February 17, 1989

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
GPU Nuclear Corporation	)	Docket No.50-320-OLA
(Three Mile Island Nuclear	)	(Disposal of accident
Station, Unit 2)	)	generated water)

TESTIMONY

Richard Piccioni, PhD
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From the response of the Board (Final Initial Decision, February 2, 1989) to testimony I presented at the Atomic Safety and Licensing Board, it is evident that my position on the question of the disposition of over 2 million gallons of accident generated water was not clearly understood. I therefore offer the following further comments as clarification.

In the analysis submitted as part of my testimony, it is evident that doses to the public, whether due to the intended consequences of the disposal method (e.g. inhalation of gaseous radionuclides as a consequence of forced evaporation) or due to the consequences of an accident (e.g., consumption of contaminated shellfish after an accidental release of stored water into the Susquehanna River) could be made as small as desired without increasing any health risks to the public, provided that the licensee was willing to pay the price in dollars.

This position is contrary to that taken by the licensee that forced evaporation, in addition to being economical, was also safer that onsite storage. To support this position, they pointed to a calculation by the NRC Staff of the consequences of an accidental release of contaminated water stored onsite. As I pointed out in my earlier testimony, that calculation ignores several obvious ways of decreasing the impact of such a release, viz., treating the water prior to storage, storing the water in multiple storage tanks, and, in the event of a release, interdicting shellfish in Chesapeake Bay. Taken together, these measures would decrease the total body population dose by a factor of approximately 100 x N, where N is the number of storage vessels. This is due to the ten-fold reductions due to water retreatment and shellfish avoidance.

In the analysis presented earlier, N was taken to be 209, since use of 11,000 gallon storge vessels was assumed. The point is that the factor can be made as small as desired by increasing N from unity, the value asssumed by the Staff. The greater the value of N, the greater the cost to the licensee, but the lower the risk to the public.

In addition, the consequence of such a release would diminish with the passage of time due to the radioactive decay of the isotopes remaining in the retreated water. Again, the longer the storage period, the greater the cost to the licensee, but the lower the risk to the public.

Thus the health impacts expected for the offsite population due to forced evaporation could be avoided to any degree desired provided the licensee was willing to spend enough money, with no added risk to the public. Since even the calculated impact is finite (less than one cancer is not the same as no cancers; it represents a nonzero risk of a person dying from cancer as a result of forced evaporation of the accident generated water) as well as uncertain (since it depends upon the actual radionuclide levels in the water, the actual filtration efficiency, and the actual tenvironmental transfer factors and biological effectiveness affecting each radionuclide released, none of which is known with certainty) it follows that the licensee is risking the health of the surrounding population in order to reduce the financial costs of the cleanup.

If the Board wishes to rule that the costs in dollars will not justify the savings in lives, even given the uncertainties, that is the Board's privilege, but it would seem appropriate for the public who is going to be subjected to the risks, be informed as to those risks, as well as the uncertainty associated with their estimation and the fact that the risks could be reduced to any extent required were the licensee willing to spend the money.

I hope this clarifies my position on this matter.

Richard Piccioni, Ph.D

(page 1 of 54 pages)

THREE MILE ISLAND Docket #50-320-OLA

ASLBP #87-554-3-OLA Disposal of accident generated water. Final Initial Decision Feb. 2, 1989

Re: #4 HEALTH EFFECTS, pages 37, 38, 39.

Enclosed are my comments plus attachments on the above issue, including the mutations, modifications and abnormalities of flora within 15 miles of TMI. The Health Effects issue has been brought before the NRC repeatedly in the past decade: radiation symptoms (1)(2) including the metallic taste, animals dropping dead in the fields (at Bainbridge, Etters, Goldsboro, etc.) the increases in neo-natal hypothyroidism, increased infant deaths and miscarriages. The following is titled Three Mile Island = Human Dosimeters and briefly explains 10 years of health issues crying for help.

We the people of Three Mile Island, alert you to the anticipated nuclear power accident of tomorrow. We implore you to be prepared with knowledge about the impending dangers and deceptions. Not only from radioactive fallout, but also to the instantaneous coverups led by our governments and the nuclear establishment.

March, 1979 began another decade of the nuclear holocaust created by man, and again we have had to learn through our personal experiences and sufferings. On behalf of global victims of radiation exposure we report our experiences so that others may learn and take action before the nuclear power doomsday clock strikes again.

Very few residents were aware of the dangers surrounding them during the early hours and days of the Three Mile Island accident. As the accident unfolded, alarming events occurred reminiscent of the bomb tests in the 50's, such as ranchers from Utah and Nevada being contaminated by radioactive fallout, experiencing symptoms, and eventually suffering health damage.

Those living near TMI, including doctors, on both sides of the Susquehanna River, independently and spontaneously complained of radiation symptoms: reddening of the skin (like a sunburn,some with blisters), irritated or burning throat or nostrils, burning or itching eyes, a strange metallic taste or smell, nausea, vomiting, diarrhea, (some with bloody diarrhea), and hair loss. People reported abnormalities, illness and death of their pets and livestock, and mutations of flora.

Authorities received thousands of phone calls and letters concerning these abnormalities, including Representative Stephen R. Reed currently mayor of Harrisburg. He wrote a letter dated August 8, 1979, to Chairman Hendrie of the Nuclear Regulatory Commission (NRC) saying, "I am entirely baffled by the apparent refusal of the U. S. Nuclear Regulatory Commission to have extensively reviewed the reports by hundreds of TMI area residents." Representative Reed asks, "Why is there a complete dismissal by the NRC of any immediate indicator of exposure to levels of radiation higher than what were immediately thought. (1)

The NRC's classic response was, and still is, "At the radiation dose rates involved, none of the effects identified above can be expected to be caused by radiation." (2)

With much of the monitoring data damaged, mislabeled, missing, or "going off-scale high" we conclude the people were the true dosimeters. (3)

As time passed, we were finding our neighbors and relatives were having too many miscarriages, thyroid disorders, respiratory ailments and eventually getting leukemias or cancers. Our fears were real; we learned that a 12 times normal clustering of neonatal hypothyroidism occurred in Lancaster county, immediately downwind from the reactor (4) and that the infant death rate in Harrisburg area nearly tripled after TMI. (5) The former Secretary of Health, Dr. Gordon MacLeod (who had been fired from that post) revealed in a speech, the omission of 88 infant deaths from the health department data when compared with the U. S. Vital Statistics. (6)

There were numerous requests in the years after the accident, from citizens asking the health department to investigate abnormal health effects in at least one small community on the east shore of the Susquehanna River, but to no avail as all requests were denied.

Finally, in April and May of 1984, a "Voluntary Community Health Survey" was undertaken by a group of local citizens. This group was led by Marjorie Aamodt, an intervenor in the TMI Unit 1 restart proceedings. Two survey areas were chosen where residents reported "radiation symptoms" during the accident. A third area, 7 to 8 miles away, was chosen as a control. The results of the Aamodt study, conducted on the west side of the river, showed a conclusive 600% cancer death rate increase for all three areas. (7) The control area also revealed increased abnormal health effects which was totally unexpected.

The Aamodt data was verified, through a review of death certificates and population statistics, by members of the scientific advisory board of the TMI Public Health Fund. The Aamodt Study also found many persons living with cancers and tumors, and eleven birthing abnormalities. As a result of the Aamodt Study the TMI Public Health Fund commissioned Columbia University School of Public Health to study TMI area cancers, and to re-examine pregnancy outcomes since "raw data" from an earlier study of fetal loss after the TMI accident suggest that the early pregnancies were indeed adversely affected in a manner consistant with radiation damage. (8)

Then came a startling revelation; the courts approved more than $3.9 million in settlements of personal injury lawsuits resulting from the accident. (9) Newspaper headlines continue to report new claims for health damages - from leukemias and cancers to birth defects and genetic damage. Ten years after the accident there are about three thousand claims awaiting trial.

Meanwhile, another citizen survey, the Lee Study was completed in the community where the health department refused to conduct an investigation. Since the accident, Lee reported: 23 cancer deaths, 45 living cancers, 53 benign tumors, 31 miscarriages, stillbirths, and defomities, and 204 cases of respiratory problems; bronchitis, chronic pneumonia, allergies, skin rashes, etc. Metallic taste during the accident was reported by 98 of those interviewed.

When the health department released its "official" cancer study in September 1985, Secretary of Health, Dr. Muller said, "The essence of the situation is this - we have not found any increase in the incidence of cancer within a twenty mile radius of Three Mile Island." (10)

Fortunately the Sunday Patriot News uncovered the deception with a front page article revealing how the health department - added 28,610 people to the five mile population and 122,000 people to the ten mile area - thus using populations outside the study areas to dilute the results of their study. (11)

While "official science" engages in deceit by modifying data to fit their predetermined conclusions (12), pure science seeks truth. The health department's epidemiologist, Dr. George Tokuhata, has been criticized for his TMI manipulations; I. D. Bross, Ph.D. recently wrote, "What he did involved statistcal fraud and deceit....." (13) We are hostages of corrupt government agencies and self-serving utilities.

When the next nuclear accident strikes - it may be you and your loved ones who will suffer the consequences of radioactive and political fallout. We implore you to be prepared: DETECT - RECORD - PHOTOGRAPH - DOCUMENT. Demand truth and accountability.

It's not your life, but the inherited genetic pool that is the ultimate loss to the survival of this planet and every living thing. The next accident is not a case of if, but where and when.

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(1) Stephen R. Reed: Letter dated 8/8/79, to Hendrie, NRC. Harrisburg.
(2) Harold R. Denton: Reply to above, dated 9/20/79. NRC.
(3) NUREG 0600: Examples; pp 15, I-2-30, I-3-21, I-4-46, II-3-20, II-3-30. NRC. 8/79.
(4) Gordon K. MacLeod: Nuclear Power: The Case for Informed Consent, Pittsburgh, 3/28/84. pp12.
(5) Harvey Wasserman: Killing Our Own, New York. Dell Publishing, 1982, pp 258.
(6) Gordon K. MacLeod: TMI and the Politics of Public Health, Pittsburgh. 11/22/80. pp 18.
(7) Marjorie M. Aamodt: The TMI Accident, An Investigation of the Effect on the Health of Residents and Flora in Three Areas WNW & SW of TMI. Attachment 3, Aamodt Motion, Revision 1. 1/15/85. (Original Study of 6/21/84, revised)
(8) TMI Public Health Fund: A Research Study to Determine the Rates of Adverse Outcomes of Pregnancy Among Residents in the Vicinity of Three Mile Island Before, During and After the Accident at the TMI Nuclear Facility. 6/13/85. pp6.
(9) Mary Warner: $3.9 Million OK'd for TMI Injury Claims, the Patriot, Harrisburg. 2/7/85.
(10) David Morris: State Finds No TMI-Tied Cancers, the Patriot, Harrisburg, 9/6/85.
(11) Frank Lynch: State's TMI Study Clouded by Survey Method Doubts, Sunday Patriot News, Harrisburg. 10/6/85.
(12) Internal Memorandum of Atomic Energy Commission: For Commissioner Haworth from Paul C. Tompkins, Dep.Dir. Division of Radiation Protection Standard. 9/25/62.
(13) Irwin D. Bross, Ph.D: Letter dated 1/26/89, to J. Lee. Eggertsville, N.Y.

Anyone worth his salt knew or should have known .....(3) way back in 1979 the causes of adverse health symptoms reported during the early hours and days of the accident.

The NRC Staff knows the record very well. They know the Aamodt's, Marjorie and Norman, and they know of their filing on health effects(4). I refer you to the 6/21/84 Aamodt Study, the 8/15/84 hearing before the Commissioners and the revised Aamodt Study of 1/15/85 with all the affidavits attached. Read those affidavits, look at C-SPAN Video taping of the August 15th meeting-afternoon session- where the Aamodts and the people they represented were lied to by the Commissioners themselves.

Remember, it was the NRC "staff" who with-held the "Leak Rate" issue from the Commissioners. It was the NRC "Staff" led by Stello & Moseley who stiffled criminal investigators like David Gamble from getting at the full truth; it was the NRC "staff" who sent incomplete and altered copy of the 6/21/84 Aamodt Study to Centers for Disease Control. Later the Aamodts found thru an FOIA request that Caldwell of CDC did write in his 1/7/85 letter that "I do agree that if all the deaths were confirmed by medical records, then this would be a statistically significant increase." Was this also withheld from the Commissioners? The Aamodts found a 600% cancer death rate increase and the deaths were independantly verified by the TMI Public Health Fund at the request of Judge S. Rambo.

The TMI health effects issue is not a dead issue; it is the most compelling issue ever brought before the NRC and for all these years you have tried to bury the issue along with the full facts.

The recent news from the Soviet Union (5) is truth coming out at last - the ultimate truth: In less than "three years after the Chernobyl nuclear disaster, some cancer rates have doubled among middleaged residents of a contaminated farm region and calves are being born with-out heads and limbs." The myth of long latency periods in order for cancers to occur has finally been disproven.

The "Moscow News said more than half the children in the Narodichsky region of the Ukraine have illnesses of the thyroid gland, which exposure to radiation can cause." Chernobyl is proving our claims of TMI health effects!

The admission by the Soviets of the doubling of cancer rates has ressurrected the health effects issue in spite of our Governments cover-up. The tragedy is not just human and genetic loss but also the apparent "ROLE REVERSAL" of the United States of America and the Soviet Union. While the Soviets are striving for new Democratic style freedoms the U. S. has caused a Democracy in crisis as the basic human rights of TMI area residents have been violated as has the Constitution of the United States. We the people - VOTED by 2 to 1, 3 to 1 and 4 to 1 to keep Unit 1 Shut.

Irreparable harm has occurred to humans near TMI as evidenced by the victims in the massive lawsuits who have already been paid millions and millions of dollars for their sufferings; many cases involving genetic damage (irreparable harm). (6)

Any additional releases from TMI will continue to be cumulative to those of us living nearby. You are dead wrong when you compare background radiation people are exposed to; exposures to radiation are cumulative not comparative.

The TMI area definitely has suffered increased background radiation caused by man over long periods of time starting with U. S. bomb test fallout raining upon central Pennsylvania, we have indeed received CHINESE BOMB TEST FALLOUT as Bill Kirk of E.P.A. always used to mention, we've had TMI routinely emmitting more than permissable limits of radiation and on top of all that we received Chernobyl fallout high in Iodine 131 (and whatever else came down) in the heavy rains that fell here in early May of 1986.

The NRC does have somewhere in their possession Infra-red aerial photos of TMI and surrounding landscape. It would be nice if they would provide before and after photos for all the world to see. I have a copy of the Remote Sensing Labs. (7) aerial radiological survey of TMI and surrounding area dated August 1983. I suggest you obtain a better copy and take a good look at the differences in the 1976 survey versus or compared to the 1982 survey - background radiation did increase! It is not a seasonal change but was caused by the accidents fallout.

The "meadow vole" study (8) did show very high iodine 131 in the thyroids of these creatures. Takeshi Seo did calculate very much higher radiation releases from TMI (9) and R. Monte Greinitz stated in her papers "This partial dose rate is larger than values discussed at the workshop by several orders of magnitude. If I neglect the contribution to th skin surface from photons originating up to 500 meters from the skin surface, and if I neglect the fraction of attenuated photons which are absorbed, then I can calculate an improper dose rate of 0.068 gamma rads/24 hour day. This improper dose rate is similar to the individual doses discussed in the workshop." (10)(She is referring to improper dose rates used in Kemeny Commission.)

Grenitz also wrote "It is shown in Appendix A that the beta dose is 100 rads/hr, which is 1,000 rem/hr for a quality factor of 10 for beta emissions. This means that people exposed from the early plume touchdowns received about 300 rem. And, this is quite consistent with the health effects reported by Mrs. Marjorie Aamodt!"(11)

I did experience metallic taste at 6:00 am on 3/28/79, and so did my husband. I did experience reddening of the skin, and so did my son aged 2 years. I did experience hair loss shortly after returning from evacuating, and so did my daughter and my son and my husband.

Starting in early April 1979, I have observed the gross abnormalities in flora each and every year since the accident at TMI. I have shown my specimens and photographs to experts. Dr. James Gunckel provided Mrs. Aamodt with a signed affidavit. (12) He also said "I think that the gross effects that young woman saw, and the more-subtle ones that I observed, were definitely radiation induced."(13)

Dr. Sadao Ichikawa told me in Washington in 1986, that the flora effects I showed him from TMI area were exactly how the flora in Europe started to grow after Chernobyl fallout.

My slide presentation shown before you in Lancaster on 11/3/88 began with an extremely important & relevant statement regarding "other possible causes" such as chemicals, pesticides, blights, or temperature extremes, etc. Please read over that transcript. What I said I will restate here by describing the first slide of the african violet:

> "This slide showing 9 <u>african violets</u> was taken from an old 1960's science book. *
>
> Most people including biologists, botanists and NRC's experts would say the cause of the effects shown "could be" from chemicals, pesticides, viruses or temperature extremes, etc. I thought so too, until I read the caption describing the experiment: MUTANT AFRICAN VIOLETS offer evidence of the effects of radiation on living things (opposite). A violet plant having normal leaves and flowers, like those shown at center, was exposed to ordinary X rays. All of the different leaves and flowers around it are mutations resulting from this radiation."

I said more but the above is the most important. Apparently the NRC "experts" involved with Nureg 0738 did not know enough about the <u>full range of effects</u> caused by radiation on flora to look beyo nd a first impression.

It is this very reason a real expert in radiation botany, such as Dr. Gunckel, must do the examining and researching of the abnormalities found around TMI.

Mike Masnik USNRC and I have had words about this at some of the TMI Advisory Panel meetings. (also see correspondence attached.) I know I'm not an expert like Gunckel and I'm not an "expert" like LaRoche, and I'm not an idiot. There is more at stake here than the nuclear industry and jobs for you or me; we're hanging by a thread - the life support system of our environment is fast becoming an endangered species, caused in a greater part than you all will admit, by the releases and accidents of nuclear facilities and synergistically with the famous or infamous acid rain and other pollutants.

I have found <u>oak leaves</u> that appear to be "mishappen". Nureg 0738 mentions the 7 rem or rad dose which causes oak leaves to become mishappen. Some time ago I did ask Masnik to provide me with a picture of a mishappen oak leaf, but I never received one - perhaps he forgot. (Two civilians in medical and military occupations did record 3 r, 5 r and 10 r in Middletown during the first few days of the accident, using good equipment.

I have also met with Walt Pasciak (see Randy Blough letter given to you on November 3, 1988) at which time I had asked if he was aware of the papers and comments of R. Monte Greinitz, because there were "<u>improper</u>" dose calculations and she recalculated them and did show very high doses occurred from the accident. The NRC did receive at their request one hundred copies of J. Beyea's dose assessment books, which has the papers of Greinitz and also contains my plant study.

* The african violet mutation experiment was brought to my attention by Mrs. Joyce Corradi, in case the book is needed by you. I'm sure you are able to get similar data from Brookhaven Lab.

Both Dr. Gunckel and Dr. Ichikawa have done research at the Brookhaven National Laboratory. Dr. George Woodwell had seen a few of my early specimens but has not commented except to tell me I should handle the specimens more carefully.

I was disappointed when I read the section #4 Health Effects. The case you the NRC attempt to make is weak. It is obvious to me that the NRC does not have an expert on radiation botany on their staff. Nureg 0738, the NRC's plant and animal report is unproffessional, of poor quality and vague. It is typical of too many of the Nuregs. The word Dr. Gunckel used to describe part of Nureg 0738 is "fallacious." (14)

I am familiar with the message stated in your quote of R. Buchsbaum:

> "All living organisims always from the time of their origin on earth until now - have been irradiated and in the future everywhere they will continue to be irradiated. Some of the radiation from the sun is necessary for continued life. Some of it is unnecessary and some is harmful. It is extremely difficult to sort out the various effects and to decide what is factual and of significance." [(I.D. @ 12) Species Response to Radiation; Radioecology]

But - you address the issue halfway; citing just the real natural background radiation. You fail to cite the multitude of man-made causes of irradiation and their CUMULATIVE effects on the biosphere and the inhabitants of that biosphere. You also failed to take into account the SYNERGISTIC effects (in the case of TMI) from the horrendous amounts of chemicals (such as boron and chlorine) also released during the accident and in routine operations.

I submit here a more complete quote by Gunckel & Sparrow (15) which is the "essence" of our concern:

> "While it is obvious that no scientific investigations concerning the effects of man-made ionizing radiations on plants could have been undertaken before the discovery of these radiations, it is equally obvious that the naturally occurring ionizing radiations (e.g., cosmic rays and those from radioactive elements) were, nevertheless, producing their biological effects since time immemorial, and that the cumulative effect of these radiations might conceivably be of considerable evolutionary significance. The recent concern over small increases in background radiation due to radioactive fall-out reflects the opinion of many biologists that an increase in the background level of radiation, if continued over long periods of time, may produce significant biological effects, mainly genetic."

This was written in 1961; much more has happened to our environment from radioactive fallout since then. The greatest concern is the survival of the species on this planet. The nuclear contamination is accellerating the harm to our biosphere. and does play a damaging role along with the acid rain, which radiation also contributes to.

If you had an expert on radiation botany you would not be having the difficulty you claim concerning the lack of information on radiation dose levels. Dr. Gunckels affidavit and a list of 4 specific publications was presented to the NRC in 1984 & 1985. I have enclosed both again. If anyone cares to look they would easily see in the paper "Ionizing radiations: Biochemical, physiological and morphological aspects of their effects on plants," on table 5: A relatively understandable listing on "Summary of morphological effects of irradiation on higher plants."

This shows part affected, nature of effect, plant, type of irradiation, dose or dose rate, duration of exposure, reference number.. The dose rates listed are anywhere from 1-10uc to over 150,000-500,000 r and for durations of a few minutes up to many months of exposure. Different species when exposed react differently. (just like humans - standard man or universal man is better able to thrive when exposed to certain levels of radiation than than a fetus- it is basic common sense.)

Dr. Gunckel did state that what Mrs. Aamodt & I had shown him was the full range of effects. As far as other causes or explanations - you're stealing my line - I have repeatedly asked officials "If TMI didn't cause these effects - what did?"

Mr. Mike Masnik, USNRC and I have wanted to take experts around TMI to examine the flora, but apparently the NRC was unwilling to foot the bill for an independent competent, genuine "expert" on radiation effects on flora; Dr. Gunckel. (see correspondence.)(16)

We have been overdosed - Unit one should never have been allowed to restart. All additional releases continue to add to our burden of cumulative radiation doses causing irreparable harm to those living near TMI. Ten years later - the flora are still growing mutated, modified and abnormal. The local vegetables are growing in bizare shapes and sizes and cancerous meats, and chickens are sold in local farmers markets, which is enough to turn one's stomach.

I am willing to particpate in a field study as we had planned, the criteria remain the same as stated in my letter to Masnik.

You are the ones making the decision. I expect you to be accountable for your actions.

Mary Stamos Osborn

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Location BY HOST INN:
see Nureg 0600,
Figure II-3-6.

February 17, 1989

encolsures are numbered.
(pages 9 to 54)

Enclosed

Bibliography and notes

9.

1. TMI Alert Health Symptom Questionaire, 1979.

✓2. Stephen R. Reed: Letter dated 8/8/79, to Hendrie, NRC. Harrisburg.

3. Norman Aamodt: Statement before the Commissioners, 8 /15/84. See C-SPAN Video.

4. Marjorie Aamodt: The TMI Accident, an Investigation of the Effect on the Health of Residents and Flora in Three Areas WNW & SW of TMI. Attachment 3, Aamodt Motion Revision 1, 1/15/85. Original study was 6/21/84, C-SPAN 8/15/84.

✓5. A.P.: Higher Cancer Rates Linked to Chernobyl, Patriot News, 2/16/89.

✓6. Mary Warner, Judge OKs $3.9 million for TMI Suits, Evening News, 2/7/85. Hbg.
✓ The Patriot, 31 blaming TMI for health problems, 3/29/85. Hbg.

✓7. Remote Sensing Lab. EGG-10282-1021, UC-41, Aug. 1983.

✓8. R.W. Field, E.H. Field, D.Zegers, and Guy Steucek: Iodine-131 in Thyroids of the Meadow Vole (Microtus Pennsylvanicus) in the Vicinity of TMI Nuclear Generating Plant, 1/5/81. Health Physics, Vol. 41 (August) pp. 297-301, 1981.
✓ Field, Zegers, Steucek, Fields: Regarding 131-I in Meadow Vole, Health Phyisics, Vol. 44, No 2 (Feb), pp.177-180, 1983.

✓9. Seo Takeshi: NRC's Gross Underestimation of the Radioactive Releases and Population Doses During the TMI-2 Accident, undated. Kyoto Univ. Reactor Lab., Japan.

✓10. R. Monte Greinitz: Correspondence to David Berger, 12/12/84. Also published in Proceedings of the Workshop on TMI Dosimetry, Vol. II.

✓11. R. Monte Greinitz: Correspondence to Roda and Aamodt, 6/14/84.

✓12. James Gunckel: Affidavit, The Bulletin of the Torrey Botanical Club, 5/11/84.

✓13. Anna Mayo: Glowing in the Wind, Village Voice, 5/13/86. pp. 31. New York.

✓14. Anna Mayo: ibid.

✓15. J.E. Gunckel, A.H. Sparrow: Ionizing radiations: Biochemical, physiological and morphological aspects of their effects on plants, 1961. Germany.

✓16. Mike Masnik: Letter to Bill Travers, NRC. 8/13/85 (Report of botanical abnormalities in the vicinity of TMI-2).
✓ Mary Osborn: Correspondence to Mike Masnik, NRC. 8/30/85.
✓ Mike Masnik: Correspondence to M. Osborn, 10/29/85.

Also enclosed; ✓One page of excerpts from Gunckel/Sparrow papers. ✓One page list of papers handed to ASLB on 11/3/88.

(2) 10.

State Represetative Stephen Reed's Letter to the NRC

August 8, 1979

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

Dear Chairman Hendrie,

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

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

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

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

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

Yours sincerely,

STEPHEN R. REED
State Representative

... 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?

(5.) 12.

a doubling of cancers in less than 3 years!

A6—The Patriot-News, Harrisburg, Pa., Thursday, February 16, 1989

Higher cancer rates linked to Chernobyl

Associated Press

MOSCOW — Three years after the Chernobyl nuclear disaster, some cancer rates have doubled among middle-aged residents of a contaminated farm region and calves are being born without heads and limbs, a newspaper said yesterday.

"My daughter recently got married. What kind of grandson will I have?" the weekly Moscow news quoted one woman as saying.

It said authorities drastically underestimated the health problems caused by the reactor explosion and fire April 26, 1986, which sent a cloud of radiation around the world.

Moscow News said more than half the children in the Narodichsky region of the Ukraine have illnesses of the thyroid gland, which exposure to radiation can cause.

High levels of cesium 137 were detected among many residents of the region, which is within 30 miles of the Chernobyl nuclear power plant and was not evacuated after the accident. Thirty-one people died as the immediate result of the disaster.

"Health officials of the republic insist there is no health danger for people outside a 30-kilometer [19-mile] zone around the atomic power station," Moscow News said. The danger zone was declared soon after the accident.

Soviet officials have said repeatedly that radiation levels are safe except in the zone, and generally have discounted warnings from some Western doctors of dramatic increases to come in cancer and other diseases.

The Moscow News article was the second in the Soviet press this month to suggest growing health problems because of Chernobyl.

(6) 13

Judge OKs $3.9 million for TMI suits

The Evening 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.

19 settlements @ $3.9 million

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

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(6) 14.

31 blaming TMI for health problems

Thirty-one people filed suit yesterday in Dauphin County Court, claiming they or their relatives suffered cancer, birth defects and other health problems because of the 1979 accident at Three Mile Island.

The suits against TMI owner General Public Utilities Corp. and related companies is similar to suits filed a week ago on behalf of a total of 43 area residents.

The suits claim that the plaintiffs suffered emotional distress because of the accident and were exposed to radiation during it and "during the aftermath and cleanup of the facility."

They say the radiation increased their risk of cancer, skin disease, genetic damage, birth defects and other ailments.

The complaints were filed by attorney Lee Swartz of Harrisburg. He said still another group of claims was "being processed."

All the complaints accuse the defendants of "fraudulent concealment," which allegedly prevented the plaintiffs from detecting until recently the connection between TMI and their illnesses.

The statute of limitations says, generally, that personal injury claims must be filed within two years of the time the victim could reasonably have detected the injury.

The plaintiffs, their current addresses and their injuries as described in the suit filed yesterday are:

Frances P. Grosky of Lemoyne, skin cancer.

Ruth E. Butler of Lemoyne, skin cancer.

Gayle Shapiro of Camp Hill, emotional distress and a malignant tumor of the kidney.

Miles and Joan Armstrong of Harrisburg, parents of Sybil Armstrong, who has Down's Syndrome.

Carol A. and John G. Shaffer of New Cumberland. She suffered central nervous chorioretinopathy.

Betty M. Boylestein and George L. Boylestein of Hummelstown. She suffered an aborted pregnancy.

Barry L. and Joyce M. Schrade of Carlisle, parents of Terry Schrade, who is mentally and developmentally retarded.

David and Sharon Beaver of Dauphin, parents of Shannon Beaver, who has Down's Syndrome.

Robert J. Christoff of Harrisburg, Ewing's Syndrome.

Joseph and Karen Durborow of Provo, Utah. He suffered a low sperm count.

Donald F. and Linda E. Fortna of Dauphin, administrators of the estate of Christopher Fortna, who was born prematurely and died.

Betty Hatter of Middletown, severe emotional distress and multiple cysts.

James F. and Joan B. Johnston of Camp Hill. He suffered lymphoma.

Debra H. and Joseph Kimmel of Etters. She suffered cancer of the cervix and their sons Josef and Jeffrey Kimmel both have Down's Syndrome.

Lydia A. Knight of Middletown, thyroid cancer.

William E. and Patricia A. Nordfors of Halifax, parents of Daniel Nordfors, who suffered a malignant tumor in the shoulder.

Dorothy J. and Rudolph R. Pavlick of Steelton. She suffered breast cancer and other ailments.

Elizabeth R. Pluta of Lancaster, mother of John Pluta, who suffered brain damage, developmental retardation and other ailments.

Sheryl L. and Harry E. Williams Jr. of Middletown. She suffered emotional distress, loss of hair and traumatic neurosis. He suffered emotional distress, depression and traumatic neurosis.

Besides GPU, the defendants are Metropolitan Edison Co., Jersey Central Power & Light Co., Pennsylvania Electric Co., Babcock & Wilcox Co., J. Ray McDermott & Co., Catalytic Inc., and Burns & Roe, Inc.

(7) 15.

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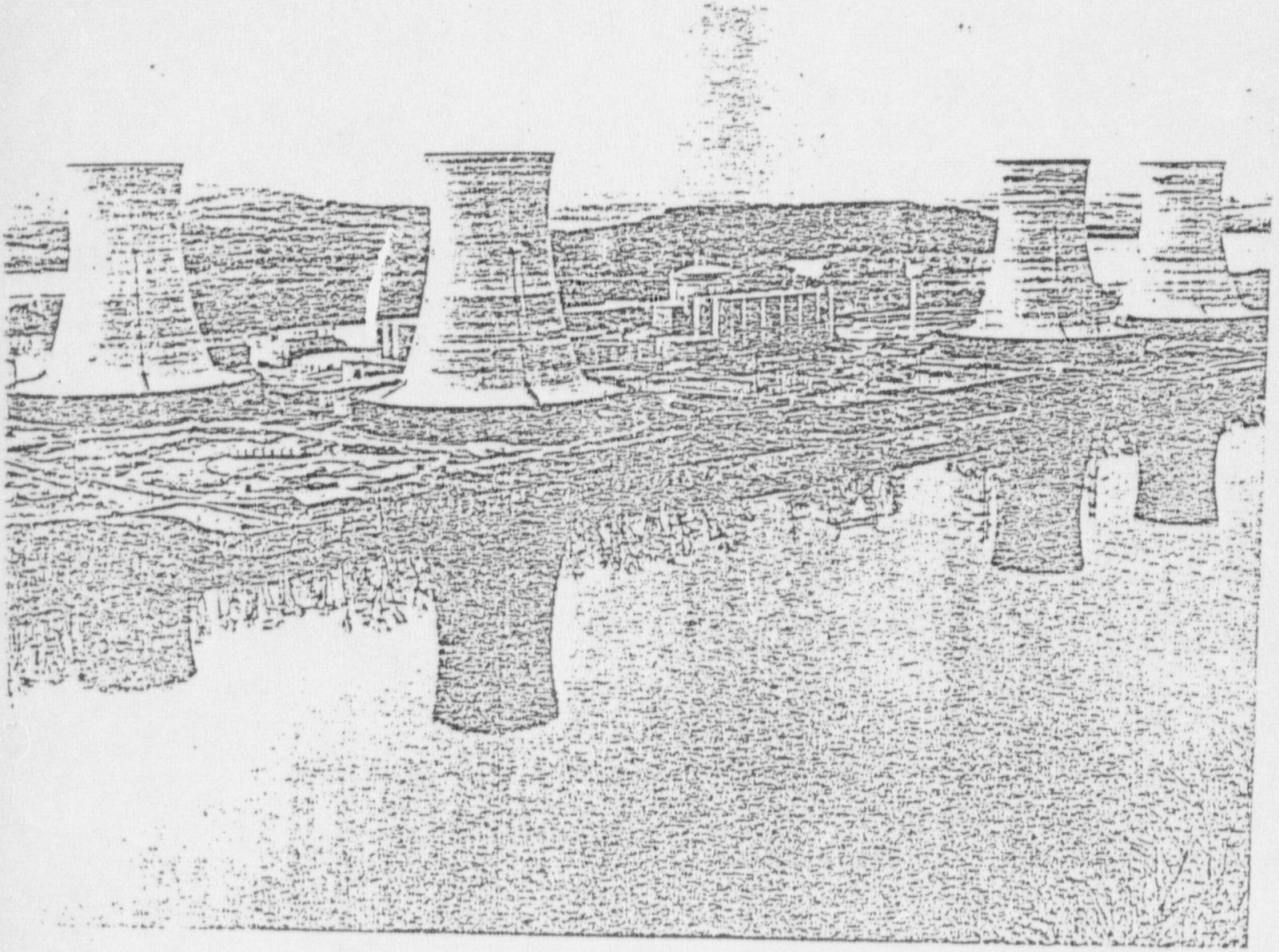


AN AERIAL RADIOLOGICAL SURVEY OF THE

THREE MILE ISLAND NUCLEAR STATION

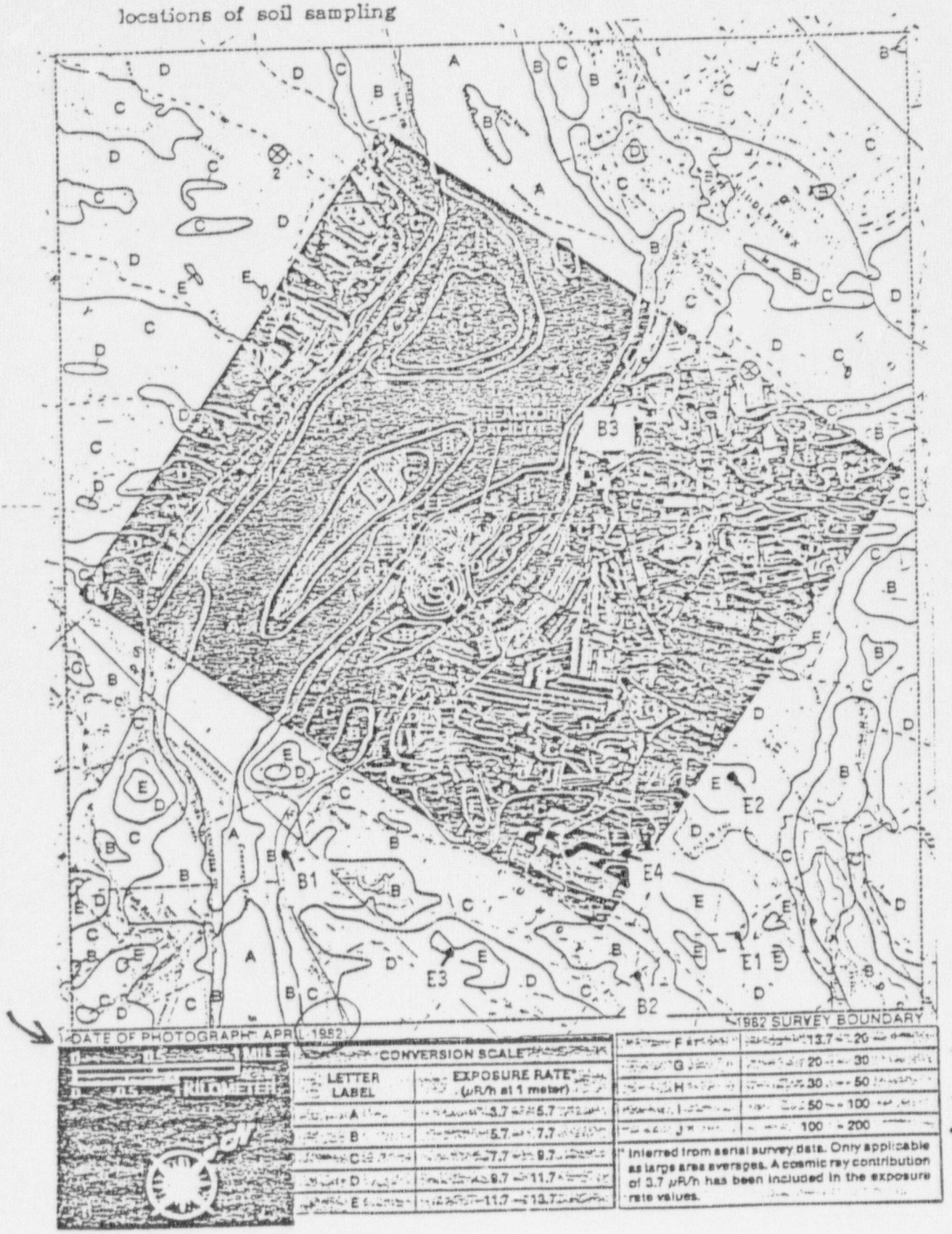
AND SURROUNDING AREA

MIDDLETOWN, PENNSYLVANIA

DATE OF SURVEY: OCTOBER 1982

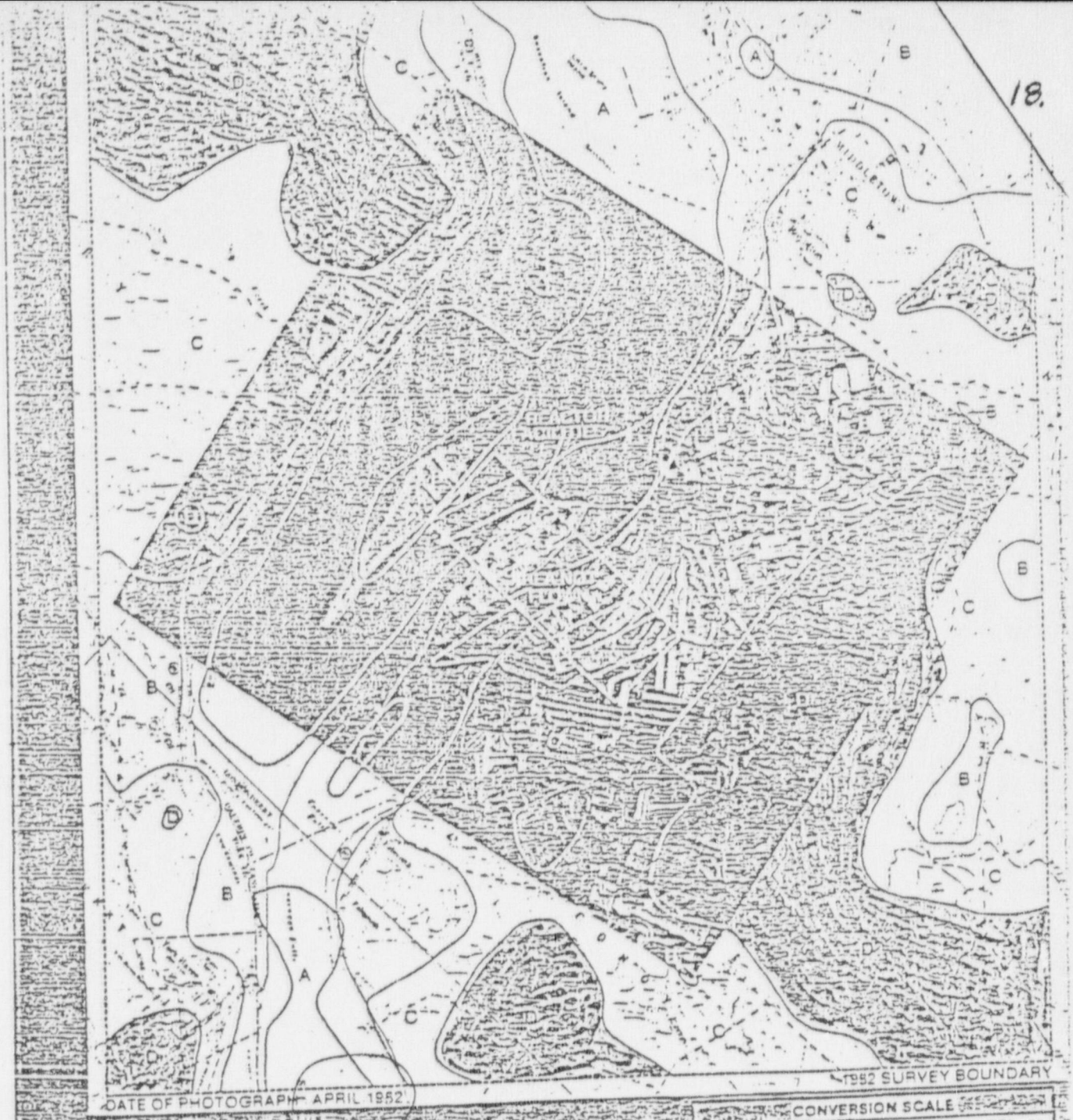
16.

Figure B-7: Results of the 1982 gamma exposure rate survey (Colton, 1983) and locations of soil sampling



my property is not shown on the 1982 survey map. Why?

Figure 8. EXPOSURE RATE CONTOUR MAP OF THE AREA SURROUNDING THE THREE MILE ISLAND NUCLEAR STATION (1982 SURVEY)



CONVERSION SCALE	
LETTER LABEL	EXPOSURE RATE* (μR/h at 1 meter)
A	3.7 - 5.7
B	5.7 - 7.7
C	7.7 - 9.7
D	9.7 - 11.7
E	11.7 - 13.7

* Inferred from aerial survey data. Only applicable as large area averages. A cosmic ray contribution of 3.7 μR/h has been included in the exposure rate values.

Figure 12. EXPOSURE RATE CONTOUR MAP OF THE AREA SURROUNDING THE THREE MILE ISLAND NUCLEAR STATIC (1976 SURVEY). Only that area covered during the 1982 survey is shown.

my property is shown on the full 1976 copy.

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Pergamon Press Ltd.

IODINE-131 IN THYROIDS OF THE MEADOW VOLE (*MICROTUS PENNSYLVANICUS*) IN THE VICINITY OF THE THREE MILE ISLAND NUCLEAR GENERATING PLANT

R. WILLIAM FIELD,* ELIZABETH H. FIELD,† DAVID A. ZEGERS* and GUY L. STEUCEK*

(*Received* 22 *October* 1980; *accepted* 5 *January* 1981)

Abstract—Meadow voles (*Microtus pennsylvanicus*) were trapped in the vicinity of Three Mile Island Nuclear Power Station between 6 and 16 April 1979. Thyroids of voles caught 1.9 km from the reactor (Site III) contained significantly higher amounts of ^{131}I than those of voles caught further away. This is in agreement with Dept. of Energy predictions that this site was contaminated to a greater degree than the other two sites sampled. The highest level of ^{131}I detected from Site III was 11.4 pCi/thyroid and the mean for that site was 5.6 pCi/thyroid. The vole is proposed as a monitoring organism for ^{131}I contamination of ecosystems.

INTRODUCTION

THE VOLE (*Microtus sp.*) is used extensively as a model organism for studying population dynamics (Kr74), nutrition (Ke78; Sh76; Sh75; Barn74, Br74; Sh74; Sh70), and bioaccumulation (Wi78; Ge77) because of its position in the terrestrial food chain, widespread distribution, abundance, small size, and limited home range (Am69; Va69). These attributes also make the vole a good model for studies involving radionuclide pollution. The accident at the Three Mile Island Nuclear Plant (TMI) provided an opportunity to use voles to determine the extent and location of ^{131}I contamination of the environment.

Radiation from gas samples from the reactor containment building on 1 April 1979 showed that ^{131}I was one of the radionuclides released as a result of the accident at TMI. The first evidence of off site contamination by ^{131}I was detected in milk samples of domestic animals taken between 31 March and 4 April 1979. The maximum levels found in cow's and goat's milk were 36 and 41 pCi/l., respectively (Bat79). Our objective was to test the usefulness of (*M. pennsylvanicus*) as a monitoring organism by using this vole to determine the extent of ^{131}I contamination of the surrounding ecosystem by comparing these results to those obtained by conventional measures.

MATERIALS AND METHODS

The study area consisted of three sites in Dauphin County, PA (Fig. 1). Site I was 12.9 km northeast of the damaged reactor and served as control. Site II was located 2.3 km east of the reactor, and Site III was 1.9 km northeast of the reactor. The three sites contained similar meadow vegetation and had not been farmed for 2 yr.

Sampling stations were placed at 2-m intervals along two 30-m lines separated by 8 m. Approximately 240 m^2 were covered by the trapping grid at each site. Trapping was done between 6 and 16 April 1979 inclusively, and utilized two Sherman live traps baited with peanut butter at each sampling station. The traps were inspected and reset daily between 1000 and 1200 hr. Captured rodents

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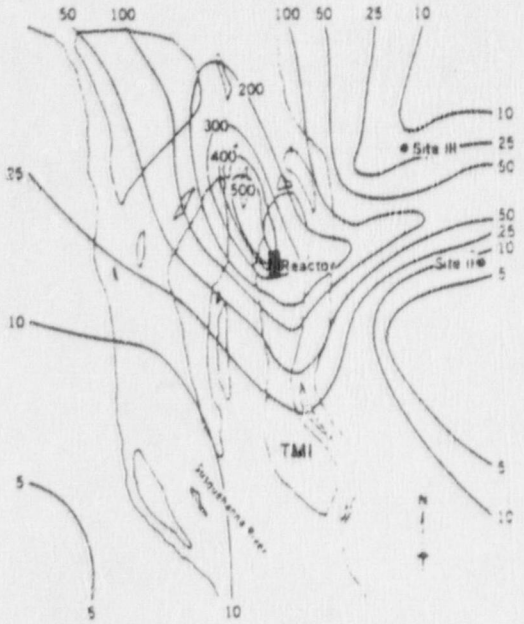

FIG. 1. Radiation (mrem) isopleths for the period 28 March–3 April 1979 in the vicinity of the Three Mile Island Nuclear Generating Plant (adapted from Dept. of Energy; Bat 79). Site I is 12.9 km northeast of the reactor and is not illustrated in this figure, Site II is 2.3 km directly east of the reactor, and Site III is 1.9 km northeast of the reactor.

were killed by diethyether and transported to the laboratory for analysis 24–48 hr after capture.

Each thyroid (< 4 mg tissue) together with a piece of trachea dissected microscopically was placed in a 12- × 75-mm disposable culture tube and analyzed for ^{131}I utilizing a Nuclear Chicago 1185 γ counter with a 5-cm NaI scintillation crystal. Each sample was counted for 10 min and background was determined over 600 min. Because of the number of samples from each site, it was possible to make site to site comparisons. Counting efficiency was determined by counting absolute standards in the same geometry and matrix. Blanks for each sample were analyzed for ^{131}I content to determine background counts. After subtracting the background from the count rate, and samples were corrected for ^{131}I decay, since the ^{131}I assays were conducted on different days during the trapping period. Xe-135 was among the radionuclides released from TMI and emits a γ of 360 KeV, which is within the window for ^{131}I. However, analyses of dissected thyroids taken from voles 24–48 hr after capture were specific for ^{131}I because ^{135}Xe is not concentrated in the thyroid, and because the half-life of ^{135}Xe is 9.2 hr and that of ^{131}I is 8.1 days.

RESULTS AND DISCUSSION

During the 10- day trapping period, the number of voles caught was 20, 22 and 18 for Sites I, II and III, respectively. Only adult voles were captured, making age class comparisons impossible between the sites. Analysis for weight differences between sites, weight differences between sexes and weight differences between site by sex revealed no significant effects. In addition, sex appeared to have no influence on the ^{131}I content of the vole thyroid.

Thyroids of voles from Site I contained no detectable ^{131}I, whereas those from Site III contained a significantly higher amount (Table 1). The highest level of ^{131}I detected at Site III was 11.4 pCi/thyroid, and the mean value obtained for this site was 5.6 pCi/thyroid. Analysis of variance revealed that the sites did differ with regard to the content of ^{131}I in vole thyroids, $p < 0.01$. The Student, Newman, Keuls multiple-range-test, at $p \leq 0.01$, indicated that means for Sites II and III did not differ significantly.

Table 1. Iodine-131 activity in the thyroids of the meadow vole (Microtus pennsylvanicus) *on 9 April 1979 in the vicinity of the Three Mile Island nuclear generating plant*

Site	Sample size	I-131 activity (pCi/thyroid) Mean*	Standard error
I	20	0.0_a	0.8
II	22	2.2_a	1.1
III	18	5.6_b	1.2

*Means with the same subscript do not differ significantly: $p < 0.01$ (Fcal = 6.76).

but that the ^{131}I in vole thyroids from Site III was significantly greater than for Site I. At $p \leq 0.05$ the content of ^{131}I in vole thyroids from Site III was significantly greater than that for animals from Site II. Analysis of variance is robust, but it assumes homogeniety of variance and normal distribution. Therefore, the data were tested for homogeniety of variance, skewness (g_1) and kurtosis (g_2). The calculated values of g_1 and g_2 for each site fell within allowable error and an F_{max} test found the variances to be homogeneous. To assure significance the data were analyzed again non-parametrically using the Kruskal–Wallis and Mann–Whitney tests. The results were essentially the same as those from parametric analysis. The between site differences in ^{131}I were significant at $p \leq 0.001$ and the Mann–Whitney test indicated that ^{131}I content of thyroids from Site III was greater than at either Sites I or II. $p \leq 0.01$ in both cases.

The ^{131}I content of thyroids from voles captured at Site III decreased during the sample period in a manner similar to that for the decay of ^{131}I. This would suggest that Site III received one dose of ^{131}I since such a decline would not be evident in a chronically exposed environment. Estimates of the distribution of ^{131}I released from TMI (Pa80) indicate that the major contamination of Site III occurred between 28 March and 1 April 1979. Although the data describing the distribution of ^{131}I are in agreement with our findings, insufficient vole data preclude a definitive statement. This points out the importance of taking successive samples from an environment thought to be contaminated by a single release of a radionuclide.

While no other systematic sampling of wild animals was undertaken in the vicinity of TMI, some scant evidence is in support of our findings. A vole captured 0.8 km east of TMI on 25 April 1979 was found to contain ^{131}I above background (Un79). In addition, a composite sample of rabbit thyroids from animals taken 1.6–4.8 km northeast of TMI on 24 April 1979 contained 161 pCi/g ^{131}I, whereas none was detected in spleen, liver and bone samples (Un79).

A number of explanations are possible for the ^{131}I content of vole thyroids at Site III. Herbicides such as 2,4 dichlorophenoxyacetic acid increases uptake of ^{131}I in animals (So58; Fl62), hence high levels of ^{131}I at Site III may have been due to herbicide treatments. However, none of the sites had been treated with herbicides for at least 2 yr. Minute amounts of ^{131}I from local hospitals are discharged routinely into sewer systems (Cl77) and may ultimately contaminate rivers downstream. Since our animals and their food source do not obtain water from the Susquehanna River, the contribution from this source is negligible.

The mean concentration of ^{131}I in the thyroids of voles from Site III was 1866 pCi/g, assuming a thyroid weight of 3 mg. Elevated levels of ^{131}I have also been found in thyroids from large mammals exposed to ^{131}I during uncontrolled releases from nuclear plants and weapons testing (Ma80; Pe71; Bara66; Be60; Ha59; Co57). While comparisons of thyroid ^{131}I content between studies are difficult, it is apparent that the relatively small vole is as effective as large mammals in monitoring ^{131}I.

In order to estimate the impact of radionuclide pollution on wildlife one must consider not only the external irradiation of organisms due to the dispersal of radioactive material outside of the organism, but also the internal irradiation due to accumulation of radionuclides in specific organs. While isopleth data (Bat79) would suggest that the voles at Site III were exposed to 18 mrem (Fig. 1), the actual radiological burden to the vole thyroid may have been several orders of magnitude greater. For example, the mean dose of radiation from ^{131}I to the thyroid of voles from Site III was 210 mrem using an accepted computational procedure (Gr70). This estimate is low for the following reasons: (a) the thyroid with the highest ^{131}I content received a dose of 420 mrem; (b) thyroid weight may be less than 3 mg, hence the mean concentration of ^{131}I was greater than 1866 pCi/g; (c) voles were exposed to ^{131}I from 28 March while thyroid contents were determined as of 9 April, more than a halflife after the major venting; (d) undoubtedly other isotopes of iodine were vented and not included in our assay of ^{131}I; (e) mixtures of iodine isotopes have been illustrated to be

more harmful than a single radionuclide for a given dose (Bo80); and (f) fetal thyroids concentrate radioiodine to a much greater degree than those of adults (Pe71). Clearly, thyroid glands of herbivores should be sampled to assess the radiological impact of radioiodine pollution of an ecosystem.

To test the validity of the vole as a monitoring organism we compared our data to Dept. of Energy estimates of the distribution of radionuclides in the vicinity of TMI. The mean ^{131}I content of vole thyroids for Site III was 2.5 times higher than that for Site II. Sample Sites II and III were placed on the exposure isopleth grid calculated for external whole body radiation exposure to the population around TMI by the Dept. of Energy (Fig. 1); from these isopleth data we estimated the ratio of radiation exposure to be essentially the same as that for our vole data. Estimates of the distribution of ^{131}I released from TMI (Pa80) show that the relative degree of contamination of Sites II and III also agree with our vole data. The use of isopleths as indicators of exposure to ^{131}I is limited because (1) the isopleths are based on γ radiation emitted mainly from noble gases and are not specific for ^{131}I, (2) sampling techniques used for calculating the isopleths are not standardized, and (3) the available isopleths do not take into account radiation released after 3 April 1979. Because the vole thyroid, radiation isopleth, and ^{131}I distribution data are in accord, the vole is useful as an assay animal.

Domestic animals have been used extensively in monitoring radionuclide pollution with an intent to assess impact on humans. However, wildlife are better indicators of environmental contamination for several reasons. First, contamination as measured in domestic animals may underestimate actual environmental contamination due to their use of stored, and therefore uncontaminated, food. This was evident in the levels of ^{131}I in thyroids of domestic sheep fed stored food compared to those of sheep allowed to graze (Pe71). Secondly, foods of wildlife may not be the same as those for domestic animals and may accumulate ^{131}I to a greater degree than domestic crops (Pe71). For many reasons the vole is ideal as a monitoring organism. Because of the limited home range, 0.04–0.66 ha (Am69; Va69), and sedentary habits of the vole the precise geometry of environmental contamination can be determined. Voles adequately sample local habitats because they consume a variety of vegetation equivalent to one third of their body weight each day. Moreover, the vole is used as a model herbivore (Sh76; Sh75; Sh74). The abundance of voles enables one to destructively sample thyroid glands relatively easily and at little expense. The widespread distribution of voles permits one to employ them as monitoring organisms in a great number of situations.

Others (Ma80; Pe71) have stressed the importance of using thyroid assays in evaluating the radiological impact of ^{131}I pollution. We found the content of ^{131}I in vole thyroid glands to reflect the extent of environment contamination in the vicinity of TMI. Hence it seems prudent to assay thyroids of voles living adjacent to sites where ^{131}I is vented to the environment. Moreover, the reservoirs and fluxes of ^{131}I in the vole should be investigated in the laboratory.

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Regarding ^{131}I in Meadow Vole Thyroids

(*Accepted* 19 *April* 1982)

Dear Sirs:

DR. KIRK questions not only the use of the vole to monitor environmental contamination by ^{131}I, but also our specific findings associated with the accident at Three Mile Island (TMI). In this reply to Dr. Kirk's queries we provide additional evidence supporting the use of the vole to monitor environmental contamination by ^{131}I.

^{131}I in Vole Thyroid Samples

While high resolution spectroscopy and radiochemical separations were not performed on our samples, sufficient evidence exists to support our claim that the vole thyroids were labeled with ^{131}I:

(1) There was an obvious source of ^{131}I. In late March 1979 approximately 27 Ci of ^{131}I were released from the nuclear plant at TMI (US79a). According to the NRC (US79b), ^{133}Xe and ^{135}Xe were the major radionuclides released as a result of the accident at TMI: "traces" of ^{131}I were also vented. Release of ^{211}Bi, ^{214}Pb, ^{227}Th, ^{228}Ac, or ^{233}Pa has not been reported, and we have not found any published reports of chronic contamination of the environment by these radionuclides.

(2) ^{131}I was positively identified in a rabbit thyroid and in an intact vole captured 1–3 miles NE of TMI using high resolution γ ray spectroscopy (US79c). These samples were taken from the general vicinity of our site III.

(3) L. Van Middlesworth "considers that if 27 Ci of ^{131}I were released from Three Mile Island, it is not unreasonable to find such small quantities as 1 to 2 pCi ^{131}I/g of sheep thyroid in Wales, 3600 miles eastnortheast of the release point" (Va81). This ^{131}I activity was confirmed by gamma ray spectroscopy.

(4) Our counter was calibrated for ^{131}I and used a window of 320–400 KeV which observed approximately 80% of the ^{131}I γ intensity. Hence radiation from a variety of radionuclides was excluded from our assay. Dr. Kirk is quick to point out that ^{228}Ac, ^{233}Pa, ^{214}Pb, ^{227}Th and ^{211}Bi all emit gammas within the window for ^{131}I and therefore would be assayed. ^{211}Bi, ^{214}Pb, and ^{228}Ac have half-lives of 2.15 min, 26.8 min, and 6.13 hrs respectively, hence interference from them would have been minimal because the thyroid samples were assayed 24–48 hr after killing the voles. Dr. Kirk agrees with this line of reasoning with regard to possible interference by ^{135}Xe. There is the possibility that the thyroids contained ^{223}Ra, ^{222}Rn and ^{228}Ra which generated ^{211}Bi, ^{214}Pb and ^{228}Ac respectively in situ. Of course one would have to explain the origin of these parents through chronic contamination of the study sites II and III; this seems unlikely in view of NRC statements (US79b). While ^{227}Th and ^{233}Pa have halflives of 18.5 and 26.9 d respectively, their γ intensities in the ^{131}I window are in the neighborhood of 5 and 28% respectively, thus the chance of detecting a decay of these nuclides is reduced.

(5) It is well documented that iodine accumulates in the thyroid, whereas the other radionuclides (^{211}Bi, ^{214}Pb, ^{227}Th, ^{228}Ac and ^{233}Pa) are concentrated in the lower region of the large intestine and in bone, lungs, liver and kidneys. While ^{131}I activity was found in rabbit thyroid tissue (US79c), no activity was found in spleen, liver, and bone samples. Therefore, this suggests that contamination by ^{227}Th and ^{233}Pa to the total activity in our assays was negligible.

(6) The activity in vole thyroids was congruent with the geographical distribution of ^{131}I as a result

the accident at TMI. It is highly unlikely that this pattern would coincide with chronic contamination of the locale because the distribution of ^{131}I was very dependent upon the specific atmospheric conditions at the time of the accident. Moreover, it is unlikely that such a relationship would exist due to variation in natural activity as Dr. Kirk implies. We made this point on page 300 (Fi81).

Vole Thyroid Activity Significantly Above Background:

Although Dr. Kirk raises some interesting questions with regard to how the data were handled, there is little doubt that the activity in the vole thyroids was significantly above background. Because we used common practices in handling our data, we believed that elaboration was not necessary in the original manuscript.

Prior to assaying each sample, an empty sample holder was counted for 10 m to assess background. Therefore, a total of 60 ten-minute counts were made. Assays were conducted on four different days. Analysis of variance revealed no significant day effect on the background count rate; in fact, day means varied by less than 5% which is entirely consistent with expected statistical variation. Moreover, control chart analysis for any given day illustrated no systematic bias in the background counts. Therefore, it seemed reasonable to pool the background count data and use one mean background count rate. Since background assays always surrounded sample assays, the question of diurnal variations in background and instrument response is not relevant.

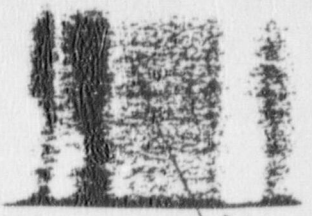
The background count rate was subtracted from sample count rate which did result in some negative counts, these were *not* replaced with zeros. Moreover, when activities were corrected for decay, the negative net counts were made more negative. Naturally, this did increase the variability of the data and hence increase the statistical uncertainty in the analysis; however, it is the only legitimate way to handle the data.

While we focus our interest on the mean ^{131}I activity in vole thyroids from a specific site and designate all thyroids from that site to represent a sample, Dr. Kirk views an individual vole as a sample and deals with that datum. We were interested in the mean activity of thyroid samples from the three sample sites because these numbers best represent the sites; therefore, the standard errors of these means were presented in Table 1 of Fi 80. This standard error included error due to counting, environmental variations within the site, variations between voles due to sex, etc. Because counting error represents only one component of the total site error, it would not be correct to consider only counting error when comparing sites. Using Dr. Kirk's one observation approach and his calculated MDA of 6–13 pCi, it is obvious that our

Table 1. Characteristics of wildlife which may be used to monitor ^{131}I in a natural environment

Species	Home Range (ha)	"Typical" Population Density (number/ha)	Individual Thyroid Mass (mg)	Total Thyroid Mass (mg/ha)
House Mouse (*Mus musculus*)	0.3_a	50.0_a	4.0_f	200
Deermouse (*Peromyscus* sp.)	0.9_a	20.0_a	1.4_b	28
Vole (*Microtus pennsylvanicus*)	1.2_a	140.0_a	4.4_b	616
Cottontail Rabbit (*Sylvilgus* sp.)	8.0_c	5.0_c	39.0_d	195
White Tail Deer (*Odocoileus virginianus*)	84.4_e	0.2_e	5100.0_b	1020

References: a(Fr 75), b(Al 62), c(Bu 75), d(Cr 40), e(Ka 75), f(Ka 71)



estimates of 48 pCi of activity harvested from site II in vole thyroids and 100 pCi from site III are much larger than the MDA. In theory, additional counting time would not alter the site means, but would reduce the standard error. There is no doubt that the mean activities of vole thyroid samples from sites II and III are above background ($P < 0.05$).

We noted that "the ^{131}I content of the thyroid samples from voles captured at site III decreased during the sample period in a manner similar to that for the decay of ^{131}I"; we also state in the same paragraph that we had "insufficient vole data" to make a definitive statement in this regard. Hence statement 5 by Dr. Kirk is of little significance.

Dose to the Vole Thyroid

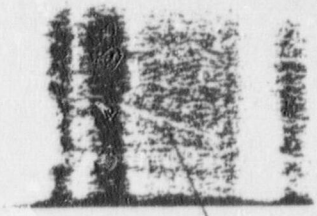
We did not determine the exact geometry of the vole thyroid, nor did we determine the distribution of ^{131}I within the vole thyroid. In addition, we do not know the biological half-time for iodine in the vole thyroid. Therefore, we estimated the dose to the thyroid as Dr. Kirk has elaborated in his letter. However, his estimates of the degree to which our dose calculations are off are grossly overstated. First, he assumes that the biological half-time is much lower than the physical half-life for ^{131}I. This may be true and is an important consideration in laboratory studies where animals are injected with a single dose of radionuclide. However, we assume the animals ingested contaminated food every day and consequently the thyroid ^{131}I level was in a quasi steady state with the environmental ^{131}I. We do not know the half-times for the ^{131}I components of the environment with which the voles interact. Consequently it seemed reasonable to use the physical half-life of ^{131}I in our computations. Secondly, there is little reason to believe that the distribution of iodine is uniform throughout the thyroid gland (Wa71). In addition, the doses within the gland will vary due to β-loss. In an empirical study using a lobe of a mouse thyroid with a mass of 1.5 mg, Walinder (Wa71) found that the dose to the center of the lobe was 80% of the dose to an infinite ^{131}I source. The dose at the periphery of the gland would be lower due to greater β-loss. Using this information and the fact that the vole and the mouse are similar in size and their thyroids are of similar size and shape, we estimate the ^{131}I dose to the vole thyroid from site III to be 168 mrem. This is a low estimate for the reasons stated in the paper on pages 299 and 300 (Fi81). In addition, this dose does not include the external radiation estimated at 18 mrem and that due to the presence of other radionuclides not assayed.

Importance of Sampling Thyroids from Wildlife

Although TLD's may be convenient to estimate the distribution of radiation in a contaminated environment, they do not interact with the environment the way an organism does. Milk from domestic animals also is a convenient sample to assess the extent of ^{131}I contamination. In addition, ^{131}I in milk provides an index of the extent to which ^{131}I will enter the human population. However, because farmers will feed their animals stored food and water in the event of suspected contamination, milk samples will underestimate the degree to which the environment is contaminated. Because wild herbivores continuously inhale air and ingest vegetation and water from the environment in which they reside, they can be a useful monitor to assess environmental impact of effluent ^{131}I. Obviously all sampling techniques are imperfect; therefore, a variety of monitoring systems should be employed to assess the extent of environmental impact associated with nuclear plant emissions.

A wild herbivore will be useful in monitoring ^{131}I if it has a small home range so that the region of contamination can be identified and if the population is sufficiently dense that a number of specimens can be obtained easily. Several small mammals have small home ranges and often are found at high population densities (Table 1). While deer have large thyroids, their home ranges are large and hence identifying a location of radioiodine pollution would be difficult. Moreover, they are difficult to capture and the sampling of a number of individuals would destroy the native population. Voles are able to produce a large amount of thyroid tissue per hectare (ha). Population densities as high as 390/ha have been reported (Fr75), this represents 1276 mg thyroid tissue per ha. Therefore, under some circumstances voles may produce more thyroid tissue per ha than deer. Moreover, voles are easily captured and provide an index of biological variability in that thyroids of many animals from a locale may be observed.

Choice of species to sample of course depends upon which species are native to the area and which are abundant at the time. While the voles have the potential to produce an adequate amount of thyroid tissue per ha, they may not be abundant even if adequate habitat is available. However, because voles are easily reared, perhaps they could be distributed in regions of suspected ^{131}I contamination where natural populations are low. Subsequent capture and assay could provide an estimate of the extent of the ^{131}I pollution. This approach merits investigation.



While public health officials are most concerned with potential hazards to the human population and survey components of the environment which humans ingest, a survey of key natural populations would serve as an early warning system of future hazards. The ^{131}I content of vole thyroids from site III was much greater than that estimated for humans (US79b). Perhaps the vole would make a good early warning indicator.

Dr. Kirk stresses the importace of proper radioassay techniques in the assessment of radionuclide pollution, and we acknowledge that we should have used γ ray spectroscopy and counted samples longer. However, the findings would not have differed substantially had we done so. Moreover, if one is truly concerned with the environmental impact of radiodine pollution from nuclear power plants, the thyroids of wild animals can not be ignored (Pe71, Va81). We contend that voles and other wildlife merit more attention in the asessment of radioiodine pollution.

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(9) 28.

NRC'S GROSS UNDERESTIMATION OF THE RADIOACTIVE RELEASES AND POPULATION DOSES DURING THE TMI-2 ACCIDENT

by Seo Takeshi

Kyoto University Nuclear Reactor Laboratory

POPULATION DOSE ESTIMATES

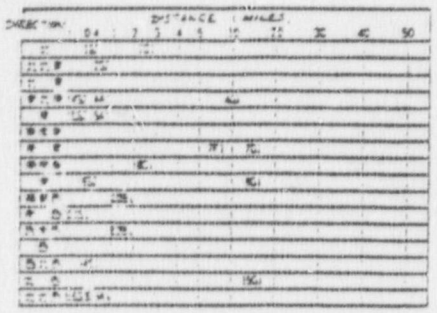

Table 1

Location of 20 TLD stations deployed by the utility, showing that there are no data at all for most of the 160 sectors (10 different distance divisions in the 16 directions). Estimates of the collective dose and quantity of released radioactivity based on this poor data cannot be accurate and should be considerably under the actual level.

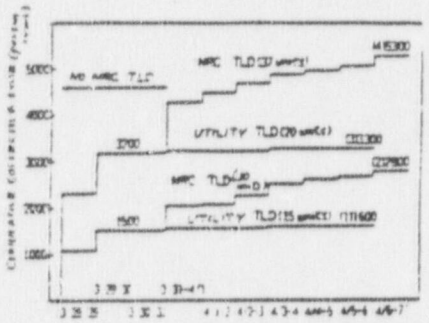

Figure 1

Estimates of the collective dose made by the ad hoc committee.[1] The collective doses are significantly underestimated when TLDs are fewer in number. Moreover, there are no NRC data for the first 3 days of the accident. By correcting these deficiencies, the collective dose should be estimated to be at least as high as 16,200 person rems.

Here, four different sets of cumulative doses are shown:

(1) 1,600 person rems based on 15 TLDs deployed within the 8 mile-radius by the utility;

(2) 2,800 person rems based on 30 NRC TLDs in the same sectors as above;

(3) 3,300 person rems based on 20 TLDs of the utility;

(4) 5,300 person rems based on all the 37 NRC TLDs.

These differences clearly indicate that the number of dosimeters affects the dose estimation. It has been pointed out that the background radiation for the NRC dosimeters was evaluated at too low a level,[2] and that the data for the first day, the period of March 31-April 1, is not reliable because of the poor maintenance of TLDs.[3] It would be reasonable to suppose that the background level was underestimated by 40 person rems per day. Consequently, the cumulative dose for the period of March 31 through April 6 is 460 person rems for the 30 NRC TLDs within the 8 mile-radius, and 770 person rems for all the 37 NRC dosimeters.

2,800 person rems	NRC TLDs (30 units)
- 2,100	NRC TLDs on March 31st (30 units)
700	
- 240	(40 person rems × 6 days)
460 person rems	

5,300 person rems	NRC TLDs(37 units)
- 4,290	NRC TLDs on March 31st(37 units)
1,010	
- 240	(40 person rems 6 days)
770 person rems	

As a result, the collective dose for the whole period based on the 30 NRC dosimeters is approximately 2,000 person rems, and 4,000 person rems for all the 37 NRC dosimeters, by addding 460 and 770 to the two different sets of doses recorded by the utility for the first three days.

Based on these figures, the dose for the first three days when NRC dosimeters were not being used should be estimated as follows: The ratio of the dose received by 15 TLDs of the utility for the period of March 31 through April 6 and that for March 28 through 31 is

$$\frac{1600 - 1500}{1500} = 0.07.$$

And as the 20 utility TLDs are concerned, it is

$$\frac{3300 - 3200}{3200} = 0.03.$$

The value of 0.05 is considered to be about the average. Then, if from the very beginning the 37 NRC TLDs had been set up, the dose of

770 / 0.05 = 15,400 person rems

would be aquired for the first three days. To this figure of 15,400, the dose of 770 for the next 6 days is added and the total of 16,200 person rems is consequently estimated to be the collective dose for the period of March 31 through April 6.

Although the above calculation is an estimation which ignores factors such as the possible changes in meteorological conditions, there is evidence that the actual dose could probably be far greater since 37 dosimeters can hardly be considered sufficient in number.

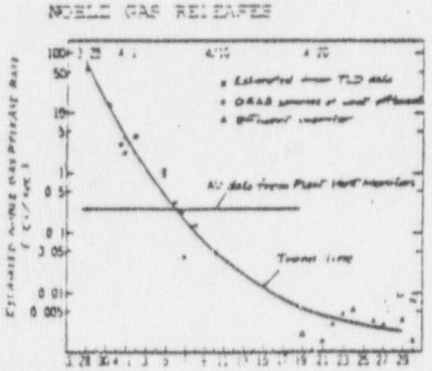

Figure 2

Estimated noble gas release rate by the utility.[8] The earliest two values based on data from the TLDs are underestimated as to be less than one fourth the actual level.

Evaluating the released amount of radioactive noble gases solely on the bases of this uncorrected TLD data, combined with the available meteorological information, cannot but result in an underestimation of the released levels. The final conclusion by NRC (NUREG-0600)[5] adopts their own preliminary estimation made in their July report[4] of 1.0 × 10E7 Ci for the total amount of the noble gas releases. This July report presents a sequence of the noble gas releases (see Figure 2) tabulated after a detailed calculation with a computor system. However, such detailed and precise calculations cannot correct an extensive loss of actual, basic data.

As already shown, the collective dose for the period of March 28 through April 6 should, by correcting the apparent technical deficiencies, be estimated at around 16,200 person rems, while NRC provides the figure of 3,500 person rems for the same period.[7] Here, the value of

3,500 / 16,200 = 0.22

should be adopted to correct the final estimation made by NRC of the amount of

noble gas releases. Thus, instead of 1.0 × 10E7 Ci (or 9 × 10E7 Ci in terms of Xe-133) should be the estimate for the amount of noble gases released.

IODINE RELEASES

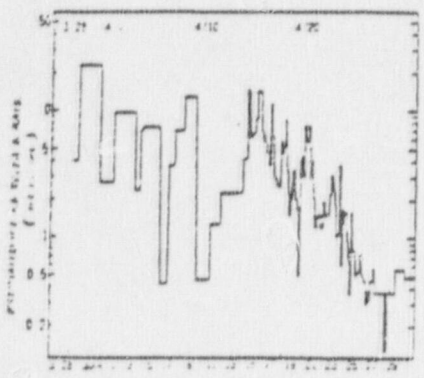

Figure 3
Radioactive iodine release rate based on TMI-2 vent monitors (charcoal cartridges).[5]

It is clear that during the first two weeks the time intervals between cartridge changings were significantly longer than the following weeks. This indicates that for the first two weeks there should be a major underestimation in the iodine releases. The actual iodine quantity released during these two weeks may have been ove several hundredfold of the level estimated by NRC.

It is clear that during the period before April 14 the average sampling intervals were seven to eight times longer than those during the period after April 14. Also it should be noted that after the sampling intervals became shorter, the declining gradient of the release rate was at a higher level by several tenfolds from that for the period between March 28 and April 14.

The Japanese Atomic Energy Commission's second report on the TMI-2 accident states that this sudden rising of the monitored iodine release is due to the filter changings done between April 12 and April 20.[7] If this were the case, however, the effects of the replacement of filters would appear in peaks rather than in the overall increased level as shown in Figure 3. Moreover, according to the NRC staff report published in June, those cartridge changings were done not during April 12-20 but on April 20, 24-25, and May 23-24.[8]

Therefore, it seems reasonable, instead, to explain this strange behavior of the monitored iodine releases as follows: For the first two weeks the charcoal cartridges were changed only every day or every two days because there existed a real danger that workers replacing the cartridges would be exposed to extremely high levels of radiation. This period was the most critical phase of the plant's status with an extremely high iodine concentration in the ventilation system. There also existed unusual amount of aqueous vapor. Under those conditions the absorbent capacity of the cartridges must have been rapidly minimized, resulting in the unusually low level of iodine concentration as shown in Figure 3. NRC and the utility did not make any corrections on those values recorded from the vent moniotors in their estimates of the actual iodine releases. This is inexcusable.

Figure 2 and 3 indicate that on April 20 the approximate quantity of released iodine and noble gases were 1.4 μCi/sec and 4,700 μCi/sec respectively. The ratio of iodine to noble gases is

1 / 3,400.

The reason for obtaining the ratio from the time period of April 20 is that the noble gas radiation monitors in the plant ventilation exhaust which went off scale at a very early stage had been recovered by then so that direct measurement of noble gas releases were available, and that the time intervals between charcoal cartridge changings were short enough to provide relatively reliable data. Then, if we assume that the ratio of iodine to noble gases was relatively constant, we can estimate the

31.

iodine/noble gas ratio for the period right after the beginning of the accident to be around

1 / 8,800

by taking the different half-lives of iodine and noble gases into account.

As the total amount of released noble gases is at least 4.5 x 10E7 Ci, the total released iodine should be estimated to be over 5,100 Ci.

However, the above assumption of constant ratio between iodine and noble gases demands some discussion. First, iodine concentration in the effluent air depends on the temperature of the liquids. During the early stages of the accident the temperature is expected to have been considerably high so that the ratio would be much greater. For example, Table II-3-3 of NUREG 0600 provides the ratio of 1 / 700 for the time period a little before 7:00a.m. March 28. Also on page II-3-20 of the same report it states that the major release of noble gases began around 7:00a.m. March 28 and that a few hours later the major iodine release started. Thus, it is very probable that after these few hours the ratio was much greater than 1 / 700 which corresponds to the quantity of 64,000Ci. It is also reported that even during routine operation these iodine filters had been used at TMI-2,[11] and there seems to be no reason to negate the value of 1 / 700.

Consequently, even the most conservative calculation would estimate the total iodine quantity released during the accident to be 5,100Ci. There remain reasons to expect that the released iodine quantity was far greater than 64,000Ci as indicated above.

Among the survey data in a task group report to the presidential commission,[12] there are some fragmentary data to challenge NRC's unconvincing estimation of released iodine. For example, (1) 1.2 x 10E-8 μCi/cc of airborne I-131 concentration recorded at 2:27p.m., March 28 in Middletown (2.6miles, north), and (2) 9.6 x 10E-6 μCi/cc during 4:00–6:00p.m. at an off-site location, are hundreds or a thousand times larger than the values expected from the assumed release rate (several ten μCi/sec) on which NRC's estimation of the total iodine release (14Ci) was based.

Also, Lake Barrett reported the rate of 40 μCi/sec of iodine release at TMI-1 vent stack (6:00a.m., March 29).[13] Now, according to the July report,[14] the rate at TMI-2 vent stack was approximately a hundred times greater than TMI-1. This leads us to estimate that radioactive iodine was released into the atmosphere at the rate of 4mCi/sec from TMI-2 at that time of the accident. This value is approximately two hundred times greater than the quantity shown in Figure 3.

TMI-1 ?!!

(Excerpts from the author's review published in Nuclear Engineering Vol.26,no.3)

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2) Ibid.

3) J. A. Auxier, C. D. Berger, C. M. Eisenhauer, T. F. Gesell, A. R. Jones and M. E. Masterson, "Report of the Task Group on Health Physics and Dosimetry to President's Commission on the Accident at Three Mile Island", Oct. 31 (1979)

4) "Second Interim Report on the Three Mile Island Nuclear Station Unit-2 (TMI-2) Accident", Metropolitan Edison Company, June 15 (1979)

5) Office of Inspection and Enforcement, Nuclear Regulatory Commission, "Investigation into the March 28, 1979, Three Mile Island Accident" NUREG-0600, Aug. (1979)

6) "Assessment of Offsite Radiation Doses from the Three Mile Island Unit-2 Accident", July 31 (1979)

7) "Assessment of Offsite Radiation Doses from the Three Mile Island Unit-2 Accident," op. cit.

8) "Second Interim Report on the Three Mile Island Nuclear Station Unit-2 Accident," op. cit.

9) [illegible] (1979)

10) J. T. Collins, W. D. Travers and R. R. Bellamy, "Report on Preliminary Radioactive Airborne Release and Charcoal Efficiency Data: Three Mile Island Unit-2", June (1979)

11) W. M. Bland, "Technical Staff Analysis Report on Iodine Filter Performance to President's Commission on the Accident at Three Mile Island", Oct. 31 (1979)

12) J. A. Auxier, op. cit.

13) L. M. Barrett, NRC memo unpublished, Mar. 30 (1979)

14) "Assessment of Offsite Radiation Doses from the Three Mile Island Unit-2 Accident," op. cit.

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June 14, 1985

Dear Mrs. Marjorie Aamodt and Mr. Roda:

MY PHILOSOPHY

I am pro-nuclear. That is, I am in favor of nuclear reactors, provided they can be designed safely.

It is my opinion that scientific work that is not classified should be published in the open literature and subjected to peer review, and should not be presented for the first time in the court room.

I cannot answer the question of whether the TMI Unit 1 should be reopened because I don't have sufficient information.

LEAK PATHS AND CONTAINMENT

There is in progress a DOE funded study on leak paths from TMI reactors and auxiliary buildings. I am not directly involved in this study, so I cannot answer the question of whether leaks will occur in the future under any circumstance -- normal operation or during an accident.

Papers in progress by me will show that containment of noble gases is inadequate during a partial melt down which was the case during the TMI accident. This inadequacy might exist at all nuclear reactors as well. Therefore, I am in the process of proposing development of constructural changes to provide containment until most of the radioactivity has decayed.

HEALTH EFFECTS FROM THE TMI ACCIDENT OR PREVIOUS LEAKS

Epidemiology studies for long term effects such as cancers are being funded by the TMI Public Health Fund now, partly as a result of Mrs. Marjorie Aamodt's work.

Epidemiology can show a correlation between health effects and the TMI accident or perhaps previous leaks. This correlation should be coupled with a cause and effect study involving environmental measurements, dosimetry and short term health effects such as fetal deaths, skin rashes and burns, and bloody diahhrea.

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ENVIRONMENTAL STUDIES ARE ABSENT FOR THE AREA AROUND TMI

Long lived fission product concentration profiles in soil and lake sediments as a function of depth have not been developed. I am proposing that this be done after I develope a relatively inexpensive method of analysis.

Intermediate lived fission products such as Zr-95 ($t_{\frac{1}{2}}$=65 days) and Ce-144 ($t_{\frac{1}{2}}$=284 days) as well as Sr-90 ($t_{\frac{1}{2}}$=28.6 years) and Cs-137 ($t_{\frac{1}{2}}$=30.2 years) and gross gamma should be monitored at several air sampling sites around nuclear reactors by the State and County health departments, and on a global basis by DOE's Environmental Measurements Laboratory (EML). The EML did this until April 1978.

Long lived gross alpha and gross beta in air samples should be monitored by the State and Counties at several sites. Colorado Department of Health and local counties jointly collect more than 1,000 samples per year.

Short lived actinides or their progeny should be measured in autopsy liver, lung, bone and testes of people who lived around TMI. Short lived actinide progeny have been found in autopsy tissues of people who lived around Rocky Flats at the time of Rocky Flats accidents. I am writing papers about the health effects of Am-242 and progeny and Pu-236 and its precursors on people around Rocky Flats. These short lived actinides bioaccumulate in specific organs and can be detected in autopsy tissue while they are below detection limits in soil and sediments. I am proposing to develope a method of analysis for autopsy studies that includes short lived actinide progeny and long lived fission products.

Chromosome abnormalities in white blood cells of people living around TMI should be studied. This has been suggested by several people. I am proposing that this be done after I develope a relatively inexpensive method of analysis. A proposal for methods development is in progress.

Short lived fission products such as noble gases like Xe-133 and Xe-133m and their health effects can only be determined after the proposed work has been completed.

DOSIMETRY

Post TMI health effects reported by Mrs. Marjorie Aamodt such as skin rashes and burns, hair loss, vomiting, and bloody diahhrea are characteristic of doses of at least 100 rem. By contrast, scientists at the TMI Public Health Fund's Conference on Dosimetry reported doses less than 0.1 rem. Due to this apparent contradiction, I am in the process of writing papers to show the need for proposed work, the type of experimental data to be obtained, and how the data will be used. The following is a summary from 3 of the papers. These will hopefully be published 9 months from now.

POTENTIAL PHOTON TRANSPORT MODELS FOR Xe-133 AND Xe-133m

The principles involved and the type of data are illustrated in Appendix B. The basic data concerning interactions of photons with matter such as attenuation, absorption, and scattering coefficients are reviewed periodically and reported by John Hubbell, National Bureau of Standards. Using the more recent 1975 and 1982 data which Dr. Hubbell sent me, I point out some contradictions with data in the energy range corresponding to Xe-133 emissions and the need for research in this area. In spite of the contradictions, I use this recent data to develope a photon transport model. The dose rate to a person surrounded by an infinite cloud of Xe-133 of uniform concentration is 6 times larger with the new data than with older 1969 data.

Dose build up factors are calculated from the transport models and are shown to be significantly different from dose build up factors calculated by Chilton, Eisenhour, and Simmons who used a method of function fitting, which is independent of a transport model.

Experimental determination of build up factors in the energy range of Xe-133 and Xe-133m emissions is necessary.

At this point in time all dose rate calculations have been based on a pyramid of assumptions. We do not have experimentally verifiable values for a given concentration of Xe-133 or Xe-133m.

From dose build up factors, the dose rate to a person on the ground from a shallow cylinder 50 meters thick with a diameter of 1 km, which contains 1 μCi/cc of Xe-133 is calculated for various elevations of the cylinder. These calculated values vary by factors of 2 to 3, depending on which basic data is used and which build up factors are used.

PLUMES FROM THE TMI ACCIDENT

Dr. Charles Eisenhour, National Bureau of Standards, a former member of the President's Commission on the Accident at TMI, sent me the "Sequence of Events" from the Task Force Reprt On Health Physics and Dosimetry. Using this data, plumes are described as a stack of cylinders with different concentrations of Xe-133 or Xe-133m when that was the dominant species in the cloud. The thickness and elevation of the plume as well as its vertical concentration profile can be described, provided measurements were taken at two or more different elevations.

The first two to five minutes of a plume is shown to have the same radiation level, expressed as R/hr, as that in the auxiliary building as indicated by dome monitors.

Since the auxiliary building monitors went off scale at about 15 R/hr, the early releases were in excess of 15 R/hr, on the average. Later plumes were at least 1.2 R/hr, on the average.

HOT TRACKS AND PLUME TOUCHDOWNS

"Hot" is commonly used to describe radioactive matter, while "cold" is commonly used to describe nonradioactive matter. Two accidents at Rocky Flats Plant, September 1977 and February-March 1978, were tracked by gross beta air measurements by Colorado State and County Health Departments. The average value in a track was 20 times that of normal background, and the maximum value was about 7 times larger than the average.

A track makes several plume touchdowns as it passes through the air. The radioactive material is air born and travels with the wind to far distances. Using EML data, the tracks could followed from Colorado to Montana, Alaska, NYC, Ontario, Greenland, Miami, and to Livermore (near San Francisco).

This means that the early plumes from the TMI accident at touchdown, gave an exposure of at least 15 R/hr on the average or 105 R/hr maximum. The early plumes could have much higher radiation levels, but there was insufficient data to estimate the exact level.

The time span of a touchdown is estimated and assumed to be related to the touchdown time for a tornado. A tornado traveling 25 miles per hour spends about 4 minutes on the ground. It is assumed a hot track traveling 5 miles per hour will spend about 20 minutes on the ground.

With these assumptions, the estimated dose from early plume touchdowns is 5 to 35 R at the minimum. This is almost equal to 5 to 35 rem. About 3 R will cause a metallic taste. Therefore, the estimated minimum dose is consistent with the numerous reports of a metallic taste after the TMI accident.

It is shown in Appendix A that the beta dose is 100 rads/hr, which is 1,000 rem/hr for a quality factor of 10 for beta emissions. This means that people exposed from the early plume touchdowns received about 300 rem. And, this is quite consistent with the health effects reported by Mrs. Marjorie Aamodt!

The accidents of September 1977 and February 1978 at Rocky Flats are distinguishable from atmospheric nuclear bomb tests by the following methods. (1) A sharp rise in air concentration of radionuclide occurs with an accident, whereas a bomb test generally gives a rise spanning 2 or 3 months. (2) The ratio of Cs-137 to Ce-144 is characteristic of the cause of the nuclear criticality and consistent with the type of accident and not a test bomb. (3) the long lived beta activity in air is 20 times that of normal background for accidents, whereas no increase (or only a barely detectable increase) in beta activity is observed with a bomb test. (4) The increased long lived beta activity can be related to progeny of short lived actinides in autopsy tissues. A paper explaining this relation is in progress.

THYROID CANCERS

Women are more sensitive than men. Thyroid cancers can be caused by external radiation as well as by internal radiation from I-131. A study of 11,000 subjects in Israel who were externally irradiated with 6 to 9 rads showed 10 excess cancers. Hyper and hypothyroidism often precede thyroid cancer.

5.f

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ABBREVIATED RESUME

Summer Fellowship (by invitation) Brookhaven Nat'l Lab, Long Island, N.Y.

B. A. 1957 Reed College, Portland, Oregon

M.S. 1963 Chemistry, Univ. of Colorado, Boulder, Colo.

Ph.D. 1966 Chemistry, Univ. of Colorado.

Member of the Transuranic Waste Systems Office which monitors and advises DOE on waste projects to be funded - 1978

One paper on Remote Handled Transuranic Waste In The DOE Complex

Coordinated other labs, Rocky Flats, and my responses to proposed waste acceptance criteria for a deep geological waste repository. These suggestions were all accepted.

All proposals for initiation of projects to be performed by others or by me were succdssful and accepted while I was at Rocky Flats.

Six papers were written on implementing at Rocky Flats Plant a very sensitive gamma-spectrometer developed by scientists at Los Alamos.

One paper on liquid wastes from various buildings at Rocky Flats. This allowed correlation of the Feb. 1978 accident with environmental measurements.

Three papers on conversion of Pu nitrate solutions to Pu oxide for nuclear fuel.

Inter reports on Pu peroxide precipitation at Rocky Flats. These allowed correlation of the Sept 1977 accident with environmental measurements.

Advised the attorney representing owners of land around Rocky Flats. My phone has been bugged and these conversations plus his communications with Rockwell have resulted in an out of court settlement by the DOE and Rockwell, the contractor for Rocky Flats.

I have been invited to submit the papers in progress for publication in a new Journal by the National Academy of Science and for publication by the International Symposium on Radiation Physics.

Sincerely,

R. Monte Greinitz

ENCLOSURES:
Appendix A
Appendix B
(Provided at 31-45)

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R. Monte Greinetz, Ph.D.
Consultant in Chemistry and
Chemical Engineering
10201 West 102nd Avenue
Broomfield, Colorado 60020
303-466-6043

(11) 38.

December 13, 1984

Mr. David Berger
1622 Locust Street
Philadelphia, Pennsylvania 19103

Dear Mr. Berger:

Thank you for inviting me to the November, 1984 workshop on radiation doses to populations around Three Mile Island, TMI. There are several types of doses shown in Figure 1 which were not discussed at the workshop. I have discussed some of these with Dr. Jock Cobb. A few nights ago I discussed my calculations for doses from ^{133}Xe with Dr. Karl Morgan who would be pleased if you would make copies of the following information and distribute them to members of the advisory committee for their next meeting December 17, 1984.

Beta Radiation from ^{133}Xe, Whole Body Exposure to External Radiation

In Appendix A the dose rate [beta rads/minute] = 1.6 rads/min per $\mu Ci/cm^3$ is derived. From Charles Pell[illegible]s presentation, ^{131}I during the first 24 hours was 0.5×10^{-6} $\mu Ci/cm^3$, and ^{133}Xe was expected to be at least a million times larger during the early releases. This gives:

(1.6 rads/min per $\mu Ci/cm^3$)(0.5 $\mu Ci/cm^3$ of ^{133}Xe) = 0.8 beta rads/min

= 48 beta rads/hour

= 1,152 beta rad/24 hour day

A dispersion model is necessary to estimate the actual ^{133}Xe concentration in the cloud engulfing a specified population. The actual concentration will be less than 0.5 $\mu Ci/cm^3$ by some factor.

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39.

At present, I think beta rads delivered to the surface of a person's skin are important. Even though the range of ^{133}Xe beta particles is only 0.1 cm in tissue, the unbound electrons and excited electrons fall into vacant orbitals and release X-rays and florescent photons with a continuous spectrum of energies ranging from 0.1 MeV down to the visible region. These secondary X-rays can travel several cm inside tissue. Also H° and OH° radicals are produced with travel by the domino effect through tissue.

X and Gamma Radiation from ^{133}Xe, Whole Body Exposure to External Radiation

The gamma dose rate due to 0.081 MeV gamma rays from ^{133}Xe is derived in Appendix B. The X-rays have not been considered yet. Therefore, the following is only a partial dose rate for photons from ^{133}Xe.

(0.583 gamma rads/min per $\mu Ci/cm^3$)(0.5 $\mu Ci/cm^3$ of ^{133}Xe) = 0.293 rads/min

= 17.6 rads/min

= 422 rads/24 hour day

This partial dose rate is larger than values discussed at the workshop by several orders of magnitude. If I neglect the contribution to the skin surface from photons originating up to 500 meters from the skin surface, and if I neglect the fraction of attenuated photons which are absorbed, then I can calculate an improper* dose rate of 0.068 gamma rads/24 hour day. This improper dose rate is similar to the individual doses discussed in the workshop.

* improper dose rate is ...

Inhalation of Short Lived Actinides from Thermal Neutron Reactions

Since ^{137}Cs contours exist in soil around TMI, I expect a

small amount of short lived actinides were also released during the accident. For major accidents at Rocky Flats Plant, I have shown that nuclear criticality excursions occurred by correlating wind direction at the time of the accidents with the geographical pattern of ^{137}Cs and ^{90}Sr in soil; with autopsy data by residence; with epidemiology results of others; and with time patterns from lake sediment depth profiles of ^{137}Cs and normal Pu isotopes from Rocky Flats released during the accidents. The time patterns were developed jointly by people from Woods Hole and the DOE's Environmental Laboratory. More recently I have heard of an article on fetal deaths which confirms these findings.

These short lived beta emitting actinides in autopsy tissue are the result of inhalation of just one or more radioactive particles. In all cases where the time lapse was sufficient for the cancer latent period, cancers or tumors developed. This is an important long term effect of accidents.

Other Categories of Health Risks and Doses

All the categories shown in Figure 1 are pertinent to the TMI accident itself or to the clean up operations. Since U and Pu that resulted from reactor burn up are present along with fission products in the Containment Building, the problems are going to be similar to those encountered in any Pu and U facility. One special comment about water which workers will think they have decontaminated sufficiently for release to the public waterways. The evidence here in Colorado from Dr. Carl Johnson on U in drinking water indicates that existing limits are probably too high for other actinides and for gamma emitting fission products also. This area needs more work.

The Bulletin
of the Torrey Botanical Club

Editor-in-Chief: James E. Gunckel

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May 11, 1984

AFFIDAVIT 9

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

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

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

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

James E. Gunckel

James E. Gunckel

Publications of James E. Gunckel

IV. The Effects of Ionizing Radiation on Plants: Morphological Effects, The Quarterly Review of Biology, Vol 32, No. 1, March 1957

✓ Modifications of Plant Growth and Development Induced by Ionizing Radiations, Encyclopedia of Plant Physiology, Vol XV/2, 1965

Aberrant Growth in Plants Induced by Ionizing Radiation, with Arnold H. Sparrow, Abnormal and Pathological Plant Growth, Brookhaven Symposia in Biology No. 6 (1954)

✓ Ionizing Radiations: Biochemical, Physiological and Morphological Aspects of their Effects on Plants, with A. H. Sparrow, Encyclopedia of Plant Physiology, Vol XVI, 1961

Village Voice 5-13-86 (MAYO)

preceding page

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, milk-white barns, and
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y closed like yellow dew,
ie branch tips had strum-
ssy blossoms. In back of
a six-foot-high Beckettish
hedge, half-dead, its branches covered with seedy growths. "We took a branch of this hedge to the TMI Advisory Council meeting," said Mrs. Hocker, a wee daffodil woman in denim and blue sneakers, "and the scientists said that the growths might be plant galls and that if they were they would have insects inside them, and one of them cut open a growth with his eyeglass and looked but there weren't any insects." PATTY died!

Mrs. Hocker said that her daughter Patty wasn't able to get out of bed. Patty has thymus cancer. The doctors told the Hockers that only five per cent of thymus cancer is malignant. "They hardly know how to treat it," said Mrs. Hocker. "She's had everything—surgery, radiation, chemotherapy, everything." She added that the daughter in the family next door had just had a malignant brain tumor removed, that the son in the family on the other side had testicular cancer, that two houses down a woman had breast cancer. It skipped a house, and then there were two more after that.

"It's always like that," said Osborn back in the car. "Wherever you find plant effects, people are sick." She said that Marjorie Aamodt's survey had revealed a 700 per cent increase in cancer in a neighborhood that had been in the line of a plume of TMI radiation. So far, 2000 damage suits for cancer and other illnesses have been brought against the owners of TMI. Since many cancers have long latency periods, further claims will certainly follow. Osborn knew of many people who have not sued, either because they didn't want to sign away their right to protest (often a condition of settlement) or because a stubborn pride prevented them from "begging" from the much-hated company.

Osborn nodded at a solitary druidic pine that towered over a graveyard by the side of the road. Three-quarters of the way up its trunk a bunch of excess branches had formed a bolus, a nice bit of radiation topiary. "I first noticed that about two years ago," said Osborn.

"Well, anyway, you look fine." I said. "Lots of color in your cheeks."

"Once or twice a week my cheeks burn," she said. "And along the top of my lip I have a line that feels like chili pepper." She said that many of her neighbors have the same burning sensation on their cheeks. One man got some prescription ointment from the doctor. The man keeps it slathered all over his face. "It's the same ointment they give workers at TMI," Osborn said. She paused. "I wish my government would do research on plant effects."

Osborn and others like her could certainly provide valuable raw material for government research, except that the only federal scientists who would listen have either been fired or have resigned.

One of the two leading researchers in the esoteric field of radiation plant biology was the late Dr. Arnold Sparrow, founder of the plant biology division of the Brookhaven National Laboratory. Sparrow made observations of plant effects in Hiroshima, the Nevada atmospheric nuclear test grounds, and the Marshall Islands (where the Bikini hydrogen bomb tests took place). At Brookhaven, he created a 10-acre "gamma garden," consisting of flowers and vegetables planted at measured distances from a stationary source of cobalt-60, and an "ecological forest" of pine, oak, and maple.

The other big name on the Brookhaven team was Rutgers professor of botany Dr. James Gunckel, who spent seven summers conducting research at Brookhaven. Gunckel is the world's leading authority on the effects of radiation on plant development. He can, for instance, use radiation to block development of a tree's vascular vein system so that leaves will either be aberrant or absent altogether. But Gunckel was no dissident. He spent his entire life in the government cocoon. It seemed unlikely that he would emerge from retirement to become an antinuclear activist at the behest of high school graduate Mary Osborn.

"I don't think maple leaves are going to stop the Bechtel Corporation," I said. "But you might as well give it a try. You should ask an impartial scientist to take a look at your specimens."

"I already took them to Dr. Gunckel," said Osborn. She showed me an affidavit that Gunckel had given her, stating that the abnormalities she had observed could have been caused by fallout from the accident.

I called Gunckel. He did not sound like a young man. He harrumphed that he had found numerous minor errors in Osborn's method. "That young woman," he said, "she's not *educated*, you know."

"How about her main point—that the effects were caused by radiation?"

"Well, theoretically, they *could* have been caused by insecticides."

"But what do you really think?"

"I think," he said, with the sudden access of feeling of a man who has held his tongue for 40 years but suddenly realizes he has nothing to lose by talking, "I think that the gross effects that that young woman saw, and the more—ahem—subtle ones that I observed, were *definitely* radiation-induced. The levels of radiation following the accident were very high. Much of the required measurement equipment wasn't functioning. The only surveys were made from helicopters at 500 feet, but plants are affected by material on the ground. That's because radioactive fallout is *heavy*—it falls down."

I asked Gunckel to comment on NUREG-0738, a 1980 report issued by the Nuclear Regulatory Commission in response to pressure from farmers and residents of Harrisburg. I read Gunckel the section on plants, which, starting with the false premise that there had been no animal effects, went on to deduce that plants, "hundreds of times more resistant to radiation than mammals," wouldn't have been affected. The report cited Brookhaven experiments that showed oak leaves do not become misshapen until they have received a radiation dose of seven rems a day for several weeks, and that it took six months at 60 rems to kill a whole oak tree.

Gunckel, who participated in those experiments, said that the NUREG statement was "fallacious," and that the effects of radiation on plants are roughly *equivalent* to those on mammals. In fact, radiation is sometimes far *more* damaging to plants, as is the case with garden lilies and spiderworts. And onions. Onions are very sensitive.

He said that the NRC statement about the oak trees was a "mishmash." "They didn't say whether they were talking about gamma rays or beta rays," he said. "It makes a big difference. Beta rays do twice as much damage. Also, they didn't talk about dose *rate*. Dose rate is what counts, not total dosage."

Gunckel said that the present administration had cut back on funding for the study of plant effects. I asked why he thought that was. "The present administration is very industry-oriented," said Gunckel. "They're just going blindly ahead. I guess they don't want to hear the bad news."

Research assistance by [illegible] *Saltzman*

Mixed greens: one normal and three mutant dandelions found near Three Mile Island on May 1 (see p

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Ionizing radiations: Biochemical, physiological and morphological aspects of their effects on plants*.

By

J. E. Gunckel and **A. H. Sparrow.**

With 1 figure.

I. Introduction.

The accumulation of information concerning the effects of ionizing radiations on plants has been closely tied to developments in the physical sciences. The discovery of X rays by ROENTGEN in 1895, of natural radioactivity by BECQUEREL in 1896 and of induced radioactivity by CURIE and JOLIOT in 1934, and more recently the many advancements associated with nuclear energy programs have all contributed to and stimulated the investigation of the biological effects of ionizing radiations. A measure of the growth of interest in plant radiobiology is given in the recent literature survey by SPARROW (1957) who noted that for the first 25 years following ROENTGEN's discovery an average of less than 10 papers a year were published as compared with an average of at least 200 papers per year for the years between 1950 and 1955 (see also SPARROW, BINNINGTON and POND 1958, for a listing of papers in plant radiobiology 1896—1955). This trend seems to be continuing.

While it is obvious that no scientific investigations concerning the effects of man-made ionizing radiations on plants could have been undertaken before the discovery of these radiations, it is equally obvious that the naturally occurring ionizing radiations (*e.g.*, cosmic rays and those from radioactive elements) were, nevertheless, producing their biological effects since time immemorial, and that the cumulative effect of these radiations might conceivably be of considerable evolutionary significance. The recent concern over small increases in background radiation due to radioactive fall-out reflects the opinion of many biologists that an increase in the background level of radiation, if continued over long periods of time, may produce significant biological effects, mainly genetic. However, since this paper is not primarily concerned with genetic effects we shall not discuss this aspect further. Recent reviews of the very extensive literature on the genetic effects of ionizing radiations on plants include those of ANGULO CARPIO (1955), KONZAK (1957), SMITH (1958) and of a number of authors in Acta Agriculturae Scandinavica (vol. 4, 1954), Brookhaven Symposia in Biology (no. 9, 1956), and in the Proceedings of the International Conferences on the Peaceful Uses of Atomic Energy held in Geneva in 1955 and 1958.

This review is mainly concerned with the non-genetic effects of ionizing radiations on plants. The literature in this general area has been reviewed earlier by several authors (GAGER 1936, JOHNSON 1936a, BRESLAVETS 1946, SCULLY 1953,

* Research carried out at the Brookhaven National Laboratory and at Rutgers, The State University (contract no. AT-30-1-1120) under the auspices of the U. S. Atomic Energy Commission.

Table 5. *Summary of morphological effects of irradiation on higher plants*[1].

Part affected	Nature of effect	Plant	Type of irrad.	Dose or dose rate	Duration of exposure[2]	Ref. No.
Flowers	Abscission of floral heads	*Antirrhinum majus*	γ	350 r/d	g.s.	*100*
		Lycopersicon esculentum	X	90 kv/5 ma/30 cm	20 min.	*135*
		Nicotiana bigelovii	γ	375 r/d	1 mo.	*174*
		N. glauca × *N. langsdorffii*	γ	325—385 r/d	6 wks.	*106*
		N. tabacum (small buds)	X	2000 r		*140*
		Phlox drummondii	X	2000 r		*140*
	Color change	*Antirrhinum majus*	γ	0.4—175 r/d	3 mos.	*266*
		Dianthus caryophyllus	X	2500—5000 r		*223*
		Nicotiana rustica	γ	12.5—100 mg radium salt	40 hrs.	*82*
		N. rustica	X	50 kv/5 ma/20 cm	1—3 hr.	*82*
		N. sanderae	γ	200 r/d	2 mos.	*100*
		N. tabacum	X	1500—2000 r		*140*
		Petunia	X	85 kv/10 ma/3″—6″	1—4 min.	*182*
		Phlox drummondii	X	1500—2000 r		*140*
		Salpiglossis sinuata	X	1500—2000 r		*140*
		Tradescantia paludosa	γ	1.8—7.9 r/d	6 wks.	*99*
	Dwarfing	*Nicotiana tabacum*	X	2000 r		*140*
		Phlox drummondii	X	1500—1800 r		*140*
		Salpiglossis sinuata	X	2000 r		*140*
	Fasciation	*Antirrhinum majus*	γ	240—350 r/d	6—9 wks.	*100, 229*
		Helianthus annuus	X	5—10 E (60 kv/5 ma/30 cm)	5.5 min.	*133*
		Linum (flax)	γ	190—425 r/d	g.s.	*54*
	Reduction in number and/or size	*Antirrhinum majus*	γ	250—500 r/d	g.s.	*270*
		Chenopodium album	γ	600 r/d	g.s.	*270*
		Coleus blumei	γ	100—240 r/d	g.s.	*270*
		Impatiens sultanii	γ	55—320 r/d	5 mos.	*100*
		Kalanchoë daigremontiana	γ	370—1500 r/d	g.s.	*270*
		Lilium longiflorum	γ	66—150 r/d	g.s.	*270*
		Lupinus albus	γ	500 r/d	g.s.	*270*
		Lycopersicon esculentum	γ	250—400 r/d	g.s.	*270*
		L. esculentum	γ	505 r/d	3 mos.	*31*
		Melilotus officinalis	γ	100—240 r/d	g.s.	*270*
		Nemophila insignis	X	1500—2000 r		*139*
		Nicotiana bigelovii	γ	300—375 r/d	6 wks.	*174*
		N. bigelovii × *N. glauca*	γ	75—375 r/d	4—6 wks.	*174*

45.

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

(16) 46.

August 13, 1985

NOTE TO: Bill Travers, Deputy Program Director

FROM: Mike Masnik, Technical Assistant

SUBJECT: REPORT OF BOTANICAL ABNORMALITIES IN THE VICINITY OF TMI-2

At the July 18, 1985 Advisory Panel Meeting in Lancaster, PA, I was given a packet of documents by Ms. M. Osborn. In that packet was a report on botanical abnormalities in the vicinity of TMI-2. The documents alleged that the abnormalities were the result of radiation released from TMI-2. During the course of the meeting Ms. Osborn, who requested that the information be provided to the Advisory Panel, approached me and requested that the document addressing the botanical abnormalities be returned to her. I expressed my own as well as the staff's interest in this matter, particularly the report of aberrantly large dandelion, Taraxacum officinale, and returned the document. I asked if she would mind being contacted by a staff biologist concerning the abnormalities and in particular the aberrant dandelion. She said she would be happy to talk to the biologist and gave me her telephone number. I provided the number to Dr. G. LaRoche, EEB, who arranged for a site visit to examine the abnormalities first hand. The trip was scheduled for August 1, 1985. On July 31, 1985, Ms. Osborn called me at work and informed me that she would like to cancel. She said she talked it over with some other people and agreed that they would rather not show the plants to us at this time. I expressed my disappointment and offered to reschedule sometime in the future convenient to her. She said she would let me know.

Mike Masnik, Technical Assistant

cc: G. LaRoche
M. Osborn

8508190071 1P

August 30, 1985 (16.) 47.

Dear Mr. Masnik,

Thanks for sending me a copy of your note (to Bill Travers dated 8-13-85) about my report of plant abnormalities around Three Mile Island area. I have a few comments to make about your note -

I do believe many abnormalities I've observed were caused by radioactive releases into the environment from TMI-2 (pre accident, post accident + accident-pseudo releases from unit I). Because I'm not an expert - I can't prove to you or anyone else TMI did in fact cause these abnormalities. At this date - 6½ years later - I don't know if anyone on earth could.

Dr. LaRoche did call me + we did set a date to meet. At that time I thought a few hours would be enough time for a field trip - but after thinking this over, the length of time really would depend on how much you want to see. If you're only interested in the large dandelion leaves - a few hours will do. If you want to travel both sides of the river + really look around, perhaps a full day should be scheduled. (I've found more things lately + have been told of another area with plant abnormalities that I've not been to yet. This would be interesting to check out.)

You mentioned a large dandelion + called this "Taraxacum

officinale". The only large dandelion listed in my report refers to huge dandelion leaves, I never saw their flowers. (Last year I asked the property owner not to mow that area - in order to see the flowers. We called on this summer about another not a dandelion plant that was over 6' tall & still growing.) I know very little about dandelions, they are not high on my list of concerns when compared to other abnormalities. The dandelion leaves I've seen so far either had jagged edges or rounded edges. I don't know which kind the "Taraxacum officinale" has. The first time I went to the "dandelion leaf" area was last September. At that time I also found very crossed unusual marigolds.

Although I did call you & cancel this project for August, I am still interested in a field trip. There is about 2 months of good weather before a heavy frost. My hesitation the last time was based on my need to have someone come with us - someone I knew. My greatest concern is the fact I am not an expert - that I lack the training & background to know what I'm being told "ain't necessarily so." I don't want to go thru another round of being told by your "experts" that not enough radiation got out during the accident to cause the problems reported by area residents, or be told in generalities that plant (Flora) damage was "attributable to normal biological & environmental factors". It is important to have input

and to get reasonable & specific answers - not vague un-answers. There is a need to have someone along who I trust, who is thoroughly knowledgeable in botany, plant abnormalities or modifications - regardless of cause, & who also knows about radiation & its effects on plants.

For these reasons I am requesting you to include Dr. James E. Gruneau in the field trip; to have his opinions & participation on every phase. Dr. Gruneau is an acknowledged expert on this matter, having done research for Brookhaven Natl Lab & at Rutgers University.

I would also expect Dr. Gruneau to be project director, if he is willing. Any fee or expense for him should be paid at the per diem rate by the NRC or any agency agreeable to all parties - with no strings attached. (details can be worked out)

I'm really looking forward to this.

Would you please put me on the mailing list for the minutes to the advisory panel meetings - I forgot to ask you this in Lancaster. Also, could you send me some background information on Dr. D. La Rocke, (I don't know what EEB stands for).

Sincerely,

Margo Osborn

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

(16.) 50.

October 29, 1985

Ms. Mary Osborn
4951 Highland Street
Swatara, PA 17111

Dear Ms. Osborn:

I received your letter and as I have mentioned before both Dr. G. LaRoche and I are still interested in meeting with you to examine some of the plant abnormalities you have brought to our attention.

In your letter you spoke of inviting Dr. James Gunckel on the field trip. We encourage you to include Dr. Gunckel; however, we are not in a position to pay for his traveling or other expenses.

s of
-12-85
O CALL

Either Dr. LaRoche or I will give you a call next week concerning the possibility of getting together in the near future.

Attached is a copy of Dr. LaRoche's professional qualifications; also, EEB is the initials of Dr. LaRoche's organization - the Environmental Engineering Branch.

We have added your name to the distribution list for the Advisory Panel.

Sincerely,

Michael T. Masnik

Michael T. Masnik, Ph.D.
Technical Assistant
Three Mile Island Program Office
Office of Nuclear Reactor Regulation

Attachment:
As stated

~~2510100001~~ 3pp.

PROFESSIONAL QUALIFICATIONS

Dr. Germain LaRoche

U.S. Nuclear Regulatory Commission

Washington, D.C.

As a Land Use Analyst in the Terrestrial Resources Section of the Environmental Engineering Branch of the Division of Engineering, USNRC, I evaluate the potential environmental impact on terrestrial ecosystems and land use.

Prior to being employed by the NRC I was director of Terrestrial Ecology for a private consulting firm for three years. In this capacity I directed and conducted baseline studies of proposed nuclear or fossil fuel power plants, and large urban and recreational developments. For ten years I taught at colleges, attaining the rank of Associate Professor of Biology. These colleges were: Empire State College, Albany, N.Y.; State University College at New Paltz, N.Y.; Manhattan College and Bronx Community College, Bronx, N.Y.; and Holyoke Community College, Holyoke, Massachusetts. Among the graduate and/or undergraduate courses I taught were Ecology, Plant Physiology, Plant Taxonomy and General Biology. I have also conducted forest and range management research with the U.S. Forest Service in Florida for 2 years.

I received the Ph.D degree in Botany-Plant Ecology from the University of Massachusetts at Amherst in 1969, the M.S. in the same areas from The Catholic University of America in Washington, D.C. in 1958, and the B.A. in Biology from The Catholic University of America in 1957. In 1950 I graduated from the Stockbridge School of Agriculture of the University of Massachusetts as a a Floriculture major.

I have also attended the following Symposia and Institutes:

- Coastal Mapping Using Remote Sensing
- Biological Evaluation of Environmental Impacts
- Land Capability Classification and Integrated Inventories for Land-Use Planning
- Physiological Adaptation to the Environment
- Primary Productivity and Mineral Cycling in Natural Ecosystems
- Environmental Analysis Workshop
- Remote Sensing for Natural Resources
- Rare and Endangered Plant Species
- Energy Sensitive Land Development
- Bayosian Reliability Analysis
- Intergrated County Level Data

- The Use of Remote Sensing Technology in Environmental Studies
- Water Resources - The Role of the University Community
- The Economic and Social Impact of Environmental Changes in the Great Lakes Region
- Summer Research Participation Program for College Teachers
- "Isotopes and Radiation Science"
- "Evolution in Vascular Plants"
- Chemical Ecology of Animals

I was elected to the Society of Sigma Xi in 1958, have been a member of the Ecological Society of America since 1957 and of the Society of American Foresters since 1972.

Publications:

LaRoche, Germain "An experimental study of population differences in leaf morphology of Aquilegia canadensis L. (Ranunculaceae)" 1978. American Midland Naturalist 100:341-349.

"Effects of Light intensity, photoperiod and gibberellic acid on leaf characteristics of Aquilegia canadensis L." Bulletin of the Ecological Society 57 (1):26, 1976. Abstract.

"The effects of restricting root growing space on the phenetics of Aquilegia canadensis." Bulletin of Ecological Society 54(1):22, 1973. Abstract.

1972 Report of a grant from the State University of New York Research Foundation entitled, "Determining the speed of germination in seeds of Aquilegia canadensis L."

"The ecology of red columbines in Western Massachusetts" Ph.D. Thesis 1969.

"Secondary Succession", pp. 113-115 in Research Problems in Biology Investigations for Students, Series 2, 1963, Anchor Books. Doubleday & Co., Inc.

"A phytosociological study of the alluvial floodplain forest community in the Patuxent Wildlife Refuge." M.S. Thesis 1958.

Seminars Presented:

1976 at York College, City University of New York entitled, "Decifering the ecological control mechanisms of Aquilegia canadensis' geographical distribution.

1972 at the University of Montreal entitled, "Technique de différenciation des contrôles génétiques des contrôles environnementaux dans les variations morphologiques d'Aquilegia canadensis L."

Below are excerpts from the booklets Dr. Gunckel gave us. This explains why even knowledgeable people have difficulty in accepting the fact that radiation damage occurred in the plants around TMI.

> Most of the radiation effects described are quantitatively rather than qualitatively different from those known to occur in unirradiated plants. (273)
>
> You have nothing that is not known in nature - you seem to be speeding up the frequency of these events. (279)
>
> Most, if not all, radiation induce effects are teratological responses observed in nature, but the frequency of such events is markedly accelerated. (373)
>
> A large variety of leaf anomalies has been noted in irradiated plants. In any given species, one or more of the following changes may appear; dwarfing, thickening, roughened or uneven texture, puckering of blade, curling of leaf margins, distorted venation, fusions, cup-shaped or tubular leaves, color changes, and premature abscission. (272)
>
> Irradiated flowering plants may show: increased height, thickening & fasciation of floral stalks, delayed and/or reduced flowering, premature or increased flowering, color changes and somatic changes, or high degree of sterility and modification in form and number of floral parts. (597)
>
> Fasciation of stems, while not uncommon in unirradiated plants occurs so frequently in irradiated plants that it may be considered a typical radiation effect. (375)
>
> It should be emphasized that the results for one species should not be extrapolated to another, as the responses of different species or even different forms or varieties within a species may vary. (595) An example was given-if you have an apple orchard with many different kinds of apple trees, and they were all exposed to equal doses of radiation, some trees could be injured while other trees are unaffected.

Dr. Gunckel and Dr. Sparrow wrote in 1961, "it is obvious that the naturally occuring ionizing radiations were producing their biological effects since time immemorial, and that the cumulative effects of these radiations might conceivably be of considerable evolutionary significance. The recent concern over small increases in background radiation due to radioactive fallout reflects the opinion of many biologists that an increase in the background level of radiation, if continued over long periods of time, may produce significant biological effects, mainly genetic." (pg. 555)

11/3/88

54.

GAVE to ASLB:

✓ ① Slides - showed.
✓ ② symptoms maps (3)
③ Randy Blough ltr.
✓ ④ Harm Menkens (2)
✓ ⑤ Gunckel Affs
✓ ⑥ Village Voice
✓ ⑦ Funky Kirkerson
⑧ Winston Richards / Palladino ltr.
⑨ B. Mollalt - Mtaste
⑩ - 9/85 cancer study critique
⑪ Dr J. (Dr. Carl Johnson) " " "
⑫ 10/6/85 States Study "map"
⑬ 6-2-87 Lipsitt "Rem"
⑭ 12-26-76 isotopes
⑮ Rietveld affs.
⑯ Cop Crime Rept. 5-11-87
⑰ Dr. MacLeod 88 infants deaths
⑱ Remote Sensing - background
✓ ⑲ Dr. Gunckel "Excerpts"
⑳ CO2 temp newsclips (2)
㉑ many lawsuit newsclips.

papers regarding
flora: #1. #2. #4. #5. #6. #7. #19.

February 20, 1989

CERTIFICATE OF SERVICE

This is to certify that SVA/TMIA application for an appeal motion for a stay, comments to the Nuclear Regulatory Commissioners and notification of temporary change of address have been sent this 21st day of February 1989 by first class prepaid mail to the enclosed service list and to the Nuclear Regulatory Commissioners.

Frances Skolnick