June 22, 1983

Ms. Brenda Witmer
1570 Ridgeview Avenue
Lancaster, Pennsylvania 17603

Dear Ms. Witmer:

We appreciated the opportunity to meet with you and the other concerned citizens from Lancaster, Pennsylvania. As you recall, you provided Commissioner Ahearne with a "Summary of Medical Material" during the meeting, which we agreed to review and provide responses. The Summary contains numerous statements concerning the risks associated with exposures to radiation resulting from the accident at Three Mile Island.

Before providing more specific responses to the Summary and to place our responses in perspective, it might be helpful to note a few things about radiation in general.

Low levels of natural radiation are all around us. Natural radiation from the earth and outer space varies from about 70 to about 300 millirems per year in the United States, depending on the location; it is about 110 mrems/yr in the Lancaster area. Human beings receive about 20 mrems/yr from potassium-40, a natural radioactive material in the body. Even though people have always been exposed to natural radiation, there is no evidence that such exposure has significantly affected human health.

Since the beginning of the twentieth century, people have also been exposed to man-made sources of low-level radiation from medical x-rays and radiopharmaceuticals, nuclear power plant releases, television sets, some wristwatches, and airline travel. The amount of radiation received by the general public from all these sources, except medical x-rays, is much lower than from natural radiation (see Enclosure 1). There are no differences in the health risks associated with a given amount of radiation, whether natural or man-made.

The amount of radiation released during the accident at Three Mile Island was higher than the amounts of radiation normally released from a nuclear reactor. The maximum dose due to the accident to an individual was estimated by government radiation specialists to be less than 100 mrems (see NUREG-0558, enclosed). The average dose to an individual within 10 miles of the site was estimated to be about 8 mrems; the average dose received by individuals within 50 miles of the Three Mile Island plant was approximately 2 mrems. Similar estimates were made by the President's Commission on the Accident at Three Mile Island, by the NRC Special Inquiry Group directed by Mitchell Rogovin, and by the Governor's Commission on Three Mile Island chaired by William W. Scranton, III, Lieutenant Governor. There would be no discernible health effects due to exposures at these levels.

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I am enclosing copies of two reports, entitled "Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station" (NUREG-0558) and "Investigations of Reported Plant and Animal Health Effects in the Three Mile Island Area" (NUREG-0738). These reports were prepared by groups of experts representing several Federal agencies and may be of interest to you and other concerned citizens. They document our analysis of the doses received from the accident and the effects of the accident on plant and animal life in the region.

As we indicated to you earlier, the NRC staff has reviewed the "Summary of Medical Material." Responses to the major issues raised in this paper are enclosed (Enclosure 2).

Sincerely,

Joseph J. Fouchard, Director
Office of Public Affairs

Enclosures:
1. Sources of Radiation (from BEIR III, p.66)
2. Responses to Specific Issues
   with Attachments A & B
3. NUREG-0558
4. NUREG-0738

cc: John F. Ahearne, Com.
Ed Branagan, RAB/NRR

Draft originated by E. Branagan, NRR

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DATE	6/21/83	6/22/83					

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TABLE III-23 Annual Dose Rates from Important Significant Sources of Radiation Exposure in United States*

Source	Exposed Group: Description	No. Exposed	Body Portion Exposed	Average Dose Rate, mrems/yr: Exposed Group	Prorated over Total Population
Natural background					
Cosmic radiation	Total population	220×10^6	Whole body	28	28
Terrestrial radiation	Total population	220×10^6	Whole body	26	26
Internal Sources	Total population	220×10^6	Gonads	28	28
			Bone marrow	24	24
Medical x rays					
Medical diagnosis	Adult patients	105×10^6/yr	Bone marrow	103	77
Medical personnel	Occupational	195,000	Whole body	300-350[a]	0.3
Dental diagnosis	Adult patients	105×10^6/yr	Bone marrow	3	1.4
Dental personnel	Occupational	171,000	Whole body	50-125[a]	0.05
Radiopharmaceuticals					
Medical diagnosis	Patients	10×10^6 to 12×10^6/yr	Bone marrow	300	13.6
Medical personnel	Occupational	100,000	Whole body	260-350	0.1
Atmospheric weapons tests	Total population	220×10^6	Whole body	4-5	4-5
Nuclear industry					
Commercial nuclear power plants (effluent releases)	Population within 10 mi	$< 10 \times 10^6$	Whole body	$\ll 10$	$\ll 1$
Commercial nuclear power plants (occupational)	Workers	67,000	Whole body	400[b]	0.1
Industrial radiography (occupational)	Workers	11,250	Whole body	320	0.02
Fuel processing and fabrication (occupational)	Workers	11,250	Whole body	160	0.01
Handling byproduct materials (occupational)	Workers	3,500	Whole body	350	0.01
Federal contractors (occupational)	Workers	88,500	Whole body	~250	0.1
Naval nuclear propulsion program (occupational)	Workers	36,000	Whole body	220	0.04
Research activities					
Particle accelerators (occupational)	Workers	10,000	Whole body	Unknown	$\ll 1$
X-ray diffraction units (occupational)	Workers	10,000-20,000	Extremities and whole body	Unknown	$\ll 1$
Electron microscopes (occupational)	Workers	4,400	Whole body	50-200	0.003
Neutron generators (occupational)	Workers	1,000-2,000	Whole body	Unknown	$\ll 1$
Consumer products					
Building materials	Population in brick and masonry buildings	110×10^6	Whole body	7	3-4
Television receivers	Viewing populations	100×10^6	Gonads	0.2-1.5	0.5
Miscellaneous					
Airline travel (cosmic radiation)	Passengers[c]	35×10^6	Whole body	3	0.5
	Crew members and flight attendants	40,000	Whole body	160	0.03
Airline transport of radioactive materials	Passengers[d]	7×10^6	Whole body	~0.3	0.01
	Crew members and flight attendants	40,000	Whole body	~3	<0.001

[a] Based on personnel dosimeter readings; because of relatively low energy of medical x rays, actual whole-body doses are probably less.

[b] Average dose rate to the approximately 40,000 workers who received measurable exposures was 600-800 mrems/yr.

[c] Total number of revenue passengers per year is 210×10^6; however, many of these are repeat airline travelers.

[d] About one in every 30 airline flights includes the transportation of radioactive materials; assuming 210×10^6 passengers per year (total), approximately 7×10^6 would be on flights carrying radioactive materials.

*From "The Effects on Population of Exposure to Low Levels of Ionizing Radiation: 1980," National Academy of Sciences (BEIR III).

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NRC STAFF RESPONSE TO SPECIFIC ISSUES RAISED
IN A PAPER ENTITLED "SUMMARY OF MEDICAL EVIDENCE"*

Issue #1

Although there have been accounts, affidavits and stories by area residents about the physical harm that has occurred, possibly as a result of the accident at TMI Unit 2 during March of 1979, these allegations have not been taken seriously by the state. Other people have taken them seriously and have done studies to investigate their validity.

Response

Although the NRC cannot respond for the regulatory bodies of the Commonwealth of Pennsylvania, NRC has taken these and similar allegations seriously. For example, a study entitled "Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station," NUREG-0558 (provided as Enclosure 3 of our letter), was performed shortly after the accident to assess the overall impact. This study documents the analysis of the doses to individuals and the population in the vicinity of Three Mile Island. The authors of this report included employees of four Federal agencies concerned with the regulation of radioactive materials. Their principal conclusion was "that the offsite collective dose associated with radioactive material released during the period of March 28 to April 7, 1979 represents minimal risks (that is, a very small number) of additional health effects to the offsite population."

The NRC staff has also investigated reports of physical harm to plants and animals, which are reported in: "Investigations of Reported Plant and Animal Health Effects in the Three Mile Island area," NUREG-0738 (provided as Enclosure 4 of our letter). These investigations were conducted by scientists from the NRC, the Pennsylvania Department of Agriculture, Argonne National

*A 6 page undated paper, author anonymous.

Laboratory, and the U. S. Environmental Protection Agency. Their conclusion was that "while in some instances not enough data were available for a detailed evaluation to be made, none of the reported problems could be linked to TMI and no general pattern of effects could be seen."

Issue #2

A book entitled Killing Our Own, written by Harvey Wasserman and Norman Solomon (Dell, 1982), describes some of the problems that TMI area residents have faced since the 1979 accident. The last three chapters are titled "How Much Radiation?," "Animals Died at Three Mile Island" and "People Died at Three Mile Island." Excerpting from Chapter 13:

> First and foremost, the utility, the NRC and the industry strove to minimize the public impression of how much radiation had escaped at Three Mile Island, and how dangerous it might be.

Response

The NRC staff is aware of the book entitled "Killing Our Own." This book has been reviewed by H. Kocol, a Health Physicist with the Food and Drug Administration, in an article published in the "Health Physics Society Newsletter," March, 1983 (Attachment A to Enclosure 2). The Health Physics Society is a respected and recognized scientific organization dedicated to the protection of man and the environment from the harmful effects of radiation, while encouraging its optimum utilization for the benefit of mankind. Kocol's main critiques of this book include such observations as:

1. "Anecdotal reporting, the use of inflammatory language, selection only of that literature that supports the conclusions of the authors, a complete disregard of the science of statistics, and sensationalism pervade the entire text,"

2. "A lay person could be very easily impressed by the raft of cases cited and by the "scientific studies" selected for citation. Few, if any, lay persons would be aware of the many scientific studies and criticisms which refute the cited works. It is obvious that the authors have studied the literature extensively; therefore, the authors seem to have consciously decided not to use the overwhelming literature which refutes their particular conclusions."

3. "The reader looks almost in vain through the index for citations of known authorities in the field of radiation safety."

4. "In summary, this is a very difficult book for a health physicist to read, but it will probably be purchased by many lay persons who lacking substantive contradictory information, will accept the authors' conclusions. It is unfortunate that the public is being taught to look for conspiracies, to accept emotional arguments, and to accept what "investigative reporters" say in print as truth."

Our review of this book leads us to a similar conclusion that Killing Our Own is not a reliable source of information.

Issue #3

From Chapter 12:

> On April 12, for example, in the midst of the crisis, an NRC official named Lake Barrett conceded that monitors in the plant stacks "did not provide accurate readings of absolute quantities of radioactivity released during the accident." High radiation levels, said Barrett, had driven monitors "off scale" and rendered them useless."

In June, Albert Gibson, a radiation support section chief who co-authored the NRC's final report on TMI emissions confirmed the problem. Testifying in front of the five NRC Commissioners, Gibson said "All the radiation monitors in this vent stack, where as much as 80% of the radiation escaped, went off scale, the morning of the accident. The stack monitors had been essentially useless during and after the accident."

Response

Although the main stack monitor did not provide accurate measurements of the quantities of radioactivity released during the accident, the quantity of radioactive material released from the stack was inferred from the response of another radiation monitor located near the stack. Thus, groups investigating the accident were able to quantify the release and use this to estimate the resulting dose to the general public. It is also important to note that there were many other types of radiation detection devices in the vicinity of Three Mile Island that also provided reliable information. For example, Metropolitan Edison had thermoluminescent dosimeters (TLDs) at a total of 20 onsite and offsite locations (see NUREG-0558, pp. 12-29). The TLDs monitored continuously the direct radiation from the radioactive materials released from Three Mile Island during the accident. Consequently, it was possible to establish maximum potential doses received by individuals and the population in the vicinity of Three Mile Island.

Issue #4

In Chapter 13, "Animals Died at Three Mile Island," Dr. Robert Weber went before a hearing of the Public Utilities Commission in March of 1980 and gave public testimony on the accident. Also included is an interview with Dr. Weber by the Japanese research team.

Response

As indicated in our response to Issue #1, NRC scientists have investigated reports of physical harm to plants and animals. The results of those investigations are contained in a report entitled "Investigations of Reported Plant

and Animal Health Effects in the Three Mile Island Area" (NUREG-0738). The principal conclusion of NUREG-0738 was that "while in some instances not enough data were available for a detailed evaluation to be made, none of the reported problems could be linked to TMI and no general pattern of effects could be seen."

Issue #5

In Chapter 14, "People Died at Three Mile Island," there is a discussion about Gordon MacLeod, Secretary of Health during the accident. Dr. MacLeod was fired eight months after the accident. The state media characterized MacLeod's firing "State government's harshest critic of the way the Thornburgh administration responded to the Three Mile Island accident, and that may have been why he was fired." Quoting from the book:

> MacLeod's problems with Thornburgh had begun on March 29, the day after news of radioactive releases from TMI began to spread. MacLeod had, in his words, "Recommended, and on the next day urged the governor, in the strongest possible terms, to call for departure of pregnant women and young children from an area within five miles of Three Mile Island." MacLeod told us later that if he had a chance to do it over he would have urged the departure of children in puberty, who are also extraordinarily radiation sensitive.

Response

It would not be proper for the NRC to respond to this comment concerning the reasons for the alleged firing of Gordon MacLeod by the Commonwealth of Pennsylvania.

Issue #6

Included are some studies published by Dr. MacLeod. One is Some Public Health Lessons From Three Mile Island: A Case Study in Chaos (Ambio, Royal Swedish Academy of Sciences.) Quoting from the summary of the study:

> The inadequacy of reactor design, safety controls, and manpower training were not the only problems to surface in the wake of Three Mile Island. Dr. MacLeod argues that Pennsylvania's public health sector was, and still is, woefully unprepared for a nuclear accident. Furthermore, throughout the crisis decisions affecting the public health were made by engineers and physicists instead of physicians. The author points out the changing patterns of hyperthyroidism before and after the accident, with a tenfold increase immediately downwind of two reactor sites in Pennsylvania's Lancaster County. He calls for physicians specializing in radiation medicine to join together with nuclear physicists and engineers in setting up more stringent public health safeguards to deal with future reactor accidents.

Other papers by Dr. MacLeod include Medical Ethics in the Nuclear Age and A Role For Public Health in the Nuclear Age (American Journal of Public Health, March 1982, Vol. 2, No. 3).

Response

Regarding the statement that there was a tenfold increase in hyperthyroidism downwind of the site following the accident and that this was due to the accident, the NRC staff has not seen any scientific data that would support this statement. Regarding the need for more stringent public health safeguards, it should be noted that the NRC, in coordination with the Federal Emergency Management Agency, has placed new requirements on licensees concerning emergency planning. These new requirements are contained in the NRC regulations (10 CFR Part 50, Appendix E).

Regarding the preparedness of the Commonwealth of Pennsylvania for the accident at Three Mile Island, the President's Commission On The Accident At Three Mile Island (p. 39) found that:

> "At all levels of government, planning for the off-site consequences of radiological emergencies at nuclear power plants has been characterized by a lack of coordination and urgency. For example, a federal response plan in preparation since 1974 by federal emergency preparedness agencies

was unfinished at the time of the accident because of an interagency jurisdictional dispute and lack of communication. Pennsylvania did not begin to develop a radiological emergency plan until 1975, even though nuclear power plants had been operating within its borders for at least a year prior to that time."

In regard to the Commonwealth of Pennsylvania's preparedness today for the Three Mile Island area, it should be noted that this issue is currently under consideration in the context of the TMI-1 restart hearing. The NRC Commission will have to make a finding regarding the adequacy of the emergency preparedness of the licensee, the State and local authorities.

Issue #7

Another controversy that arose concerned the Pennsylvania Department of Health studies lead by Dr. George Tokohata. Again, Chapter 14 deals quite extensively with the discrepancy between Dr. Tokohata's actual findings and what the press releases were reporting.

Response

Based on the NRC staff's interaction with Dr. Tokohata, we have found him to be a reliable source of information, who bases his findings on scientific principles and reliable data.

Issue #8

Dr. Bruce Muhlholt, a biogeneticist with the Environmental Cancer Prevention Center in Philadelphia, now teaching at Haverford University, conducted a study on Biological Effects of the Accident at Three Mile Island. He presented this testimony at the U. S. NRC TMI Restart Hearings in Harrisburg, March 16, 1981. Quoting from his study:

> The GPU Emergency Plan thus attempts to lull the public into a false sense of security that they are being protected above and beyond those radiation protection guidelines set by the EPA. In fact, the truth is the opposite. The GPU Emergency Plan misrepresents the sense of EPA GHPHEs and based its "extra measure of public protection" upon this distorted interpretation. Furthermore, in failing to put any potential releases of radionuclides to the public residing near Three Mile Island into the context of the accident at TMI-2, the GPU Emergency Plan overlooks the cumulative nature of radiation-induced carcinogenic and mutagenic damage to the public.

Response

The NRC requires reactor licensees to develop a capability to respond to releases of radioactive materials to the environment, in terms of identifying the releases, and projecting possible doses to members of the public, and taking appropriate action to limit doses following the release. See Issues 1, 2, 3, 7, 9 and 13 regarding public doses due to the TMI accident. This issue is currently under consideration in the context of the TMI-1 restart hearing.

Issue #9

In 1982 the Japanese research team interviewed over 200 people who said they

experienced a strange taste in the mouth after the accident, who smelled an odor like burnt metal, who had dryness of the mouth and throat, or sunburn-like sensations on their skin. Some people claimed they had tearing and irritation of the eyes, tightness of breath, or nausea and diarrhea.

Response

None of these symptoms has been directly associated with radiation exposure at the dose levels estimated to have resulted from the Three Mile Island accident. Some of the symptoms described (such as gastrointestinal disorders and skin reddening) have been found to be associated with exposures to ionizing radiation thousands of times greater than the doses estimated to have been received by those individuals living adjacent to the Three Mile Island Nuclear Station. Chapter 9 of a book by A. Casarett, Radiation Biology (Prentice-Hall, 1968), which is available in technical libraries, describes these effects resulting from severe radiation exposure.

With respect to reports of the metallic or iodine-like taste, the technical literature cites no evidence that people can sense the presence of ionizing radiation or radioactive materials at levels below those that would produce observable biological damage.

In addition to previously cited NRC studies of the health impact from the accident at Three Mile Island, the President's Commission thoroughly investigated the accident at Three Mile Island. Regarding health impact, the Commission concluded that "The major health effect of the accident appears to have been on the mental health of the people living in the region of Three Mile Island and of the workers at TMI. There was immediate, short-lived

mental distress produced by the accident among certain groups of the general population living within 20 miles of TMI." (Report of the President's Commission On The Accident At Three Mile Island, October, 1979, p. 35).

Issue #10

Quoting from the forthcoming book, Three Mile Island Revisited:

> In addition to people's own experience during the days of the accident, there were a number of sudden deaths of adult animals, and a rush of stillbirths and newborn deaths among the domestic animals in the vicinity of the plant. Then, through the following months, hundreds of cats died from unknown illnesses, and now, three and one half years after running into stillbirths and C-sections, a local veterinarian is witnessing a three-fold increase in cancer cases of pets and livestock.

The Katagiris ask why have these episodes not been taken up by or caught by the interest of the country's medical and health experts? Is this another case of the traditional coverup? or is there a built in insensitivity in today's health sciences, whose highly systemitized methodology is too alien for such bizarre local episodes?

Response

Such episodes of animal and plant distress, when made known to authorities, were investigated as indicated in our response to Issue #1. In particular, pages 19 to 26 of NUREG-0738 describe and evaluate specific cases that were investigated by the NRC.

Issue #11

The Katigiris continue:

> There is, however, one well ascertained fact: A standard argument pervades and is openly spoken about within the American scientific establishment. The argument goes as follows: The local farmers' and the veterinarians' allegations were scientifically discredited and claims of symptoms by humans should be considered, rather in the realm of psychology. This is a perversion worthy of extensive socioclinical study, for there is an apparent pathological complexity involved here. Scientists have even failed to consider atmospheric phenomena, which many local people observed, and which would logically have been expected to occur due to the radioactive releases.

Response

See responses to Issues #1 and 9 for some of the evidence that disputes the authors claims. In addition, the NRC staff, which includes meteorologists and radiation biologists, is not aware of any scientifically valid studies indicating changes in weather patterns resulting from nuclear radiation, even at high dose levels.

Issue #12

Included is one of those interviews from Three Mile Island Revisited. It is about Becky Meese who is a 32 year old nurse who lives in Middletown with her husband and 4 year old daughter, Pam, who has been diagnosed as having cataracts in both eyes.

A summary of the Katagiri research states that:

1. Hundreds of people experienced a strong metallic taste in their mouths. Some people noticed that the air seemed very heavy, and their voices sounded flat.

2. Dryness of the mouth and throat was experienced; often soreness and burning sensation; persistent thirst.

3. Hot sensations of the skin, particularly on the face and arms, often resulting in a "sunburn."

4. Irritation of the eyes, burning and tearing.

5. Tight chest, shortness of breath, burning in lungs.

6. Nausea and sometimes vomiting. Anxious feeling in the stomach.

7. Diarrhea that persisted in some cases for weeks and months.

8. An area nurse who became very ill after the accident has had recu splotching of the skin and burning of her cheeks and nostrils. T 45 recurring outbreaks correlate exactly with radiation venting l admitted by GPU.

9. Two dentists practicing in Lewisberry Township, on the west shore the river across from TMI, noticed a fogging or banding of x-ray f exposed on Wednesday, March 28, 1979 and Thursday, March 29, 1979. from the same batch exposed before the accident was normal. Neither dentist knew of the accident until Thursday night, March 29.

10. One physician in Goldsboro reports a pronounced increase in leukemia and lymphoma starting about one year after the accident.

11. One physician in New Cumberland reports increases in underactive thyroids, rashes and other dermatological problems, and two and one half years after the accident observed a doubling of colon cancer.

Response

Regarding health impacts on humans, see responses to Issues #1 and 9. With respect to fogging of x-ray films, the Bureau of Radiological Health of the U. S. Public Health Service analyzed photographic film collected from shops in the vicinity of Three Mile Island. The results of their study were published in FDA Publication 81-8142 and in an article entitled "Use of Photographic Film to Estimate Exposure Near TMI," Health Physics, 41, pp. 195-199 1981 (Attachment B of Enclosure 2). Their principal conclusion was:

> "This study while not sensitive enough to establish the actual exposures, rules out exposures much larger than those predicted by the Ad Hoc Group [i.e., NUREG-0558] and corroborates their predictions for our film sites."

Issue #13

In a 2 page synopsis of the Katagiri findings, the Three Mile Island Public Research Center concludes with the following quote:

> The government refuses to acknowledge the tremendous cost of this accident in human suffering when the truth is that the death toll is mounting and the agony of these diseases have human faces and names. They are our friends and families.

David Burger, attorney with Burger & Montague, Philadelphia, has won a $25-million class action suit against General Public Utilities. Included in the suit was a $5-million public health fund, intended to benefit the people within a 25-mile radius of TMI. Mr. Burger has assembled some of the world's most eminent minds on radiation. On March 28-30, 1983, he held a public forum on nuclear power in Middletown. Citizens met with this eminent group of people, chaired by Dr. Karl Z. Morgan, Arthur Upton of NYU, Hiro Kato of Hiroshima, Dr. Dean Abrahmson, Dr. Edward Radford, Ian McHarg, Frank Von Hipple, Jan Beyes, George Woodwell, and others. The forum participants were asked to conduct a longitudinal biomedical health study on the people who were within the 10-mile radius at the time of the accident. They were also asked to conduct a public health study of the workers at TMI since its opening in 1974; to fund the Katagiri project and to devote the health fund's millions only to the study of problems of those in the TMI area.

Area citizens are asking the news media to look into these issues, to call these eminent professors, study the questions, and learn if there really is a big story here...

Response

As described in the preceding responses, scientists from the NRC, as well as other Federal agencies, and national laboratories have analyzed and reported the potential health impact of the accident at Three Mile Island. We have concluded that the maximum dose that was received by an individual located offsite in a populated area was less than 100 mrems. The average dose to an individual within 10 miles of the site was estimated to be about 8 mrems, and the average dose received by individuals within 50 miles of Three Mile Island was approximately 2 mrems. Similar estimates were made in the Report of the President's Commission On The Accident At Three Mile Island (October 1979, pp. 34, 35), and in an NRC Special Inquiry Group's study (Three Mile Island, A Report To The Commissioners And To The Public, Volume II, Part 2, M. Rogovin and G. T. Frampton, Jr., pp. 398 ff). Based on our analysis of these doses, there would be no acute effects in this population due to radiation exposures. We have estimated that exposure to radioactivity released from the accident could result in less than one cancer death over the remaining lifetimes of the population within 50 miles of the Three Mile Island nuclear station. This potential cancer death would be indistinguishable from cancer due to other causes, and would be completely masked by the natural incidence (which normally accounts for about 20% of all deaths) of about 440,000 cancer deaths expected to occur in the population of about 2.2 million.

Book Reviews

Killing Our Own. Harvey Wasserman and Norman Solomon. Delta. New York. 1982. $12.95 (paperback).

Unfortunately, space does not permit a full review of this book. To separate fact from half-truths from innuendo and to correct all the misconceptions and errors of science would encompass more pages than the book contains. Therefore, this review can only be a broad criticism of the content.

The content of this book raises the alarming possibility that the publicly available collection of misinformation on this subject may be approaching a critical mass. The jacket indicates that the two authors are "investigative reporters." As such, this book is an indictment of investigative reporting; the book can be a script for an exceedingly long segment of any one of several popular investigative television shows. Anecdotal reporting, the use of inflammatory language, selection only of that literature that supports the conclusions of the authors, a complete disregard of the science of statistics, and sensationalism pervade the entire text.

Anecdotal reports of "victims" of supposed "misuse" of radiation abound. A lay reader would be led to believe that there were thousands of such "victims" for each one quoted in the text. Some of the people interviewed undoubtedly suffered serious illnesses; however, in a great majority of the cases, the only direct link of the illness to radiation is the victim's own statement that the illness must be attributable to radiation. The victim may be enlisted in the Armed Forces, a farmer, a housewife, or a skilled tradesperson; the very fact of illness seems to make the person an expert on radiation effects.

(Continued)

A lay person could be very easily impressed by the raft of cases cited and by the "scientific studies" selected for citation. Few, if any, lay persons would be aware of the many scientific studies and criticisms which refute the cited works. It is obvious that the authors have studied the literature extensively; therefore, the authors seem to have consciously decided not to use the overwhelming literature which refutes their particular conclusions.

This is an extremely difficult book for an aware person to read. With almost every paragraph, the temptation is to point out the errors in science, statistics, and conclusions, but there is no one with whom to speak. The authors are not available for rebuttal. Stress accrues rapidly.

An appendix lists "Organizations," presumably for the use of the reader to receive further information. Organizations listed are such as: Union of Concerned Scientists, Committee for Nuclear Responsibility, Nevada Test Site Radiation Victims Association, SANE, and Critical Mass Energy Project. Unlisted are: Health Physics Society, American Nuclear Society, Atomic Industrial Forum, American Physical Society, American Association of Physicists in Medicine, or any other professional association of knowledgeable individuals.

The reader looks almost in vain through the index for citations of known authorities in the field of radiation safety. The names of Cohen, Fabrikant, Hull, Maxey, Taylor, Yalow, and others are totally missing from the index, although some are mentioned in the text. The index does list names such as Caldicott, Commoner, Gofman, Sternglass, and Tamplin.

There are many examples of inflammatory language, for example, calling the incidence of four leukemia cases "when one would be expected" an epidemic; to the lay audience, at whom this book is aimed, an "epidemic" means everyone is dropping like flies. Words and phrases such as "iodine-131 in milk ... reaching dangerous levels" without listing the actual level, "abnormal" without specifying normality, "possibly hazardous" without listing any of the assumptions upon which the possibility is based nor specifying the hazard implied, "dangerous levels" without stating the numbers that define dangerous, and the "devastating effect" of radioactive iodine on the thyroid making no distinction of the level of radioactivity involved.

An interesting exercise related to scanning the index can be performed by checking for references to various diseases: "Cancer, See Radiation"; "Genetic Defects, See Radiation"; "Leukemia, See Radiation"; "Lymphoma, See Radiation"; "Multiple Myeloma, See Radiation"; "Myelofibrosis, See Radiation"; etc. The indication is that all these diseases are created by radiation and radiation alone.

The Health Physics Society is wrongly criticized. The authors state that when dosimetry problems were determined, "the response by the Health Physics Society, which sets monitoring standards, however, was not to improve the technology—but rather to relax the dosimetry standards, making it easier for the industry to pass future tests." A lay person reading such a statement would not understand that the Health Physics Society is not a technology-improving organization, but, in this area, can only determine what is the current state of the art.

Ad hominem arguments also abound. The National Academy of Sciences is denigrated as "an institution with long standing and harmonious ties to governmental nuclear interests" in order to explain away any of the Academy's disagreement with the authors' conclusions. Bernard Cohen is remarked to have "one of the most active scientific imaginations on the nuclear scene", the remark is not meant to be complimentary. Thomas Gerusky, Margaret Reilly, and George Tokuhata, all "would later become key figures in defending the nuclear industry at Three Mile Island." TLD readings at Three Mile Island are supposed to be in dispute because the two companies which supplied the service "had clear financial interests in defending atomic power." By such arguments, the authors instruct the reader to disregard all studies whose conclusions disagree with their own.

Of course, the authors completely disregard the fluctuations in natural background and also the radiation fluctuations due to normal activities (living at higher altitudes, natural radon in drinking water, choice of construction material, etc.) because all studies of populations with such differences of radiation doses do not show the biological effects that the authors purport exist under very low level radiation exposures (even less than background fluctuations). The authors also, predictably, try to make an issue that no one knows "precisely" the amount of radioactivity released at Three Mile Island; the authors, however, disregard all studies, such as those to determine the fogging of photographic film stored in the area, which support the population doses calculated by all competent authorities.

In summary, this is a very difficult book for a health physicist to read, but it will probably be purchased by many lay persons who, lacking substantive contradictory information, will accept the authors' conclusions. It is unfortunate that the public is being taught to look for conspiracies, to accept emotional arguments, and to accept what "investigative reporters" say in print as truth. Any success of this book will be further evidence for the scientific illiteracy of the American population, as feared by educational experts. The publisher obviously does not know any better because this book is listed for the purposes of classification in book stores as Current Affairs Science, instead of Fantasy.

The frightening aspect of such a book is that it will be read and accepted by people who have no access to contradictory information. This book is, of course, only the latest in a long line of such misinformational materials. It is obvious that the professions involved in radiation safety need authors who can write for the mass market and who will communicate proper perspectives to the public on this issue. If we professionals communicate only with each other and only through scientific journals and meetings, the public cannot be blamed entirely for purchasing and believing uncritically the content of this type of book. We will share the guilt for "Misinforming Our Own."

Hank Kocol

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Committee Activities

EDUCATION AND TRAINING

Summary Report: Audio-Visual Aids Preview Session at the 1982 Annual Meeting in Las Vegas

The Education and Training Committee sponsored an Audio-Visual Aids Preview Session at the 1982 Annual Meeting in Las Vegas. A summary of the programs shown and the comments by attendees is provided in the accompanying table.

A lay person could be very easily impressed by the raft of cases cited and by the "scientific studies" selected for citation. Few, if any, lay persons would be aware of the many scientific studies and criticisms which refute the cited works. It is obvious that the authors have studied the literature extensively; therefore, the authors seem to have consciously decided not to use the overwhelming literature which refutes their particular conclusions.

This is an extremely difficult book for an aware person to read. With almost every paragraph, the temptation is to point out the errors in science, statistics, and conclusions, but there is no one with whom to speak. The authors are not available for rebuttal. Stress accrues rapidly.

An appendix lists "Organizations," presumably for the use of the reader to receive further information. Organizations listed are such as: Union of Concerned Scientists, Committee for Nuclear Responsibility, Nevada Test Site Radiation Victims Association, SANE, and Critical Mass Energy Project. Unlisted are: Health Physics Society, American Nuclear Society, Atomic Industrial Forum, American Physical Society, American Association of Physicists in Medicine, or any other professional association of knowledgeable individuals.

The reader looks almost in vain through the index for citations of known authorities in the field of radiation safety. The names of Cohen, Fabrikant, Hull, Maxey, Taylor, Yalow, and others are totally missing from the index, although some are mentioned in the text. The index does list names such as Caldicott, Commoner, Gofman, Sternglass, and Tamplin.

There are many examples of inflammatory language, for example, calling the incidence of four leukemia cases "when one would be expected" an epidemic; to the lay audience, at whom this book is aimed, an "epidemic" means everyone is dropping like flies. Words and phrases such as "iodine-131 in milk . . . reaching dangerous levels" without listing the actual level, "abnormal" without specifying normality, "possibly hazardous" without listing any of the assumptions upon which the possibility is based nor specifying the hazard implied, "dangerous levels" without stating the numbers that define dangerous, and the "devastating effect" of radioactive iodine on the thyroid making no distinction of the level of radioactivity involved.

An interesting exercise related to scanning the index can be performed by checking for references to various diseases: "Cancer, See Radiation"; "Genetic Defects, See Radiation"; "Leukemia, See Radiation"; "Lymphoma, See Radiation"; "Multiple Myeloma, See Radiation"; "Myelofibrosis, See Radiation"; etc. The indication is that all these diseases are created by radiation and radiation alone.

The Health Physics Society is wrongly criticized. The authors state that when dosimetry problems were determined, "the response by the Health Physics Society, which sets monitoring standards, however, was not to improve the technology—but rather to relax the dosimetry standards, making it easier for the industry to pass future tests." A lay person reading such a statement would not understand that the Health Physics Society is not a technology-improving organization, but, in this area, can only determine what is the current state of the art.

Ad hominem arguments also abound. The National Academy of Sciences is denigrated as "an institution with long standing and harmonious ties to governmental nuclear interests" in order to explain away any of the Academy's disagreement with the authors' conclusions. Bernard Cohen is remarked to have "one of the most active scientific imaginations on the nuclear scene"; the remark is not meant to be complimentary. Thomas Gerusky, Margaret Reilly, and George Tokuhata all "would later become key figures in defending the nuclear industry at Three Mile Island." TLD readings at Three Mile Island are supposed to be in disrepute because the two companies which supplied the service "had clear financial interests in defending atomic power." By such arguments, the authors instruct the reader to disregard all studies whose conclusions disagree with their own.

Of course, the authors completely disregard the fluctuations in natural background and also the radiation fluctuations due to normal activities (living at higher altitudes, natural radon in drinking water, choice of construction material, etc.) because all studies of populations with such differences of radiation doses do not show the biological effects that the authors purport exist under very low level radiation exposures (even less than background fluctuations). The authors also, predictably, try to make an issue that no one knows "precisely" the amount of radioactivity released at Three Mile Island; the authors, however, disregard all studies, such as those to determine the fogging of photographic film stored in the area, which support the population doses calculated by all competent authorities.

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Inclusion of the adjoining walkway and control building entrainment and thus additional dilution could reduce the calculated concentrations a factor of ~2. This further calculation is significantly more difficult to conceptualize.

The purpose of these calculations and measurements was to ensure compliance with USNRC requirements for air concentrations in unrestricted areas. Therefore, local meteorological data were assimilated to average the dilutions factors for 1 yr. For an anticipated monthly release rate of 10 Ci/month, the calculated concentrations were less than 1% of the MPC (air). The measured concentrations and comparisons with predicted values supports the conservativeness of employing these yearly averaged dilution factors.

Acknowledgements—We would like to express our appreciation of the assistance of Eric Kearsley, Medical Physics Section, Dept. of Radiology, University of Wisconsin-Madison, in several phases of the sample collection and analysis.

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*Although Kodacolor 400 displays relatively high sensitivity to X- and γ-radiation, the manufacturer advises that this film is not designed for radiation dosimetry purposes, is not tested routinely or controlled for this property, and will not necessarily continue to have the same radiation response found in this study.

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Use of Photographic Film to Estimate Exposure Near TMI

(*Received* 7 *November* 1980; *accepted* 13 *November* 1980)

Introduction

FOLLOWING the 28 March 1979, incident at the Three Mile Island Nuclear Power Station (TMI), the Bureau of Radiological Health (BRH) purchased photographic film from five shops in Pennsylvania (PA) near TMI and used it to obtain an independent estimate of the radiation exposure levels resulting from the incident. Kodak Kodacolor 400* film was chosen because it was sensitive to the expected radiation levels, was available in nearby communities, and samples were likely to have been in place during the initial days of the incident.

Photographic film, although in general designed to respond to light, is also sensitive to the thermal environment and ionizing radiation. Heat and humidity increase the rate of fog growth, which is a highly nonlinear function of temperature, while storage at 0°F almost eliminates thermal fog. Fog growth from exposure to ionizing radiation is cumulative and linear, at least for small values of developed density. Exposure to manmade radiation

may be evaluated by comparing a film's fog density increase to that of films having similar environmental temperature and natural background radiation exposure histories. The processed film may also be examined for any density patterns resulting from attenuation of radiation by the film cassette, spool core, external packaging, the film roll itself, and surrounding materials. These density increases and patterns would be compared to those on films exposed to known amounts of radiation under geometric conditions simulating those of the expected irradiation. Both approaches were attempted in this study.

Where available, six rolls of Kodak Kodacolor 400 35 mm film (CG135) with "develop before" dates from September 1979 to January 1980 were purchased on 2 May 1979, from five shops in PA within 10 miles of TMI. Films used near their "develop before" date may have elevated fog levels due to thermal effects and natural background radiation, while films dated much beyond January 1980 were not likely to have been on the shelf during the incident. Films also were collected from Rockville and Frederick MD to provide an indication of the fog levels resulting from environmental effects (thermal fog and natural background radiation).

The PA films may have been exposed to radioactive gases, principally ^{133}Xe. Average yearly environmental radiation exposure estimates (Go79) for the PA, MD and Rochester areas indicate similar background radiation levels. Hence, any significant fog difference between the MD and PA samples in excess of 0°F controls should be due to thermal effects and to radiation exposure other than background. If the thermal histories of the MD and PA films are similar, TMI emissions could account for fog level differences.

All films were processed in Rochester NY (three rolls from each site on 9 May, the remainder on 17 May) under carefully controlled commercial processing conditions by the Kodak Park Division, Eastman Kodak Co. Kodak provided samples stored at 0°F for films collected in PA and for most of those from MD. The 0°F films were used as a basis for estimating any increase in fog associated with radiation exposure from TMI. This approach, which assumed that none of the observed density increase is due to thermal fog, overestimated exposure received by the PA films since their thermal history cannot be reconstructed but did exceed 0°F.

To simulate exposure of the PA films, Kodacolor 400 films in their original packaging were positioned in the center of the floor of an 8 m^3 plastic-walled chamber located at BRHs Cincinnati Nuclear Medicine Laboratory and irradiated with known quantities of ^{133}Xe gas. Independently of this study, Frazier (Fr79) evaluated by calculation and TLD measurements the X- and γ-ray exposure from ^{133}Xe at the center of the chamber floor. ^{133}Xe exposures are for the X- and γ-ray component incident on the exterior of the manufacturer's packaging (a paper box, a plastic humidity-proof container, and an 0.28-mm-thick steel cassette).

For all processes done by Kodak, the densities of the process control films (both BRH X-ray films and Kodak sensitometric strips) were identical within the precision of the densitometer, so there was no significant error due to processing.

Results

Film response curves for Kodak Kodacolor 400 film (Fig. 1) show net blue diffuse optical density vs exposure for ^{133}Xe X- and γ-radiation (distributed and point sources), radium γ-rays, and 100 kVcp X-radiation. (The blue layer is more responsive to ionizing radiation than the green or red layers.) Base plus fog values were obtained from unexposed film of the same batch. These curves apply only to film in the 35-mm cassette format because attenuation of radiation by the cassette and packaging results in less exposure to the film itself than indicated. Net density increases linearly with exposure to a net density (ND) of about 0.2. The response per unit exposure (ND per mR) below 0.2 ND is about 0.006/mR for ^{133}Xe.

Unexposed Kodacolor 400 films were irradiated one at a time with the same quantity of radiation over a 2-month period. These were processed together and, measurements indicated no detectable fading for storage times of 1–59 days.

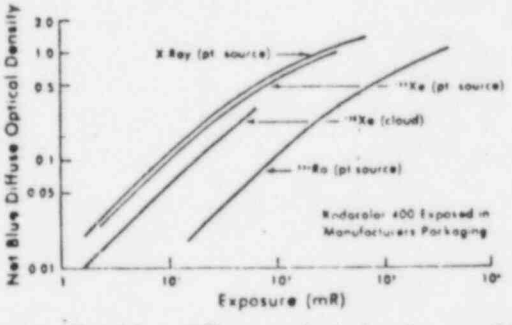

FIG. 1. Net blue diffuse optical density resulting from 100-kVcp X-radiation, ^{226}Ra γ-radiation, and ^{133}Xe gas (distributed and point sources) irradiation of the exterior of the Kodak Kodacolor 400 film packages.

Table 1. Blue diffuse net optical density (ND)[a] for Kodak Kodacolor 400 film samples obtined from PA near TMI and from MD

Pennsylvania Sites	Number of Samples	ND[a] ± 1σ	Emulsion #	"Develop Before" Date
Elizabethtown[b]	6	0.023 ±0.004	377	6/79
Middletown[c]	6	0.030 ±0.007	303	10/79
Manchester	5	0.016 ±0.011	316	12/79
New Cumberland	6	0.016 ±0.005	286	12/79
Steelton	6	0.016 ±0.006	327	1/80

Maryland Sites	Number of Samples	ND[a] ± 1σ	Emulsion #	"Develop Before" Date
RWh	2	0.120 ±0.004	294	8/79
RDD	4	0.054 ±0.011	306	9/79
FDD	3	0.033 ±0.003	308	9/79
RPk	1	0.035 --	286	12/79
FP	2	0.030 ±0.0	277	12/79
RDD	1	0.020 --	304	12/79
RDD	2	0.00 ±0.01	324	1/80
RMe	6	0.012 ±0.007	333	1/80

[a]ND is obtained by subtracting the gross density of unexposed 0°F control film from the gross density of the test film.
[b]This site is a photographic supply shop; the film when purchased was stored in a film refrigerator.
[c]This site was approximately 3.5 miles east of Middletown.

Fog Comparisons

Net density differences for the PA samples are presented in Table 1; the gross optical density of the 0°F sample supplied by Kodak was subtracted from the gross optical density of the PA sample. Results are arranged by decreasing film age; the largest density difference (0.035) was found for the Middletown samples. Table 1 also shows density differences for the MD films. A sample of emulsion No. 286 (the emulsion number of the film from New Cumberland PA) was also found in Rockville and had a fog level 0.02 OD higher than the average for the New Cumberland samples.

Density Patterns, Site Films

Scans of four MD samples are presented in Fig. 2(a). The net density values range from 0.01 to 0.12 OD greater than those of the 0°F samples provided by Kodak. Net density correlates well with age of sample; the oldest sample is designated RWh, and the youngest is RMe (Table 1). As the net density increases, complex patterns appear on the scans. Representative scans from the PA sites (two scans from Middletown) are presented in Fig. 2(b). One sample from Middletown (shown in Fig. 2b) seems to have a barely perceptible pattern with periodicity similar to the ^{133}Xe samples, while the patterns on the remainder of the Middletown samples appear normal for films having these net densities.

Density Patterns, Calibration Films

Figure 2(c) illustrates the periodic pattern produced when roll film is placed on its side on the chamber floor and irradiated (1.5–47.6 mR) with the cassett core parallel to the floor. Net densities for these films were measured on the peak amplitude at the tongue end of the film, but exclude the density spike often seen on the patterns. For 1.5 mR no cyclic pattern is apparent, while for 2.7 mR the cyclic pattern is observed but no spike is apparent. Note the distinct sinusoidal pattern and the periodic spikes produced with this geometry. The spikes result from ^{137}Cs X-rays, which pass through the cassette mouth, but are highly attenuated by the 0.28-mm-thick steel wall. The periods of these patterns differ slightly due to differences in film core winding tension.

To study a different orientation, nine samples were centered on the floor in a square array with their cores perpendicular to the floor. Kodacolor 400 films were placed in the center, on a corner, and in the center side of the array (Fig. 2c, film roll vertical). Instead of the regular periodic patterns seen previously, these scans show more complex patterns with smaller amplitudes and less prominent spikes.

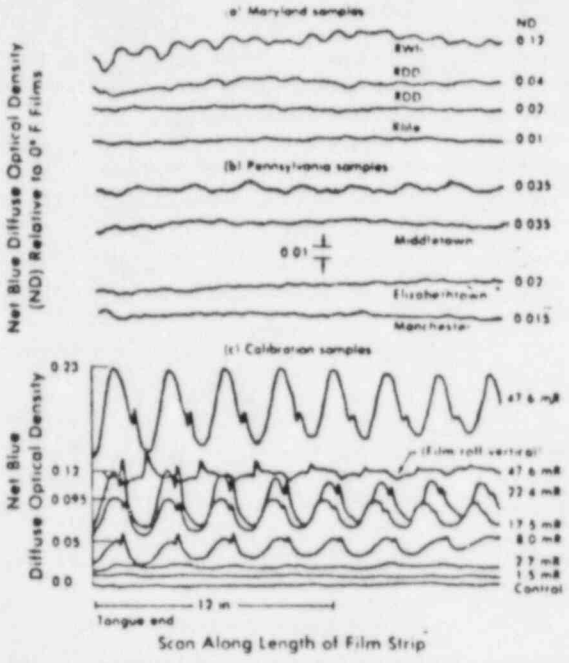

FIG. 2. Scans of films from PA near TMI and from Rockville and Frederick MD, illustrating the density trace patterns on films with net density values ranging from 0.01 to 0.12. The MD scans (2a) illustrate density traces from an area subject only to thermal effects and natural background radiation. Note the periodic pattern on sample RWh. Figure 2(b) shows representative PA scans. Two of the six Middletown scans are shown; the top scan is of the sample with a periodic pattern. Figure 2(c) shows scans of films exposed to 1.5–47.6 mR from a distributed source of ^{133}Xe while centered on the exposure chamber floor; the core of the film spool was parallel to the floor. The trace of an exposed control is included. Other samples were exposed to 47.5 mR simultaneously in a nine-package square array with the cassette cores oriented vertically (one scan is illustrated). The pattern is still periodic, but the amplitude and ND increases are smaller than with the horizontal core geometry.

Conclusion

No apparent difference was observed in net density levels of MD and PA samples of similar age. The observed net densities are fully explainable by thermal effects and, based on the similarity of measured net densities on films from these two areas, it is unlikely that any significant portion of the net density increase measured on the PA films is due to radiation. The MD films have (on the average) slightly higher net densities than those from PA, although (neglecting differences in thermal history) one would expect the same net density for the MD films due to the small difference in natural background radiation for these two areas.

One film of six from near Middletown had a barely perceptible periodic pattern similar to that observed on calibration films, but no patterns were observed on the remainder of the films from this town. (Note that patterns caused by natural processes were seen on control films with elevated fog levels.) These six PA films had ND values which were identical within densitometer precision. The average ND value was 0.3, corresponding to an exposure of 5 mR if all fog was due to radiation. (This entire density increase, however, could not be due to radiation.) Based on measured fog increase, radiation exposure much above background to any of the five PA locations can be ruled out. Five mR is a conservative upper estimate of exposure to any of these sites and is in agreement with predictions of the Ad Hoc Population Dose Assessment Group (Ad79). This study, while not sensitive enough to establish the actual exposures, rules out exposures much larger than those predicted by the Ad Hoc Group and corroborates their predictions for our film sites.

A more detailed report on the present study will be published by BRH.

Acknowledgements—I am indebted to personnel of Eastman Kodak Co. who graciously provided guidance, processing, and assistance in interpretation of the density patterns observed on the films. Special thanks also to Jerry Gels, Harley Piltingsrud, and John Frazier of the BRH for film dosimetry in this study.

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April 10, 1985

FREEDOM OF INFORMATION
ACT REQUEST

FOIA-85-285
rec'd 4/22/85

Director, Office of Administration
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Director:

Under the provisions of the Freedom of Information Act, 5 U.S.C. § 552, I am requesting access to records concerning the possible health effects on the local residents of the major nuclear accident which occurred on March 28, 1979, at the Three Mile Island (TMI) nuclear power station in Pennsylvania. Specifically, I am interested in data and studies on the changes in disease rates and other health-related problems among this population for a period of years before the accident and the six years since that event. For example, the types of information sought could include, but are not limited to, the disease rate for the common forms of cancer, the rates of miscarriages among women of childbearing ages, the rates of development abnormalities, and the rates of genetic defects both before and after the accident.

If there are any fees for copying, please fill the request if the charge does not exceed $25.00. However, if the fee is in excess of $25.00, please inform me of the amount of the total charge before completing the request.

Furthermore, if all or any part of this request for records is denied, please cite the specific exemption that justifies your refusal to release the information and inform me of the appeal procedures available to me under the law.

I would appreciate your handling this request as quickly as possible and look forward to hearing from you within ten working days as the law stipulates.

Sincerely,

Connie M. Lodge

Connie M. Lodge

CML/ljj

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