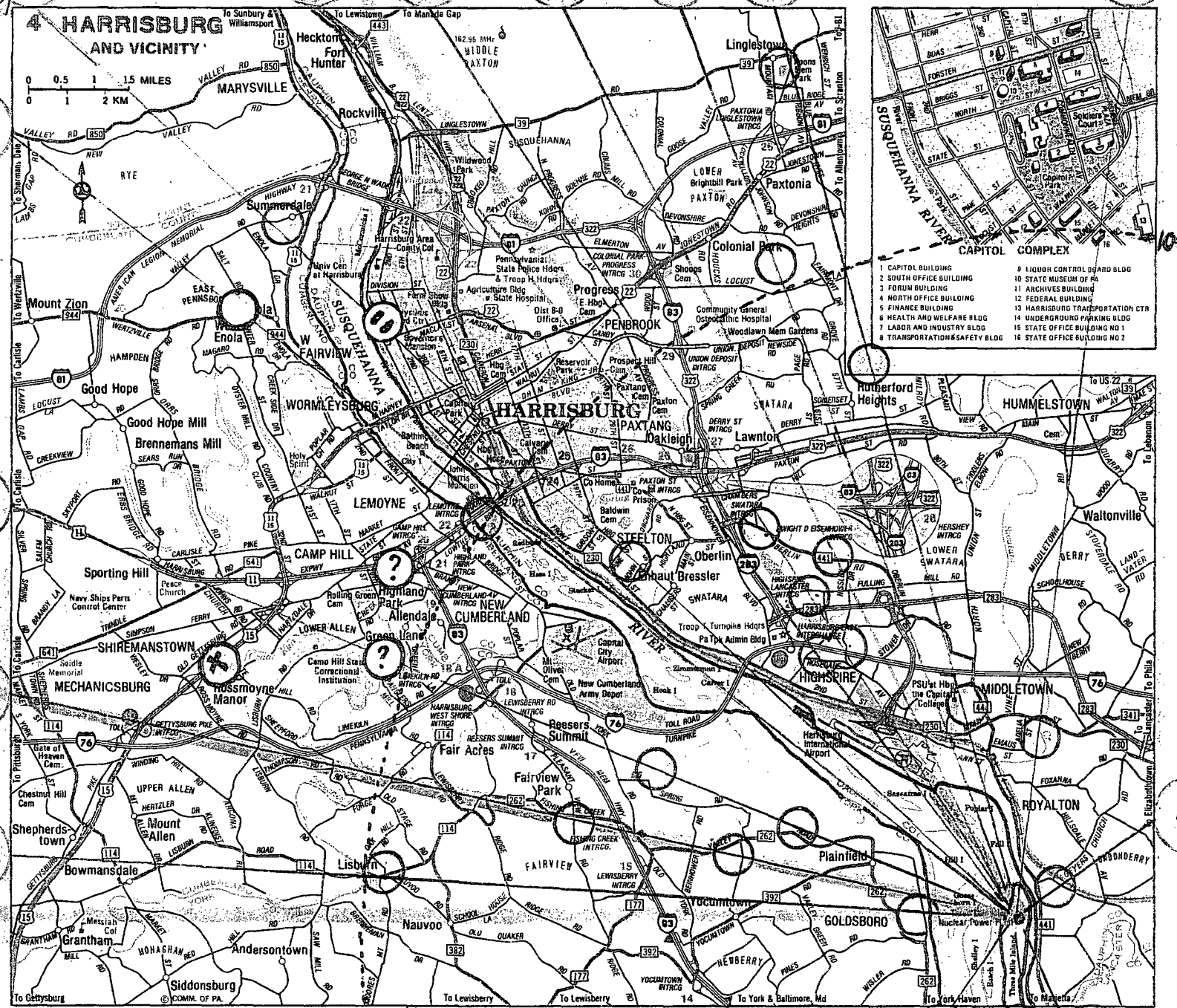
4 - Columbia: Leukemia and cancer clusters.

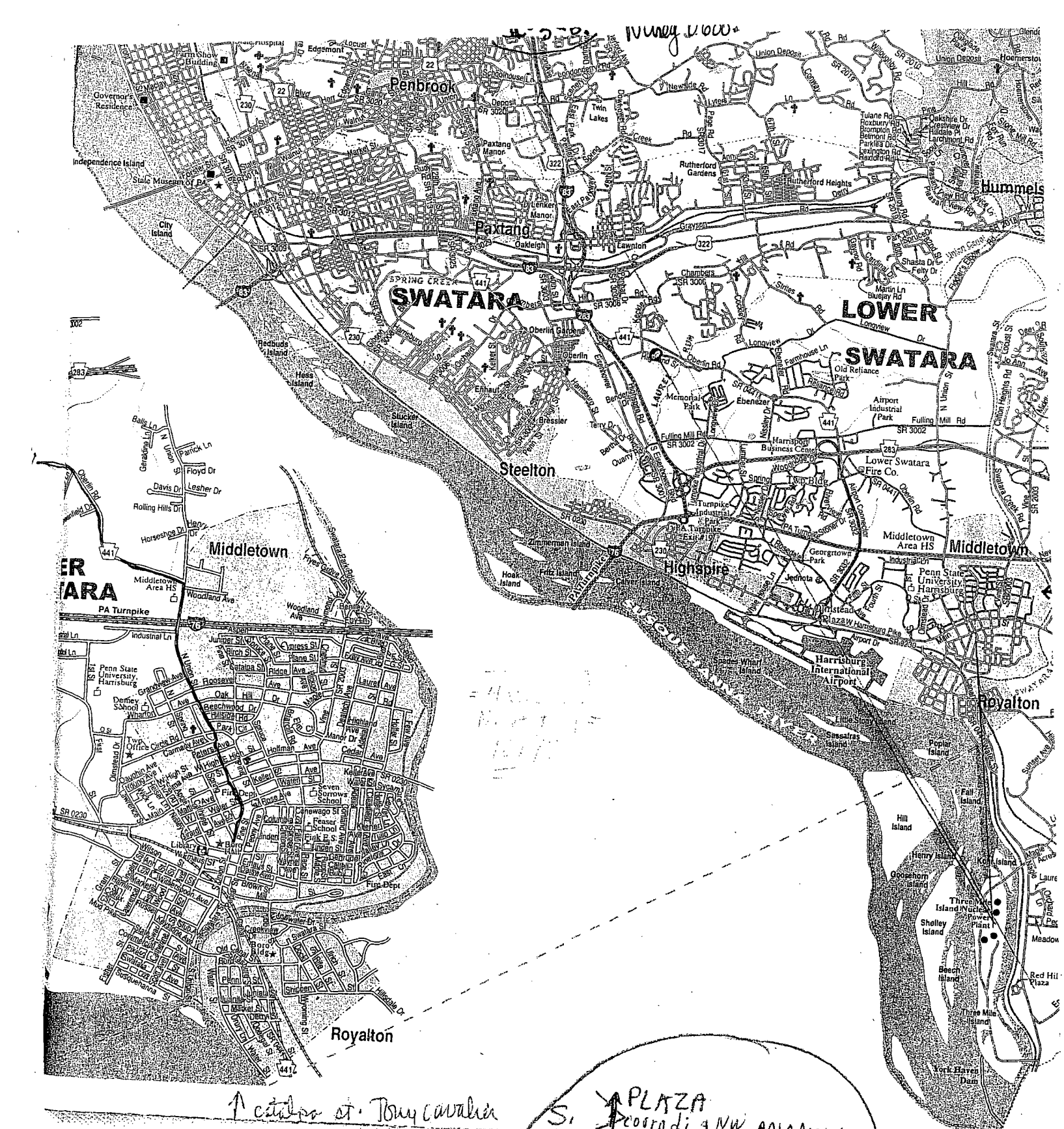
5 - York Haven: Metallic taste, respiratory disorders, animals died, human cancers.

4-1-08 much worse - needs updating. ISO

Areas in the northeast, southeast and southwest all reported similar severe symproms, not just northwest.

OTE: This information was collected by Mary Osborn from newspapers, the TMI Alert Questionaires, personal conversations and interviews, Nureg 0600 from NRC, PaDoH cancer report, & personal experiences. This is not all the data and health effects will continue . . . . . The humans were the true dosimeters.


4 HARRISBURG AND VICINITY
0 0.5 1 1.5 MILES
0 1 2 KM
To Sunbury & Williamsport
To Lewistown
To Mandata Gap
162.55 MHz MIDDLE PAXTON
Hecktorn
Fort Hunter
MARYSVILLE
Rockville
Linglestown
Paxtonia
Colonial Park
Summerdale
Mount Zion
Enola
W FAIRVIEW
WORMLEYSBURG
HARRISBURG
PAXTANG
Oakleigh
Lawnton
Rutherford Heights
HUMMELSTOWN
Good Hope
Good Hope Mill
Brennemans Mill
LEMOYNE
PENBROOK
Progress
Lower Brightbill Park
Woodlawn Mem Gardens
Community General Osteopathic Hospital
Prospect Hill Cem
Paxtang Cem
Baldwin Cem
Co Home
Co Prison
STEELTON
Oberlin
Penhaut Bressler
CAMP HILL
Sporting Hill
Navy Ships Parts Control Center
Peace Church
Rolling Green Cem
Highland Park
Allendale
Green Lane
NEW CUMBERLAND
LOWER ALLEN
SHIREMANSTOWN
MECHANICSBURG
Rossmoyne Manor
Camp Hill State Correctional Institution
Capital City Airport
New Cumberland Army Depot
Troop T Turnpike Hdqrs
PA Tpk Admin Bldg
HIGHSPIRE
PSU at Hbg the Capital College
MIDDLETOWN
Harrisburg International Airport
Reesers Summit
Fair Acres
Fairview Park
Gate of Heaven Cem
Chestnut Hill Cem
UPPER ALLEN
Shepherds-town
Mount Allen
Bowmansdale
Lisburn
Plainfield
ROYALTON
Yocumtown
GOLDSBORO
Nauvoo
Andersontown
Grantham
Siddonsburg
Waltonville
Susquehanna River
To Gettysburg
To Lewisberry
To Lewisberry
To York & Baltimore, Md
To York Haven
To Marietta
CAPITOL COMPLEX
1 CAPITOL BUILDING
2 SOUTH OFFICE BUILDING
3 FORUM BUILDING
4 NORTH OFFICE BUILDING
5 FINANCE BUILDING
6 HEALTH AND WELFARE BLDG
7 LABOR AND INDUSTRY BLDG
8 TRANSPORTATION & SAFETY BLDG
9 LIQUOR CONTROL BOARD BLDG
10 STATE MUSEUM OF PA
11 ARCHIVES BUILDING
12 FEDERAL BUILDING
13 HARRISBURG TRANSPORTATION CTR
14 UNDERGROUND PARKING BLDG
15 STATE OFFICE BUILDING NO 1
16 STATE OFFICE BUILDING NO 2



↑ catalpa at Derry Cavalier

S. PLAZA
coordinate ANOMALY
CAIRO KUNKLE SCHOOL
NO

NO in Swatara @ Highland St

5R/hr downtown Mdtx (lower)

10R/3R @ Catalpa (elevated)

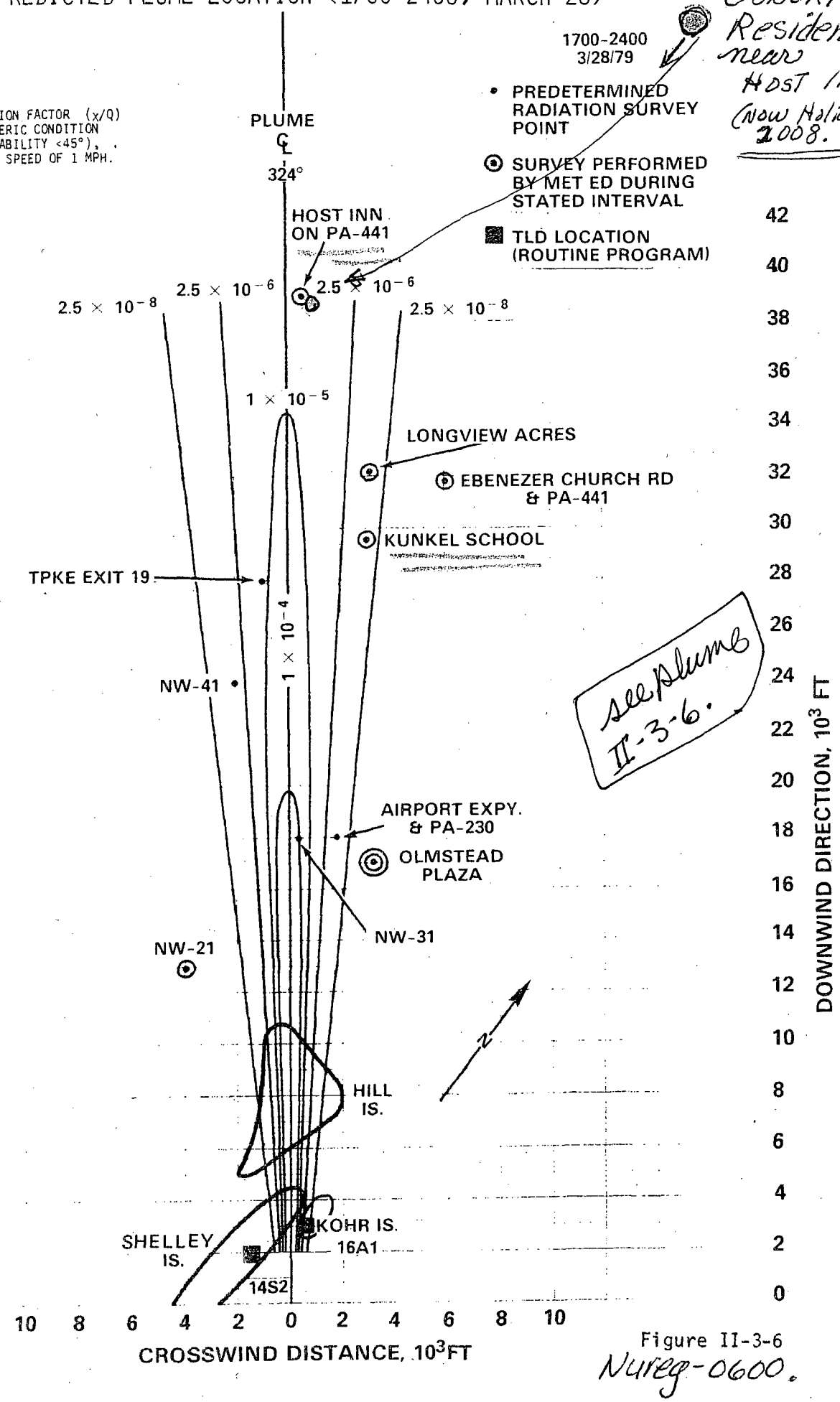
* 10R on porch x 3R in rm = 7R/hr. hot-plate & 2R/hr. ?

5R/hr.
10R/hr.
3R/hr.

- 1979 -

OSBORN Residence near HOST INN, (now Holiday) 2008.

PREDICTED PLUME LOCATION (1700-2400, MARCH 28)

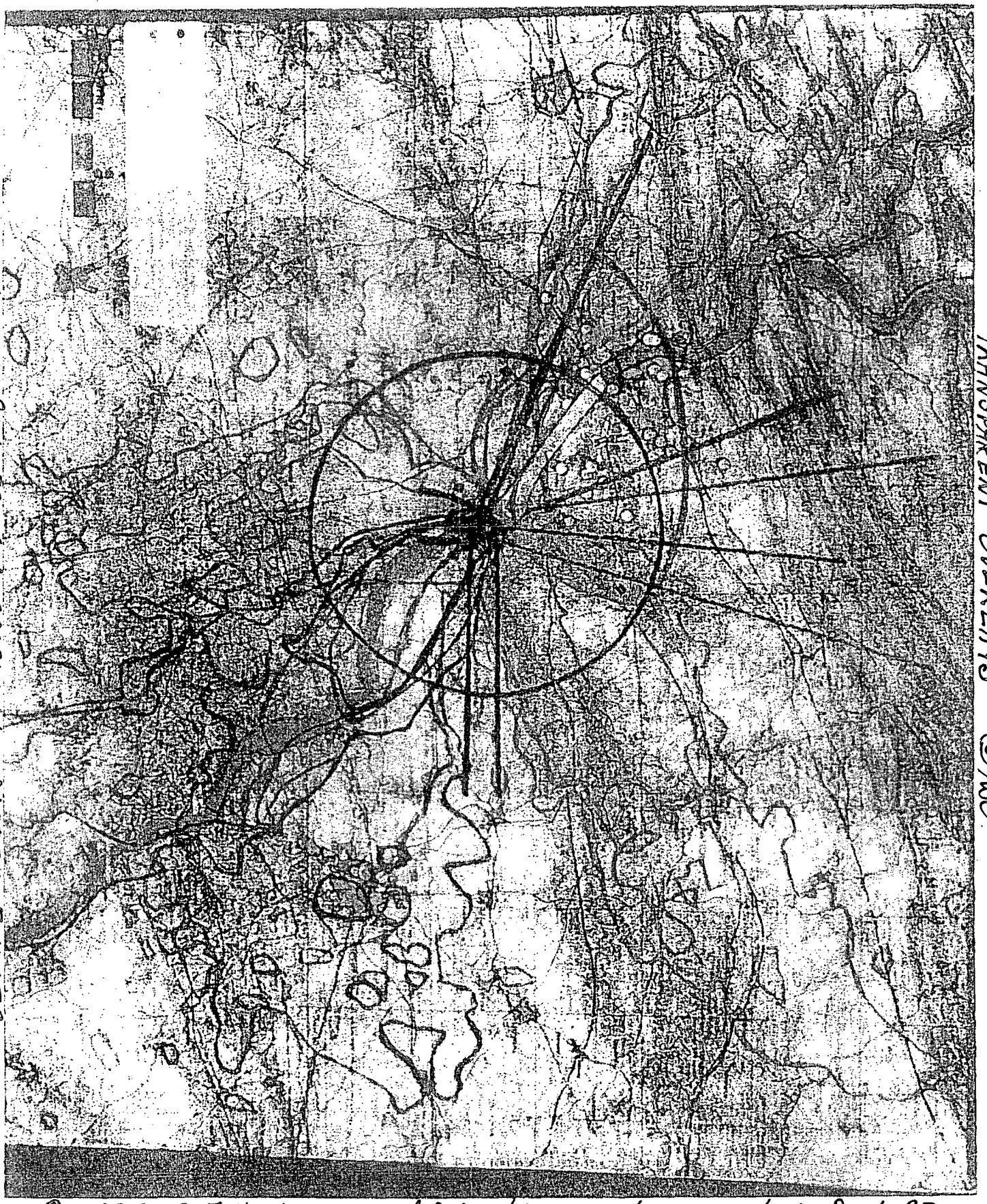


see plume II-3-6.

Figure II-3-6

Nureg-0600.

circles = 10 mile radius
20 mile radius



GAUSSIAN FALLOUT PLUMES - TOPOGRAPHICAL & DOTTED PLUMES.

TRANSPARENT OVERLAYS ©MC

• SOURCE of Fallout maps: A.R.A.C / Lawrence Livermore Lab, Dept. of ENERGY.
Fallout beyond 10+20 mile radius = reported in Albany, N.Y., New York, New England coast, Canada, Philadelphia, New Jersey, Maryland...
+ Chesapeake Bay

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Processes, dynamics and modelling of radiocaesium cycling in a chronosequence of Chernobyl-contaminated Scots pine (*Pinus sylvestris* L.) plantations

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Abstract

In a large forested area affected by the Chernobyl radioactive fallout, especially in CIS, the lasting recycling of radiocaesium (^{137}Cs) by the trees is a source of long-term contamination of woody products. The quantitative description of the ^{137}Cs dynamics in contaminated forest is a prerequisite to predictive modelling and further management of such territories. Three even-aged mono-specific Scots pine stands (17, 37 and 57 years old) were selected in a contaminated woodland in southeastern Belarus to constitute an adequate chronosequence. We determined the potassium and radiocaesium annual fluxes involved in the biological cycling in each stand using a well-documented calculation methodology. Qualitatively, ^{137}Cs was shown to be rapidly recycled in trees through the same pathways as K and to redistribute similarly between the tree components. Compared to K, a higher fraction of ^{137}Cs, corresponding to about the half of the annual uptake, is immobilised in perennial organs. With tree development, trunk wood and bark become prevailing sinks for ^{137}Cs since they represent an increasing pool of biomass. In the pine chronosequence, the current root absorption, respectively, mobilizes 0.53, 0.32 and 0.31% year^{-1} of the total ^{137}Cs pool in soil. Variations in the ^{137}Cs uptake do not reflect differences in the ^{137}Cs balance between stands. In the two older stands, 51 and 71% of the current tree contamination are related to earlier accumulation subsequent to the initial fallout interception and recycling. The soil is the dominant source of long-term tree contamination. A simple modelling based on the measured ^{137}Cs fluxes indicates that, for young stands, radioactive decay-corrected contamination would stabilize after reaching a maximum of 25 years after the ^{137}Cs deposition. Stemwood presents a maximum of 15 years after the deposition and decrease afterwards mainly through radioactive decay. In the older stands, the decontamination is constant without local maximum of ^{137}Cs level in the wood. The ^{137}Cs contamination of tree components is the result of different influential processes like root uptake, internal translocation and immobilisation. For more accurate predictions, the calibration of existing models would be benefited by comparing with the ^{137}Cs annual fluxes instead of the simple transfer factor coefficients. In the perspective of other applications, there is a need of such data for other radionuclides as well as for heavy metals.

Keywords: Forest biological cycling; Annual fluxes; Chronosequence; Chernobyl consequences; Wood contamination; Modelling of radiocaesium transfer

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0048-9697/04/$ - see front matter
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1. Introduction

The post-Chernobyl atmospheric fallout affected large forested area with long-lived radionuclides like ^{137}Cs, especially in CIS and to a minor extent in western Europe. In the early period following the ^{137}Cs interception by the forest canopy (i.e. the acute phase, lasting 2–3 years), large variations have been observed in the ^{137}Cs contamination of tree components depending on the nature of deposits and forest ecological features (Tikhomirov et al., 1993; Mamikhin et al., 1997). In the subsequent years, stemwood, which represents the most important pool of aboveground tree biomass, was identified in many situations as the main reservoir for radiocaesium in forest vegetation (Mamikhin et al., 1994; Fawaris and Johanson, 1994; Melin et al., 1994; Strandberg, 1994; Strebl et al., 1999). A long-lasting recycling of ^{137}Cs by the vegetation is promoted by its persistence in the surface soil layers. The net downwards ^{137}Cs export from the rooting zone was determined to be less than 0.007% per year in forest stands of the Chernobyl zone (Tikhomirov et al., 1993). Besides the humus layers were shown to act as a major source of ^{137}Cs transfer to vegetation (Bunzl et al., 1989; Thiry and Myttenaere, 1993; Thiry et al., 2000; Kruyts and Delvaux, 2002). Even in moderately contaminated forests, several decades ($T_{1/2}=30.2$ years for ^{137}Cs) will likely be necessary before timber wood harvesting will be re-authorised, with great social and economical consequences for the local population and the forest industry (Ipatyev et al., 1986; Shaw et al., 2001).

The longevity and heterogeneity of forest ecosystems complicate the modelling of ^{137}Cs accumulation in tree as well as the definition of simple vulnerability indices required to categorize and further adequately manage contaminated forests. Even at those sites where a radiocaesium monitoring was performed, the studies were generally limited in time or to some narrow aspects of the ^{137}Cs transfer to the trees using integrated parameters like aggregated transfer factors or residence times (Nimis, 1996). Several models, developed independently and calibrated with different site-specific data sets, predict a maximum ^{137}Cs concentration in wood of coniferous trees to occur within a period of 10–20 years after the accident, the age of the trees and the soil properties being the determining factors (Schell et al., 1996; Avila et al., 1999; Ipatyev et al., 1986). A quantitative comparison of these models suggest that the predictions of the ^{137}Cs transfer to tree wood, needles and shoots should be improved through a better description and quantification of the process of ^{137}Cs root uptake, in particular (Goor and Avila, 2003).

The ^{137}Cs incorporation in tree through root uptake is only one aspect of the forest biological cycling which involves various exchange mechanisms resulting in a continuous circulation of elements mobilised during biomass elaboration and turnover (Switzer et al., 1966). These processes can be quantitatively described with a limited number of fluxes using a conceptual model of nutrient cycling in forests (Cole and Rapp, 1981; Ranger and Bonneau, 1984). This assessment technique of forest nutrition has been implemented in numerous case studies as a key phase of more extensive input–output budget calculations (Ranger and Turpault, 1999) but never for long-term assessment of radioactive contaminant cycling. Fifteen years after the Chernobyl accident, the ^{137}Cs redistribution in trees has reached a dynamic quasi-equilibrium and the fluxes are stabilised (Shcheglov et al., 2001). In these conditions, the holistic *cycle* approach can help to quantify the uptake and redistribution fluxes characterizing the ^{137}Cs dynamics in contaminated stands. For that purpose, the cycle approach was applied to a chronosequence of Scots pine stands from a representative Chernobyl contaminated forest area in Belarus. The current ^{137}Cs distribution and its recycling dynamics was discussed and compared to those of potassium, a chemical analogue and major nutrient. Distribution and fluxes data were used to assess the evolution of the ^{137}Cs contents associated with tree growth.

2. Materials and methods

2.1. Site description

The sampling site is a vast Scots pine (*Pinus sylvestris* L.) woodland located close to Vetka

Table 1
Total ^{137}Cs deposition on soil and redistribution between soil layers

	17 years	37 years	57 years
Total ^{137}Cs content in soil (GBq ha^{-1})	17.46	15.21	9.89
Of+Oh	2.25	3.72	5.00
OAh	6.21	6.51	2.54
Ah	9.00	4.97	2.34

(52°37.8′ N, 31°13.1′ E, 159 m above sea level) in the Gomel district in southeastern Belarus. Following the Chernobyl accident in April 1986, the Gomel area was severely affected by ^{137}Cs deposits (Izrael et al., 1996). The climate of this region is continental and sub-boreal. The average annual temperature is 6.5 °C but the seasonal variations are high (annual range: 30 °C). The average precipitation is 550 mm $year^{-1}$. The vegetative period lasts for approximately 6 months, from April to October. The landscape consists of slightly sloping plateaus intersected by a network of rivers and swampy areas. The maximum altitude variation does not exceed 5–10 m. The soils derive from glaciofluvial deposits of the Quaternary age (Dnieper glaciation). The dominant particle size fraction is sand (85–90%). In forest areas, the soil features are closely linked to the relief, the hydrological regime being the main differentiation factor (Sorokina, 1996). On the plateaus, the soils are not influenced by lateral water drainage or variations of the water table level (*automorphic* conditions, dry soils) (Shcheglov et al., 2001). These soils can be classified as Dystric Cambisols (Driessen and Dudal, 1991). They are more or less podzolised depending on previous land use. In the region considered, farmlands occupying these soils were largely afforested with pine plantations especially after World War II for timber wood production.

2.2. The chronosequence of stands

The chronosequence approach, i.e. the selection of an adequate age series of forest stands, is a suitable and well-accepted methodology to study the evolution of biomass production and nutrient distribution during stand development, particularly if differences in growth factors can be avoided (Cole and van Miegroet, 1989; Marques, 1996; Colin-Belgrand et al., 1996). Accordingly, we selected three even-aged mono-specific Scots pine plantations (17, 37 and 57 years old) established on a former-tilled soil in a contaminated zone representative of the automorphic conditions, and categorised as *Pinetum cladinosum* according to the local classification (GOSKOM, 1984). The dominant ground species observed in the different stands were *Hieracium pilosella* L., *Thymus serpyllum* L., *Sedum acre* L., *Calamagrostis epigeios* L., *Festuca ovina* L., *Dianthus arenarius* L., *Antennaria dioica* L., *Calluna vulgaris* L., and *Pleurozium Schreberi* (Brid.) Mitt.

The distribution of trunks circumferences at 1.30 m (breast height, CBH), was determined from a systematic measurement of all trees located within three circular subplots with a radius of 6 m in the young stand and of 12 m in the two older stands. Ten soil profiles were randomly sampled to a depth of 10 cm in each stand. Three horizons were distinguished: humus (Of+Oh), OAh and Ah. A measurement of ^{137}Cs content in bulk soil samples completed the stand inventory (Table 1).

Nine trees were then chosen in the different CBH categories, proportionally to their relative importance. Three trees are representative of the average CBH category. The trunk dimensions, i.e. total height and diameter at breast height, were first compared to local forest productivity tables (Fig. 1). Both diameter and height values of the average trees of each stand fit well in the relation between age and the former criteria characterizing the evolution of a reference pine stand of productivity class Ia. In addition to the ecological similarities, the dendrometric observations including the number of trees per hectare confirms that the three stands belong satisfactorily to the same chronosequence of Scots pine plantations. The data

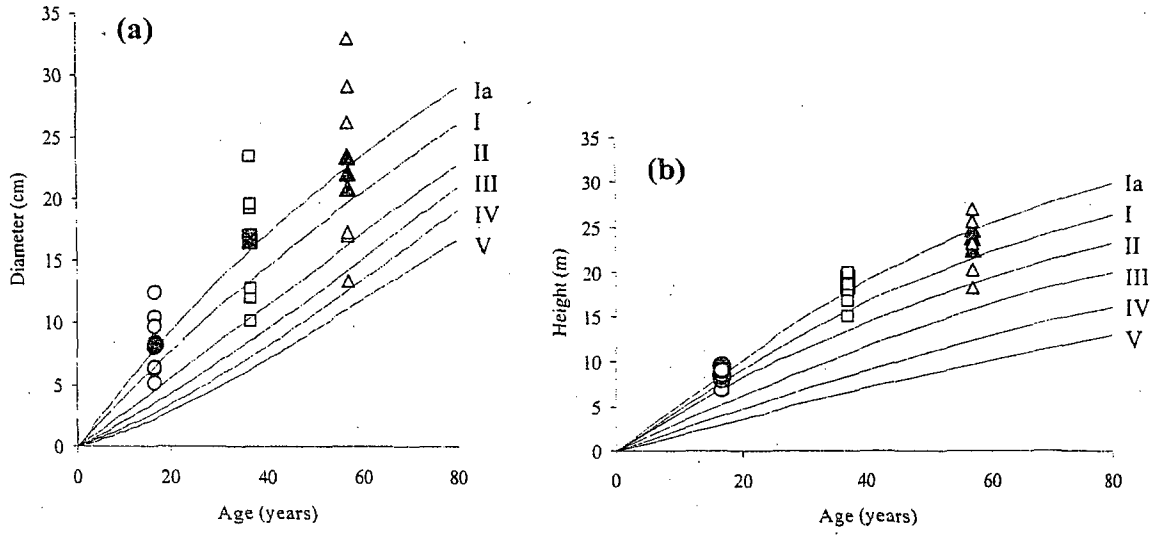

Fig. 1. (a) Diameter and (b) height of the nine trees selected per stand. The filled symbols correspond to the sampled trees and the plain curves represent the evolution of the respective parameter for different productivity classes decreasing from the top, respectively, Ia, I, II, III, IV and V (GOSKOM, 1984).

describing the biomass distribution in each stand and the annual production of the above-ground tree components (stem, branches, foliage, bark) were extracted from the corresponding productivity tables and further used to estimate the K and ^{137}Cs distribution and budget in each stand.

2.3. Sample preparation and chemical analyses

After tree felling, the separation of tree components and the elaboration of composite samples were performed similarly in the three stands. The crown sampling consisted in representative aliquots of the needles of the year, old needles (>1 year old), twigs, living and dead branches for each tree sampled. In addition, nine aliquots of fresh litter (needles) were collected. From the three trees of the average class, 2-cm trunk discs (including wood and bark) were cut at the trunk base (0 m), 1.30 m, 6 m (5 m for the 17 years stand) and then every 6 m up to the top of the trees, allowing the estimation of total trunk volumes as series of truncated cones (Rondeux, 1993). In the laboratory, internal bark (phelloderm), external bark (rhytidome) and wood were separated for each trunk disc. The wood disc (without bark) surface was then polished and scanned in order to reveal annual rings. The average xylem wood density was measured from fresh volume (water displacement of a saturated sample) and dry weight from two radial segments sampled on each wood disc. Another large segment was used for determination of the ^{137}Cs and K content in wood. Before analysis, the segment was divided into sapwood and heartwood. For the sapwood, we distinguished the young sapwood (made of the 3 outermost rings) from the rest. After drying, wood, needles, twigs, branches and litter samples were separately grinded and homogenised before analysis.

All the samples were conditioned into 20-ml Packard glass flasks, dried out and weighed (dry weight). After calcination at 550 °C in a furnace, the ash samples were solubilised in 10 ml HNO_3 2 N and the volume was brought up to 20 ml with distilled water. Reference flasks (blanco's) were added to the samples as control for each procedure. The ^{137}Cs content in each flask was measured by gamma spectrometry (NaI detector–Minaxi γ Packard 5000 series). The counting time was adjusted in order to maintain the counting error below 3%. The ^{137}Cs activity was decay-corrected back to April 26, 1986. The K content in an

aliquot of the solutions was measured by atomic absorption spectrometry (AAS).

2.4. Determination of the element cycling

The methodology to assess the element cycling was progressively refined and applied to the study of the functioning of various forest ecosystems (Ulrich, 1973; Malkonen, 1974; Cole and Rapp, 1981; Ranger and Bonneau, 1984; Helmisaari, 1995; Ranger and Colin-Belgrand, 1996; Ranger et al., 1997; Berthelot et al., 2000). In this model, the tree is compartmented into main annual and perennial parts, some components (trunk wood, bark, branches) including both annual and perennial sections. On the basis of the changes observed in biomass production and element content in the various tree compartments, the biological cycling in the ecosystem can be quantitatively described with three main annual fluxes: the requirement, the uptake and the translocation.

The **requirement** (R) corresponds to the total quantity of element mobilised by the current production of biomass (needles, twigs, branches, wood and bark). It is calculated as the sum of the biomass productivity of annual tree parts multiplied by the stabilised concentration in element (i.e. measured at the end of the growing season when the internal transfer are accomplished):

$$R = \sum_i \text{biomass}_i \times [\text{element}]_i \quad (1)$$

where i = needles, twigs, branches, wood and bark, with R = total requirement (MBq or kg/ha/year); biomass_i = current biomass productivity of the tree compartment i (t DM ha^{-1}); and $[\text{element}]_i$ = element concentration in the tree compartment i (Bq or g kg^{-1}).

For needles, wood and bark, the concentrations in element were measured in, respectively, the needles of the year, the three youngest (external) stem wood increments, and the inner bark. For the branches, no radial variation of the element concentrations was considered.

The **uptake** (U) corresponds to the quantity of elements taken up from the soil through absorption by roots. It is calculated as the sum of the element immobilisation in the perennial forest compartments (wood, branches, bark), the element returns to the soil (litterfall, throughfall) and the changes of element content in the canopy due to variations in the standing needles biomass (Ranger and Bonneau, 1984):

$$U = \sum_i \text{immobilisation}_i + \sum_j \text{returns}_j \pm \Delta f \quad (2)$$

where i = trunk wood, branches and outer bark; j = litter (litterfall) and leaching of standing needles (throughfall), with U = total uptake (MBq or kg/ha/year); immobilisation_i = element immobilisation in the tree compartment i (MBq or kg/ha/year), corresponding to the current biomass production in this compartment multiplied by its element concentration; for trunk wood, it corresponds to the weighted average concentration of wood for the whole trunk; returns_j = element returns to the soil from the forest compartment j (MBq or kg/ha/year). Litterfall corresponds to the current litter biomass production multiplied by its concentration in elements. The throughfall could not be measured directly in situ in our experimental plots. For K, an average value was deduced from litterfall measurements using leaching–litterfall ratios for Scots pine from the literature (Malkonen, 1974; Cole and Rapp, 1981; Ranger and Bonneau, 1984; Lim and Cousens, 1986; Daldoum and Ranger, 1994; Helmisaari, 1995). For ^{137}Cs, we used measurements from Chernobyl-contaminated Scots pine stands (Klyashtorin, 1999; Dvornik, unpublished data); Δf = changes of element content in the canopy due to variations in the standing needles biomass (MBq or kg/ha/year).

The **translocation** (T) corresponds to the internal transfer of elements from senescing tree parts to support new biomass production.

For a matter of simplification, the whole life-cycle of the needles was integrated (from needles of the year to litter). For branches and bark, the translocation was calculated by considering differences between the pool of, respectively, senescing branches vs. twigs, and senescing bark vs. inner bark. In both the cases, the senescing biomass was supposed to correspond to the annual production

Table 2
Annual productivity and biomass content in the different tree compartments for each stand of the chronosequence

	17 years		37 years		57 years	
	Productivity (tons/ha/year)*	Total biom. (tons ha^{-1})*	Productivity (tons/ha/year)*	Total biom. (tons ha^{-1})*	Productivity (tons/ha/year)*	Total biom. (tons ha^{-1})*
Needles	3.64	9.04	3.71	9.82	3.12	8.51
Twigs	1.35	1.35	0.72	0.72	0.43	0.43
Branches	1.55	9.42	1.76	19.15	1.40	24.32
Total crown	**6.54**	**19.81**	**6.19**	**29.69**	**4.96**	**33.26**
Stemwood	5.17	50.10	5.64	130.20	4.10	176.50
Bark	0.23	4.40	0.45	9.85	0.34	13.40
Total trunk	**5.40**	**54.50**	**6.09**	**140.05**	**4.44**	**189.90**
Total tree	**11.94**	**74.31**	**12.28**	**169.74**	**9.39**	**223.16**
Litterfall	**5.91**		**5.54**		**4.53**	
Needles	3.50		3.56		3.03	
Branches	2.39		1.96		1.49	
Bark	0.016		0.022		0.011	

* Dry weights.

of new organs. For stemwood, the evolution of the element content was considered for the common wood rings between two successive tree ages.

$$T_{needles} = biomass_{litter} \times ([element]_{young\ needles} - [element]_{litter}) - throughfall \quad (3)$$

$$T_{branches} = biomass_{branches} \times ([element]_{twigs} - [element]_{branches}) \quad (4)$$

$$T_{bark} = biomass_{bark} \times ([element]_{inner\ bark} - [element]_{outer\ bark}) \quad (5)$$

$$T_{wood} = biomass_{heartwood} \times ([element]_{sapwood} - [element]_{heartwood}) \quad (6)$$

with T_i = element translocation from the compartment i (MBq or kg/ha/year); $biomass_i$ = current biomass productivity of the tree compartment i (t DM ha^{-1}); $[element]_i$ = element concentration in the tree compartment i (Bq or g kg^{-1}); throughfall = element throughfall (MBq or kg/ha/year).

3. Results

3.1. Biomass production and allocation between tree compartments

The production and distribution of dry matter among tree components of the chronosequence as well as in litterfall are synthesised in Table 2. The total crown biomass and corresponding litterfall reach a maximum of productivity early in the life of the stand (i.e. approx. 20 years) and then decrease progressively with stand ageing. Apart from the twigs, the annual increment of each individual component is, however, the highest in the 37 years stand, which is the apparent transition stage towards stand maturity. The trunk contains the main part of the tree biomass and, due to the perennial character of woody tissues; this proportion increases importantly with time. In these stands, the maximum stem growth rate (including thinnings) is achieved at approximately 70 years with a mean annual volume increment of 10 m^3/ha/year (GOSKOM, 1984), which is intermediate between the yields reported for temperate (Bradley et al., 1966; Decourt, 1984) and boreal pine stands (Malkonen, 1974; Helmisaari, 1995).

Table 3
^{137}Cs and K concentrations in the different tree compartments

	17 years		37 years		57 years	
	^{137}Cs (Bq g^{-1})*	K (Mg g^{-1})*	^{137}Cs (Bq g^{-1})*	K (Mg g^{-1})*	^{137}Cs (Bq g^{-1})*	K (Mg g^{-1})*
Crown						
Needles (1)	43.3	3.7	18.2	3.9	21.3	4.2
Needles (>1)	19.3	3.4	7.3	3.4	8.8	3.6
Twigs	52.6	3.3	25.6	3.3	28.9	3.4
Branches	11.9	1.0	5.1	0.8	6.1	1.0
Total crown						
Wood (total)	6.1	0.4	2.7	0.3	3.4	0.3
Wood (current)	7.3	0.4	4.1	0.4	4.9	0.4
Inner bark	40.1	1.9	30.7	2.4	62.4	3.5
Outer bark	19.5	0.9	8.1	0.5	7.6	0.3
Litterfall						
Needles	5.29	0.39	3.92	0.65	4.94	0.47
Branches	1.82	0.10	2.56	0.15	3.09	0.24
Bark	19.5	0.9	8.1	0.5	7.6	0.3

NB: The ^{137}Cs concentrations in the 37 and 57 years stands have been adjusted according to the deposition in the 17 years stand, in order to allow the comparison of the 3 stands on a same basis.
* Dry weights.

3.2. Elements content and distribution between tree compartments

Independently of stand age, the K concentrations globally decrease in the sequence: young needles > old needles > twigs > inner bark ≫ branches ≫ outer bark > wood (Table 3). As a rule, the young, actively growing tissues of trees are richer in K than the older ones. The K concentrations are in the range (lower limit) of usual values reported for coniferous trees (van der Stegen and Mytten-aere, 1991; Helmisaari, 1995; Ranger et al., 1995). The ranking of tree compartments regarding the ^{137}Cs concentrations is significantly different than for K: inner bark ≥ twigs > young needles ≫ old needles = outer bark > branches > wood. A similar ^{137}Cs pattern was observed in several previous studies dedicated to Scots pine (Melin et al., 1994; Strandberg, 1994; Fesenko et al., 2001) as to other coniferous trees (Melin et al., 1994; Barci-Funel et al., 1995; Strebl et al., 1999).

There are also differences in element content with increasing stand age, especially for ^{137}Cs. These differences, combined with changes in biomass allocation as the stand develops, affect the relative importance of the different stand parts in the element distribution (Fig. 2). The foliage compartment dominates for K in the young plantation, while ligneous organs becomes more important in the older stands. This is mostly due to woody biomass accumulation, the K concentration in stemwood and branches decreasing slightly with tree age. The general distribution of ^{137}Cs and K presents evident similarities. In each stand, the contribution of trunk components (wood and bark, in particular) to the total element content in trees is, however, higher for ^{137}Cs compared to K, and this proportion increases as tree ages. At this time, respectively, 877, 650 and 662 MBq ha^{-1} are incorporated in pine vegetation of the 17, 37 and 57 years old stands. These values correspond to, respectively, 4.8, 4.1 and 6.2% of the total ^{137}Cs contamination of each soil–tree associations.

3.3. Elements fluxes

3.3.1. Requirement (Table 4)

The 17 and 37 years old stands present similar levels of K requirement, which decrease in the older stand. These differences are linked with changes in growth rate of the canopy components, needles and twigs in particular (Table 2). The flux

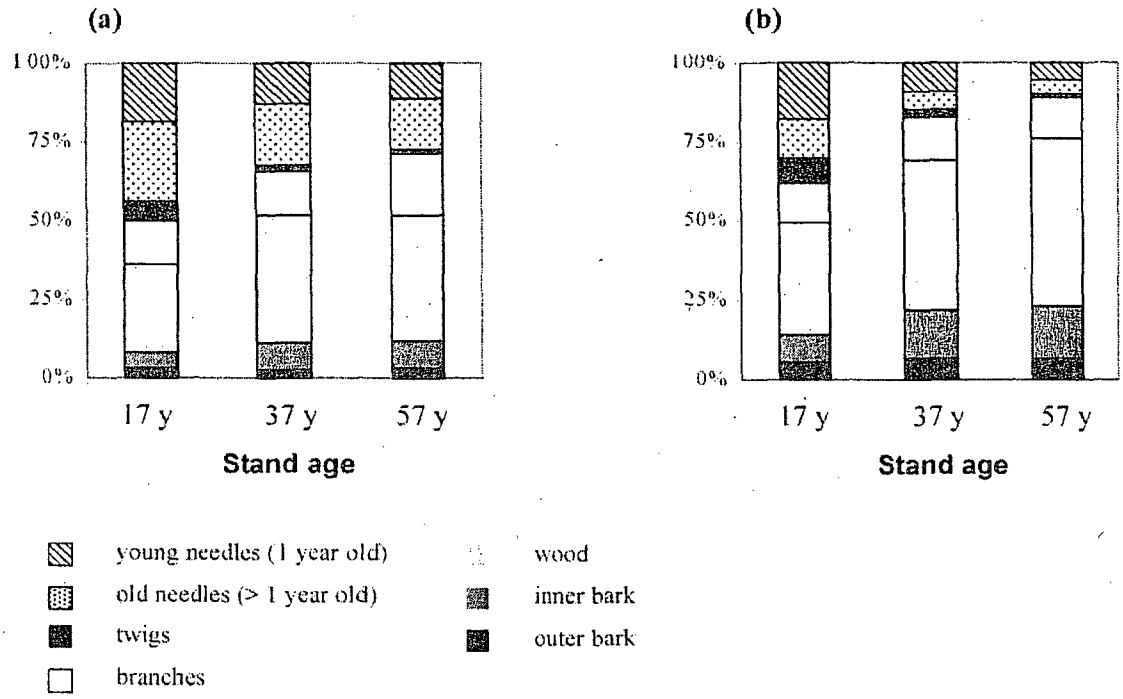

Fig. 2. Relative distribution of (a) K and (b) ^{137}Cs between the different tree compartments for each stand of the chronosequence.

of ^{137}Cs associated with the mobilisation of element for new biomass production is 2 times higher in the young stands than in the two older stands, which show similar values. The last-formed foliage mobilizes the largest amounts of both ^{137}Cs and K in each stand but the fraction of ^{137}Cs allocated to new trunk parts is considerably greater than that of K and enhance with tree age. This fraction is doubled for stemwood and even multiplied by a factor 3 for bark in the oldest stand.

3.3.2. *Uptake (immobilisation + return to the soil) (Table 5)*

The K uptake, i.e. the K absorbed by roots from the soil available pool, shows a maximum in the 37 years old stand and decreases afterwards. In each stand, litterfall and leaching return to the soil a major part of the K uptake (52–63%), this fraction increasing with tree age. The part of K that is immobilised annually in perennial organs decreases greatly in the oldest stand, the contribution of the branches to the total immobilisation becoming prevailing.

For ^{137}Cs, the uptake is maximum in the youngest stand. The evolution of the uptake with tree age shows a distinct pattern compared to K, the differences being similar to those depicted for the requirement fluxes. Compared to K, all stands immobilize a higher fraction of ^{137}Cs corresponding to about the half of the ^{137}Cs uptake (46–59%). Among ligneous organs, stemwood is the dominant sink for ^{137}Cs in all stands. The litterfall pathway is a prevailing vector of ^{137}Cs return to the soil, contrary to K for which the leaching process dominates.

3.3.3. *Translocation (Table 6)*

The amount of K mobilised by the internal transfers increases slightly with tree age, but represents an important and increasing contribution to the K cycling compared to the root uptake (Table 5). In the different stands, 60–72% of the annual

K requirement is supplied by retranslocation, the tree crown and especially the foliage being the main sources. Stemwood shows a low retranslocation efficiency, while bark becomes more important in the older stands.

Similarly to K, the rate of ^{137}Cs retranslocation is high compared to the root uptake flux, which reflects the important input of internal transfers in the current ^{137}Cs cycling. The ^{137}Cs retranslocation evolves similarly to the uptake, suggesting that the ^{137}Cs internal transfer is more closely linked to the pool of ^{137}Cs available for annual cycling than to specific stand development factors. Compared to K, the role of the foliage in the ^{137}Cs translocation is less important. Conversely, the contribution of perennial organs to ^{137}Cs internal transfer is higher. The bark senescence in particular mobilises 1.5–2.7 times more ^{137}Cs than K, relatively to total translocation, with a considerable proportional increase with tree age.

4. Discussion

4.1. Element redistribution and processes involved

In our study, the current distribution and accumulation pattern for K and ^{137}Cs is closely linked to biomass production and allocation between tree components. In particular, the role of foliage as a sink for both elements decreases with tree age while that of ligneous compartments becomes dominant. Potassium is the second most abundant cation after calcium in trees. It is usually present in a soluble form, implying frequent redistribution (Duvigneaud, 1964; van der Stegen and Myttenaere, 1991; Helmisaari, 1995). One year after the Chernobyl fallout, foliage and bark components contained most of the ^{137}Cs initially intercepted by the forest canopy (Tikhomirov and Shcheglov, 1994; Mamikhin et al., 1997; Plamboeck et al., 2000) but 15 years after the contamination, ^{137}Cs has largely been redistributed, similarly than K, within the trees of each stand. Radiocaesium presents analogous physico–chemical properties as K. Although there is no role for trace Cs^+ in plant nutrition, our results indicate that globally both elements circulate through the same pathways in trees, confirming previous assumptions (Ronneau et al., 1991; Myttenaere et al., 1993).

The K dynamics described for the pine chronosequence is classical for forest trees and in agreement with other studies of K cycling in Scots pine (Malkonen, 1974; Helmisaari, 1995) and other coniferous (Ranger et al., 1995). The results show that the K annually incorporated in new organs (requirement) and the K absorbed by roots (uptake) decrease with stand age, in parallel with the biomass production rate. The inverse trend is observed for the K internal transfer. The retranslocation flux was 1.5–2 times higher than the uptake. The contribution of K internal transfer to tree functioning is thus important, demonstrating the efficiency of forest trees to optimise the nutrient use by mobilizing K from senescing organs. Litterfall and leaching return to the soil a major part of the K uptake. Considering the total amount of K mobilised in the system (requirement), this leads to a limited annual K immobilisation, which decreases significantly in the older stands. The comparison of the ^{137}Cs and K fluxes points out that, in each individual stand, the current annual cycling of ^{137}Cs can be depicted with a similar scheme than for K, involving a high mobility and similar transfer processes. There are, however, significant differences in the relative allocation of these two elements. Compared to K, relatively less ^{137}Cs is incorporated in new foliage but approximately 2 times more ^{137}Cs is allocated to new wood formation (Table 4) and the immobilisation in trunk (i.e. wood and bark) is also relatively higher (Table 5). Similar discrepancies were determined in a comparison of ^{134}Cs and K redistribution in willow trees grown in hydroponics (Gommers et al., 2000). The selectivity pattern of trace caesium over potassium in root organs is well documented (Shaw and Bell, 1991; Smolders et al., 1997). At the xylem vessels, Erdei and Trivedi (1991) showed that an additional selective barrier may prevent the extensive caesium accumulation in new shoots, limitations in the transport of Cs towards the shoot becoming maximal at low K supply (van Iren et al., 1981; Buysse et al., 1996).

In the pine stands, the radiocaesium cycling differs from that of K in two other aspects. Foliage

Table 4
^{137}Cs and K requirement fluxes

	17 years		37 years		57 years	
	^{137}Cs (MBq/ha/year)	K (kg/ha/year)	^{137}Cs (MBq/ha/year)	K (kg/ha/year)	^{137}Cs (MBq/ha/year)	K (kg/ha/year)
Requirement	**293.3**	**21.6**	**131.6**	**21.8**	**128.0**	**18.8**
Needles	157.7	13.4	67.5	14.5	66.5	13.2
Twigs	70.8	4.4	18.3	2.3	12.5	1.5
Branches	18.4	1.5	9.0	1.4	8.6	1.4
Wood	37.8	1.9	23.0	2.5	20.1	1.6
Bark	8.6	0.4	13.7	1.1	20.3	1.1

Table 5
^{137}Cs and K uptake fluxes

	17 years		37 years		57 years	
	^{137}Cs (MBq/ha/year)	K (kg/ha/year)	^{137}Cs (MBq/ha/year)	K (kg/ha/year)	^{137}Cs (MBq/ha/year)	K (kg/ha/year)
Uptake	**92.4**	**8.0**	**56.6**	**9.8**	**54.2**	**6.7**
Immobilisation	**54.3**	**3.8**	**28.1**	**3.6**	**25.1**	**2.6**
Branches	18.4	1.5	9.0	1.4	8.6	1.4
Wood	31.8	2.0	15.4	1.9	14.1	1.1
Bark	4.2	0.2	3.6	0.2	2.5	0.1
Return to the soil	**38.1**	**4.2**	**28.5**	**6.3**	**29.1**	**4.2**
Litterfall	23.2	1.6	19.1	2.6	1.96	1.8
Needles	18.5	1.4	13.9	2.3	14.9	1.4
Branches	4.3	0.2	5.0	0.3	4.6	0.4
Bark	0.3	0.0	0.2	0.0	0.1	0.0
Crown leaching*	11.9	2.3	9.8	3.7	10.1	2.5
Δf	3.0	0.3	−0.4	−0.1	−0.7	−0.1

* Values inferred from litterfall measurements by using average throughfall/litterfall ratios found in the literature.

Table 6
^{137}Cs and K internal transfers

	17 years		37 years		57 years	
	^{137}Cs (MBq/ha/year)	K (kg/ha/year)	^{137}Cs (MBq/ha/year)	K (kg/ha/year)	^{137}Cs (MBq/ha/year)	K (kg/ha/year)
Internal transloc.	**188.6**	**12.9**	**93.8**	**13.3**	**90.3**	**13.6**
Needles	121.3	9.2	41.1	7.9	39.4	8.9
Branches	62.9	3.5	36.2	4.3	31.9	3.4
Wood	4.4	0.2	10.1	0.8	17.8	1.0
Bark			6.5	0.3	1.2	0.2

leaching contributes to the ^{137}Cs recycling to a lesser extent than for K (Table 5) but radiocaesium is relatively more retranslocated through inner bark (Table 6), which shows a high ^{137}Cs content. This picture is in accordance with the results of Gommers (2001) who measured, for willow coppice, a lower leaching along with a larger shoots-to-roots retranslocation of ^{137}Cs in autumn, compared to

K. The ^{137}Cs phloem mobility in plants has been shown to be very high (Buysse et al., 1995). In tulip poplar tree, downward translocation to roots via the phloem exceeded the upward fluxes only 2–4 weeks after ^{137}Cs inoculation in the trunk (Olson, 1965). van Iren et al. (1981) demonstrated that ^{137}Cs uptake in the leaf cell vacuoles is very limited compared to K. In these conditions, as suggested by Buysse et al. (1995), a much higher proportion of ^{137}Cs remains in the cytoplasm and is available for remobilisation through phloem transport. In other terms, the limiting capacity of the foliage to withold ^{137}Cs, while its transfer to conductive organs (xylem and phloem) is relatively enhanced, indicates that ^{137}Cs can be discriminated against K not only at the root level but also during its transport over biological membranes of the aboveground tree parts. As a result of these discrimination processes, stemwood and bark become important ^{137}Cs sinks with tree development, since they represents an increasing pool of biomass.

4.2. *Influence of root uptake vs. previous interception process on ^{137}Cs accumulation in pine trees*

Variations in the current ^{137}Cs activity ratio between pine vegetation and soil clearly indicate that from the initial fallout, ^{137}Cs built up 1.3–1.5 times more efficiently in the oldest stand compared to the younger plantations. The measured current annual ^{137}Cs uptake as well as the immobilisation are, however, much lower in the oldest stand than in the youngest stand (Table 5). In the chronosequence, the current root absorption might thus not reflect differences in the ^{137}Cs balance between stands. It is possible that, in addition to root uptake, the ^{137}Cs initial interception and its subsequent translocation in trees had varying influence on the contamination of each pine stand. Considering a rapid stabilisation of the ^{137}Cs migration and availability in soil after the deposits (Guillitte et al., 1990; Bunzl et al., 1995), this hypothesis was tested by comparing the total K and ^{137}Cs contents estimated a posteriori from the current fluxes with the values measured in the three stands.

The equation is slightly different for K and ^{137}Cs, which were not introduced similarly in the ecosystem. The total content of K, native in the ecosystem, can be calculated as follows:

$$TC_{K,a} = TC_{K,a-1} + (\Delta a - 1) \times \text{immobilisation} + \text{uptake} \quad (7)$$

with $TC_{K,a}$ = total content of K in whole trees for the tree age a (kg ha^{-1}); $TC_{K,a-1}$ = total content of K in whole trees in the corresponding preceding stand (0, 17 and 37 years for, respectively, 17, 37 and 57 years), taking the exportations (thinning) into account (kg ha^{-1}); Δa = tree age difference with the corresponding preceding stand (year); immobilisation = current K immobilisation in whole trees (kg/ha/year); uptake = current K uptake in whole trees (kg/ha/year) [for units consistency, the uptake is supposed multiplied by a factor 1 (year)]. However, ^{137}Cs was only recently (15 years) introduced in the ecosystem. In this case, the total ^{137}Cs content in whole trees can be calculated as follows:

$$TC_{Cs,a} = (\Delta t - 1) \times \text{immobilisation} + \text{uptake} \quad (8)$$

with $TC_{Cs,a}$ = total content of ^{137}Cs in whole trees for the tree age a (MBq ha^{-1}); Δt = time period between deposition and sampling (year); immobilisation = current ^{137}Cs immobilisation in whole trees (MBq/ha/year); uptake = current ^{137}Cs uptake in whole trees (MBq/ha/year). For units consistency, the uptake is supposed multiplied by a factor 1 (year).

Fig. 3 presents the calculated values of K and ^{137}Cs contents in whole trees for 17, 37 and 57 years old stands. For K, these values are in good agreement with the measurements, independently of the age of the trees. Conversely, for ^{137}Cs, the results are satisfactory for the 17 years stand but not for the 37 and 57 years stands where, respectively, 51.4 and 71.3% of the ^{137}Cs measured in trees are not explained by the current fluxes. The discrepancies for ^{137}Cs in the 37 and 57 years old stands may be connected with the interception, redistribution and accumulation of ^{137}Cs in trees following the atmospheric input. This effect does not appear in the 17 years old stand because the canopy was not developed at the time of deposi-

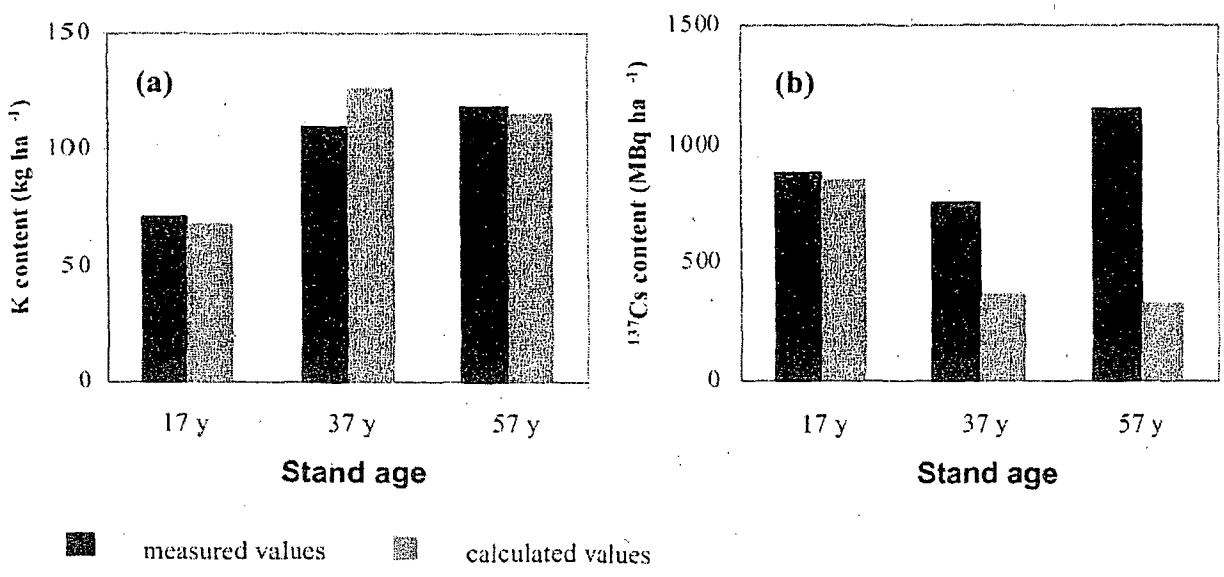

Fig. 3. Comparison of the (a) K and (b) ^{137}Cs contents measured in pine trees of the chronosequence with the values calculated from the current fluxes (according to Eqs. (7) and (8)).

tion. Conversely, the 57 years old stand had a maximum foliage development and a *wood/foliage* ratio 2 times higher compared to the young stand. Besides, the amount of ^{137}Cs involved in recycling from the foliage to the soil but also within the tree was greatest during the acute phase (Tikhomirov and Shcheglov, 1994), leading to a high transient ^{137}Cs bioavailability. A higher stemwood biomass, coupled to a high radial mobility of ^{137}Cs in stemwood (Thiry et al., 2002), might thus promote the retention of ^{137}Cs originating without distinction from root uptake as well as from foliar absorption and subsequent shoot-to-root transfer. The dynamics of ^{137}Cs relocation and dilution in ligneous organs was illustrated in other studies. Five months after foliar contamination of a young spruce, 55% of the residual ^{137}Cs activity in the tree were transferred to woody parts (Thiry, 1997). In a root absorption scenario, Plamboeck et al. (2000) showed that only one year after artificial soil contamination with ^{134}Cs, stemwood and stump of 40–70-year-old pine trees retained approximately 80% of the total ^{134}Cs uptake. Today the soil is the dominant ^{137}Cs reservoir in the stand series and root uptake in particular governs the rate of radiocaesium accumulation by trees though internal translocation involves more important ^{137}Cs activities. In pine stands of the chronosequence, we calculated that root absorption, respectively, mobilizes 0.53, 0.32 and 0.31% $year^{-1}$ of the total radiocaesium pool in soil. This is consistent with the range of values reported in another study where the soil was the unique source of radiocaesium for pine trees (Plamboeck et al., 2000).

4.3. Modelling the evolution of ^{137}Cs content in pine trees

As previously mentioned, 15 years after the Chernobyl fallout, the fate of ^{137}Cs in contaminated forests may be characterised by a low vertical ^{137}Cs migration in soil layers and a dynamic equilibrium in the ^{137}Cs redistribution between tree components. In these conditions, a realistic picture of the evolution of the ^{137}Cs content in trees for the next decades can be approximated from the current ^{137}Cs fluxes measured in forest stands. The annual variation of the total ^{137}Cs content in trees corresponds to the sum of the ^{137}Cs immobilisation in perennial tree compartments with the variation of ^{137}Cs content in annual tree compartments as

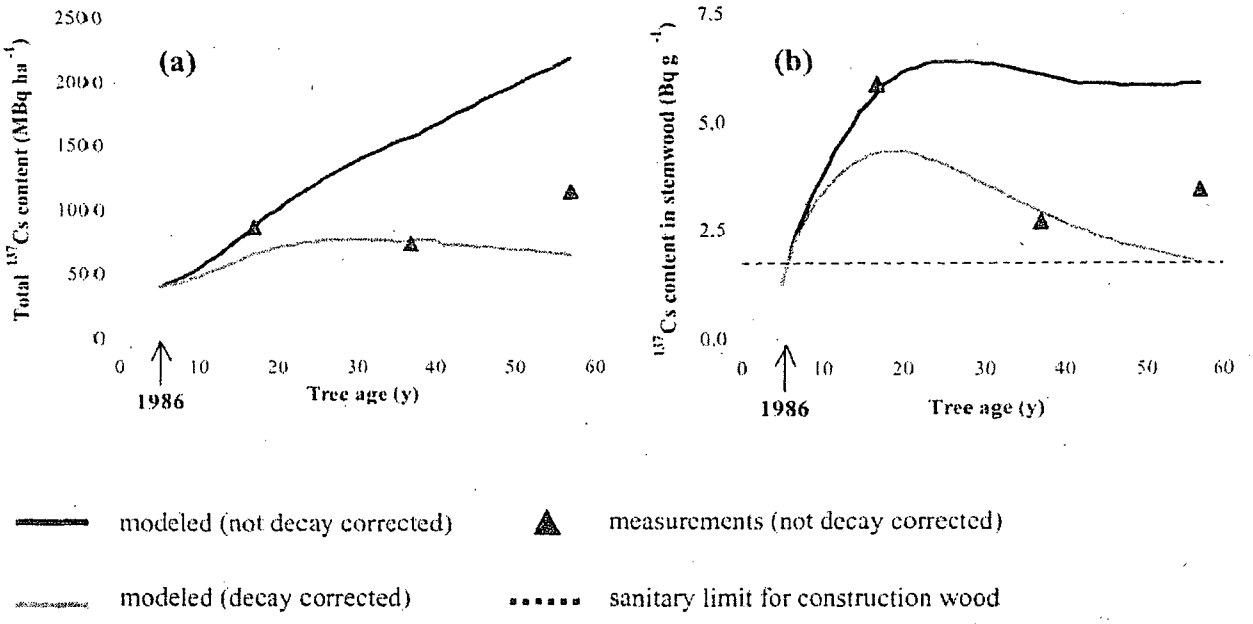

Fig. 4. Dynamic modelling of the evolution of the ^{137}Cs content in (a) whole trees and (b) stemwood compartment for a young pine stand, i.e. planted just before the Chernobyl fallout (according to Eq. (9)).

follows:

$$TC_{Cs,t} = TC_{Cs,t-\Delta t} + \sum_{i,j} (\text{immobilisation}_i + \Delta\text{content}_j)\Delta t \quad (9)$$

where i=trunk wood, branches and outer bark; j=needles, twigs and inner bark, with $TC_{Cs,t}$= total content of ^{137}Cs in whole trees for the year t (MBq ha^{-1}); $TC_{Cs,t-\Delta t}$=total content of ^{137}Cs in whole trees for the year $t-\Delta t$ (MBq ha^{-1}); immobilisation$_i$=current ^{137}Cs immobilisation in the component i (MBq/ha/year); Δcontent$_j$=variation of the ^{137}Cs content in the component j (MBq ha^{-1}); Δt=time step (year).

The calculation (Eq. (9)) may be limited to one or several tree components, and ^{137}Cs concentration may be deduced from total ^{137}Cs content and biomass estimates. The evolution of the total ^{137}Cs content in trees and of the average ^{137}Cs concentration in stemwood are presented in Fig. 4 for the 17 years old stand, representative of young forests planted just before the Chernobyl accident. The real ^{137}Cs contents measured in the three stands are included in the same figure. If radioactive decay is not considered, the total ^{137}Cs content in trees increases regularly with time, ^{137}Cs being immobilised through biomass accumulation in perennial tree components (stemwood, branches, bark). The ^{137}Cs contents measured in situ in the 37 and 57 years stands (symbolised by ▲ in Fig. 4) are lower than the corresponding simulated values. This discrepancy can be explained by the dilution of ^{137}Cs in the important volume of woody biomass in well-developed trees at the time of the ^{137}Cs fallout, and by the comparatively higher rate of ^{137}Cs uptake in young stands (Tikhomirov and Shcheglov, 1994; Mamikhin et al., 1997; this study). The dilution effect of ^{137}Cs in mature stands is confirmed in Fig. 4b, which shows that the current ^{137}Cs concentrations measured in stemwood of the 37 and 57 years old stands are lower than the values extrapolated from the young stand using the age-dependent fluxes intensity. Similar differences were highlighted in another study. Seven years after the contamination, the specific ^{137}Cs content in stemwood (Bq kg^{-1}) of 80 and 50

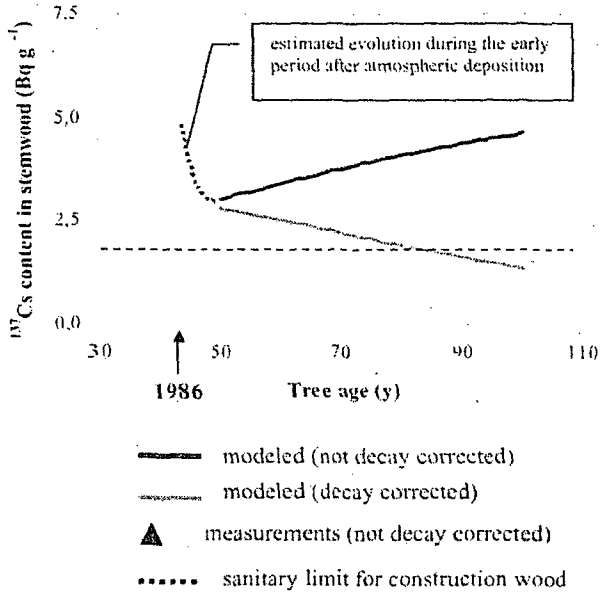

Fig. 5. Dynamic modelling of the evolution of the ^{137}Cs content in mature trees (according to Eq. (9)).

years old pine trees was, respectively, 3.3 and 2.4 times lower than in 20 years old trees from a comparable forest area in Belarus (Ipatyev et al., 1999). By taking into account the radioactive decay, the total ^{137}Cs content in trees (Fig. 4a) tends to stabilize after reaching a maximum of approximately 25 years after the deposition (in 2010). In Fig. 4b, the ^{137}Cs concentration in stemwood shows a maximum of approximately 15 years after the deposition (in year 2000) and decreases afterwards. In our conditions, the tree decontamination is a slow process, which proceeds mainly through radioactive decay.

The evolution of ^{137}Cs content in stemwood is, however, rather different in forests well-developed at the time of the Chernobyl accident. Fig. 5 focuses on the 57 years old stand. In this stand, uncertainties remain concerning the ^{137}Cs redistribution rate in trees in the early period after the contamination, for which no values could be calculated from the current fluxes. The interception of a great part of the ^{137}Cs deposits by the tree canopy (Schell et al., 1996), rapidly followed by an active biological decontamination (Shcheglov et al., 2001), likely resulted in a rapid decrease of the ^{137}Cs content in the different tree components. Afterwards, the ^{137}Cs concentration in stemwood starts to increase mainly due to root uptake and ^{137}Cs immobilisation in new biomass (Mamikhin et al., 1997). Accordingly, the curve of decay-corrected ^{137}Cs content in wood shows no local maximum contrary to the young stand. This difference is confirmed by in situ measurements (Mamikhin et al., 1994; Tikhomirov and Shcheglov, 1994) but is not considered in recent empirical models, which predict similar time dynamics of ^{137}Cs concentration in stemwood for young and mature forests (Avila et al., 1999; Dvornik and Zhuchenko, 1999). Actually, the models which do not consider the ^{137}Cs translocation nor the ^{137}Cs redistribution in the early phase after deposition overestimates the part of the uptake which is immobilised in stemwood.

The evolution of tree contamination has great implications on the future marketability of woody product and the nature of forest management. From the economic viewpoint, the exploitability of contaminated forests is primarily based on the comparison of the ^{137}Cs content in stemwood (corrected for decay) with sanitary restrictions for contaminated wood use. In Belarus, two limits have been fixed at, respectively, 1.85 (dashed line in Fig. 4b and Fig. 5) and 0.74 Bq g^{-1} (plain line) for lumber and domestic fuel wood (Dvornik and Zhuchenko, 1999). According to our predictions (Figs. 4 and 5), wood resources from young and mature stands will have ^{137}Cs content consistent with harvesting criteria in, respectively, 2040 and 2020 in case of lumber, and not before 2050 in case of fuel wood. For possible new plantations (Fig. 6), the extent of stemwood contamination will greatly depend on the year of planting since in the long term, radiological decay was shown to be a major factor affecting the tree contamination. Accordingly, in forests planted after 2010 in the Vetka area, the harvest of timber for construction wood could begin after 30 years but not before 60 years, for fuel wood purposes. In the study area, the current stock of contaminated wood available for harvesting is particularly important but the marketability of woody products is problematic for a long time. Compared to agricultural systems, many countermeasures designed to decrease the

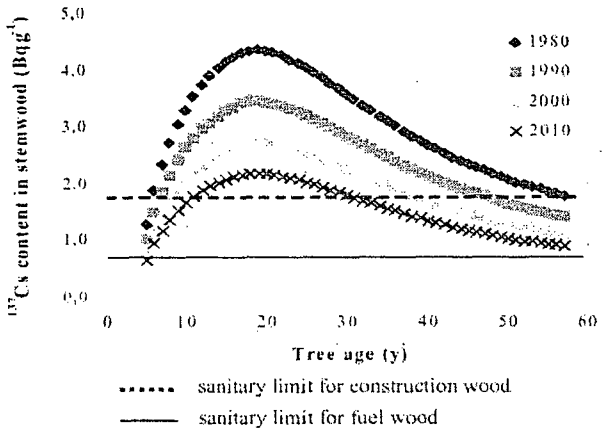

Fig. 6. Influence of the year of plantation on the expected ^{137}Cs content in new pine stands (according to Eq. (9)).

level of tree contamination are unworkable (Guillitte et al., 1993). In economic terms, Shaw et al. (2001) showed that cost-effective management strategy requires novel alternatives uses of contaminated forests which could provide added value to the standing crop in return for small increase in public and worker doses. One rational valorisation option might be the extensive use of contaminated wood as biofuel (Shaw et al., 2001; Goor et al., 2003) through combustion (Dubourg, 1994) or gazeification (Thiry et al., 2001) in a controlled industrial chain.

5. Conclusions

Fifteen years after the Chernobyl atmospheric fallout, the long-lasting ^{137}Cs availability to forest vegetation cycling is evident. Uncertainties remain, however, about the rate of ^{137}Cs uptake and accumulation by trees, which may pose problems for the long term management of contaminated forests. This study reported on an original quantification of the processes involved in the ^{137}Cs and K recycling by Scots pine in a series of three contaminated stands corresponding to different stages of development. Our results showed that, qualitatively, ^{137}Cs was redistributed between tree compartments similarly to K. With stand ageing, the perennial organs act as a major sink for K and for ^{137}Cs to a higher extent. The comparison of the annual fluxes confirmed the influence of discrimination mechanisms through element exchange between tree compartments. Compared to K, a higher proportion of ^{137}Cs was transferred to and immobilised in wood and bark whereas its annual allocation to the foliage was relatively lower.

The analogy between ^{137}Cs and K seems limited in a perspective of long term modelling of ^{137}Cs cycling in trees. Important discrepancies were further highlighted regarding the contribution of root uptake to the elements cycling. We showed that variations in ^{137}Cs uptake only could not account for differences in the measured tree contamination between stands, suggesting the influence of other processes. In particular, the low input of root uptake in the ^{137}Cs cycling was evidenced comparatively to the large contribution of retranslocation processes for the automorphic pine edaphotopes. Such a pattern explained why the models developed on the basis of soil-to-plant transfer measurements without considering the translocation processes, most likely overestimate the ^{137}Cs root uptake and its further accumulation in trees.

Practically, our estimations based on root uptake and immobilisation fluxes values confirmed the model predictions for the young stands for which the soil was the primary source of contamination. It was not the case for the old stands in which the initial interception and further recycling of the ^{137}Cs fallout was important and can still influence the ^{137}Cs content in trees. Our results also illustrated that, due to the low ^{137}Cs uptake, radioactive decay will play a major role in tree decontamination in the future. For new plantations in the studied area, the wood, which will be harvested after 30 years may be expected to conform with the sanitary rules for contaminated wood use.

The observed ^{137}Cs contamination of tree components was the result of different influential processes like internal translocation, root uptake and immobilisation. In case of perennial vegetation, the use of soil-to-plant transfer coefficients has limited relevancy since it does not integrate the effect of the various processes controlling the continuous element circulation. For more accurate predictions, the calibration of existing forest tree models would benefit from comparison with ^{137}Cs

annual fluxes instead of simple transfer factor values. In the perspective of other assessments of vegetation impact on pollutant budget (like for revegetation of contaminated sites, long term consequences of leakage from waste repositories, phytostabilisation of mining sites,...), there is a need of such data for other radionuclides as well as for heavy metals.

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The grebe family is an ancient group, with no close relatives among living birds. As far as we know, all grebes have asymmetrically lobed toes and the mode of swimming described here is probably optimally suited to this morphology.

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Table 1 Frequency of rare microsatellite variants in the offspring of wheat plants

Type of variant	Frequency*		Ratio to control	P†	Wilcoxon test	
	Control	Exposed			z	P‡
Nulls (homozygotes)	0.0056	0.0066	1.17	0.8334	0.42	0.6754
Losses (heterozygotes)	0.0010	0.0066	6.45	**0.0054**	2.57	**0.0100**
Losses (homozygotes)	0.0015	0.0029	1.88	0.5461	0.74	0.4606
Gains (heterozygotes)	0.0031	0.0087	2.82	**0.0270**	1.84	0.0654
Gains (homozygotes)	0.0015	0.0021	1.34	0.9722	0.41	0.6831
Heterozygotes losses + gains	0.0041	0.0153	3.73	**0.0003**	3.19	**0.0014**
Homozygotes losses + gains	0.0031	0.0050	1.61	0.4686	0.53	0.5930

We screened 186 and 150 wheat plants grown from seeds collected from exposed and control plants, respectively (further details are available from the authors). Assuming selective neutrality, the equilibrium frequency of heterozygous variants, H_e, was approximated as $H_e \approx 4N_e u_e/(1+4N_e u_e)$, where N_e and u_e are effective population size and spontaneous mutation rate, respectively[9]. If N_e 1 for self-fertilized plants, then u_e $H_e/4$. Homozygosity in the exposed group, f_t, was approximated as f_t [(1/2N_e) (1 (1/2N_e))] (1 u_e)^2, where f_{t-1} and u_e are the homozygosity of the previous generation and mutation rate in the exposed population, respectively[9]. If f_{t-1} 1 H_e, then u_e (H_e H_e/2)/2.
*Frequency was estimated as the number of variants per microsatellite locus.
†Probability of difference from the control group (Fisher's exact test, two-tailed; statistically significant values are in bold).
‡Probability of Wilcoxon test (statistically significant values are in bold).

Germline DNA

Wheat mutation rate after Chernobyl

The accident at the Chernobyl nuclear power plant in 1986 has generated concern over the genetic consequences of chronic exposure to radiation. Here we describe a new approach to monitoring germline mutation in plants and find evidence for a remarkably strong induction of germline mutation in wheat upon chronic exposure to ionizing radiation produced by the Chernobyl accident.

We compared wheat plants descended from two genetically identical populations, derived from the same homogeneous parental line. One population was grown for one generation (10 months) in a heavily contaminated plot (900 Ci km ^{2}) near the Chernobyl nuclear power plant[1], the other was sown in a clean (1 Ci km ^{2}) control area 30 km away in soil with comparable agrochemical characteristics.

Using the polymerase chain reaction, we profiled offspring plants for 13 single-copy monomorphic microsatellite loci[2]. Evidence for alterations (variants) was obtained for all 13 loci, including gains and losses of repeats, as well as complete loss of microsatellite bands (nulls) (Table 1). Offspring derived from exposed plants showed no increase in the frequency of homozygous variants and a threefold increase in the frequency of heterozygous structural variants, attributed to all loci within this group of plants.

Differences between the two initially identical populations, presumably arising over one generation, may result from seed contamination, migration or mutation. Seed contamination is unlikely, however, because neither plot had previously contained wheat. Seed contamination would also have affected the frequency of all three types of variant, including nulls and other homozygous variants. Cross-pollination can also be excluded as wheat is an obligatory self-pollinator, preventing the migration of pollen between neighbouring populations. We conclude, therefore, that the increased diversity in the heterozygous variants in the offspring is probably due to a radiation-induced increase in microsatellite mutation in the exposed plants.

Assuming that the control population is in equilibrium (Table 1), we estimate that the spontaneous mutation rate is 1.03 10 ^{3} per locus (95% confidence interval, 0.44 10 ^{3}–2.03 10 ^{3}), whereas mutation rate in the exposed group was 6.63 10 ^{3} (95% confidence interval, 4.28 10 ^{3}–9.70 10 ^{3}). Thus we attribute the more than threefold increase in heterozygosity in the exposed group to a more than sixfold increase in the mutation rate over the single generation of exposure to ionizing radiation.

We estimate that the wheat plants have been exposed to relatively low doses of chronic irradiation of about 0.3 Gy, with external and internal components of 0.2 and 0.1 Gy, respectively[3]. Theoretically, this low-level exposure should not cause such a large increase in the mutation rate, suggesting that chronic exposure to ionizing radiation has effects that are as yet unknown. Other studies have shown that chronic internal exposure is far more efficient at inducing somatic recombination than acute external exposure[1,4].

The estimated increase in mutation rate in the offspring of exposed plants is too high to be due to direct targeting of microsatellite loci by ionizing radiation. The wheat genome contains 16 10^{9} base pairs[5], and the mean size of the 13 microsatellite loci included in this study is about 100 base pairs. Attributing a sixfold increase in the mutation rate to direct radiation-induced DNA damage at the microsatellite loci would mean that the expected damage to the whole wheat genome was (increase of mutation rate) (genome size)/(size of locus) 80,000 damaging events — much higher than any experimentally derived measurements of the initial yield of radiation-induced damage to a eukaryotic cell[6]. The increase in microsatellite mutation rate in plants may therefore be better explained by a non-targeted effect of ionizing radiation elsewhere in the cell, as described for mammalian minisatellite loci[7,8].

Our findings raise the important issue of the genetic hazard of chronic radiation exposure to the germ line, showing that the apparent rate of induced microsatellite germline mutation is much higher than existing estimates of absorbed doses of exposure would predict. Further study is needed to analyse the genetic effects of chronic radiation exposure.

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Metabolic scaling

Energy constraints on carnivore diet

The energy expenditure of mammals reflects their habits and environments[1], subject to limitations associated with body size. Carbone *et al.*[2] combined scaling relationships to argue that large species of the mammalian order Carnivora (weighing more than 21.5 kg) do not specialize on invertebrate prey. However, many tropical mammals that feed exclusively on ants and termites are much heavier than this, often weighing up to 60–70 kg; they survive by progressively reducing their metabolic rate to below that expected from their body size. I believe that this response indicates that it is not body size that limits the determination of diet, but rather the maximal rate of energy expenditure.

The size limit for a predator exclusively dependent on invertebrate prey is not absolute. For example, the sloth bear (*Ursus ursinus*), a carnivore that can weigh as much as 145 kg and feeds extensively (but not exclusively[3]) on termites, was considered by Carbone *et al.* to be an outlier — but outliers should not be ignored as they may tell us that our theories are incomplete. Their analysis[2] fails to recognize that all scaling relationships contain biologically relevant variation, and inherent in this residual scatter are adjustments that permit a large mass in carnivores and other terrestrial mammals that consume invertebrate prey.

Large mammals (over 20 kg) that specialize in eating tropical ants and termites include the aardvark (*Orycteropus afer*) and some pangolins (*Manis temmincki* and *M. gigantea*), tamanduas (*Myrmecophaga tridactyla*) and armadillos (*Priodontes maxima*). These[4,5] and the sloth bear[6] generally have lower standard rates of energy expenditure than other mammals. As ant and termite predators increase in size, their basal rate of metabolism decreases (Fig. 1), a trend that is particularly evident when species in a family are compared (to correct for any putative effect of phylogeny or ecological/behavioural uniformity).

A reduction in metabolic rate reduces the effective body size, which can be estimated from the total basal rate of the largest committed ant/termite eaters. If an all-mammal standard[7] for basal metabolic rate is used, a 15.9-kg *Manis crassicaudata* has the basal rate of a 3.4-kg standard mammal, a 30.6-kg *Myrmecophaga* has that of a 10.9-kg standard mammal, a 45.2-kg *Priodontes* has that of a 13.4-kg standard mammal, a 48-kg *Orycteropus* has that of a 36.2-kg standard mammal, and a 67.0-kg *U. ursinus* has that of a 56.5-kg standard mammal.

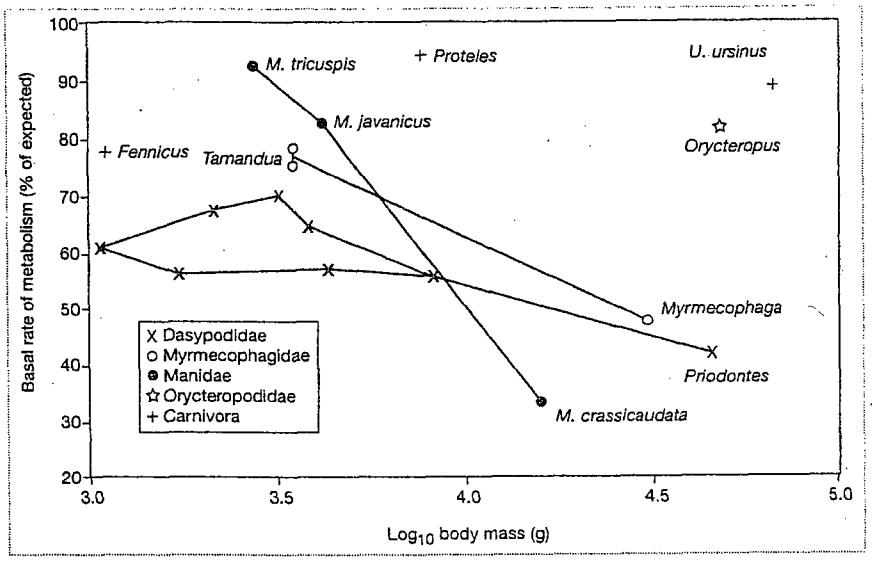

Figure 1 Basal rate of metabolism, expressed as a percentage of the basal rate expected from an all-mammal curve[7], in various mammals[4–6] that specialize on soil invertebrates, as a function of body mass. Species that belong to the same family are connected.

These calculations indicate that the maximum body mass in a standard mammal compatible with an ant/termite-eating habit is 11–13 kg, with the exception of the aardvark and sloth bear. This calculation may account for the comparatively high basal rate in *Proteles* (Fig. 1), which weighs less than 10 kg — at that mass, an adjustment of basal rate may not be required. What seems to be limited is the total rate of energy expenditure, not body mass: a limiting rate may be encountered in various masses at the expense of conforming to a standard curve and having effective endothermic temperature regulation.

Two of the species shown in Fig. 1 exceed the 11–13-kg limit to the 'adjusted' mass. The large mass and comparatively high basal rate of the sloth bear correlate with a diet that is about 50% fruit[3], although it is not clear whether addition of fruit to the diet permits a higher expenditure or size. The most distinctive large terrestrial specialist insectivore is the aardvark, which conforms neither to the original analysis[2], nor to the evasion described here. How it can have its comparatively high basal rate and a large body mass, and eat only ants and termites, is unknown. Under the assumption that a limiting energy expenditure exists, some other evasion may apply.

A limit to the exclusive use of invertebrates by terrestrial mammals, if one exists, may be associated with the cost of prey collection, which is why the largest species are tropical and feed on ants and termites: only these prey occur in sufficiently large colonies to make prey acquisition energetically feasible, and such large colonies occur only in the lowland tropics. In the absence of colonial ants and termites, terrestrial invertebrate-eaters might attain a maximal mass of 10 kg (ref. 5). The absence of an ant/termite specialization in large carnivores may occur because this niche was occupied by other mammals before the evolution or arrival of carnivores, the only opportunity available being at intermediate masses, which was exploited in Africa by the aardwolf and the bat-eared fox (*Otocyon megalotis*).

Although it might be argued that this analysis fails to take phylogenetic history into consideration, it has been pointed out[8] that 'corrections' for proposed phylogeny erroneously assume the priority of phylogeny as a factor influencing phenotypic characters, thus ignoring the complex interactions among determinative factors. The model of Carbone *et al.*[2] is ultimately called into question because it ignores the residual variation and therefore the biological flexibility inherent in all scaling functions.

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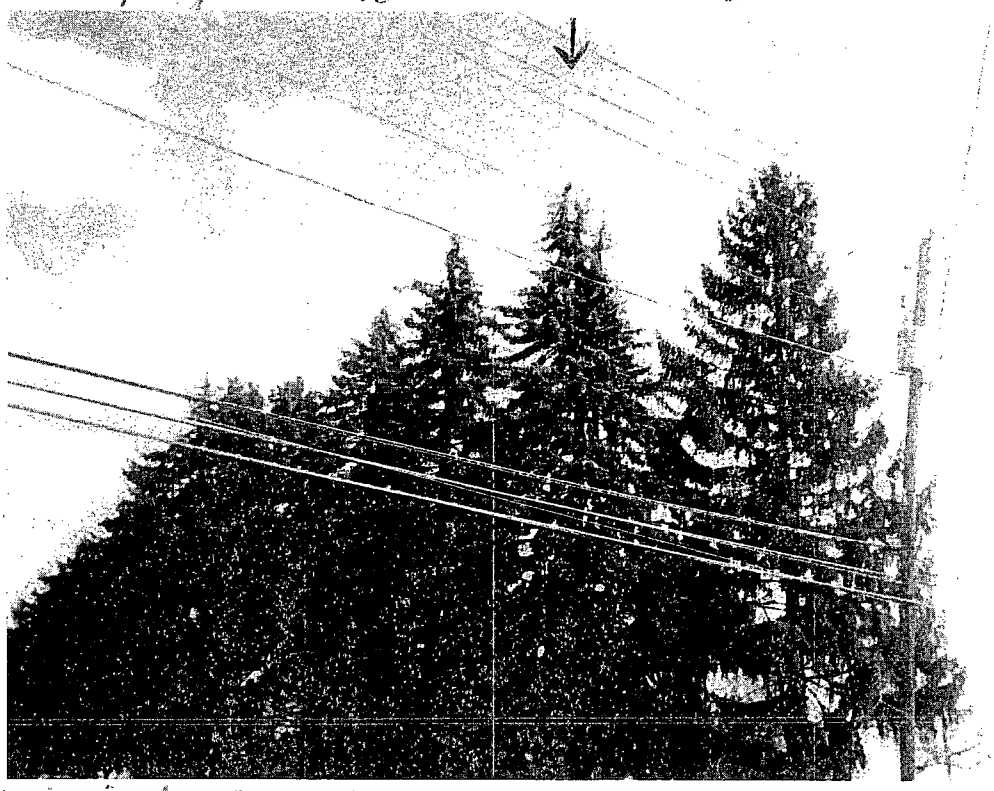
"Nuclear" sites in PA / MD

@ Chambers Hill & Reckler - tree tops - damage by TMI per Dr. James Deckel, Brookhaven Lab & Rutgers Prof Emeritus. March 2008 - 29 years.

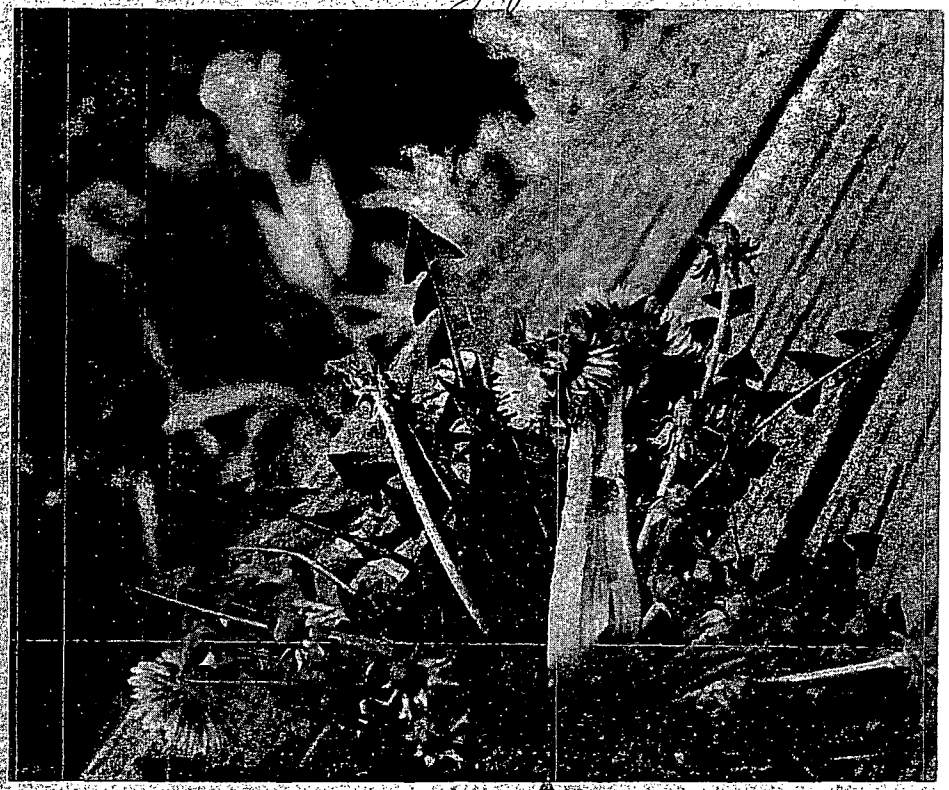


Many more found beyond 25 miles; all over central PA

Now - looks like defoliation ↑

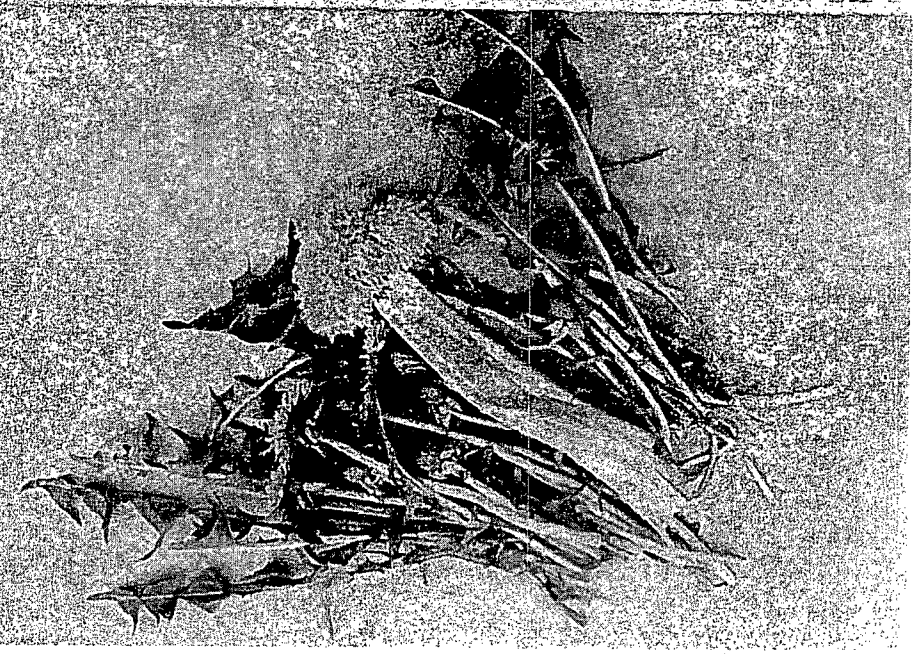
@ Goldsboro on river -
Whitlock died of cancer
+ wife has cancer!

6½ miles N.N.W.
Every year since accident

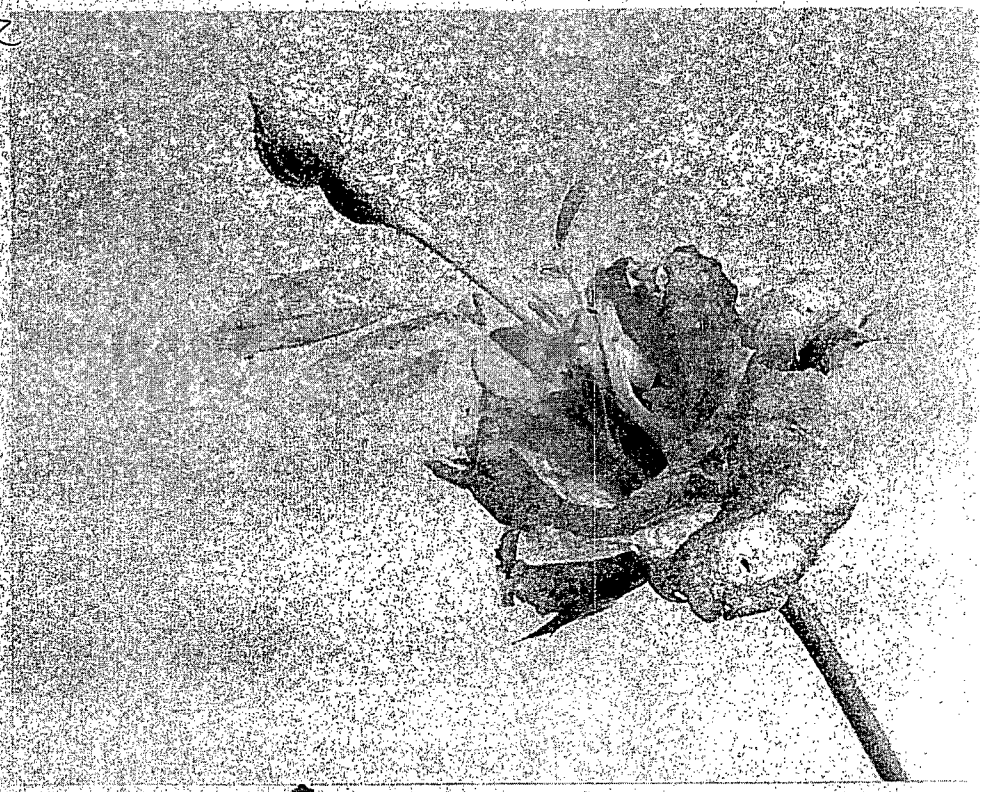


GLORIOSA DAISY 1999

DANDELION 2002 ↑ 1987 ↓

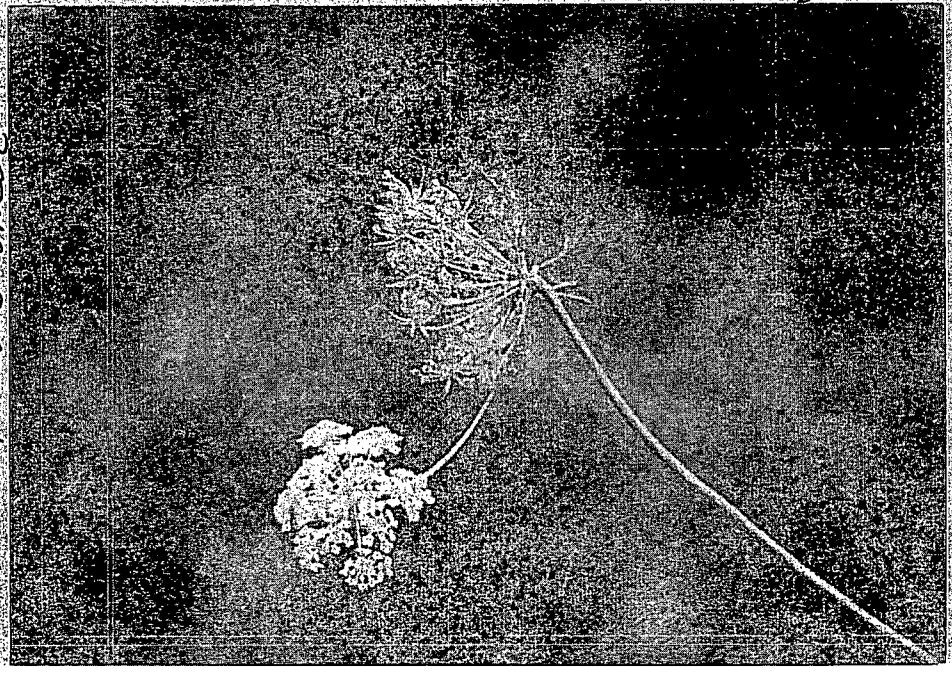


This rose bush had one white rose the summer of 1979. Lady had cancer in 2006.



ROSE 1987 - DOUBLE ↑ QUEEN ANNE'S LACE 1986 ↓

ROSE ↕ 1987 - NO REPRODUCTIVE PAR



Rose - lady died of brain cancer

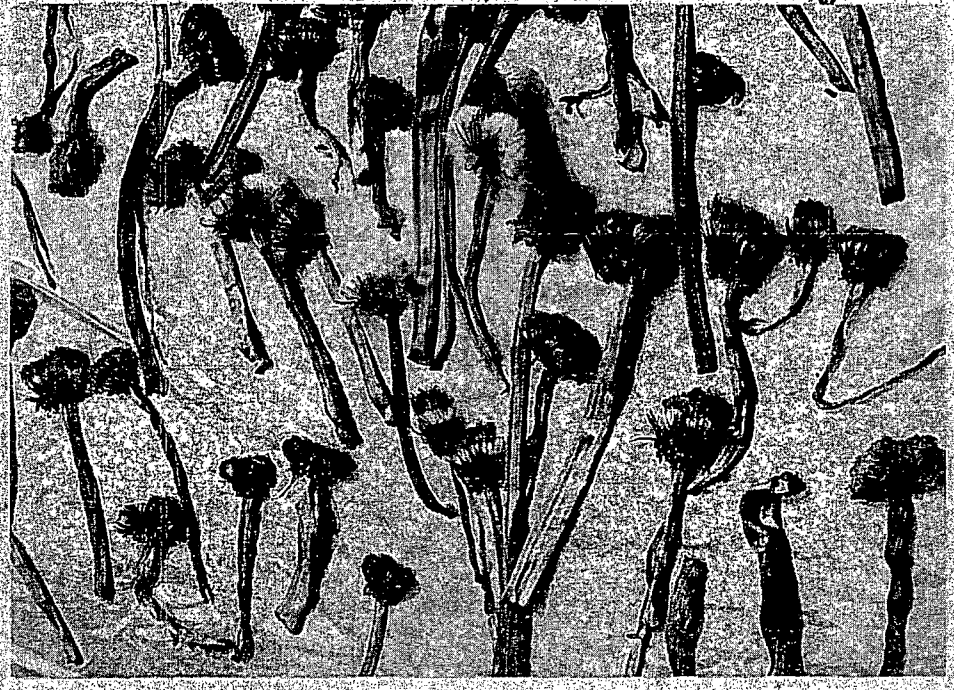
Lancaster County - [illegible]

[illegible] cures - [illegible]
radiation effect.

4 eye
2 ear

ZINNIA 1984 ↑ DANDELIONS 1992 ↓

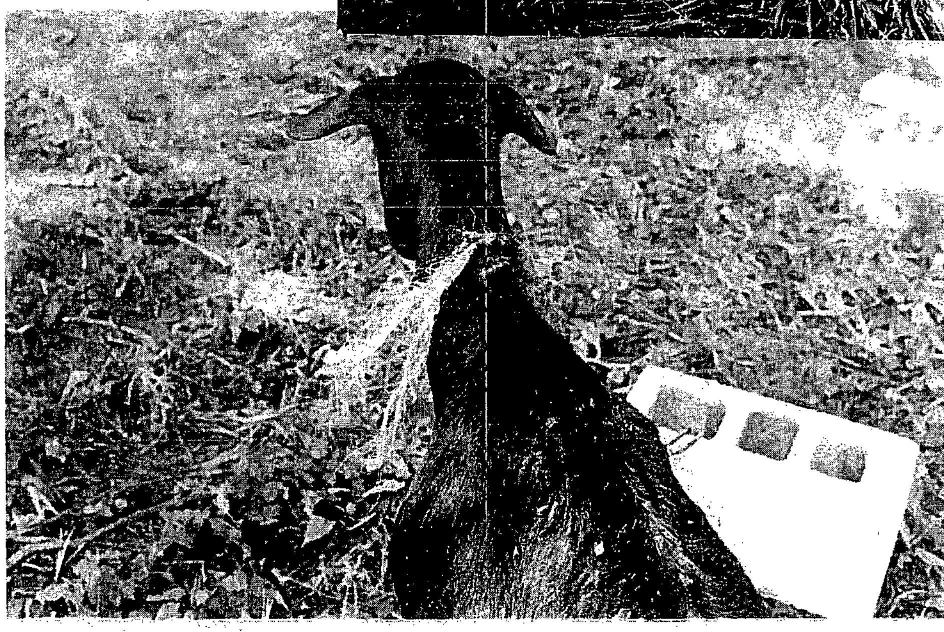
↑ EVERGREEN TREE 1984. DOUBLE HEADED CALF ↓



farmer Myers died of thyroid cancer in 1989

Etters - Farmer died of Cancer

near TMI - Middletown NO EYES! she sued & got $. Poodles →



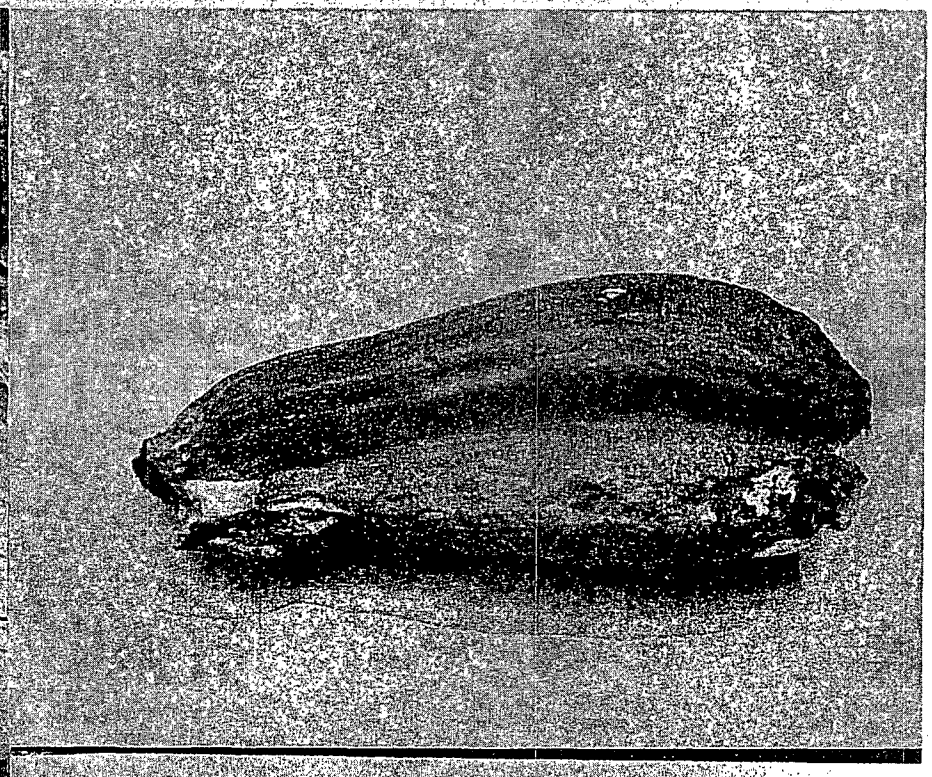
• 1 goat w/ hair loss •

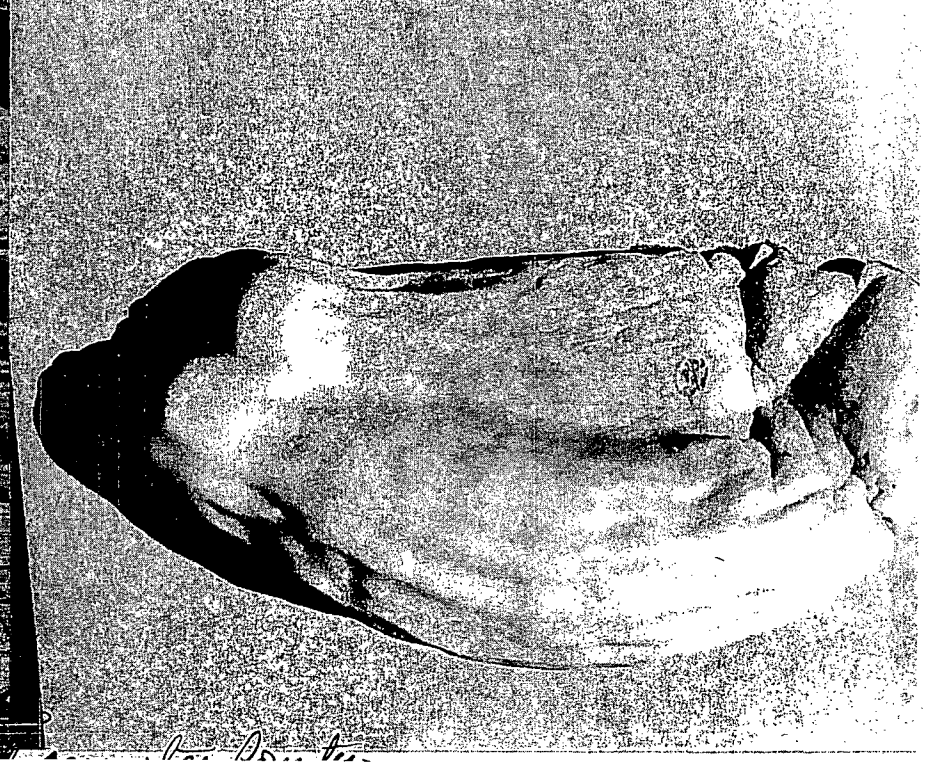
stillborn calf w/ ? calcification - placenta? →

• Black poodle w/ eye sockets, but no eyes! across street from TMI •

Dauphin County

Double Squash





Chicken with four legs goes on tour

By FRAN DOLL
Special Correspondent

NEW FREEDOM — The little town of Goldsboro in the northern part of the county gained national notoriety because of the TMI incident, but for a little while in the small community of New Freedom in the southern part of the county it seemed that "Mr. Costa's Chicken" might over-shadow Goldsboro's importance.

Now a parent with three boys fighting over the two legs of an ordinary fryer could probable best appreciate this particular chicken, who by some turn of nature, was born with four legs.

However, before rushing off to visit this unusual member of the animal world, "Mr. Costa's Chicken" will not end up in the frying pan, not in the immediate future anyway.

"Mr. Costa's Chicken," now nine weeks old, has moved on to bigger and better things as a star performer with Billett's Amusement Rides.

"It," it was not determined if it was he or she, is now appearing in North Carolina on the same billing as a boy who swallows snakes.

Actually the chicken was not formally named but it sounds funny just writing chicken all the time. It was called "Mr. Costa's Chicken" since that was what everybody was calling it anyway.

Stephen Costa, 230 Second Ave. was visiting the poultry farm of Emmett Markey, Dallastown RD 1, when he noticed that one of the latest group of future fryers seemed to have an extra set of legs attached to it's body. The chicken Dick Ruff helped separate it from several thousand other squakers, Markey gave it to Costa.

Upon closer examination, Costa discovered that aside from having two extra legs there also seemed to be another chicken inside.

According to Margaret Galloway, 234 Second St., who took care of the chicken for Costa, you could actually hear another chicken chirping inside "Mr. Costa's Chicken."

The chicken walked on its front pair of legs. But, when the inside chicken chirped, the back legs, which were facing in the opposite direction, started wiggling.

Mrs. Galloway feels that the two chickens were joined in the breast area of the outside chicken. That area of the outside chicken seemed rather thinner than normal and you could see it move as if the other chicken was breathing, according to Costa.

When "Mr. Costa's Chicken" ate it would stretch its head way back as if trying to make sure the inside chicken got food.

Everytime it took a bite to eat, it would then take a drink. It would reportedly drink a one-pound margarine container of water over a four-hour period.

And for those wondering, "it" did it's business in the normal way.

One lady came to visit the chicken four times and even dreamed about it. She was so fascinated that she says she hasn't eaten chicken since.

One of Costa's neighbors, who works for Johns Hopkins Hospital, expressed an interest in examining the chicken, felt to ascertain just what was inside, feeling that an X-ray might be harmful.

According to a hatchery, they only see a four-legged chicken twice in every 150,000 peeps, so most people will have to be content with squabbling over the two-legged variety for awhile.

For those skeptics who would like to see for themselves "Mr. Costa's Chicken," will have to visit Billett's Musement Rides in Columbia in June.

Stephen Costa and 'The Chicken'

Could you farm through fallout?

By ALEXANDRA KNOX

Suppose the Hanford Nuclear Reactor in Washington State suffers a meltdown, spewing 7% of its radioactive core into the atmosphere. Winds headed east across the U.S. would bury some of this country's prime farmland in fallout—the kind that sticks around for decades.

Not likely, you say? Maybe not. But the "Bulletin of the Atomic Scientists" at one time considered it possible enough to come up with this scenario:

"Truck farmers in central Idaho are told to plow under leafy vegetable crops such as spinach and lettuce [because radiation sticks to vegetation]; Minnesota dairy farmers are told to keep all their livestock in barns [to limit exposure and prevent grazing on contaminated forage]; in Madison, Wis., dairy sales fall 90% in response to rumors of radioactive iodine in milk . . ."

Depending on the time of year, precipitation patterns and soil types involved, South Dakota's sheep could turn up radioactive years later, having grazed on forage that has confused cesium-137 and strontium-90 with potassium and calcium. Wyoming's beef cattle, having accumulated cesium over hundreds of acres, could measure "well-done" on a Geiger counter. And in the Northeast, with its nutrient-poor, rock-bottomed lakes, certain fish might become the hottest food around.

Over the long-run, crops like corn and wheat would be in relatively good shape because their leaves—not the grain itself—would hold most of the radioactive particles.

Scientists picked the Hanford plant for good reason. It is the U.S.'s version of the Chernobyl Atomic Energy plant that melted down in Russia two years ago this month. The Hanford plant had been leaking for years. Last year, in light of safety problems spotlighted by the Chernobyl accident, the Hanford plant was shut down.

But nuclear plants around the world are aging, a fact that's not lost on people who deal in food—whether they raise it or trade it.

In mid-February, rumors of another nuclear accident in Russia sent domestic markets into a fury. Although the "nuclear" accident actually turned out to be a chemical spill, it's an example of how nuclear problems have become an everyday concern.

Throughout Europe, farmers are right now living—and farming—with a situation exactly like the one outlined above.

Although the Chernobyl reactor itself has since been incarcerated in concrete, the damage from it persists. Some of the fallout's effects in agricultural areas are just beginning to surface:

- Cesium-saturated grazing areas in Lapland continue to contaminate thousands of reindeer, at an estimated cost of $182 million.
- In Sweden, radioactive milk, fish and wild mushrooms are still a problem.
- Northern England, Wales and Ireland report radioactive sheep. Radioactive meat from Denmark has appeared in Venezuelan ports. Turkey has "hot" hazelnuts, and West German deer have set off Geiger counters.

The Chernobyl experience provides a better understanding of how farmland interacts with fallout. The accident has, in effect, offered scientists a real-world laboratory for combating radioactivity in our soils.

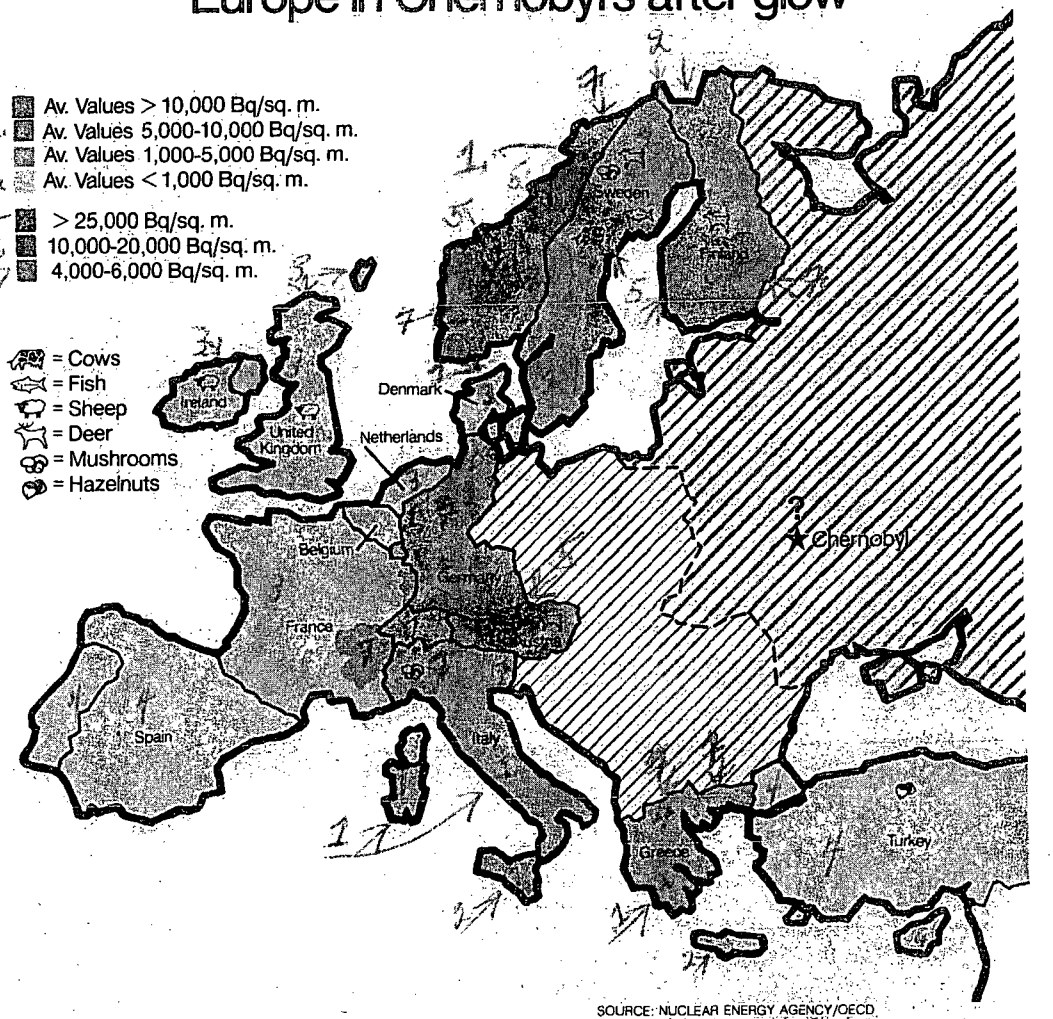
In late-April 1986, winds carried radioactive particles and gases thousands of miles from the Chernobyl Atomic Energy Plant. Rain and snow cleared the air but loaded vegetation and soils with iodine-131, cesium-134, cesium-137 and, to a lesser degree, strontium-90. The fallout forced the Soviets to remove and bury 650,000 cubic yards of contaminated soil—about 400 acres scraped one 1' deep.

Today, the 18-mile zone surrounding the plant in the agriculturally important Ukraine remains highly contaminated in parts, say the Soviets, although safe enough to allow the return of some of the 115,000 evacuees. Farming there is impossible.

But that's just a small part of the Chernobyl problem. Damage to crops, livestock and farmland ranges far from the site. Radioactivity from the accident is still playing havoc with farmers' livelihoods.

Take Lapland, for instance. A forested wilderness extending across northern Norway, Finland, Sweden, Lapland lies about 1,100 miles from Chernobyl. The lichen that carpet its forest floors are saturated with cesium-137, a radioisotope with a half-life of over 30 years.

Europe in Chernobyl's after glow



SOURCE: NUCLEAR ENERGY AGENCY/OECD

THIS MAP SHOWS THE AVERAGE amount of cesium-137 and -134 in 1,000 becquerels per square meter, as measured on European soils from May 1986 to April 1987. Cesium concentrations are highlighted. Since the data were gathered, some of the cesium will have washed away or have been trapped in the soil. But plants and animals are still picking up the long-lived radioactive particles, even in some low fallout areas.

(that is, its radioactivity will be half as active in 30 years as today).

Reindeer herded and eaten by the Lapps graze on the lichen. Swedish authorities have detected up to 100 times more radioactive cesium in those reindeer than permissible. Tens of thousands of reindeer have had to be fed to mink instead of sold for human consumption. To lessen the economic blow, the Swedish government buys the contaminated meat at an estimated $182 million.

The contamination elsewhere in Sweden is abating. Yet some farms are today producing radioactive milk; fish in Sweden's nutrient-poor, granite-bottomed lakes are showing higher and higher concentrations of radioactive cesium; and wild mushrooms—very popular in Sweden—remain off limits, says Ake Bruce, nutrition expert at Sweden's National Food Administration.

It takes several years for cesium to migrate from the environment to food and then to humans. In most cases, concentrations diminish. In others, radioactivity can increase. How long before it goes away? Sometimes very long.

In northern England, sheep from 635 farms suffer from radiation levels exceeding government safety limits, according to the Country Landowner's Association.

The problem is that the soil where these sheep graze has failed to trap the cesium. Two years ago, says Frances Livens, radiochemist at the Institute of Terrestial Ecology in Britain, "We thought the cesium would lock up in the soil in three months. We're finding that the relatively acidic soils high in organic matter can't do that."

Livens speculates that it may take years before the cesium locks up in "peats and thin, nasty soils." Meanwhile, hundreds of thousands of sheep are banned from public sale. The affected farmers may have to wait *three decades* before they can sell their animals on the open market.

Scientists have discovered that, generally speaking, the stingiest soils under the nuclear cloud's path are those most likely to offer long-term harvests of cesium-137. That's because crops grown on poor soils will take whatever nutrients they can get. Plants on richer soils will usually choose standard elements before chemically similar radioactive ones.

Carl Rosen, soil scientist at the University of Minnesota, explains that cesium behaves like potassium in soil. In basic soils, cesium is trapped by clay particles. Likewise, say Swedish scientists, cultivated, fertilized soils rich in minerals bind cesium ions. But in poor soils with little clay and minerals (tundra, sandy soils) or mostly organic matter (such as peats and tropical soils), cesium remains available to plants.

To limit the migration of cesium into the food supply, the USSR has had to deep plow, irrigate and lime hundreds of thousands of acres. Additional measures, says Harold Denton, a Nuclear Regulatory Commission (NRC) director, include treating highly contaminated areas with calcium to fix radionuclides in the soil. "Then the areas might be sown with crops such as lupines that absorb radionuclides. These crops would then be harvested and buried."

Generally, cesium-137 will reside near the soils' surface unless plowed under. Thus, shallow-rooted crops like potatoes or sugar beets are more likely to be long-term problems than deep-rooted ones like grains, says Gary Paulsen, Kansas State agronomist. He says contamination depends on the stage of growth and even variety; however, soybeans, requiring more potassium than grasses like rye, are likely to take more cesium up through their roots.

In the short-run, according to George Ham, Kansas State agronomist, rice would best resist the tissue-damaging beta particles emitted by radionuclides. Corn, sorghum, potatoes and sugar beets are moderately resistant. Wheat, oats and barley are very sensitive.

Processing removes much of the contamination. Potatoes lose radionuclides when made into starch; in milk they are filtered out during cheese-making. Other good crops are flax or cotton, because they aren't edible. "As it happens, rye, potatoes and flax are customary crops in the soils of the Chernobyl area," says Denton.

Fighting fallout has proved disruptive, costly, rarely practical and full of unknowns, say experts. Our best lab is Russia, but its experience, like its fallout, make take years to surface. ◀

insert into aquatic Nureg Effects

Met-Ed GPU

Metropolitan Edison Company
Post Office Box 480
Middletown, Pennsylvania 17057

Writer's Direct Dial Number

Met-Ed's FISH MUTATIONS in Susquehanna River

September 12, 1980
TLL 458

I guess I'm not the only person finding mutations.

TMI Program Office
Attn: Mr. Bernard J. Snyder
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Request for Additional Information Regarding the
1979 Annual Report of Aquatic Ecological Studies at TMI

Enclosed please find the information as requested in your letter of August 5, 1980, to Mr. R. C. Arnold.

Table 1 of the enclosure is the delineation of data for the four creel survey areas as requested in item 1 of the attachment to your letter.

Table 2 through 7 are tabulations of the raw data for Ichthyoplankton in the format requested in item 2 of the attachment to your letter. Again, it is stressed here that these tabulations are of raw data. At present, attempts are ongoing to better quantify and categorize the data so handling damage and physical damage can be more uniformly separated. Presently, the occurrence or percentage incidence of deformities of fish larvae is unknown, as are fluctuations in such occurrences. Only after two or three years of comparable data would it be possible to draw any conclusions. For these reasons, the use of the above Ichthyoplankton data for publication and widespread distribution is not recommended.

In response to your last request for detailed descriptions of deformities, based on preliminary data, malformations included the following:

1. Eyes unsymmetrically aligned on the head sometimes accompanied by unusual head formations (a bulge or depression where normally the contour would be smooth).
2. Eyes fused together.
3. Ventral part of head (including mouth) absent.
4. One eye underdeveloped.
5. The notorchord crooked or kinked.

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Other types of deformities found which probably resulted from handling damage included:

1. Missing or partial eyes, with the eye socket formed but healed over without eye.
2. Missing and broken fins.
3. Eyes popped out.

These types of injuries occur during the collection and sample processing and were not counted in the above tables.

If you require additional information concerning this data, please let us know.

Sincerely,

G. K. Hovey
Director, TMI-2

GKH:SDC:dad

cc: John T. Collins

Enclosures

Table 7.

Summary of numbers of ichthyoplankton taken in day and night samples at 14 stations in York Haven Pond, May 1979. Numbers in parentheses denote deformed ichthyoplankton.

	May 1	May 8	May 15	May 22	May 29-30	TOTAL	% Abundance
Cyprinidae	-	-	5	4	3	12	-
Cyprinus carpio	-	-	2172(83)	646(7)	13	2831(90)	3.2
Notemigonus crysoleucas	-	-	2	-	-	2	-
Notropis amoenus	-	-	1	5	1	7	-
N. hudsonius	1	60(2)	538(65)	661(35)	18	1278(100)	7.8
N. procne	-	-	-	-	1	1	-
N. spilopterus	-	-	1	3	1	5	-
Pimephales notatus	-	-	-	-	1	1	-
Rhinichthys atratulus	-	-	-	-	2	2	-
R. cataractae	-	-	-	-	1	1	-
Rhinichthys spp.	-	-	3	-	-	3	-
Semotilus atromaculatus	-	-	-	1	-	1	-
Semotilus spp.	-	5	4	-	-	9	-
Carpiodes cyprinus	-	137(2)	1629(31)	333(3)	201(1)	2300(37)	1.6
Catostomus commersoni	5	82(1)	39	43(1)	67	236(2)	0.8
Hypentilium nigricans	-	1	10	2	6	18	-
Moxostoma macrolepidotum	-	1	7	19	22	48	-
Ambloplites rupestris	-	1	-	3	3	6	-
Lepomis gibbosus/L. macrochirus	-	-	1	15	-	16	-
Micropterus dolomieui	-	-	1	1	4	6	-
Pomoxis spp.	-	-	1	-	-	1	-
Etheostoma olmstedi	7(1)	130(4)	220(5)	86(4)	56	499(14)	2.8
E. zonale	1	38	82(6)	46(3)	296(6)	463(15)	3.2
Perca flavescens	1	-	-	-	-	1	-
Percina peltata	7	15(1)	38(1)	5(1)	10	75(3)	4.0
Stizostedion v. vitreum	10(1)	7	-	2(1)	-	19(2)	10.5
Unidentified	-	-	-	-	18	18	
TOTAL	32(2)	474(10)	4754(191)	1875(53)	724(7)	7859(263)	

Table 7 continued.

	IM-LF-10P2 D	IM-LF-10P2 N	IM-LF-10P3 D	IM-LF-10P3 N	IM-LF-9A1 D	IM-LF-9A1 N	IM-LF-11A1 D	IM-LF-11A1 N	IM-LF-16A1 D	IM-LF-16A1 N	TOTAL D	TOTAL N	% DEFORMED D	% DEFORMED N	GRAND TOTAL	% DEFORMED
Notropis hudsonius	-	6	-	1	-	1	-	7	2	6	2	58(2)	-	3.4	60(2)	3.3
Semotilus spp.	-	-	-	-	-	-	-	-	-	-	-	5	-	-	5	-
Carpiodes cyprinus	1	17(1)	-	3	-	19	-	3(1)	-	1	2	123(2)	-	1.6	137(2)	1.4
Catostomus commersoni	-	2	1	14	-	2	-	-	-	3	1	129(4)	-	3.1	130(4)	3.1
Hypentilium nigricans	-	9	-	3	-	5	-	2(1)	-	2	-	38	-	-	38	-
Moxostoma macrolepidotum	-	-	-	-	-	1	-	-	-	2	1	77(1)	-	1.3	82(1)	1.2
Ambloplites rupestris	-	-	-	-	-	1	-	-	-	-	-	16(1)	-	7.1	15(1)	6.7
Lepomis gibbosus/L. macrochirus	-	-	-	-	-	1	-	-	-	2(1)	-	-	-	-	-	-
E. zonale	-	-	-	-	-	1	-	-	-	-	-	7	-	-	7	-
Percina peltata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stizostedion v. vitreum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	D	N	1	34(1)	1	21	-	30	2	12(2)	2	16(1)	23	451(10)		476(10)
GRAND TOTAL				35(1)		22		30		14(2)		18(1)				

Table 1.

Distribution of anglers (among creel survey areas) fishing in the Susquehanna River near THINS, 1979. Numbers in parentheses denote anglers who reported changing their use of catch after the 28 March 1979 accident at THINS.

CREEL SURVEY AREAS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL ANGLERS
CR	-(-)	-(-)	2(-)	45(2)	106(6)	135(4)	127(6)	82(9)	59(5)	30(2)	33(-)	1(-)	620(34)
WEST DAM	-(-)	-(-)	-(-)	19(-)	48(6)	45(2)	16(4)	10(-)	15(-)	10(-)	-(-)	-(-)	163(12)
EAST DAM	-(-)	-(-)	20(-)	66(3)	75(5)	46(6)	21(6)	5(-)	18(3)	14(3)	7(-)	3(-)	275(26)
YRGS	16(-)	7(-)	64(-)	139(5)	222(8)	145(8)	132(3)	120(6)	81(10)	50(5)	29(-)	14(3)	1019(48)
TOTAL*	16(-)	7(-)	86(-)	269(10)	451(25)	371(20)	296(19)	217(15)	173(18)	104(10)	69(-)	18(3)	2077(120)

* Total does not include 266 anglers for which use of catch was unknown. Anglers interviewed more than once on a survey date were asked for use of catch data on the first interview only. Subsequent interviews listed use of catch as unknown.

Numbers of ichthyoplankton taken in day (D) and night (N) samples by push net at 14 stations in York Haven Pond, 1-May 1979. Numbers in parentheses denote deformed ichthyoplankton.

	TH-LF-16R1		TH-LF-15R1		TH-LF-1R1		TH-LF-12R1		TH-LF-12A1		TH-LF-13A1		TH-LF-13A2		TH-LF-4A1		TH-LF-10B1	
	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Notropis hudsonius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Catostomus commersoni	1	1	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1
Etheostoma olmstedi	-	2(1)	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
E. zonale	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Perca flavescens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Percina peltata	-	1	-	2	-	-	-	1	-	-	-	1	1	-	-	-	-	-
Stizostedion v. vitreum	-	-	-	1	-	5(1)	-	-	-	-	-	-	-	1	-	-	-	-
TOTAL D N	1	5(1)	1	3	-	9(1)	1	2	-	-	-	1	1	1	-	-	-	2
GRAND TOTAL	6(1)		4		9(1)		3		-		1		2		-		2	

Table 2 continued.

	TH-LF-10B2		TH-LF-10B1		TH-LF-9R1		TH-LF-11A1		TH-LF-16A1		TOTAL		% DEFORMED		GRAND TOTAL	% DEFORMED
	D	N	D	N	D	N	D	N	D	N	D	N	D	N		
Notropis hudsonius	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Catostomus commersoni	-	-	-	-	-	-	-	-	-	-	3	2	-	-	5	-
Etheostoma olmstedi	-	-	-	-	-	-	-	-	-	-	-	7(1)	-	14.3	7(1)	14.3
E. zonale	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Perca flavescens	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Percina peltata	-	-	-	-	-	-	-	1	-	-	1	6	-	-	7	-
Stizostedion v. vitreum	-	-	-	-	-	1	-	-	-	2	-	10(1)	-	10.0	10(1)	10.0
TOTAL D N	-	1	-	-	-	1	-	1	-	2	4	28(2)				
GRAND TOTAL	1		-		1		1		2						32(2)	

Table 4

Numbers of ichthyoplankton taken in day (D) and night (N) samples by push net at 14 stations in York Haven Pond, 15 May 1979. Numbers in parentheses denote deformed ichthyoplankton.

	TM-LF-14R1		TM-LF-15R1		TM-LF-1R1		TM-LF-12R1		TM-LF-17A1		TM-LF-13A1		TM-LF-13A2		TM-LF-4A1		TM-LF-10R1	
	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Cyprinidae	-	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyprinus carpio	2	68	3	6	27	150(3)	1	10	2	12	4	8	14	329(2)	4(1)	309(22)	4	3
Notemigonus crysoleucas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Notropis anogenus	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
N. hudsonius	-	82(1)	-	2	3	26(1)	-	18(3)	1	18(1)	-	1	2	29(2)	1	119(19)	1	1
N. spilopterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Rhinichthys spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Semotilus spp.	-	1	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Carpiodes cyprinus	-	30	2	114	12(1)	116(1)	-	54	1	335(5)	2	73(1)	1	48	3	130(4)	2	18(2)
Catostomus commersoni	-	9	-	4	-	2	-	-	-	8	-	-	-	2	-	9	-	-
Hypentilium nigricans	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	7	-	-
Moxostoma macrolepidotum	-	-	-	2	-	3	-	-	-	-	-	-	-	-	-	1	-	-
Lepomis gibbosus/L. macrochirus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Micropterus dolomieui	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Perca spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Etheostoma olmstedi	1	4	-	6	1	16	-	10	-	66(3)	-	6	1	1	-	1	-	4
E. zonale	-	4	-	6	1	12(1)	2	4	-	4	-	5(1)	-	10(1)	4	4	1	1
Percina peltata	3	5	-	-	-	1	-	-	-	1	-	-	-	6	10	1	-	-
TOTAL D N	6	204(1)	5	143	44(1)	376(6)	3	96(3)	4	449(9)	6	91(2)	17	427(5)	22(1)	584(45)	8	27(2)
GRAND TOTAL	210(1)		148		370(7)		99(3)		453(9)		97(2)		444(5)		606(46)		35(2)	

Table 4 continued.

	TM-LF-1/R2		TM-LF-10R1		TM-LF-9R1		TM-LF-11A1		TM-LF-16A1		TOTAL		% DEFORMED		GRAND TOTAL	% DEFORMED
	D	N	D	N	D	N	D	N	D	N	D	N	D	N		
Cyprinidae	-	-	-	-	-	1	-	-	-	-	-	5	-	-	5	-
Cyprinus carpio	-	12	2	428(14)	7	141(9)	11	215(17)	9	393(15)	90(1)	2082(82)	1.1	3.9	2172(83)	3.8
Notemigonus crysoleucas	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-
Notropis anogenus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
N. hudsonius	1	73(16)	-	21(1)	-	45(6)	6	51(7)	1	36(8)	16	522(65)	-	12.4	538(65)	12.1
N. spilopterus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Rhinichthys spp.	-	-	-	2	-	1	-	-	-	-	-	3	-	-	3	-
Semotilus spp.	-	1	-	-	-	-	-	-	-	-	-	4	-	-	4	-
Carpiodes cyprinus	-	56(8)	-	73(2)	-	260(4)	-	156(2)	2	141(1)	25(1)	1604(30)	4.0	1.9	1629(31)	1.9
Catostomus commersoni	-	2	-	1	-	1	-	1	-	-	-	39	-	-	39	-
Hypentilium nigricans	-	-	-	-	-	-	-	-	-	-	-	10	-	-	10	-
Moxostoma macrolepidotum	-	-	-	-	-	-	1	-	-	-	1	6	-	-	7	-
Lepomis gibbosus/L. macrochirus	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Micropterus dolomieui	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-

Table 5

Numbers of ichthyoplankton taken in day (D) and night (N) samples by push net at 14 stations in York Haven Pond, 22 May 1979. Numbers in parentheses denote deformed ichthyoplankton.

	TM-LF-16B1		TM-LF-15B1		TM-LF-1B1		TM-LF-12B1		TM-LF-12A1		TM-LF-13A1		TM-LF-13A2		TM-LF-4A1		TM-LF-10B1	
	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Cyprinidae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Cyprinus carpio	-	10	1	2	-	4	1	-	-	4	-	69(2)	1	12	-	17	-	2
Notropis amoenus	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
N. hudsonius	4	132(5)	1	7	-	19(1)	-	67(5)	-	62(8)	1	-	1	31	-	117	1	7
N. spilopterus	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Semotilus atromaculatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Carpiodes cyprinus	-	4	-	27	4(1)	18	2	6	-	5	3	5	2	27	-	96	-	7(1)
Catostomus commersoni	-	14	-	-	-	2	-	-	-	-	-	4	-	3	-	6	-	1
Hypentilium nigricans	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moxostoma macrolepidotum	-	1	-	-	-	-	-	1	-	2	-	-	-	-	-	11	-	-
Ambloplites rupestris	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-
Lepomis gibbosus/L. macrochirus	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	5	-	-
Micropterus dolomieui	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Etheostoma olmstedi	-	3	-	3	1	3	-	4(1)	-	23	-	2	-	8(1)	-	8	-	3(1)
E. zonale	1	-	-	6	-	7(2)	1	-	-	1	-	-	3	5	-	1	2(1)	1
Percina peltata	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Stizostedion v. vitreum	-	-	-	-	-	1(1)	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL D N	3	166(5)	2	45	5(1)	57(4)	4	79(6)	-	97(8)	4	81(2)	7	89(1)	1	264	3(1)	21(2)
GRAND TOTAL	169(5)		47		62(5)		83(6)		97(8)		85(2)		96(1)		271		24(3)	

Table 5 continued.

	TM-LF-10B2		TM-LF-10B3		TM-LF-9B1		TM-LF-11A1		TM-LF-16A1		TOTAL		% DEFORMED		GRAND TOTAL	% DEFORMED
	D	N	D	N	D	N	D	N	D	N	D	N	D	N		
Cyprinidae	1	-	-	-	-	2	-	-	-	-	1	3	-	-	4	-
Cyprinus carpio	-	2	-	423(4)	-	77(1)	-	9	1	11	4	642(7)	-	1.1	646(7)	1.1
Notropis amoenus	2	-	-	-	-	-	-	1	-	-	2	3	-	-	5	-
N. hudsonius	1	43(3)	-	48(2)	-	22	3(1)	29	1(1)	68(7)	9(2)	652(31)	22.2	4.8	661(33)	5.0
N. spilopterus	-	1	-	-	-	-	-	-	-	-	-	3	-	-	3	-
Semotilus atromaculatus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Carpiodes cyprinus	-	33	-	15	-	15	3	17	1	43(1)	15(1)	318(2)	6.7	0.6	333(3)	0.9
Catostomus commersoni	1(1)	8	-	1	-	-	-	1	-	2	1(1)	42	100.0	-	43(1)	2.3
Hypentilium nigricans	-	1	-	-	-	-	-	-	-	-	-	2	-	-	2	-
Moxostoma macrolepidotum	1	2	-	-	-	1	-	-	-	-	1	18	-	-	19	-
Ambloplites rupestris	-	-	-	-	-	-	-	-	-	1	-	3	-	-	3	-
Lepomis gibbosus/L. macrochirus	-	-	-	-	-	-	-	1	1	2	3	10	-	-	15	-
Micropterus dolomieui	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Etheostoma olmstedi	-	-	-	-	-	9	-	4	1	14(1)	2	84(4)	-	4.8	86(4)	4.6
E. zonale	-	-	-	1	-	-	-	7	2	5	12(1)	34(2)	8.3	5.9	46(3)	6.5
Percina peltata	1(1)	-	-	-	-	-	-	-	-	-	4(1)	1	25.0	-	5(1)	20.0
Stizostedion v. vitreum	-	-	-	-	-	-	-	1	-	-	-	2(1)	-	50.0	2(1)	50.0
TOTAL D N	7(2)	90(3)	-	488(6)	1	126(1)	6(1)	70	7(1)	146(9)	56(6)	1819(47)				
GRAND TOTAL	97(5)		488(6)		127(1)		76(1)		153(10)						1875(53)	

Numbers of ichthyoplankton taken in day (D) and night (N) samples by push net at 16 stations in York Haven Pond, 29-30 May 1979. Numbers in parentheses denote deformed ichthyoplankton.

	TM-LF-14B1		TM-LF-15B1		TM-LF-1B1		TM-LF-12B1		TM-LF-12A1		TM-LF-13A1		TM-LF-13A2		TM-LF-4A1		TM-LF-10B1	
	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Cyprinidae	-	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-
Cyprinus carpio	-	1	-	-	1	-	-	1	-	1	1	1	-	2	-	-	-	-
Notropis amoenus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. hudsonius	1	3	-	-	-	-	-	2	-	-	-	1	-	3	-	-	-	1
N. procne	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
N. spilopterus	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Pimephales notatus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhinichthys atratulus	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
R. cataractae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carpiodes cyprinus	-	7	2	-	1	4	1	5	2	6	2	21	2(1)	21	-	11	-	-
Catostomus commersoni	8	19	2	1	1	-	4	12	1	6	-	-	-	2	-	-	-	-
Hypentilium nigricans	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Moxostoma macrolepidotum	-	-	-	-	-	-	-	1	-	-	1	-	1	1	-	-	-	-
Ambloplites rupestris	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-
Micropterus dolomieui	-	2	-	1	-	2	-	3	1	3	1	13	2	4	1	1	2(1)	4(1)
Etheostoma olmstedi	18	24(2)	5	4	5	4	15	10(1)	12	15	15	11	20	29(1)	3	1	-	-
E. zonale	3	-	-	-	1	-	2	-	-	-	-	-	-	3	-	-	-	-
Percina peltata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL D N	33	58(2)	9	5	10	10	23	37(1)	16	31	21	48	25(1)	65(1)	9	13	5(1)	5(1)
GRAND TOTAL	91(2)		14		20		60(1)		47		69		90(2)		22		10(2)	

Table 6 continued.

	TM-LF-10B2		TM-LF-10B3		TM-LF-9B1		TM-LF-11A1		TM-LF-16A1		TOTAL		% DEFORMED		GRAND TOTAL	% DEFORMED
	D	N	D	N	D	N	D	N	D	N	D	N	D	N		
Cyprinidae	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	
Cyprinus carpio	1	-	-	1	-	2	-	1	-	2	3	10	-	-	13	
Notropis amoenus	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	
N. hudsonius	2	-	1	1	1	1	-	1	-	-	5	13	-	-	18	
N. procne	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	
N. spilopterus	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	
Pimephales notatus	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	
Rhinichthys atratulus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
R. cataractae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	
Carpiodes cyprinus	1	20	1	38	-	41	1	7	1	5	15(1)	186	6.7	-	201(1)	0.5
Catostomus commersoni	2	3	1	2	-	2	1	-	-	-	21	46	-	-	67	
Hypentilium nigricans	-	-	1	-	-	-	1	-	-	-	4	2	-	-	6	
Moxostoma macrolepidotum	2	7	-	7	1	1	-	-	1	-	6	16	-	-	22	
Ambloplites rupestris	-	-	-	-	-	-	-	-	-	-	2	1	-	-	3	
Micropterus dolomieui	-	2	-	1	-	-	-	-	-	-	-	4	-	-	4	
Etheostoma olmstedi	1	4	-	6	2	5	1	2	1	-	10	46	-	-	56	
E. zonale	14	8	5	2	37	8	6	1	4	10	165(1)	131(5)	0.6	3.8	296(6)	2.0
Percina peltata	-	-	-	-	-	-	-	-	1	-	7	3	-	-	10	
Unidentified	-	-	-	18	-	-	-	-	-	-	-	18	-	-	18	
TOTAL D N	23	45	9	76	41	60	10	12	0	17	242(2)	482(5)			724(7)	
GRAND TOTAL	68		85		101		22		25							

REVERSING THE BIRTH OF THE EARTH

The Health Menace of Nuclear Power

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With a Foreword by

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Preface

The preservation of life and health is the routine obligation of physicians, but until recently the poisonous effects of nuclear contamination seemed more than I could grasp or cope with. It was not enough to know that humanity was threatened with unprecedented cancer and mutations from radioactive chemicals slowly but steadily invading the environment; and that engineering mistakes, earthquakes, political instability, or nuclear war could increase the contamination to catastrophic dimensions.

For peace of mind, I depended on the hope that science would find a way to handle nuclear poisons, and on a feeling of deep and helpless resignation that the economic and political forces involved in nuclear energy were so great that there was nothing I could do.

Then, on the 25th of last December, a comprehensive and forthright article appeared in *Business Week*, on the economic frailities of nuclear power, and especially the failure over thirty years to solve the problem of nuclear waste. A few weeks later, an article appeared in *Science* on the government's repudiation of its Rasmussen report, which had claimed that the chance of a major nuclear accident was about the same as a meteor hitting the earth.

In the midst of this news, (all before the accident at Three Mile Island), I heard a woman physician from Australia, Helen Caldicott, eloquently describe to a full house in Santa Barbara the health hazards of nuclear energy and the remarkable story of what she had done almost single-handedly on television to stop the French atomic bomb tests which were contaminating Australia. She is now at the Boston Childrens' Hospital, and a central figure in an organization, *Physicians For Social Responsibility**, formed to oppose nuclear power and sponsored by many eminent heads of medical school departments in Boston and other cities on the East Coast.

To those who see and hear her, Dr. Caldicott seems like a modern Joan of Arc, clear in speech, passionate in belief, solid in science, and determined to cut through the mystery and incompetence which have surrounded nuclear energy. She has written a book, *Nuclear Madness — What You Can Do*†, dedicated to her husband who is Assistant Professor of Radiology at Harvard Medical School and their three children.

Pioneers like Dr. Gofman and Dr. Caldicott show how much can be accomplished by one determined individual. The accident at Three Mile Island now calls us all to put our shoulders to the wheel.

Stewart Mancusco, Steenglass & Bertell

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†Autumn Press, $3.95, 25 Dwight Street, Brookline, MA 02146

REVERSING THE BIRTH OF THE EARTH

The Health Menace
of Nuclear Power
by
Miles H. Robinson, M.D.*

It is time that the public was told how *permanent* is the effect on human health of the contamination of the land, water, and air by the man-made radioactive elements (nuclides) produced by nuclear power plants.

The remarkable photographs recently sent back by our space probe to Jupiter provide a priceless insight into our nuclear predicament. The pizza-like face of the satellite, Io, wracked by volcanoes, and bathed in radioactivity from nearby Jupiter, remind us of how our earth was born. Life on earth could not evolve until its original radioactivity had decayed over millions of years to a biologically tolerable level.†

By mining uranium and splitting the atom, we are reversing the birth of the earth, and recreating the primordial environment of hostile radioactivity in which life as we have known it cannot exist. In this reversal of evolution, human life will become ever shorter and more miserable from cancer and mutations, before it phases out entirely. Then eons will be required before human life can reappear, waiting for slow radioactive decay to detoxify the long-lived nuclear contents of the Pandora's box which we have so rashly opened.

We have it in our power to stop this accelerating process of human extinction, and at least limit the damage which has already been done.

It is one thing to foul our nest with ordinary garbage, some of which we have had enough sense to outlaw, like PCB's; or which we can chemically convert, like discarded war gases. But nothing known or contemplated in our science will hurry up the incredibly slow rate with which the most dangerous nuclides decay. We have brought the cold, unfeeling pace of the stars into our frail and precious lives. What arrogance! On a stellar scale of magnitude, will be our punishment.

We all know from personal experience that the hardest thing in the world for a man to admit is that he has made a serious mistake. Nuclear engineers, politicians, and statesmen are no exception. And this applies equally to the medical profession, which has been negligent about the cancerous effects of low-level radiation from X-rays, and almost as uninformed as the rest of the country about the danger of long-lived man-made nuclides.

*Formerly Instructor in Physiology at Vanderbilt Medical School, Instructor in Pharmacology at University of Pennsylvania Medical School, and Medical Consultant on the Staffs of U.S. Senators Paul Douglas of Illinois and Edward Long of Missouri.

†A small residue of this radioactivity still resides in the earth, producing heat which is stored thousands of feet beneath the insulating blanket of the earth's crust. (*Science News*, May 12, 1979, p. 312). "By an enormous factor, products of man-made nuclear fissions are more intensely radioactive, more plentiful, and more concentrated than are the naturally occurring radioactive materials that evolution has reluctantly accommodated (although life did not evolve at all until most of those materials had been safely locked away)." (Jean Jacques Cousteau, Conference on Nuclear Energy and World Order, United Nations, N. Y., May 13, 1976).

There are always *individual* differences in susceptibility to low levels of radiation, but it is now well established that any increment of exposure to radiation, including that from the long-lived nuclides, rigorously increases the incidence of cancer and mutations in the population as a whole.†

Note that once a cancer occurs, it is impossible to say which of several possible cancer-provoking agents caused that particular case. This enables the nuclear industry, like the cigarette companies, to claim that their product did not cause a given case.

We all must face the fact that nuclear energy has become a *medical problem.* We dare not leave it to the engineers. The handwriting is on the wall at Harrisburg.

The common man, the voter, now that he sees the nuclear threat in his own backyard, should rise up and use his superior collective strength to take the first step and phase out this *tangible* menace. This action may be the only way to bring the world to its senses, driving home the imperative need to outlaw nuclear warfare. The Achilles' heel of the nuclear bomb is the nuclear power plant ticking away next door. They are bloody brothers under the skin. The "peaceful atom" does not deserve the name.

The controversy over nuclear power tends to arouse strong emotions, partly because of the unprecedented danger to present and future human life, but also because it involves another fundamental question of survival: what standard of living and life-style are really desirable and suitable today?

The answer that comes easiest to "stubborn, unruly" mankind*, is to pursue an unbalanced, cancerous growth of society, with increasing deception, crime, and warfare, sustained overall by an extravagant expenditure of energy from man-made machinery.

A more intelligent program is to obey the ancient laws of restraint, simplicity, and physical activity, which have always been necessary for durable human health and satisfaction. The pendulum of the industrial revolution has swung too far, carrying us away from "small is beautiful", and over the atomic pit. In stark terms Nature tells us now to swing back or die.

No Retreat To The "Cave"

Eliminating nuclear power plants and their intolerable pollution from plutonium and other long-lived nuclides does not mean our culture would be moving back toward the caves of prehistoric man. The following excerpt from a recent paper by Gofman[45] cuts through this favorite fog of nuclear advocates:

† Established in many scientific papers by J.W. Gofman and A.R. Tamplin in 1969-1970 (See references in *"Irrevy"—An Irreverent, Illustrated View of Nuclear Power*, J.W. Gofman, published by the Committee for Nuclear Responsibility, Main P.O.B. 11207, San Francisco, CA 94101, $3.95. Confirmed by the Advisory Committee of the Biological Effects of Ionizing Radiations, *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation*, National Academy of Sciences, Washington, D.C. 20418. 1972.

*". . . like their ancestors, a stubborn and unruly generation . . ." (Psalms 78:8). ". . . a rebellious people, lying children, children that will not hear the law . . . " (Isaiah 30:9). See also Exod. 32:9; Deut. 9:13; 31:27.

[45] J.W. Gofman, "Nuclear Power: The Need For A Fog-Cutter," *National Forum*, published by the Honor Society of Phi Kappa Phi, Summer 1979, pp. 35-36.

electric pollution

Energy use

"All authorities—even those in the Department of Energy—agree that 45% of U.S. energy use is sheer waste. This has nothing to do with our values, for instance, with our allegedly "materialistic" life-styles. The 45% waste is simply a measure of the *inefficiency* with which we use energy to satisfy our values.

No expert denies that the cheapest, largest source of energy available to us in the early future is 'energy efficiency.' Efficiency alone would permit us almost to double our effective energy supply. This is not idle speculation. In several Western European countries, our standard of living is achieved with about *half* the per capita consumption of energy.

Carefully researched studies by the American Institute of Architects four years back[46] conclude that simple energy-efficiency alterations in new building construction, plus some retrofitting of existing buildings, could *save* enough energy to substitute for the energy which would be generated by some 430 giant 1000-megawatt nuclear plants. Today, the U.S. has the equivalent of 50 such plants operable (sometimes).

There is an additional, huge source of energy which we are presently *throwing away*, an energy source which we once used until the electric utilities managed to destroy it in order to increase their own business. That source is called cogeneration of power.

industries cogenerating power

Innumerable industries generate vast quantities of steam for their industrial processes. If turbines were installed in many of those industries, they not only would generate their own electricity, but they could also feed large quantities of surplus power into the electric power grid. The ultimate result would be the production of power equivalent to some 200 giant 1000-megawatt nuclear plants, according to the studies of Dr. Robert Williams at Princeton University.

Both of these applications of energy efficiency—in our buildings and in cogeneration—would be more reliable than nuclear power, conserve scarce capital resources, increase the number of jobs created per capital-dollar invested, and *raise* our standard of living through reduced energy costs. Paying for energy which we throw away is just *lowering* our standard of living.

It makes no economic sense at all to invest in expensive nuclear power plants just to attain the privilege of throwing their energy away. Elimination of nuclear power would be a boon to every important aspect of our economy, not a threat.

With the equivalent of 630 giant nuclear power plants available to us through energy efficiency, it is obvious there is no energy 'crisis' requiring nuclear power. The 'need' for nuclear power plants, which still supply only 3½% of the country's total energy, is a hoax. Another hoax is the alleged need to choose between 'clean nukes' or 'dirty coal.' The choice is properly presented as 'filthy nukes' vs. 'clean energy efficiency,' with clean solar power coming along well in spite of pitifully feeble government support."

[46] *Energy and the Built Environment* and *A Nation of Energy Efficient Buildings by 1990*, American Inst. of Architects, 1735 New York Ave., N.W., Washington, D.C. 20006.

The Short-lived Nuclides

The authorities have provided considerable information about the *short-lived radiation* escaping from the damaged reactor at Three Mile Island near Harrisburg. This largely involved carcinogenic iodine-131 with its half-life of about 8 days.‡ Pregnant women and young children were advised to leave the vicinity. 240,000 vials of ordinary potassium iodide were rushed to Harrisburg, in accordance with a plan, eventually not implemented, to saturate the thyroid glands of everyone in the vicinity with this potassium iodide before the iodine-131 could invade their glands.[1]

The publicity about even the short-lived radiation, however, has been misleading and deceptive. The impression has been fostered that the soil in the vicinity was not significantly contaminated, since various samples of milk have tested clean. It is seldom mentioned that farmers were told to keep their cows off the pastures and to feed them *previously stored* feed. Furthermore some of the milk has, in fact, been found to contain iodine-131.[2] Transcripts of the meetings of the Nuclear Regulatory Commission reveal that Harold Denton, head of the agency's reactor division, stated: "Why is the FDA finding it and we're not?"[3]

Dr. Chauncey Kepford, a radiation chemist from State College, Pa., at a hearing held June 2, 1979, by the House Subcommittee on Natural Resources and Environment, testified that "There were so few radiation detectors out in the field in the first few days after the accident that it is really impossible to say what effect the radioactive emissions might have had . . . The more I look at the data [compiled by the utility company], the more I think most of the radiation exposure was missed."[4] According to NRC's Albert Gibson, it will never be known how much radiation escaped because the monitoring instruments in the vent stack were not designed for such high levels and went off scale during the accident."[44]

The whole thrust of the pronouncements by government and utility spokesmen has been that the hazards of the "incident" at Three Mile Island are *temporary* in keeping with the 8 day half-life of iodine-131, and similar to the risks of ordinary medical X-rays.

The Long-lived Nuclides

Almost no publicity has been given to the long-lived nuclides which, along with the iodine-131, have also escaped from the nuclear reactor vessel into the domed containment and neighboring pump-house buildings. These are far more

‡*The numbers appended to the element identify it. Half-life is the time for half of a given quantity of the* radioactive element to disappear, after which half of the remainder will again disappear during a repeat of the same span of time, and so on. As a rule of thumb to calculate almost total disappearance, multiply the half-life by 20. Thus, practically all the iodine-131 will be gone in 160 days.

[1] *Washington Post,* April 9, 1979, p. A-14.

[2] *Los Angeles Times,* April 4, 1979, p. I-12.

[3] *Washington Post,* April 26, 1979, p. A-7.

[4] *Santa Barbara News-Press,* June 3, 1979, p. A-3.

[44] *Los Angeles Times,* June 23, 1979.

dangerous, because they keep emitting carcinogenic radiation for generations, centuries and millenia. Strontium-90 has a half-life of 28 years; cesium-137, 30 years; americium, 460 years; and plutonium, 24,400 years. (For essentially total decay, plutonium requires about 500,000 years, compared to 160 days for iodine-131.).

Particles of these elements are like miniature X-ray machines which are never turned off, *continuously* irradiating for almost incomprehensible periods of time whatever living tissue they touch.

How much of these long-lived nuclides have already escaped, or will yet escape, into the environment at Three Mile Island? We will come to this question, but first let us review briefly the nature and effects of these elements. They are the reason for the faint mention in the press that a large section of Pennsylvania could have been rendered uninhabitable indefinitely, if a *full* meltdown had occurred at Three Mile Island. (See pp. 12-13).

All nuclear plants, as well as explosions of nuclear bombs (regardless of whether the bombs are detonated in the air or under ground), produce the long-lived nuclides — subtle, invisible, and incredibly persistent radioactive poisons. Yet the nuclear industry and the government have consistently deprecated and misled the public about the resultant *long-lived* contamination of the environment.

This is partly because the industry is *trapped* in a shortsighted multibillion dollar investment very costly to write off; partly because so many other scientific triumphs have led our civilization to the *arrogant belief* that it could lick any chemical/physical problem (just as penicillin convinced doctors that drugs could solve most health problems); and, perhaps most important of all, partly because the government has been *mesmerized* by the imminent hazards of nuclear warfare to the point where the hazards of nuclear power plants and their pollution seem almost trivial by comparison.

Carefully kept quiet has been one of the most fortunate aspects of the Harrisburg accident. Since the plant had been in operation only three months, its core had produced only a fraction of the long-lived radioactive nuclides which would have been present after a year of operation. A meltdown could then release into the environment as much long-lived nuclides as the explosion of 1,000 Hiroshima-type bombs.[5] The threat of contamination of the Susquehanna river (pp. 7-8) would also be more serious, even without a meltdown.

The greatest danger is from plutonium, not only because of its half-life of 24,400 years, but also because it is one of the most carcinogenic substance known, and is *handled in quantities of pounds and tons.* Unlike X-rays, the alpha radiation from plutonium travels only a microscopic distance; but once in the body, only a millionth of a gram is needed to produce cancer in an adjacent cell. In other words, one pound of plutonium is enough to give cancer to 500 million persons, if evenly distributed among them.[6]

[5] J.J. Berger, *Nuclear Power — The Unviable Option,* Dell, 1977, p. 36.

[6] J.W. Gofman, *"Irrevy"—An Irreverent, Illustrated View of Nuclear Power,* $3.95; Committee for Nuclear Responsibility, Main P.O. Box 11207, San Francisco, CA. 94101, 1979, pp. 39, 105.

Plutonium is used in reactors in the form of its dioxide, which can circulate as a dust, contaminate the water supply, and enter the food chain. It is biologically concentrated, as by oysters filtering enormous quantities of water through their digestive systems, big fish eating little fish, and so on.

Not only are these man-made nuclides highly carcinogenic. They also inevitably produce mutations of the human and other species, by action on the sensitive genes in the ovaries and testes. They are like *thalidomide forever.* The very ashes of a person who dies from these monstrous elements are equally harmful for some other living person.

Land heavily contaminated by these substances in the meltdown of a nuclear reactor would be uninhabitable for centuries. No food raised on it would be safe, and the ground water draining from it would eventually contaminate rivers, bays, and oceans.

There are already 2,200 pounds of plutonium in about 10,000 tons of nuclear waste stored in the United States alone, containing long-lived nuclides which must be kept out of the environment practically forever. By 1984, it is estimated that worldwide production of plutonium will be 33 *tons* per year, if a fully developed nuclear economy were allowed to proceed.

Cancer From Plutonium In The Denver Area

A month ago, in an address to the Sixth International Congress of Radiation Research in Tokyo*, Carl J. Johnson, M.D., Ph.D., Director of the Jefferson County Health Department, described a startling increase in cancer associated with windblown plutonium escaping from a nuclear plant near Denver.

The population was studied for 3 years, and there was a total of 501 excess *cases of cancer* downwind from the plant, compared to the incidence in nearby unexposed areas. (Table 1).

Table I
Increase In Cancer

Distance downwind from Rocky Flats plant	Plutonium contamination of soil in millicuries per square kilometer	Percentage Increase In cancer	
		Men	Women
Area I: up to 21 kilometers	0.8 - 50	24%	10%
Area II: 21 - 29 kilometers	0.2 - 0.8	15%	5%
Area III: 29 - 35 kilometers	0.1 - 0.2	8%	4%

Certain kinds of cancer were increased by the following percentages: lung cancer in men, 41%; leukemia in men, 40%; lymphoma and myeloma, 40% in men, 30% in women; testis, about 100%; ovary, 24%. Higher than expected incidences

* Sixth International Congress of Radiation Research, Tokyo, Japan, May 13-19, 1979. Dr. Johnson's paper will soon appear in a scientific journal. A copy of his abstract of it will be sent free of charge by Citizens For Health Information, on receipt of a self-addressed, stamped envelope.

were also found for the pharynx, esophagus, stomach, liver, pancreas, thyroid, and brain.

After reviewing these statistics of Dr. Johnson, the National Institutes of Health has recently given him a grant of $101,000 for further studies.

Nuclear Advocates Ignore Biological Hazards

The government and power companies admit that nuclides have frequently escaped from nuclear plants; but by ignoring the true extent, toxicity, and permanence of the leakage, they can claim that the benefits outweigh the risks. In effect, they are really relying on a perpetual dilution of the long-lived nuclides in the land, oceans, and air. This dilution cannot be reversed, and simply means a lower cancer dose (for the time being) for *more* people.

John W. Gofman, M.D., Ph.D., points out that the injury to human beings begins the moment a nuclear plant starts operation. He is Emeritus Professor of Medical Physics at the University of California at Berkeley, formerly Associate Director of the Lawrence Livermore (Radiation) Laboratory there from 1963 to 1969, and the discoverer of the fissionability of uranium-233 with slow and fast neutrons. This discovery makes uranium-233 available for use in nuclear power plants and nuclear weapons. Gofman calculates that even with 99.99 percent containment of leakage, by the year 2000, 160 pounds of plutonium will have escaped into the environment. This amount contains enough doses to give cancer to 15 times the present population of the earth. (Vide supra).

The nuclear engineers who have been playing[38] with this deadly stuff have proved their incompetence in the Harrisburg "incident", and in hundreds of less serious accidents. These men have been so wrapped up in the challenge of their work, in the financial and other rewards at the seat of power, and no more immune than the rest of us from the thrill of gambling in the face of danger, that they obviously have *no real appreciation* of the terrible hazard to human health and survival of the human species inherent in what they do.

These men are not biologists. They do not realize how fragile life is. They have never had the medical and surgical experience of opening up a living human body and seeing a tangled mass of wide-spread cancer, for which *absolutely nothing* can be done to save that person's life. They are insulated from this kind of reality, constantly faced by doctors and other biologists.

The nuclear engineers have been fascinated with the Frankenstein they have created. They have no qualms about standing with their families next to the nuclear genie, while it undergoes a convulsion, as Mr. Schlesinger did in Alaska and Mr. Carter did at Harrisburg. Their interest is narrowly professional, which enhances efficiency and peace of mind. Deep contemplation of the dreadful biological possibilities would strike at the very heart, pride, confidence, and power of the apostles of high technology.

[38] MIT professor Henry Kendall, during the acute phase of the accident at Three Mile Island, said, "They are way out in an unknown land with a reactor whose instruments and controls were never designed to cope with this situation. They are like children playing in the woods." (*Newsweek*, April 9, 1979, p. 24.)

They have the effrontery to call a nuclear plant "clean" in comparison with fossil fueled plants, deprecating the deadly radioactive waste which they agree should be kept out of the environment forever. Yet great quantities of it will escape in catastrophic accidents, far worse than Harrisburg, which are bound to occur sooner or later. The waste is also constantly leaking from mine tailings, the power plants, and their dumps, a problem no nearer solution than it was 30 years ago.[7]

The fact that the earth is already moderately contaminated with the fall-out from nuclear bombs has bred contempt for the very idea of contamination. Abundant power today is considered more important than the end of life on our planet tomorrow. There is a great temptation to drift into the philosophy of "Eat, drink and be merry, for tomorrow we die."

As physicians, we also accept death; but we do not *invite* it in return for a *material* benefit. In effect, that is what the nuclear proponents do on the greatest scale ever attempted. What nuclear expert, heavily dependent on the exotic specialty of nuclear power for his livelihood, can take an unbiased, scientific view of the biological dangers? To him and his associates, nuclear energy is inevitable. *Once this inevitability is granted,* any associated horror finds a place of spurious respectability in their cold calculations.

Chesapeake Bay In Danger

Returning to the subject of nuclides escaping from the plant at Three Mile Island, why did so much of the short-lived iodine-131 come out? This was simply because iodine turns into a gas when heated, and came out with the other radioactive gases in the puffs of steam both accidentally and intentionally vented when too much pressure from steam/water leaks accumulated in the domed reactor building and neighboring pump-house building. Note that the normal operating steam pressure in the reactor is *2,250* lbs/square inch.

The long-lived nuclides, however, such as plutonium and the others mentioned earlier, are *non-volatile* and, therefore, can only escape in water from the plant. We have not been told how much water in droplet form was in the escaping puffs of steam, but probably a great deal was flying around in the building since cesium-137 (and, therefore, the other non-volatile nuclides as well) was plastered all over the inside of the containment building when the core overheated and the relief water/steam valves were forced open:

> "sources said radioactive debris is everywhere in the containment. It's on the walls, in the dome, on pumps, valves and pipes. Most of it is radioactive iodine, which has a short half-life of eight days. Some is cesium-137, whose 29-year half-life means it will be dangerously radioactive for at least that long."[8]

Regardless of how much of the long-lived nuclides got out in the watery puffs and plumes of steam early in the accident, there is now a new and urgent problem: what to do about the large volume of water heavily contaminated with these

[7] *Business Week,* December 25, 1978, pp. 60-63.

[8] *Washington Post,* May 5, 1979, p. A-5.

during acc! they dumped "Reprocessing GRADE" Radioactive water into our River & to the Chesapeake Bay!

nuclides, which is steadily leaking on to the floor of the containment building. At first, it amounted to about 200,000 gallons[9], and was about 2 feet deep. On May 1st, NRC's Carl Berlinger stated that there were 425,000 gallons, 5 feet deep, and that it was due to "continuing leaks."[10] "By May 18th, there were 600,000 gallons, and by July 29th it was 8 feet deep."[43]

The leakage is uncontrollable, because it comes from leaks in the closed loop of piping cooling the shut-down reactor core, requiring a constant addition of new water from the river, lest the reactor core again heat up and threaten to melt down. For at least a year it will not be possible to locate and repair these leaks, because they are in the containment building where the long-lived radioactivity is so great — 30 times the level that the Pentagon considers certain death on the battlefield[11] — that it is estimated a year must elapse before even a robot device can be sent into the building for an inspection.[12]

What can be done about this inexorable accumulation of highly contaminated water, which is rising in the containment building at the implacable rate of ½ inch per day? In this urgent dilemma, the NRC at first announced that it would "treat" this water to bring its radioactivity down to NRC standards, and then discharge it into the Susquehanna river.[13]

But given the past performance of the nuclear industry and the government, and their substantial unconcern about the terrible threat to life of long-lived nuclides in the environment, what assurance do we have that the NRC's decontamination standards are safe? Or that the standards will be adhered to, in the face of the undoubtedly heavy expense of achieving them? Will the Chesapeake Bay be permanently contaminated? At stake is the health of everyone down-river, now and in the future.

In the latest development, the representatives of 110,000 people who get their drinking water from the river below Three Mile Island have expressed their lack of faith in the NRC by filing two lawsuits to block the discharge of the water in question. The NRC has responded by plans to examine the risks more thoroughly and to consider alternatives, such as storing the water in tanks and evaporating it to concentrate the nuclides. Meanwhile, the NRC will allow the discharge of only "routine low-level" radioactive water from the undamaged twin reactor and certain auxiliary equipment, which were accidentally contaminated in the March 28 accident.[14]

This response suggests that NRC would, indeed, have dumped water into the river which was *not routine* with respect to radioactivity. The actual content of long-lived nuclides in *any* of these discharges is evidently not a subject which NRC considers suitable to be published in the news media.

[9] *Science News, April 7, 1979, p. 228.*

[10] *Washington Post*, May 1, 1979, p. A-2.

[43] *New York Times*, July 29, 1979, p. 22.

[11] *Los Angeles Times*, April 3, 1979, p. I-1.

[12] *Washington Post*, May 5, 1979, p. A-5.

[13] *Wall Street Journal*, May 18, 1979.

[14] *El Paso Times*, May 28, 1979, p. 9-A.

Nuclear Brinkmanship

A nuclear power plant is totally unlike a fossil-fueled plant, where all one has to do in an emergency is vent the pure steam and turn off the fire. The ferocious fire in a nuclear reactor is only partially abated after the control rods are inserted in their shutdown position in the core. The residual radioactivity can still generate enough heat to produce a meltdown anytime the flow of cooling water fails. A complete loss of cooling would cause even the shutdown core to heat up to more than 5,000°F., at the rate of 400°F. every ten seconds.[15]

The NRC now believes that the reactor core at Three Mile Island was completely without cooling water for as long as 50 minutes on the day of the accident, and that it was during those minutes that the reactor suffered most of its damage. According to Harold Denton, NRC director of reactor regulation, "The only thing cooling the fuel rods during that time was a very low flow rate of steam . . . It's still too early to say how close we were to a meltdown but the core clearly reached very high temperatures, having come uncovered several times."[16]

According to one top executive of Babcock & Wilcox, which built the Three Mile Island plant, "if the core is uncovered — as happened at Three Mile Island - 2 — the potential for a serious accident is so great that any other actions by operators [than attention to cooling] become secondary."[17]

NRC representatives have reported that the nuclear core, which contained about 100 tons of uranium fuel, is now so badly damaged that it is like an inverted pyramid of debris and fragmented fuel with 93 percent of the flow path for cooling water blocked off.[18]

The rapidity and complexity of catastrophic events in a nuclear power plant can easily exceed human ability to control them. For example:

> "The two night operators pushed and pulled as many as fifty buttons and levers in *fifteen seconds* and the reactor shut down. ... But it wasn't enough. *Within minutes*, there was a serious leak of radioactive steam — and several more in the days following — spreading over an area up to 20 miles from the plant. ... tanks overflowed onto the floor of the auxiliary building — and radioactivity shot through a vent stack. These accumulating mishaps piled rapidly one atop the other in less than *five minutes*."[39]
>
> "Operators at Three Mile Island did not notice for *eight crucial seconds* that the two main auxiliary feedwater system valves were closed, moments in which core temperature skyrocketed."[19]

Anyone who has seen pictures of the large control room of a nuclear plant may well wonder how the two operators on duty can be expected to notice trouble showing up on their innumerable gauges in a mere eight seconds! Operator Craig

[15] J.J. Berger, ref. supra, p. 35.

[16] *Washington Post*, May 1, 1979, p. A-1.

[17] *Nucleonics Week*, April 26, 1979.

[18] *Science News*, May 5, 1979, p. 292.

[39] *Newsweek*, April 9, 1979, pp. 24, 28, emphasis supplied.

[19] *Washington Post*, April 18, 1979, p. A-9, emphasis added.

Faust testified that more than 200 alarms went off in the first seconds of the accident, and that "I like to [sic] have thrown away the alarms . . . they weren't giving us any useful information."[20]

The NRC has been puzzling over whether to have indicators on all of the reactor's 1000-plus valves to show whether they are open or closed, but consultant Carl Michelson of the TVA said the Commission "could create safety problems with such a high degree of complexity."[21]

Thus, with nuclear power, man is caught between the rock and the hard place —between his inability to do the right thing in "eight seconds" and the complexity of his machine which cannot be further increased without further confusing him. Increased complexity, of course, also increases the risk of mechanical failure.

The problem of a hydrogen bubble forming in the reactor vessel and then exploding (a small hydrogen explosion actually occurred) had not been anticipated by the nuclear engineers. They had not designed the reactor to handle it and had no plans for dealing with it. According to Harold Denton, NRC reactor operations chief, "It's a new twist . . . It is not a standard assumption."[22]

> "One thing all the engineers agree on is that formation of such a bubble had never been anticipated in the calculations of possible accident scenarios."[23]
>
> "We saw failure modes the likes of which have never been analyzed . . . No plant has ever been in this condition."[24]
>
> "We were not prepared for what happened."[25]

Yet, the production of hydrogen in a reactor and the great risk of an explosion has been known for years. Former Atomic Energy Commissioner, Theos Thompson, stated almost 10 years ago that "a lot of the gases which come out from this plant are really *hydrogen* and *oxygen* which are disassociated in the core of the reactor — there is a possibility that unless one is very careful you will induce an explosive hazard."[26]

With regard to explosions in general, related to high operating pressures of nuclear plants, Prof. Robert L. Whitelaw, Project Engineer for the power plant of the nuclear ship, N.S. Savannah, stated that "there is still by common consent an *unwritten agreement to treat as 'incredible' the most fearful of all nuclear accidents* that can occur in any plant with a highly pressurized primary system. Such accident is, of course, the *explosive rupture* of the primary vessel itself."[27]

[20] *Santa Barbara News Press*, May 31, 1979, p. A-5.

[21] Ibid.

[22] *Los Angeles Times*, April 2, 1979, I-9.

[23] *Science News*, April 7, 1979, p. 228; see also *Time*, April 9, 1979, p. 15.

[24] Roger Mattson, NRC safety expert, *Newsweek*, April 23, 1979, p. 30.

[25] Walter Creitz, president of Metropolitan Edison Co., *Washington Post*, April 23, 1979, p. A-3.

[26] Testimony before Joint Congressional Committee on Atomic Energy, cited by J.W. Gofman & Arthur R. Tamplin, *Poisoned Power*, Rodale, Emmaus, Pa., 1971, pp. 152-153.

[27] Ibid., p. 162, quoting IEEE Transactions on Aerospace and Electronic Systems, vol. AES-5, May 1969, emphasis added.

The scenario of an unusually large amount of hydrogen being produced by overheated zirconium cladding of the fuel rods reacting with the cooling water, and then exploding and cracking open the containment building with massive release of long-lived nuclides, was thoroughly described in precise and authentic detail by J. J. Berger in 1977.[28]

The many statements by authorities that the hydrogen bubble at Three Mile Island came as a complete surprise served very successfully to ward off a charge of *deliberate* negligence, and to persuade the public that the hydrogen bubble was the *only* unexpected event the authorities had failed to foresee and prepare for. In other words, the public could now have faith that the worst is over:

> "the nuclear-power industry views destruction of the reactor core at Three Mile Island as a *one-in-a-lifetime* 'opportunity' to glean actual data and experience on reactor accidents."[29]†

The re-establishment of public confidence, needed to protect the pocketbook and face of industry and government, is well worth the confession, however contrived, of incompetent foresight and engineering. Where confession is deemed inadequate, the bull of minimization is seized by the horns:

> "The Three Mile Island accident became a media show, a Roman Holiday. It was less serious than the media made it out to be. The real flap was about nothing that had happened, is unlikely to happen, and would be less serious than imagined if it did happen."[30]

This posturing of the nuclear industry and its advocates, ranging from falsehood to bluster, fundamentally arises from, and is nourished by, a *unique immunity* from financial liability. The insurance industry has steadfastly refused to insure anyone for more than $125 million against a nuclear accident. To get around this immovable obstruction, the Price-Anderson Act of 1957 set the maximum legal liability for a nuclear power plant accident at $560 million, of which the government picks up $435 million. In addition, homeowners' insurance policies specifically exclude damage from nuclear accidents and radiation.

These two umbrellas, without which every nuclear plant in the country would shut down tomorrow, were created in response to the 1957 Atomic Energy Commission's Brookhaven Report[41], which found that a major accident in a nuclear power plant would cause 3,400 deaths and $7 billion in property damage. In 1965, the AEC updated* the deaths to 45,000 people, the injuries to 100,000, the damage to $17 billion, and predicted that land-use restrictions because of long-lived

[28] *Nuclear Power — The Unviable Option*, Dell, 1977, pp. 23-24.

[29] *Science News*, May 5, 1979, p. 292, emphasis added.

†This view ignores the partial meltdown which occured in 1966 at the Fermi breeder reactor near Detroit, during which officials considered evacuating Detroit.

[30] Frank H. Spedding, former head of the Ames Laboratory of AEC, quoted in the *Iowa Stater*, Iowa State University, June 1979, pp. 1-2.

[41] U.S. Atomic Energy Commission, *Theoretical Possibilities and Consequences of Major accidents in Large Nuclear Power Plants (WASH-740)*, March 1957.

*Documents obtained by attorney Myron Cherry from Atomic Energy Commission under the Freedom of Information Act. See J.J. Berger, cit. supra. pp. 44-45.

nuclides might persist for five hundred years downwind of the accident throughout an area the size of Pennsylvania.

The nuclear power industry is thus able to trumpet extravagant assertions that the nuclear power plants are safe, while quietly aware that in a major catastrophe its insurance will not have to pay more than about 3 percent of the damage ($17 billion/$560 million), if its bluff is called.

We are not likely to hear much truth about nuclear dangers from the nuclear industry or government, until Price-Anderson is repealed, a repeal which ought to be demanded by every informed citizen who cares about his children and the future.

The transcript of the deliberations of the five NRC Commissioners, as they tried to handle the Harrisburg accident, show a wandering, confused discussion, in which Mattson suggested burning out the cooling pumps (!) to cause a recognizable loss-of-cooling-water accident, so as to "get into a mode for which all these systems were designed and we could cope with."[31]

What more needs to be said about the incompetence of nuclear engineering?

It is time to recognize that the responsibility for the catastrophes at stake are not the kind of thing which we dare entrust to engineers. The fatal crash of an airliner with 500 people on board, or the 50,000 deaths on the highways each year, are not even faintly in the same ball park. Such one-time accidents do not leave a *perpetual legacy* of cancer and cumulative genetic degradation, edging up steadily to the extinction of all life on earth.

Radioactive and deformed toads, frogs, and lizards were found recently 90 miles north of New Orleans near the underground Tatum Salt Dome used in the 1960's for testing nuclear explosives. As a consequence, Gov. Cliff Finch of Mississippi on May 25 advised evacuation of homes in the vicinity.[32] Such mutated animals are the "canaries of the mines", warning us of our fate, as the long-lived nuclides inevitably seep into our water and food.

Familiarity Breeds Contempt

What happened at Three Mile Island tells us that it is imperative to cork the nuclear Frankenstein back in the bottle as soon as possible. Quite aside from the hazard of nuclear power stations and the holocaust of nuclear war, the problem of *keeping nuclear wastes already on hand* out of the environment is almost beyond the world's technical and political capability.[33]

No one has yet come up with an acceptable plan for the safe disposal of this waste. Richard W. Reilly, Governor of South Carolina, recently announced that his state refuses to be the radioactive garbage dump of the nation: "South Carolina can no longer be the path of least resistance in seeking the national answer to nuclear waste disposal."[34] Note the word, "seeking". This search has been going on

[31] *Washington Post*, April 14, 1979, p. A-1, 6.

[32] *El Paso Times*, May 26, 1979, p. A-9.

[33] See the long and gloomy assessment in *Business Week*, December 25, 1978.

[34] *Washington Post*, April 23, 1979, p. A-23.

unsuccessfully for 30 years. What is involved? At Three Mile Island, experts hope to decontaminate the reactor, washing down the walls and other surfaces, which will cost millions and take a long time. Then the nuclides in the wash water must be concentrated, and perilously shipped across the continent to Hanford, Washington, since South Carolina has rejected them.

The other course is to entomb the plant (after it has cooled down sufficiently), joining three other nuclear-age sarcophagi in Hallam, Nebraska; Piqua, Ohio; and Puerto Rico. According to a federal nuclear cleanup specialist, "It's a little like King Tut's tomb. You pour concrete over the whole thing, walk away and leave it sealed up for a thousand years."[35] And hope that unlike a lot of concrete, it does not crack and crumble after a few decades.

In the opinion of Rep. Morris Udall (D-Ariz), "Nuclear may be one of those technologies that gets so complicated that they fall of their own weight."[36]

In any event, there are four profound reasons which keep most people complacent about nuclear power plants: (1) they are producing electricity; (2) the public utilities, in order to get back their investment of billions of dollars, bombard the public with false information about the safety and economy of the plants*; (3) our civilization has rather arrogantly come to believe that any chemical/physical problem can be solved; and (4) familiarity with the fear of sudden nuclear war has bred contempt for the contamination produced by the nuclear plants.

On the last point, even if the public were adequately informed, which it is not, about the creeping, invisible, and implacable pollution from nuclear plants and their wastes, where would it get the strength to worry about this, while constantly faced with the strong possibility of a nuclear war which will hopelessly contaminate the whole world in 20 minutes? With such insanity so rife, no wonder nuclear plants look sane to our leaders in business and government!

Like salamanders changing color against a dark background, our judgments reflect our eroded standards of sanity and morality, the product of an overcrowded world, in which men and women refuse to curb their appetite for too many offspring and unnecessary machines. The Sacred Groves, the Baals, and Golden Calves we worship today — often to save us somehow from the ancient fault of excess — are the modern machines we have fabricated. And now we find that they, too, are fallible.

Nature does not permit gross imbalance in her world, and quite justly will destroy the perpetrators of that dangerous condition. She does not tolerate the familiarity which breeds contempt.

The Government's Position

President Carter, in his campaign for election, took the position that he favored nuclear power only as a last resort, and led us to believe as a result of his Navy career that he was thoroughly familiar with nuclear hazards. Now we find, three weeks after the Harrisburg accident, that he wrote an unpublished letter to

[35] *Washington Post*, April 11, 1979, p. A-24.

[36] *Washington Post*, April 15, 1979, p. A-10.

* See footnote, p. 15

congressional leaders voicing strong support for expanding nuclear power, including its most dangerous variety, the plutonium breeder reactor:

> "I want to emphasize that my opposition to the CRBR [Clinch River breeder reactor] does not imply opposition to breeder reactors in general or to nuclear power. Along with developing our renewable energy resources based on solar energy and fusion, breeder reactors hold the promise of providing essentially inexhaustible supplies of electrical energy."[37]

Furthermore, solar research has been badly neglected, and Governor Rockefeller of West Virginia has stated that the Carter administration has not encouraged the coal industry. A study by the AEC in 1970 stated that a coal-fired boiler could replace the reactor in a nuclear plant, using the same turbines, electric generators, and condensers, for a cost of only 12 percent of the total investment in the nuclear plant.[42] Even a cost several times as great would leave most of the investment salvageable.

We constantly hear the argument that nuclear energy is cleaner than coal, based on the false assumptions that catastrophic nuclear accidents will not occur and that permanently radioactive wastes are not steadily and disastrously leaking into the environment.

We wonder if anything less than the loss of a large city from a nuclear accident will convince President Carter and his group that nuclear power should be phased out.

The arguments about the need to continue getting 13 percent* of our electric power from the atom, and about the loss of billions of dollars if nuclear power plants are abandoned, become *totally inconsequential* compared to the grim fate faced by humanity as carcinogenic and mutagenic nuclides inexorably accumulate in the environment.

What The United States Must Do

As we chase the chimera of "inexhaustible electricity," our world of life is slipping out of our hands. Fast breeder reactors serving fast breeding populations or short-run higher standards of living will simply drown us in nuclear pollution over the long run.

No other country but the United States, the most powerful and democratic in the world, can afford to take the initiative of closing down the nuclear power plants. And if we shun this burden, we do not deserve the leadership of the world, and Nature will see to it that we neither lead nor live on this precious green planet which we now despoil.

[37] *Washington Post*, May 4, 1979, p. A-12.

*This oft-cited figure is grossly misleading. From it should be subtracted the vast amounts of energy required to prepare uranium (by "enrichment") for use in nuclear power plants. In the 1960's, this amounted to 5 percent of all the electricity used nationally. In addition, the government enrichment plants pay no taxes, insurance, or profits to investors. (J.J. Berger, op. cit., pp. 146-147). Finally, no allowance is made for the billions of dollars which will have to be spent in the effort to keep atomic waste out of the environment.

[42] U.S. Atomic Energy Commission, *Trends in the Cost of Light-Water Reactor Power Plants for Utilities (WASH-1150)*, May, 1970.

Addendum

All the data on the Three Mile Island accident was carefully studied by the President's Commission for 6 months. Commissioner Peterson concluded, "There isn't any question that we will have future accidents as severe or more severe than Three Mile Island. The question is when exactly and where it will happen."[10] Commissioner Lewis has stated that "the results of compounded individual frailities can be so enormous, so terrifying, that it is hard for me to conceive of any trade-off that might be worth that risk . . . The ultimate nuclear accident is projected to kill or sicken some 45,000 people immediately, to cause genetic damage to generations in the future and to make uninhabitable vast areas of land and water."[11]

With reference to the large increase in cancer downwind from the Rocky Flats nuclear plant near Denver (pp. 6-7), the latest government opinion is that the plutonium found on the soil was not due as first believed to a fire which occurred, but to the escape of plutonium stored in leaky drums.[1] Government monitoring in the vicinity has also shown that levels of resuspended plutonium in the air did not decline over five years[4], and the levels there are by far the highest of 48 sites around the world.[8]

Nuclear proponents argue that the *planned* releases of plutonium will be kept to not more than one part in a billion.[2,6] This, of course, does not include frequent *unplanned* releases, not to mention accidents like the one at Three Mile Island. Recent investigations show that the government does not know how 4 tons of "special nuclear materials", consisting of plutonium and uranium-235 used to make atomic bombs, have disappeared from its inventory.[3]

On the basis of the containment record of the nuclear industry to date, Gofman estimates that we would be fortunate to achieve a containment (even without a catastrophe such as Three Mile Island nearly became) of one part in ten thousand; and that in a fully developed plutonium-energy economy, this would lead to 139,000 additional lung cancer fatalities per year in the U.S. alone.[6]

A U.S. Atomic Energy Commission report has measured the average air concentrations of plutonium from U.S. weapons-testing.[7] Using this and estimations of lung depositions in humans, coupled with lung cancer doses, Gofman has calculated that about 1 million lung cancer deaths over about 30 years will have occurred in the Northern Hemisphere as a result of this airborne plutonium.[5] The age-adjusted death rate per 100,000 population for primary cancer of the respiratory system from 1946 to 1977 has increased 3.6 times in males and 6.4 times in females.[9]

[1] J.W. Gofman, *"Irrevy"—An Irreverent Illustrated View Of Nuclear Power*, Committee For Nuclear Responsibility, P.O. Box 11207, San Francisco, Ca. 94101, pp. 41-42.

[2] Ibid., pp. 41, 66, 109, 162.

[3] Ibid. pp. 106-107.

[4] *U.S. AEC Rocky Flats Plant Surveillance*, monthly reports, Denver, Colorado Department of Health, 1970-1975.

[5] J.W. Gofman, J.A.M.A. 236: 284-286, 1976, p. 285.

[6] Ibid., p. 286.

[7] B.G. Bennett, U.S. AEC Report HSAL-278, 1974, pp. 41-66.

[8] U.S. Dept. of Environmental Energy, *EML-363-Appendix*, pp. C-138 to C-160, October 1, 1979.

[9] U.S. Public Health Service publication #1677, 1968; and Dept. HEW publication #79-1120, May 11, 1979.

[10] *Los Angeles Times*, October 30, 1979.

[11] *Newsweek*, November 12, 1979.

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UNITED STATES ARMED FORCES

Medical Journal

60 per cent of the cases.[35] The first wave of casualties had very poor prognosis; the clinical course was fulminating; practically all of these patients died within 2 weeks postexposure from dehydration with vascular collapse, or fatal bleeding, or septicemia.

The second wave of radiation casualties entered medical care about 3 to 4 weeks after the attack. Since by that time the worst confusion had subsided and the improvised clinical facilities had been much improved, and since the Japanese medical personnel had begun to understand the etiology of the unfamiliar disease,[31] clinical observations, laboratory examinations, and hospital records obtained on these patients, as compared to those on patients of the first wave, were much more complete and reliable. Generally, exposure had occurred in open air or in Japanese-type housing at a distance of 1,000 to 2,000 meters from the hypocenter; in the occasional instances where the distance had been less than 1,000 meters the individuals had been sheltered by heavy concrete buildings. This second wave of casualties displayed the "typical" acute radiation syndrome. A brief prodromal phase of 3 days' duration was followed by a latent period lasting about 3 weeks. During that time most of the patients continued to work; frequently they participated in the strenuous duties of clearing the rubbish of the city. In only a few instances was there a record of persisting weakness and easy fatigability. Approximately 2 weeks after the attack, the hair of the scalp became loose; this was considered an ominous sign.[34] A few days later general malaise, fever, purpura, and other typical complications compelled the patient to seek hospital admission. Hachiya,[34] director of the Hiroshima Communications Hospital, describes in his diary the following case as characteristic: The 28-year-old female patient had been inside a solid building at 700 meters from the hypocenter. Shortly after the bombing, she developed weakness, nausea, vomiting, general malaise, and diarrhea. Two days later these complaints had vanished and physical strength as well as appetite began to return. Thereafter, she ate plenty and did light work, although some fatigue and malaise persisted. On the 19th day, while combing, she noticed large amounts of loose hair. Recognizing this as a portentous sign, she asked for a physical examination on the 22d day. Nothing abnormal was found with the exception of severe weakness, epilation of about two-thirds of the scalp area, and marked leukopenia. She was admitted to the hospital where her condition deteriorated swiftly. In days postattack the sequence of events was as follows: 25th, petechiae and severe malaise; 29th, anorexia, increase in size and number of petechiae, and fever of 101.5°; 33d, weak pulse, and further enhancement of petechial bleeding; 37th, death.

Survey of the entire *JBC* data revealed a rather uniform clinical course for patients of the second wave.[2-4, 32, 35, 36, 38, 39] Around

the 20th day after the bombing, general malaise, pharyngeal pain, and ascending unremittent fever appeared. Within a few days, petechiae and ulcerative lesions of lips, mouth, and pharynx became manifest. Leukopenia and thrombocytopenia were most pronounced between the 3d and 5th week postexposure. During this period, representing clinically the critical phase of the illness, severe hemorrhage and overwhelming respiratory or enteric infection caused the death of about 50 per cent of the patients. In the survivors, recovery was heralded between the 5th and 6th week by cessation of the pharyngitis followed by disappearance of petechiae and fever, and finally by healing of the ulcerative lesions. This improvement was associated with an increase in circulating leukocytes and platelets, while red cell count and hemoglobin content of the blood generally continued to decline, reaching the minimum around the 6th and 8th week. Most patients became completely asymptomatic at 3 months following the attack.

Comparison of the *JBC* data with the experience gained from radiotherapy and nuclear accidents leads to several important conclusions. The first wave of casualties obviously represents the fulminating form of the acute radiation syndrome with direct radiation damage to the gastrointestinal epithelium as the determining pathogenic factor. It then follows that these patients must have been exposed to air doses in excess of 500 r. The second wave of casualties evidently represents the typical form of the acute radiation syndrome with hematopoietic depression as the determining pathogenic factor. These patients, therefore, must be assumed to have been exposed to air doses ranging from 200 to 500 r. These conclusions, compelling as far as the clinical symptomatology is concerned, do not agree with dose estimates calculated from physical considerations. These calculations do yield doses higher than 500 r for the area described around the hypocenter by a radius of 1,000 meters, but they arrive at only 15 r for a distance of 2,000 meters where the clinical picture demands at least 200 r. This obvious discrepancy between medical and physical dose estimates has already attracted attention and speculation about its cause.[40] In the present report, precluding the treatment of technical dosimetric problems, this interesting phenomenon cannot be analyzed. The physical factors involved have been re-examined in a recent study of the bomb data.[41]

SUMMARY OF DOSE-EFFECT RELATIONSHIP, AND DEFINITION OF CLINICAL THRESHOLD OR HOSPITALIZATION DOSE IN MAN

When for a large group of whole-body irradiated animals the mean survival time is plotted as a function of dose, the graph does not proceed in a smooth curve but forms three distinct steps.[42] Furthermore, it can be shown that these steps reflect three different pathogenic mechanisms. Death is caused in the

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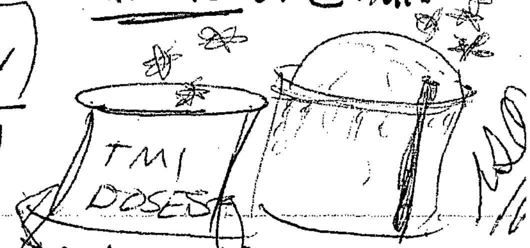


NDO

[ALSO → DAVID GAMBLE'S issues - VS - STELLO Letter
= 2MR/hr?]

• NOT HUNDREDS of Rems-Rads:

(1) Define low dose? NRC doesn't have definition yet

TMI (2) 10R/hr - GUR & Karl Z. Morgan (PADoH - Advisory Mtg

(3) 10R/hr - Gerusky 3/28/79 AM per J. Johnsrud

(Bombs) (4) 9R/hr - R. Yallow re: Hiroshima Nagasaki (on Nite Line in 198_

(5) 3-5-16R - John Fuller (The Day We Bombed Utah)

→ + higher = same as TMI symptoms @ (animals & humans)

TMI (6) 5R - S. Cairo (her dad @ New Cumberland Depot - took readings on Mdtn during acc. Lived in Pineford Village Mdtn - wife lost hair all over body - eyes like looking thru water - died of cancer).

(7) 10R to 3R - Tony Cavalier of Hershey Med on Catalpa St., Mdtn

Bombs (8) 15R - Gerstner - 15R - VS - 200/300 via physics calc's.

Rad symptoms of 200/300R - but calculations ↑ were @ 15R

(9) 0.5 to hundreds = Under the Cloud - By Richard L. Miller on bomb tests @ appendix!!!

Doses @ 1 hour after detonation @ ground zero.

0.5 R/hr	7,500R (Jangle - Sugar)
15 R/hr	4.5 R
20 R/hr	300R = UPSHOT Knothole; Simon.

Fallout to HBG

(10) 5R - Bross ltr = the COURT ruled 5R was dose causing cancers / lethal / for harm. [was it upheld?]

(11) the trees are dying here; at Karthaus & at N.W. PA - below Erie

(12) Gunckel said - only 2 Low Dose Studies were done @ Brookhaven @ 35R or less... & funding was cut!! *

(13) + ALICE STEWART'S dose ("2R") did gamma field - but @ TMI it was a-B-γ! & Ni whats in soil... NO TECHNOLOGY WITHOUT BIOLOGY!!

ALSO { Aileen - infra-red aerial photos - NRC couldn't find -
[illegible] - [illegible] TBI [illegible] ... placed incorrect?

Views from the Pennsylvania Radiation Protection Program

Thomas M. Gerusky, CHP

On 28 March 1979, a date I will never forget, I was Director of the Commonwealth of Pennsylvania's Radiation Protection Program. I had been in charge of that program since 1961.

A new administration under Governor Dick Thornburgh had just come on board and, like with every new administration, some changes were destined to be made. The Secretary of Environmental Resources had called me in and proposed that the regulatory part of our program (x rays and radium) be transferred to the Department of Health, since most of those activities involved the healing arts professions. I had fought successfully to keep the radiation protection program staff together when all of our activities were initially moved to the new environmental department in the early seventies. This time the arguments were falling on deaf ears.

Tom Gerusky

Then, I received a telephone call at approximately 7:00 a.m. on the morning of 28 March informing me that an accident had occurred at TMI-2, just a few miles south of Harrisburg. For the next 30 days, the radiation protection office was open 24 hours a day. Our whole staff responded in a qualified and professional manner. We interacted with the governor, giving him our advice on actions that needed to be taken and continually updating him and his staff on current events. We interacted with the utility by establishing an open telephone line between the reactor control room and our office. We interacted with other state and federal agencies in an attempt to coordinate the response to the accident. We kept the Legislature informed. We interacted with the public and the press in an attempt to keep everyone fully informed of what was happening. And we attempted to interact with the health physics community in the area and across the world.

As the emergency aspects of the accident wound down and the mundane problem of defueling and decontaminating TMI-2 became prominent, we continued to participate as representatives of the governor and the state. Initially, we set up with the NRC numerous public meetings to discuss the need to vent the ^{85}Kr from the reactor containment. We established additional environmental monitoring programs, reworked the emergency response plans, and served on the NRC's Citizen Advisory Board on the decontamination. We testified in numerous federal and state hearings on the accident and our response to it.

Our program gained respect in Pennsylvania. Legislation was passed to provide us with additional funds, responsibility, and staff. There was no more discussion on the proposal to split up the Radiation Protection Program.

Ray Urciuolo

The morning of the accident, Jim Kopenhaver and I headed by car from our downtown Harrisburg state office toward TMI to check things out. Our mission was to circle the island on both sides of the river, taking meter readings along the way. We had basic instrumentation, GMs which only went up to 50 mR h^{-1}, an alpha scintillator detector with an internal 1 R h^{-1} GM, and a survey meter with a 1" NaI crystal. Those kinds of things. No anti-Cs. No portable air samplers (not even a Hi Vol). I don't think we really expected to actually find anything. We were young and had unquestioning faith in our technology.

The instruments were turned on as we rode the elevator down from the fifth floor of the Fulton Bank building alongside the capitol complex in downtown Harrisburg. As we walked to the car, I noticed that the background was higher than it should be but dismissed it as a possible environmental effect of going from a warm building to the outside. As we started to follow the river toward Middletown and the Island, it began to dawn on us that the random chirping of the GM meter was no longer random. Readings were slowly increasing as we went. We had actually been detecting the accident in Harrisburg at the μR h^{-1} level.

We circled the plant for the next couple of days until federal support engulfed us and made our contribution insignificant. The measurements had not been that frightening, mostly in the 10ths of mR h^{-1}, though there

was a brief bubble of 5-14 mR h^{-1} that passed by the Observation Center on the east side of the river. Conventional theory says that even though we were seeing the very heavy gases of xenon and maybe krypton, the gases mix at ambient temperature and do not sink. However, from observation, detection was mostly confined to the riverbed and valleys. As we crossed the turnpike bridge to the north, or the valleys on the west side, the readings would rise and then fall away. It seems mixing, or the lack of it, played a greater role.

Events fade into the past now, but three small events stand out. A trailer village of support personnel and media grew up in the substation just south of the Observation Center. One morning as I walked from my car to attend a meeting, it was misting rain. I raised my umbrella under the canopy of high voltage wires far above. Upon hearing a crackling sound coming from the wire ribs of the umbrella, I quickly folded it back up and decided a little water never hurt anyone. Another day when the sky was clear, we had stopped in the parking lot behind the Observation Center to take a lunch break. While we were there, the aerial monitoring helicopters all came down at the same time in back of us about at the spot where the training center now stands. It was impressive. The third memory involves an end of a shift. I live 11 miles from the plant. I could detect the releases all the way home on Interstate 283 right up to my exit ramp a mile from the apartment. The chirping GM finally quieted down just as I got home.

I only saw a small part of the action. Sometimes I was answering phones, fielding calls. One woman called and asked if it was safe for her child to be at college. It turned out she was talking about a location north of Pittsburgh, over 200 miles away! Another morning, I spent babysitting a local legislator. He insisted that someone be assigned to him in case he needed a translation of the techno-babble. Politicians, news reporters, and the general population were all at a loss trying to understand most of what was said.

All in all, neither I nor my family suffered from the event. My son was one year old at the time; he had been subjected to a fetal bone x ray just before he was born because he was three weeks late in coming. Then he lived through this. The result was he skipped kindergarten, went on to be recognized in the national merit scholarship, and finished second in the Jeopardy Television College Tournament two years ago. My daughter was born a couple of years later and is just as intelligent, but she wears size 11 shoes.

Maggie Reilly, CHP

At the time of the accident, I was a health physicist in the Bureau of Radiation Protection (BRP) in the Pennsylvania Department of Environmental Resources (DER). My job was to run the group that handled emergency planning, environmental monitoring, the Rad Lab, and nuclear engineering (all nine of us). We were located in downtown Harrisburg, about ten miles from the Island. The Bureau had a reputation for radiological "firsts" among state rad programs.

Bill Dornsife, our duty officer for the month and sole nuclear engineer, notified me at home at a few minutes after 7:00 a.m. By the time I got to the office around 7:30, Tom Gerusky was getting the word that the situation had escalated to a General Emergency. By 8:00 a.m., based on operator dose projections and subsequent verification, we called for and then canceled a recommendation to evacuate downwind areas. What a way to start the day!

My role in the accident was as liaison with Pennsylvania Emergency Management, Health and Agriculture; the rest of DER; USDOE, NRC, EPA, HHS/FDA; and non-essential players. An unwritten role was to help kahunas avoid making dumb decisions.

There is at least one story behind each of the following observations:

- Reliable information and its communication to those who need it are all that matter in a crisis.
- Post-accident dose assessment is the best motive for maintaining extensive, passive environmental monitoring programs.
- Nothing beats a physical on-site presence for gathering reliable information.
- Negative data has the same dignity as positive data, a fact frequently forgotten.
- Some information/data will be bogus.
- Some people will behave better than your wildest dreams; some worse.
- Basic physical requirements of the responders need attention: things like eating, sleeping, and a change of clothes.

As one can imagine, I place events in my life as being before or after the accident. The same is true for radon, and graduate school, and so on.

The best recounting of the accident can be found in Mitchell Rogovin's *Three Mile Island—A Report to the Commissioners and to the Public*, Volume I (January 1980). It reads like a dime novel!

A bit of TMI trivia: the DOE project name for its response to the accident was "Ivory Purpose."

nuclear power plant, "One of the last things that we need to do to this economy is to take money out of your pocket and fuel government."[6] But, as we will see, the nuclear power industry's revival is utterly dependent upon taking money out of the taxpayer's pocket.

Before we examine the true economic realities of nuclear power it must be clearly stated to those investing millions of dollars in this technology that they will lose all, should there be a catastrophic nuclear meltdown in the United States or any other part of the world. Such an event would signal the end of nuclear power forever. A very experienced nuclear engineer, David Lochbaum, who works for the Union of Concerned Scientists is deeply concerned about the current lack of safety standards in U.S. reactors and is convinced there will be a nuclear catastrophe within the near future. He said to me, "It's not if but when." It seems, therefore, that it is a very risky business indeed to invest in nuclear power no matter what the industry or the government is currently saying.

Nuclear power has been and still is dependent upon government subsidies at every level. The U.S. government spent a gargantuan $111.5 billion on energy research and development between 1948 and 1998, allocating 60% or $70 billion of this to the nuclear industry alone.[7] Over the same fifty years, $26 billion was allocated to oil, coal, and natural gas; $12 billion went to renewable energy sources such as wind, hydro, geothermal, and solar power; and only $8 billion went to energy efficiency technologies.[8] In other countries, the Organisation for Economic Co-operation and Development (OECD) governments spent $318 billion by the year 1992 specifically on nuclear energy R&D.[9]

With this level of government support, it is no wonder that the nuclear power industry was wildly optimistic about its future by 1972, the year in which the Atomic Energy Commission predicted that the United States would have 1,000 nuclear power plants by the year 2000, as well as reprocessing plants to recycle spent fuel and breeder reactors that would produce as much nuclear fuel as

they consumed. Dixie Lee Ray, then-head of the AEC arrogantly claimed that the disposal of spent nuclear fuel would be "the greatest nonproblem in history" and would be accomplished by 1985.[10]

In fact, the year 2000 saw completion of only 103 reactors, no operating breeders, no operating reprocessing facilities, and no high-level waste disposal sites whatsoever.

On the private financial side, the enormous expense of simply constructing a nuclear reactor—double the capital cost of a conventional coal plant—means that investors remain less than enthusiastic. The government has offered various incentives to try to engage private investment in the nuclear power industry. But even so, the rating agency Standard and Poor's recently concluded that "the industry's legacy of cost growth, technological problems, cumbersome political and regulatory oversight, and the newer risks brought about by competition and terrorism may keep credit risk too high for even federal legislation that provides loan guarantees to overcome."[11]

Caren Byrd, executive director of the global power and utilities group at Morgan Stanley, is cautiously optimistic, saying that for the first time in many years Wall Street believes that new nuclear reactors could become part of the nation's long-term energy future. She points out, however, that this forecast is largely dependent upon government support. She said that the Shoreham plant in New York was closed down after construction in 1985 because of enormous public opposition and that dozens of plants were cancelled in the 1980s, while others were plagued by long delays. "Tens of billions went down the drain at that time," she said. "We can't take that risk, and the investment community has long memories."[12]

In truth, the U.S. nuclear program in the past has been marred by construction cost overruns, delays, cancellations, premature plant closings, poor operational performance, and an inability to find a permanent storage site for its long-lived toxic radioactive waste. In one of the biggest cost overruns, the Seabrook reactor in

5-5-07

Ida R. Hoos Is Dead at 94; A Critic of Systems Analysis

By KATIE HAFNER

Ida R. Hoos, a prominent critic of assessing technology solely on the basis of mathematical models that failed to take account of societal factors, died on April 24 in Boston. She was 94 and lived in Brookline, Mass.

The cause was complications of a lingering case of pneumonia, said Judith Hoos Fox, her daughter.

Dr. Hoos, a sociologist, was widely recognized as an outspoken critic of systems analysis, which came to prominence after World War II. The approach used mathematical models to perform cost-benefit analyses and risk assessments on complex technologies like radar systems and military aircraft.

With the concept strengthening in the 1950s and '60s, when the use of computers to assess technology grew more popular, she wrote widely on a need to balance it with other considerations like effects on the work force.

"A kind of quantomania prevails in the assessment of technologies," Dr. Hoos wrote in 1979 in the journal Technological Forecasting and Social Change. "What cannot be counted simply doesn't count, and so we systematically ignore large and important areas of concern."

Dr. Hoos urged national decision makers to take such assessments "with a large measure of skepticism lest they lead us to regrettable, if not disastrous, conclusions."

Often, this social scientist thought 'the king was naked.'

Harold A. Linstone, emeritus professor of systems science at Portland State University and longtime editor in chief of Technological Forecasting and Social Change, said Dr. Hoos was in many ways the intellectual conscience in the field of technology assessment.

"She basically pointed out that in a lot of complex social and technical systems, a reliance on these systems analysis approaches couldn't always do the job," Dr. Linstone said. "She would not accept the superficial answers or phony arguments."

Dr. Hoos also questioned the usefulness of systems analysis when evaluating public policy. Her 1972 book, "Systems Analysis in Public Policy: A Critique," cast a critical eye on the prevailing methods for evaluating education, waste management and health care.

"These technical-think-tank types were riding high," and Dr. Hoos " wasn't averse to pointing out that the king was naked," said Louis Feldner, an engineer who worked with her on several technical committees over the years. "And she was respected for it."

Ida Simone Russakoff was born on Oct. 9, 1912, in Skowhegan, Me., the middle of seven children. Her parents were immigrants from Russia, her father a jeweler.

She graduated from Radcliffe in 1933. While studying for her master's degree, which she received from Harvard in 1942, she founded Jewish Vocational Services in Boston, to help Jewish women who were working in the city's garment district find better jobs.

Carol Palmer, 1996

Ida R. Hoos

In 1942, she married Sidney S. Hoos, an economist. The couple later moved to Berkeley, where Mr. Hoos taught in the agricultural economics department at the University of California.

Ida Hoos began to pursue her Ph.D. there and became interested in the effects of automation and technology on workers. She received her doctorate in 1959, and her dissertation was published in 1961 as "Automation in the Office." Another book, "Retraining the Work Force," was published in 1967.

Dr. Hoos remained at the University of California as a research sociologist, first at its Institute of Industrial Relations, then at the Space Sciences Laboratory. At the laboratory, where she was the lone social scientist, she expressed concern over the effect of satellite surveillance on individual privacy.

She retired from the university in 1982. Over the years, she also served on committees at the National Science Foundation, the National Academy of Sciences, NASA and the Department of Energy.

In addition to her daughter Judith, of Boston, she is survived by another daughter, Phyllis Daniels of Goldendale, Wash.; a brother, Philip Russakoff of Skowhegan; three granddaughters; and three great-grandchildren.

Dr. Hoos was largely unfazed by being a woman in what was seen as a man's field. In an unpublished memoir, she wrote of serving in the 1980s on a high-level committee at the Congressional Office of Technology Assessment. The committee had a preponderance of aerospace industrialists.

"I was the only woman," she wrote, "and thoroughly used to the Happy Hour salutation of 'Hey fellas — oh, excuse me, Ida!' "

On Jan. 1, 1984, Dr. Hoos was called by National Public Radio and asked for her thoughts on George Orwell's predictions of universal surveillance, now that the year had actually arrived.

"On that subject," she later recalled, "I could only say that thanks to the dramatic developments in information technology, we had already been here a long time."

rec'd newspaper in Bundle of 4-9-08. N

what is the Real total cost of NUKES? CRADLE to grave & HOW MANY LIVES?

"life - liberty" & the pursuit of happiness?

"cost-benefit" is inhumane & unconstitutional!

Incredible! she's right!

PA-DoH: TMI Advisory Panel on Health Research Studies

293.

Dr. Abrahamson asked when the Department will be wrapping up the Pregnancy Outcome Study. Dr. Tokuhata replied that he is trying to get it done quickly, perhaps needing another year to complete it.

Minutes of the Tenth Meeting

THYROID/FETAL DOSE RADIATION

presented by

Dr. David Gur

(University of Pittsburgh)

6-10-83

Dr. Gur began his presentation by summarizing his involvement in the TMI studies over the last three years including the assignment of dose estimates to individuals in the 5-mile radius of TMI during the period of the accident and the assignment of dose estimates to pregnant females in the 10-mile radius. A comprehensive data base has been established for future evaluations. A 10-mile map of the area was digitized. The census data were processed and resulted in a roster of information for households and individuals. A time-dependent dose rate distribution for outdoors was developed by using relative intensity from direct measurements fitted to TLD measurements with hour by hour rotating sectors with averaging wind direction. Personal data from census file information was superimposed over this distribution to give a maximum dose for the individual. "Maximum" and "likely" doses have some differences which depend upon several things but especially on the variability between actual monitors around the plant. The results of the dose assignments are in agreement with other reports and, if anything, the assignments are somewhat conservative.

Several position papers have been submitted to the Pennsylvania Department of Health relating inhalation exposures, indoor and outdoor exposure considerations, and assessing thyroid dose to the fetus.

A handout was distributed with a sample of thyroid doses to pregnant women and fetuses. This dose was based on inhalation alone. A shielding factor of 1.5 to 2 can be expected; therefore, the fetal dose should be lower. The whole body dose to fetus and mother are the same. A listing was distributed which included numbers, distances, angles, and doses to the fetuses and mothers.

Q. How does one "shield" inhalation dose?

Dr. Morgan asked about the thyroid dose to the fetus being calculated from the estimation of inhalation of radioiodines by the mother. Dr. Gur responsed that in relation to the age of the fetus, the thyroid is not active prior to 12 weeks; at 12-16 weeks the exposure to the fetal thyroid is equal to the mother's exposure; and after 16 weeks of age, the fetal dose overshoots the mother's dose. Whole body doses are the same for the fetus and the mother. Thyroid doses are not the same.

Dr. Kramer stated that there are ventilation effects, but no attempt was made to determine a ventilation effect per household. He also felt that the evacuation might increase radiation inhalation. Dr. Gur replied that evacuation decreased inhalation because of the speed at which people were able to leave areas of potential exposure. Mrs. Bratz added that there is detailed information on evacuation in the pregnancy outcome file, and that doses were calculated only for women who were pregnant during the TMI accident.

Permission Rec'd from Gov's office - NO (never rec'd Gur data there were to send me)

294 End

Dr. Morgan asked if the calculations considered the release of 16 curies of I-131. Dr. Gur said that a total of 15.5 curies of I-131 were released by April 30 and that close to one-half of that was released in the first ten days. Dr. Morgan asked if any consideration was being given to account for the millions of curies that should have been present. Dr. Gur replied that his calculations are based on actual measurements in the field. Dr. Morgan asked about a time distribution of the radiation and also whether calculations included I-132, I-133, I-134, I-135. Dr. Gur responded that they looked at possible contributions of other iodines. If other iodines were released in a puff, the total contribution would increase by a factor of .46. He continued that short lived radioiodines would not get to the fetus anyway. Dr. Gur said that iodine is a reliable indicator; the highest iodine level was found in goat milk at 90 picocuries per liter.

Dr. Gur also stated that there are certain minor differences in radiation dose estimates between the same persons in the 5-mile census and 10-mile pregnancy outcome files. He attributed this to the women telling their evacuation information in two different ways.

Dr. Gur then reviewed the summary tables with the Panel members.

Dr. Abrahamson asked if "fencepost data" (i.e., dose assignments to areas where no individuals resided) was available. Mr. Gerusky replied that the Department of Energy (DOE) has such data. Dr. Gur stated that there are several models of dose distribution not related to TLD measurements. The models using TLD's are similar to his own model. Mr. Gerusky added that some DOE data were derived from aircraft measurements.

Dr. Purdom questioned meteorological influences on the radiation distribution. Dr. Gur said some of those influences were considered for the plume.

Dr. Morgan asked what the total person-rem and the maximum dose was. Dr. Gur responded that the thyroid dose was 27 person-rems in the first few days. The highest maximum was 10 rem.

Dr. Gur said that evacuation did little to change the possible whole body gamma dose, but thyroid dose would have been saved because of the timing of the releases. There is a 2.5 ratio of "maximum possible" dose to "likely" dose. He felt that his "likely" dose is 40% conservative. His staff has reviewed 150 reports which have doses ranging from 2 times higher to 10 times lower than his own assignments. There are also age-dependent correction factors for the ages, abilities, increased thyroid activity, and decreased inhalation rates in his model. In summary, for the 0-5 mile radius, there is a conservative estimate of an average of 10 mrem per person. For pregnant females, in the 0-10 mile radius, there is an estimate of an average of 3 mrem per pregnant female for whole body gamma dose. The whole body gamma dose to the fetus is the same value as for the mother but can be assumed to be lower than that due to shielding from the mother.

Bullshit

10R

10 CFR 20 @ ___ States "2mr" offsite limit!

- aBX INHALATION INGESTION - V-8

PROBABILITY OF RADIATION CANCER CAUSATION

presented by

Mr. Robert Casey

(Brookhaven National Laboratory)

6-9-83

Mr. Robert Casey of Brookhaven Laboratory spoke on the probability of causation as a method of deciding radiation health claims (specifically cancer). At present, deciding on radiation damage claims is rather arbitrary. He gave three examples of awards for radiation-induced cancer claims from the Veterans Administration.

A. Exposed to 3,000 mrem gamma-radiation:
developed lymphoma.

Board decided radiation was a "probably factor"-
ruled in favor of claimant.

B. Exposed to 0.4 rem gamma-radiation:
developed lymphoma.

Board decided there was "reasonable doubt"-
ruled in favor of claimant.

C. Exposed to 800 mrem gamma-radiation:
developed adenocarcinoma.

Board decided there was "reasonable doubt"-
awarded benefits.

Releases of 3,000 mr on Thurs 3/29/79 29

Traditional tort law is usually difficult in these cases. Cancers are not identifiable as to cause. Courts sometimes have required "a reasonable degree of medical certainty" that a particular event (exposure) was a substantial factor in producing the disease. Common law says the plaintiff must prove "proximate cause" of injuries (a substantial factor in the disease, if not the only one). The burden of proof is on the plaintiff. The preponderance of evidence is to prove cause and effect. The possibility of causing the disease is inadequate. Questionable cases are to be resolved by court.

With cancer, there is no "proof"--no evidence--that a specific cancer is caused by a specific incident of radiation exposure. In the past, they've looked to medical science for evidence, but only a few malignancies are such that the causative agent can be identified with a high degree of probability.

"Excess incidence" is used to relate cancers to exposure. In experiments with large doses there are additional injuries produced and these are recognizable as radiation effects. These results can be extrapolated to low doses (linear assumption).

One way to use what is known to decide cases equitably is using probability of causation:

$$PC = \frac{R_r}{R_b + R_r}$$

where: R_r = increase due to dose
R_b = baseline rate.

Baseline rates for that age and sex group (or even more specifics if applicable) can be obtained from sources like SEER. Excess incidence due to dose can be obtained from sources such as the BEIR report--there is an assumption of linearity over dose ranges and time upper limits would be used. Some specific examples were given for a 25-year old male exposed to 10 rads who developed leukemia.

The risk = 2.5×10^{-6}/yr/rad.
The baseline = 36×10^{-6}/yr.

$$PC = \frac{(10)(2.5 \times 10^{-6})}{(36 \times 10^{-6}) + (25 \times 10^{-6})} = 41\%$$

Other risk factors (smoking, chemical exposure, etc.) could be included in the denominator if an appropriate baseline were used. Because of the linear assumption:

$$R_r = D = \frac{R}{D} = C \times RC$$

where: D = dose
R = risk
RC = risk for unit dose
R_r = increase due to dose.

Including other factors:

$$PC = \frac{R_r}{R_r + R_b + R_o + R_a}$$

where: R_r = risk for that radiation dose
R_b = baseline
R_o = risk from other radiation exposure
R_a = risk from other agents.

Doubling dose is when $R_r = R_b$, therefore:

$$PC = \frac{R_r}{R_r + R_r} = 50\%$$

These values will change somewhat as new BEIR values for dose and new baseline values become available but they aren't expected to change too greatly. It would still be up to the courts or boards to decide what probability would be an appropriate cut-off point. They could even institute sliding scales giving higher awards when the probability of causation from this particular exposure is very high and lower awards when it is lower (therefore, less certain). On the Veterans' Administration cases reported above, PC's can be computed:

A.	3000 mrem	7% probability
B.	0.4 rem	2% probability
C.	800 mrem	2% probability

Dr. Seltser pointed out difficulties in including other factors. The baseline rates would have to be different (rates excluding those factors). He also mentioned that instantaneous rates here are derived from lifetime rates. Dr. Morgan said this doesn't address the claims of those who, as exposed, are at risk but haven't developed cancer. He also asked how an annual rate is derived from a lifetime rate. Mr. Casey explained that since it's assumed to be linear, lifetime rate is divided by age. Dr. Jones pointed out that these factors obviously aren't linear but that's an assumption made and that's the best so far.

LONG TERM EFFECTS OF STRESS: PROPOSAL

presented by

Dr. Susan Streufert and Dr. Seigfried Streufert

(Hershey Medical Center)

Dr. Susan Streufert and Dr. Seigfried Streufert outlined their proposal for the study of the long term physiological and task performance effects of exposure to the TMI experience (see proposal). The proposal was submitted simultaneously to the Berger Committee and the TMI Panel for review.

The proposal covers a 10-year period, planning to study in depth about 180 adult residents, 120 of which would be residents of a ten-mile radius around TMI who were present at the time of the TMI accident. The remaining 60 would be controls, half from the 10 mile radius and half from 40 miles away.

The idea is to measure the cumulative effects of multiple stressors as measured by task performance. It is hypothesized that those persons who underwent the TMI experience have one extra major stress to cope with in their lives and that due to an "adaptive cost" their performance under other stressful situations might be different from the control persons.

The researchers felt that a sample size of 30 in each cell was plenty high (infinite power?) to yield meaningful results. Dr. Sheehe questioned what was so ideal about 30, as power is dependent on such things as normality, magnitude of difference being detected, multiplicity, as well as sample size. Dr. Seltser agreed.

Elements of the proposal were discussed. Dr. Morgan suggested that someone ascertain the prevalence of metalic taste in the mouth, nausea, and so on, which were apparently experienced by a number of persons at the time of the accident. He also asked whether the Streuferts could bring subjects in for measurements every other year rather than every year to cut down on cost. Dr. Streufert said this could be done. Dr. Seltser asked if the stress tests were developed by the Streuferts and whether they were standardized. Dr. Streufert answered that some were and some were not.

When asked how the samples were to be selected, the Streuferts said this would be a combination of using systematic location map, telephone directories and also some previous study participants. Many Panel members were not satisfied with the various aspects of the study methodology as presented by the researchers.

STRESS PROXY VARIABLES AND PREGNANCY OUTCOME:

PRELIMINARY

presented by

Ms. Jane Bratz and Dr. Joyce Kim

(Division of Epidemiology Research, PA DOH)

In formulating the pregnancy outcome study, two basic questions were considered: first, did pregnant women living within a 10-mile radius of the TMI plant, as a whole, experience any detectable stress effects; and, secondly, did any particular segment of the pregnant population show any measurable sign of adverse consequences.

Preliminary data with respect to three specific aspects of maternal stress-related behavior during and shortly after the TMI accident were presented; namely, increased smoking, increased drinking, and increased medication and how these stress proxy variables were related to six selected measures of adverse pregnancy outcome.

The data showed that neither fetal death nor neonatal death was correlated with maternal smoking, drinking, or medication in general. A significant correlation was found between smoking and immaturity, prematurity, and low Apgar score. Maternal drinking was also significantly correlated with congenital anomalies and prematurity. These general observations have been reported elsewhere. However, the current important findings were related to increased medication during the TMI accident. Specifically, those mothers who increased medication during or shortly after the accident were significantly correlated to the increased risk of immaturity, prematurity, and low Apgar score.

Several Panel members asked questions during the presentation of this data. Most of the questions focused on how the variables were defined. These were explained (see Dr. Tokuhata's paper "Pregnancy Outcome Around TMI", 1981).

Dr. Muller asked if smoking information by trimester of pregnancy was available and was informed that it was available. Dr. Kramer felt that the data should also be analyzed for the measures of non-adverse pregnancy outcome.

The data also showed that increased smoking during the TMI accident was significantly correlated only with low Apgar score. Increased drinking during the TMI accident was significantly correlated only with congenital anomalies.

A further analysis indicated that both routine smoking and TMI related increased smoking were significantly correlated with low Apgar score, thus, the risk of low Apgar score cannot be attributed to the TMI accident. Likewise, the risk of congenital anomalies cannot be attributed to the TMI accident as both routine drinking and TMI-influenced drinking were significantly correlated to the incidence of congenital anomalies.

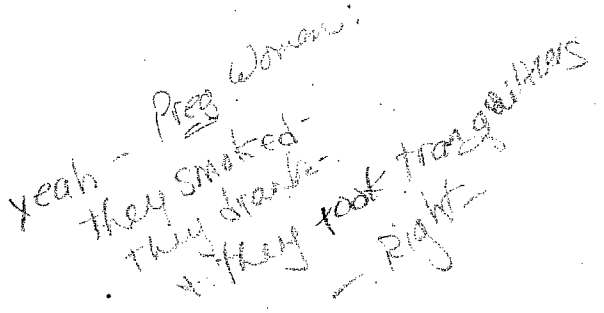
Since the TMI-influenced medication was significantly correlated with maturity risks, the TMI cohort was divided into four subgroups according to stage of gestation at the time of the TMI accident. The data showed that immaturity and prematurity risks were significantly elevated within the third and zero trimester groups. (The zero trimester group represents women who became pregnant within 3 months after the accident.) Low Apgar score was significantly correlated only within the first trimester group.

At least three additional data analyses are scheduled. The results of these analyses (including multivariate analysis, group comparison, and internal control analysis) will clarify the relationships between increased medication due to anxiety and stress and pregnancy outcome.

Starting out the discussion period, Dr. Seltser requested and recorded the numbers for each adverse pregnancy outcome.

Dr. Kramer then asked why a correlation coefficient was used for analysis, as opposed to numbers and rates. He also asked how the correlation coefficient was computed. It was explained that the entire cohort was used in all tables and that correlations were based on dichotomus variables. It was stated that this technique is widely used. Dr. Frederick reminded the Panel that this presentation was only a small piece of the pie. The researchers stated that correlation was only one of many other methods being used. Dr. Seltser felt that presentations of the data should be in a format that is least apt to be misconstrued by the reviewers.

Dr. Sheehe stated that since "TMI-influenced" implies an influence caused only by TMI, a different word such as "TMI-related" (as suggested by Dr. Frederick) might be more appropriate.



Testimony of Eric J. Epstein, Chairman Three Mile Island Alert Inc.*

May 1, 2008

Re: NRC SEEKS PUBLIC INPUT ON ENVIRONMENTAL IMPACT STATEMENT FOR THREE MILE ISLAND 1 LICENSE RENEWAL APPLICATION

"This application does not involve the adjoining Three Mile Island 2 reactor, where a severe accident occurred in 1979. That unit has been out of service since the event. It has been defueled and decontaminated to the extent that the plant is in a safe, stable condition suitable for long-term monitoring."
(NRC Press Release)

The core melt accident occurred at TMI-2 in March-April 1979 was followed by a tax payer and ratepayer subsidized $1 billion de-fueling process. Post De-fueling Monitored Storage was approved in 1993. There is no significant dismantlement underway. GPU Nuclear retains ownership of TMI-2, and contracts to AmerGen for maintenance and surveillance activities. Both units are currently expected to be decommissioned together in 2014. Most of spent fuel was removed except for debris, defuel and contaminated parts in the primary systems. The fuel is currently in storage at the Idaho National Engineering and Environmental Laboratory. The Department of Energy has taken title and possession of the fuel.

The costs to defile TMI-2 do not include nuclear decontamination and decommissioning or restoring the site to "Greenfield".

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* *Mr. Epstein is the Chairman of Three Mile Island Alert , Inc.*, tmia.com, *a safe-energy organization based in Harrisburg, Pennsylvania and founded in 1977. TMIA monitors Peach Bottom, Susquehanna, and Three Mile Island nuclear generating stations.*

Legacy Issues at TMI-2

1) How much fuel is left in the reactor vessel? What is the K-effecitve? (1)

2) What is the status of cork seam leakage at TMI-2? (2) Is there an underground plume? If so, has the plume migrated towards the River?

3) How many fires have occurred at this "safe and stable plant" since 1990? (3)

4) How many non conforming conditions adverse to quality or safety have been identified at Unit-2. (ADAMS, ML073531346)

5) Does the plant have any economic value? (4) Does the NRC consider TMI-2 to be a "Brownfield" site?

6) Is this a historic site? It has a PHMC designation.

7) A historic district requires or site requires "architectural compatibility.: Zoning ordinances usually preclude construction within certain areas of the historic district or site. Is this the reason TMI-1's is not decontaminated or decommissioned.

8) How many people work at TMI-2?

9) How would you characterize the relationship between FirstEnergy and Exelon?

10) How would you characterize the most recent FirstEnergy tour of Three Mile Island?

11) How much was in the decommissioning fund at the time of the accident? How much is the fund now? (5)

12) How much will be needed to actual decommission the plant, i,e,. real 2008 dollars?

13) What is the targeted funding level for nuclear decommissioning?

14) Is there any reason TMI-2 can not be decommissioned or decontaminated while TMI-1 is operating? Please provide the safety and technical challenges that preclude immediate cleanup of TMI-2.

15) How many other licensees does holding a POL or materials license have been convicted of a felony? (6)

16) Please provide a study or empirical data that demonstrates it is safe to store high level radioactive waste on an island next to a river that empties into the Chesapeake Bay?

17) What assurances exist that TMI-2 will not became a HLRW site for spent fuel from other Exelon sites?

Three Mile Island Unit-1

"Three Mile Island 1 was not affected by the accident and has had a safe operating record for many years."(NRC Press Release)

18) How many people work at TMI-1? How many people worked at TMI-1 when AmerGen purchased the plant from GPU? How many people does the NRC project will be working at TMI-1 in 20 years?

19) Is it unusual for a licensee to to go through four vice presidents for one nuclear reactor in eight years? What is the average industry term a Vice president serves at a reactor site?

20) Can you factor economics, staffing levels, or the tax base into a relicensing decision?

21) Can the NRC relicense a plant for less than 20 years? Has the NRC extended a license for more than 40 years, but less than 20 years? If so, please identify the plant and the extension conditions. (7)

22) Hasn't TMI's license already be extended by 6 years? (8)

23) TMI-1 continues to operate with the most damaged steam generating tubes in the country. From November 1981 to January 1982, GPU discovered it had damaged over 29,000 steam generator tubes at TMI-1. (9)

Is there an operating plant with more plugged steam generating (SG) tubes? If so please identify the plant and the number of plugged tubes.

24) Is there an operating plant with more plugged SG tubes as an overall percentages? If so please identify the plant and the percentage of plugged tubes.

25) Is there an operating plant with more sleeved steam generating tubes? If so please identify the plant and the number of sleeved tubes.

26) Is there an operating plant with more sleeved SG tubes as an overall percentage? If so please identify the plant and the percentage of sleeved tubes.

27) Exelon Nuclear has selected Washington Group International and Areva Inc. to replace two steam generators at Three Mile Island.

"The project will require workers to cut a hole through the 4-foot-thick concrete walls of the reactor containment building. The work will be done during the refueling and maintenance outage in the fall of 2009, said Ralph DeSantis, spokesman for AmerGen Energy, operator of TMI and a subsidiary of Exelon. Exelon has budgeted $280 million for the work." (The Patriot News, October 28, 2006)

Is it realistic to believe that the NRC would not factor a $280 million investment in the license extension process?

28) "The major overhaul will put the nuclear power plant in better position to be re-licensed in 2014, the company said."

How is this not a down payment on relicensing?

29) Shouldn't the NRC extend the life of TMI to coincide with its inability to offload its fuel core? (10)

30) The National Academy of Sciences issued a report that had been requested by Congress in March 2005. The report questioned the safety and security of highly crowded spent fuel pools currently storing the nation's nuclear inventory The report concluded that the government does not fully understand the risks that a terrorist attack could pose to the pools and ought to expedite the removal of the fuel to dry cask storage casks that are more resilient to attack.

Since reracking has produced very dense spent fuel pools at TMI, shouldn't the utility also be applying for additional spent fuel storage capacity? When will TMI-1 loose off-load capacity?

31) Barnwell S.C. announced that it will close to generators on June 20, 2008.

The NRC staff concluded that there was no new and significant information and therefore there would be no impacts of low level waste storage and disposal associated with the renewal term. The GEIS stated that, "...The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small."

TMI is located on Susquehanna River so any leaking contaminants from waste storage facilities will flow towards and eventually into the Bay. There are no monitoring wells lining the shoreline.

We deserve to know what the LLRW storage plans are before the application is decided; so that the re-licensing decision does not prejudge any LLRW storage decision.

Where will the LRW going to be stored? For how long? And will the location be above the flood plain?

32) The federal relicensing system used to ensure nuclear plants are safe to operate for an extended period beyond their original license of 40 years, has come under sharp criticism. The Nuclear Regulatory Commission's (NRC) Office of Inspector General (OIG), Audit of NRC's Renewal Program (OIG-07-A--15) found key safety evaluations lacked critical documentation.

> Essentially , DLR [the Division of Licensing Renewal] lacks a complete report quality assurance process to ensure documentation of the staff's aging management program review methodology and substantive support for staff conclusions.
> (OIG-07-A-15, September, 2007, p.11.)

Currently, Pennsylvania has three nuclear stations involved in the relicensing process: Beaver Valley Nuclear Generating Station (Shippingport), the Susquehanna Steam Electric Station (Berwick), and the Three Mile Island Nuclear Generating Station (Londonderry Township).

What guarantees exist that the NRC will not perform a "cut and paste" job at TMI?

> Essentially , DLR [the Division of Licensing Renewal] lacks a complete report quality assurance process to ensure documentation of the staff's aging management program review methodology and substantive support for staff conclusions.
> (OIG-07-A-15, September, 2007, p.11.)

33) Why not emulate the conditions in Sarbannes Oxley for corporate officers, and allow NRC staff to sign-off on the license extension subject to a bonus for good performance and a felony for material false statements?

34) How many NRC staff members are here this evening?

35) How many staff members will be here in 20 years?

36) The disposal of highly radioactive waste contained in nuclear reactors' used, or spent, fuel rods poses another serious problem. This waste must be isolated for at least tens of thousands of years, if not longer. It ultimately should be stored in a permanent, underground geologic repository, but the proposed site at Yucca Mountain in Nevada may never be licensed. The report recommends that the Department of Energy identify other potential sites. In the interim, the report concluded that the waste can be stored safely in dry casks for the next 50 years, but only if the casks are hardened against attack by surrounding them with earthen berms. Currently, casks are sited in the open on concrete slabs.

When will TMI build dry cask storage casks at TMI to store spent fuel?

37) How many DOE employees are in attendance?

38) What's the industry average for "inattentive" or "sleeping" workers compared to the number of incidents at TMI over the last two years?

39) The Ninth Circuit Court said the NRC violated the National Environmental Policy Act when it didn't include a terrorist attack in an environmental impact report for an application to create dry cask storage at the Diablo Canyon Power Plant?

What impact will Diablo Canyon spent fuel case have on the TMI license extension? (11)

40) What is the impact of an aging workforce on relicensing? What is the average age of the TMI workforce and how does it compare to the industry average?

41) Tritium and other leaks – examples and NRC policy on self-monitoring - also exist at Three Mile Island. How has the NRC changed modified its relicensing process to evaluate tritium monitoring?

42) How does the NRC plan to deal with the following water related issues and structural challenges caused by:

Micro fouling versus macro foiling, micro biologically influenced corrosion, biofilm's disease causing bacteria such as Legionella and listeria, the difficulty in eliminating established biofilms, oxidizing versus non-oxidizing biocides, chlorine versus bleach, alkaline versus non-alkaline environments, possible decomposition into carcinogens, and the eastward migration of Asiatic clams, zebra mussels and the anticipated arrival quagga mussels?

39) "Whether the kills are legal or not, a former southern Lancaster County worker at the Peach Bottom nuclear plant said he was "sickened" by the large numbers of sport fish he saw sucked out of the Susquehanna. "When the water comes in, fish would swim in through tunnels and swim into wire baskets," said the man who lives in southern Lancaster County and asked that his name not be used. "There were hundreds and hundreds of fish killed each day. Stripers and bass and walleye and gizzard shad and all kinds of fish. It took a forklift to carry them out. "Every species in the river comes in there when they turn those big intakes on." (*Intelligencer Journal*, January 15, 2005)

TMI has a similar system for disposing of the fish and other organisms that make it through the intake maze. "If they get that far, they're not going back," said Pete Ressler, a spokesman for TMI owner Exelon Nuclear. "They are dumped into a container and disposed of."

Will this system function in the same manner for an additional 20 years?

"The NRC has approved license renewal for 48 generating stations and 38 other license renewal applications are pending or have been announced."
(TMI Press Release)

40) How many companies applying for license extensions have been denied?

41) How many companies applying for license extensions are actually incorporated in the same state as the operating plant?

42) How many Company's applying for a license extension have been fined for stealing water?

43) Can TMI afford to shutdown or is the decommissioning fund underfunded? (12)

44) How much money does TMI have in its dedicated decommissioning fund? (13)

45) What is the targeted funding level for decommissioning TMI-1?

46) What is the funding level for decommissioning TMI-1 in real, 2008 dollars?

47) How much high level radioactive waste is currently stored at TMI?

48) How much additional HLRW will be stored if the plant if it is relincensed?

49) In January, the NRC's Inspector General issued a report highly critical of the NRC, noting the agency has known since 1994 that the Hemyc barrier fails fire tests in minutes – less than half the duration required by NRC regulations. Of the 16 plants the IG found to be in violation, six are owned by NC-based Progress Energy and Duke Energy. To compensate for the years of noncompliance – the NRC is allowing the plants to rely on "interim" measures that have been neither tested nor approved by the agency.

What interim fire protection measures have been deployed at TMI?

50) On September 12, 2007, Mr. Epstein filed a "Petition For Rulemaking Requiring Periodic Comprehensive NRC Review Of Emergency Planning Around U.S. Nuclear Power Plants During The License Renewal Process?" Also pursuant to NRC Regulations Section (D) of §2.802, this petition requests the Commission immediately suspend all licensing proceedings throughout the United States until validation of "reasonable assurance of adequate protection of the population" has been re-established by the NRC for all US Licensees. (14)

What impact does this filing on the present proceeding?

ENDNOTES

1 CORK FILLED CONSTRUCTION JOINT within AUXILIARY BUILDING SEAL INJECTION VALVE ROOM

- **October 22, 1993** (pm) In a phone conversation with **Dave Beaulieu (NRC/TMI)**, Eric Epstein reported a safety allegation relating to the inability of the cork in an Auxiliary Building joint to contain the spread of radioactive contamination. Mr. Epstein also stated that the issue should have been included in the PDMS close out schedule. Mr. Beaulieu recorded Mr. Epstein's allegation and reported to NRC Region I.

In response to Mr. Epstein's concerns, Mr. Beaulieu stated: "...hasn't been written in Inspection reports...Contamination there and moving slowly...and not [an] immediate safety concern...Radiation can deteriorate lining if it is high enough...Talked about making it a PDMS issue...It's a concern to me, to Lee [Thonus/NRC] to everybody...[GPU is at the stage of] data collection process."

- **October 24, 1993** (evening) Phoned **Rich Janati, DER/BRP**, and left a message on his home phone informing Mr. Janati of the safety allegation.

- **October 25, 1993** (8:30 am) Mr. Janati returned Mr. Epstein's call: "Aware of this issue...General Review Group brought it up twice [Mr. Miles]...They're aware of it...We do have a concern...Couple of options considering: 1) Remove whole thing...very costly. 2) Other option: find where the leaks are and stop the leaks. Come up with new materials [foam]...We're hoping they're doing it as soon as possible. Expressed our concern to NRC, but we don't have enforcement authority. Going to cost bucks...Removing is probably the last [option] because [of] the cost and material disposal issues.

- **October 25, 1993** (8:45 am) Ralph DeSantis, **GPU Nuclear** was informed of Mr. Epstein's concern. A letter was prepared and sent to GPU, their legal counsel, Mr. Epstein's counsel and the ASL&B. (See enclosure.)

- **October 25, 1993** (8:50 am) Mr. Epstein contacted Dr. Michael Masnik, **NRC/Bethesda** and informed of previous discussions. Mr. Masnik explained: "...part of the problem [GPU/NRC] weren't sure of the extent of the contamination...conflicting information...came to a head within the last couple of weeks. I have a better understanding. It is going to be a PDMS issue. No way they're going into PDMS with water [500 gallons] in crack. They owe us a letter."

- **October 25, 1993** (1:00 pm) Michelle Evans, Senior Resident Inspector **NRC/TMI,** phoned Mr. Epstein to request that he withdrawal the allegation for the time being and proceed informally. Mr. Epstein agreed.

- **October 26, 1993** (pm) Mr. Epstein recontacted Lee Thonus, **NRC/TMI-2,** and arranged to meet with him to discuss the cork seal problem.

- **October 27, 1993** (8-9:30 am) Lee Thonus **NRC/TMI-2** explained issues relating to cork seal problem: "Cork does not serve any structural purpose...Just keeps them [concrete slab flow] from separating...Prevent ground water from getting in...Radioactive water leaking in...[Cork] in tact on bottom...Captured [in punch list on Auxiliary Building] and we won't break out separate item." GPU now pursuing with a "higher level of interest." The water was pumped out but leaked backed in "gradually." The water contains Cesium-137 and "significantly" smaller amounts of Strontium. Tritium levels are "very, very small .009...more than a factor of two below AGW...10-20 curies in cork seal..." Approximately 600-1000 gallons in seal cork boundary. Leaks occurring from roof, horizontal and vertical joints. Expecting letter from GPU on November 15, 1993. Radioactivity can not degrade plastic [liner] over 40 years: "Radiation contamination calculation was 3% of depletion..."

- Conversation with Lee Thonus of NRC (Third week, **March, 1996**): "We closed out cork seam. On tracking system...On autopilot...[GPU] has an adequate program to look at it...It hasn't evaporated...[Check cork seam] At least weekly..."

- **July 23, 1996** Telephone message from Ralph DeSantis, GPU Nuclear: There was extra water "about three months ago...primarily from winter snow and rain. At no time was there a problem with the processing [of] that amount of water. Levels well within system capacity for processing the water." The water levels have returned to normal.

2 **SUMMARY OF REMAINING FUEL at TMI-2**

Video estimate of remaining fuel at TMI-2 (GPU) GPU concluded there was **850 kilograms** of fuel remaining at TMI-2.

Defueling Completion Report (GPU) - GPU's video camera and visual inspection of the amount of fuel remaining in TMI-2: **608 kilograms; Criticality 94.** According to Dr. Mike Masnik supervisor of the NRC effort at TMI-2, the NRC was intimately involvement in this project.

Safety Evaluation (NRC) - The NRC staff approves GPU's fuel estimate based on their own visual analyses.

Distenfeld Study (GPU) - As part of the fuel storage agreement with the Department of Energy (DOE), GPU predicted there was **1,322 kilograms** of fuel remaining in TMI-2. GPU tried to determine how much fuel was left at, and around, the reactor vessel by subtracting the amount of fuel used when TMI-2 began operation from the amount of fuel remaining at TMI-2. The difference was supposed to be in DOE's possession. Clearly, **Distenfeld's** figures raised "concern" for GPU and the NRC and both entities recognized there was a "potential for more fuel." However, Dr. Masnik noted "Quite frankly we had some questions on Distenfeld's [criticality analyses study.] " *

When Dr. Michio Kaku asked Lee Tonus (NRC site staff) for a copy of Distenfeld's study he was told it was available in the Public Document Room. Then Tonus admitted he didn't know where it was published.

In fact the document is so obscure and the only record of its contents is a conference proceeding of the Institute for Nuclear Material Management.

* Phone conversations with NRC staff in early to mid April, 1993.

Rasmussen Study (GPU) - GPU commissioned Norman Rasmussen to critique Distenfeld's study; however, nowhere in Rasmussen's study is Distenfeld name's found. Rasmussen concluded there was **935 kilograms** of fuel remaining at the bottom of TMI-2. According to Dr. Masnik, Rasmussen's study is the "best estimate." This study concedes that **super-criticality** could result with the removal of the neutron "poison" (borated water.) This scenario is unlikely but possible during an explosion, fire or crash.

Kaku's Study (TMI-Alert/TMI-Legal Fund): After evaluating the above mentioned studies, Dr. Kaku noted: "It appears that every few months, since 1990, a new estimate is made of the core debris, often with little relationship to the previous estimate...estimates range from **608.8 kg to 1322 kg**...This is rather unsettling, because there is significantly more than enough uranium debris to give critical mass. The still **unanswered questions** are therefore: precisely how much uranium is left in the core, and how much uranium can collect in the bottom of the reactor to initiate re-criticality."

3 August 5, 1992 - GPU "declared an event of potential public interest when the Unit-2 west cooling tower caught fire." The fire lasted for ten minutes.

"On July 2, [2003] area firefighters and the Pennsylvania State Police responded to the electrical fire that damaged the turbine building's switchgear room at TMI Unit 2. "Although a five-member AmerGen fire brigade also responded to the blaze, Akron, Ohio-based FirstEnergy is responsible for the operation of TMI Unit 2...

"The company will spend more than $100,000 to replace the damaged 55-gallon drum-sized transformer, switchgear, wires and other equipment damaged in the smoky blaze, he said.

"For the next two months, while workers repair the equipment, TMI Unit 2 will use temporary lights, Wilkins said. "It's not unusual for a transformer to fail," Wilkins said. "It's not unheard of." (*York Daily Record*)

4 Unit 2 at TMI was pronounced worthless by First Energy in a lawsuit against Dauphin County." The deal means the plant will be exempt from property taxes after the assessment on the reactor and its contaminated site was readied from $16.2 million to zero...First Energy Spokesman Scott Shields said the company considers Unit 2 useless and has absolutely no plans for building on the land." (Nuclear Engineering International, April 1, 2005)

TMI-2's turbine(s), which is for sale, has value and use if accelerated stress corrosion or relicensing force TMI-1 to seek a replacement.

TMI-1 and TMI-2 were built with Westinghouse turbines, and 1500 and 1800 rpm pressure turbine discs. The NRC staff, and Westinghouse's Turbine Division determined on November 20, 1979 that cracking attributed to stress corrosion phenomena had been found in these turbines.

Resale value needs to be determined, but a high-quality used turbine at TMI-2 could have enormous resale value. The Cooper Nuclear power plant in Nebraska is replacing both turbines. Cooper is a 778-MWe, BWR that came on line at roughly the same time as TMI-1 (July, 1974). The price for replacing both turbines to accommodate a 20-year relicensing extension is **$35 million**.

5 In July 1990, GPU submitted its funding plan for placing $229 million in escrow for radiological decommissioning.

February, 1997 - In their *1997 Annual Report*, GPU reported that the cost to decommission TMI-2 doubled in four years. The original $200 million projection has been increased to $399 million for radioactive decommissioning. An additional $34 million will be needed for non-radiological decommissioning. The new funding "target" is $433 million; or a 110% increase in just 48 months.

According to the NRC , as of September, 2004, $421 million resides in the TMI-2 Decommissioning Fund (2003 dollars.)

A recent withdrawal for an undisclosed amount was made on February 14, 2005 to dispose of TMI-2 filters stored at the INEGL in Idaho.

6 February 29, 1984 - A plea bargain between the Department of Justice and Met Ed settled the Unit 2 leak rate falsification case. Met Ed plead guilty to one count, and no contest to six counts of an 11 count indictment.

The Company also agreed to pay a $45,000 fine, and establish a $1 million dollar interest-bearing account to be used by the Pennsylvania Emergency Management Agency. The Settlement stipulated that the fines, emergency preparedness fund, and legal cost of the prosecution, would not be paid by GPU/Met Ed rate share holders. (See May 22, 1979, for initial complaint.)

7 "The California Public Utilities Commission approved a massive $680 million renovation that would extend the life of the San Onofre Nuclear Generating Station by at least 13 years.

"The commission on Thursday gave Southern California Edison the green light to replace four aging steam generators that power the two nuclear reactors at the seaside plant about 60 miles south of Los Angeles. (AP Wire: Regulators approve plan to extend life of SoCal nuclear plan, Fri, Dec. 16, 2005)

8 Three Mile Island began commercial operations in September 1974.

9 Status of damaged SG tubes at TMI. The limit on out-of -service tubes is 2,000 per generator out of **15,531** per generator.

A: 14,019 in service at the end of 2003.
B: 14,979 in service at the end of 2003.

The new standard will increase the plugging limit to **3,106**.*

NRC reported plugging at Steam Generator A: **1,300**
NRC reported plugging at Steam Generator B: **395**

Sleeved in A: **248 (Examined)**
Sleeved in B: **253 (Examined)**

Update provided by Rich Barkely: #610-337-5065 of the Nuclear Regulatory Commission.

The old SGT limit is 2,000 per generator out of **15,531** per generator.

* The new standard will increase the plugging limit to **3,106**.

NRC reported plugging at Steam Generator:
A: **1,300** A: **1,512** (2003)

NRC reported plugging at Steam Generator
B: **39** B: **552** (2003)

Sleeved in A: **248**
Sleeved in B: **253**

10 Exelon is in the process expanding of a spent-fuel storage capacity. The project will last from 2002-2009 and re-rack "wet storage". AmerGen is increasing capacity through three phases:

Source: *AmerGen and Exelon Meeting with EFMR on January 23, 2003, at the Three Mile island Training Center, S 1-2: Peach Bottom-2 & -3 and Three Mile Island-1, Meeting & Action Items.*

• Phase 1 - Complete;

• Phase 2 - Completed in mid-2003. An additional 216 re-racked cells added were installed, or enough for three refueling cycles, were installed.

• Phase 3 - To be completed by mid-2009, and would add another 432 re-racked cells extending storage capacity through 2018. (4)Because of the additional capacity, and Three Mile Island-1 core size, (177) the Company will not lose full core off -load capability until 2018. In other words, lack of waste storage space will not force TMI to close prior to its license expiration.

"The configuration of spent fuel pools is essentially the same for all nuclear power plants. The pools are rectangular in vertical and horizontal cross section. The spent fuel assembles are stored in racks at the bottom of the pool. Insertion or removal of the fuel assemblies is accomplished vertically from above the storage racks. The 13.5 to 14.5 foot long fuel rods must remain submerged during fuel removal or insertion into the racks; thus, for this reason alone, the spent fuel pool must be at least 27 feet deep. However, an additional eight to ten feet of water is required for shielding an irradiated fuel assembly just removed from the reactor. The spent fuel pool depth must therefore be approximately 40 feet. The direct radiation at the the pool surface from the fuel stored at the bottom is very low because of the water depth of about 25 feet above the top of the irradiated fuel assemblies is equivalent to about 10 to 11 feet of concrete shielding value." (David Lochbaum, Union of Concerned Scientists, "Nuclear Waste Disposal Crisis", Spent Fuel Pools, p. 52., 1996.)

11 WASHINGTON, Jan. 19, 2007 (UPI) -- The U.S. Supreme Court decision Tuesday not to hear an appeal by a California nuclear company means federal regulators will have to decide how to factor in terrorist attacks when evaluating environmental impacts of nuclear waste storage.

In denying Pacific Gas & Electric's appeal of a June 2 ruling by the Ninth Circuit Court of Appeals in San Francisco, the high court may have forced the U.S. Nuclear Regulatory Commission to address the threat of terrorist attacks on nuclear facilities like it hasn't in the past.

The appellate court said the NRC violated the National Environmental Policy Act when it didn't include a terrorist attack in an environmental impact report for an application to create dry cask storage at the Diablo Canyon Power Plant near San Luis Obispo, Calif.

12 **Study: Yankee can't afford shutdown**

Rutland Herald Nov 15, 2007 By Susan Smallheer Herald Staff

"VERNON If Vermont Yankee nuclear plant shut down today, or even in 2012 when its federal license expires, there would not be enough money in its decommissioning fund to pay for it to be dismantled and disposed of safely."

"The plant would have to be essentially mothballed for 12 to 15 years for its stock market-invested trust fund to build so there was enough money to dismantle it, Entergy Nuclear engineer David McElwee told the Vermont State Nuclear Advisory Panel Tuesday evening."

13 Exelon manages the money in an externally, segregated sinking fund. According to AmerGen, the last official accounting for the fund demonstrated the Company was making progress towards their savings goal:

> The amount of decommissioning funds accumulated through December 31 , 2002 was **$ 285.2 million**. However, [u]under the plant purchase agreement, there is no remaining amount to be collected from the previous owner [.] A two percent annual real rate of return is being assumed on the decommissioning trust funds. Financial assurance for decommissioning continues to be provided by the prepayment method, coupled with an external trust fund. (Jeffrey A. Benjamin, Vice President, Licensing and Regulatory Affairs, AmerGen Energy Company, LLC, March 31, 2003)

As part of the purchase agreement between GPUN and AmerGen, GPUN agreed to prefund the TMI-1 decommissioning trust account for at least **$303 million**. This amount exceeds the minimum amount required by the generic formulas in 10 CFR 50.75(c), and thus allows AmerGen to buy TMI-1 without providing additional assurance for any unfunded portion of the decommissioning cost estimate. However, in an effort to forestall any adverse Federal income tax consequences from the sale of TMI-1 and the buildup of additional decommissioning funding required under the terms of the sale, GPUN and AmerGen proposed that GPU Energy (the three owner subsidiaries of GPU, Inc., the parent company of GPUN) hold the decommissioning trust until such time as the U.S. Internal Revenue Service (IRS) issued a favorable ruling on the tax consequences related to the transfer of TMI-1 decommissioning funds. (Dr. William Travers, EDO, NRC, "Lessons Learned from the Transfer of the Operating Licenses of the Three Mile Island-1 and Pilgrim Nuclear Power Stations, July 1, 1999).

Several months later, Exelon spokesman Craig Nesbitt stated, "All of our sites are **fully funded** for decommissioning. They are on track to be fully funded now, and they will be fully funded when the time comes to decommission" (*Lancaster New Era,* December 3, 2003).

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September 12, 2007

Ms. Annette Vietti-Cook
Secretary
US Nuclear Regulatory Commission
Washington, DC 20555

Re: Petition For Rulemaking Requiring Periodic Comprehensive NRC Review Of Emergency Planning Around U.S. Nuclear Power Plants During The License Renewal Process

Dear Ms. Vietti-Cook,

Pursuant to the NRC's §2.802 rulemaking process, I'm writing to submit a petition for rulemaking.

This petition seeks new NRC rulemaking requiring periodic comprehensive NRC review of emergency planning around U.S. nuclear power plants during the license renewal process for the purpose of making a new finding of reasonable assurance of adequate protection of the population.

Also pursuant to NRC Regulations Section (D) of §2.802, this petition requests the Commission immediately suspend all licensing proceedings throughout the United States until validation of "reasonable assurance of adequate protection of the population" has been re-established by the NRC for all US Licensees. Thank you for your assistance with this issue.

Sincerely,

Eric Epstein
Three Mile Island Alert
4100 Hillsdale Rd.
Harrisburg, PA 17112
(717) 541-1101