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THREE MILE ISLAND NUCLEAR PLANT ACCIDENT

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HEARING

BEFORE THE

SUBCOMMITTEE ON
NATURAL RESOURCES AND ENVIRONMENT

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

FIRST SESSION

JUNE 2, 1979

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THREE MILE ISLAND NUCLEAR PLANT ACCIDENT

SATURDAY, JUNE 2, 1979

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON NATURAL RESOURCES AND ENVIRONMENT,
Elizabethtown, Pa.

The subcommittee met, pursuant to notice, at 9:40 a.m. in the auditorium of the Elizabethtown College, Elizabethtown, Pa., Hon. Jerome A. Ambro (chairman of the subcommittee) presiding.

Mr. AMBRO. The subcommittee will please come to order.

We are a good 40 minutes late, so I think it is appropriate merely to move the entire agenda up 40 minutes, and we will try later on in the program to compress so the time constraints are met.

OPENING STATEMENT BY HON. JEROME A. AMBRO

The Subcommittee on Natural Resources and Environment, a subcommittee of the Committee on Science and Technology, meets today to conduct a hearing on the environmental and health effects of the accident at Three Mile Island II. This hearing proceeds under the jurisdiction of this subcommittee which is in the area of environmental and natural resources research and development, including those activities of the Environment Protection Agency, and environment, health, safety, life sciences, and biomedical activities of the Department of Energy.

While many panels of investigation and inquiry have preceded us and, doubtless, many will succeed us, we believe this is the first hearing devoted solely to the environmental and health effects of the accident, the plans of the responsible Federal agencies for dealing with environmental contamination, and the plans for disposal of the contaminated water in the containment building, along with the use to which DOE will put the \$2.5 million authorized by the Walker amendment.

We are here because of our deep concern with respect to the resolution of these problems and at the request of Congressman Robert Walker, the ranking minority member of the subcommittee, and Congressman Allen Ertel, a member of the full committee.

We will not be discussing the causes of the accident, nuclear reactor safety, operator training, alternate energy sources, or any other matters outside the subcommittee jurisdiction. I will reluctantly rule out of order any comments or questions which are in any of these areas.

The hearing will be conducted in a panel format, as shown on the witness list and schedule available at the door. Since our schedule is tight, I request that witnesses not exceed their allotted time and that Members adhere to the 5-minute rule in their questioning.

Now, we are here because of our deep concern with respect to resolution of these problems at the request of Congressman Robert Walker, the ranking minority member.

I would like to, before I call on Mr. Walker, welcome our colleague, Congressman Winn, of Kansas.

Now, I would like to turn the microphone over to Congressman Walker.

Mr. WALKER. Thank you, Mr. Chairman. I will say briefly that I, too, want to welcome you, and our colleague, Larry Winn, to the Pennsylvania Dutch country for this particular hearing.

I think that this hearing can produce some very valuable information, not only for our subcommittee, for the Congress, and for the public throughout America, but particularly for the people of this area.

I have found in the discussions that I have been holding with hundreds of my constituents over the last several weeks with regard to Three Mile Island, that the great concern that they have is about what the environmental costs were, what the health costs were to them and their families and to the area in general.

We are very proud of our quality of life in this area, and there is a feeling that the quality of life has been impacted upon by what took place at Three Mile Island. There are some serious and severe questions about that. I think this gives us an opportunity to look at some of the questions that most people are asking; namely, what is the scientific data, what is the base upon which we build public knowledge of what took place, and what can we expect in the future? I find one of the things I am disturbed about is they are not sure whose information to trust.

There are too many people involved in the talk about Three Mile Island, and the after effects of Three Mile Island, starting from the position of advocacy, who have based their research and their knowledge on that, whether they be pronuclear or antinuclear, and I think it is important that we try to establish here a base of knowledge on which people can begin to depend for their long-term welfare, and I thank you for bringing the subcommittee to Lancaster County for this very important hearing.

Mr. AMBRO. Thank you, Mr. Walker. I would like to now call up Dr. Chauncey Kepford, of the Environmental Coalition on Nuclear Power, and Dr. Nathaniel Hager, Jr., physicist and research scientist.

If you gentlemen will be seated, since this is a field hearing, we are going to swear all of the witnesses.

Do you solemnly swear to tell the truth, the whole truth, and nothing but the truth so help you God?

Dr. KEFFORD. I do.

Dr. HAGER. I do.

Mr. AMBRO. Thank you.

If you will proceed, Dr. Kepford, and then Dr. Hager.

STATEMENT OF DR. CHAUNCEY KEPFORD, ENVIRONMENTAL COALITION ON NUCLEAR POWER

Dr. KEPFORD. Thank you very much, Mr. Chairman, Congressman Walker, Congressman Winn.

It is a pleasure to be here today, in a way, It is also not a pleasure, because I am here in a rather awkward role, and that is I guess I am here in a sort of "I told you so" role. Back on the subject of licensing of Three Mile Island by the NRC, one of the contentions in our intervention petition had to do with the fact that the radiation monitoring system around Three Mile Island would not be worth much in the event of an accident, would not be able to tell accurately what kind of doses were received by the members of the public, and unfortunately, I think the fears that we suspected, way back in 1974, when this proceeding began, were realized when the accident happened on March 28.

There were on those 2 days, from what I have heard over the radio, and been told, some rather large releases of radioactive materials, but unfortunately, there were so few detectors out in the field that it was very difficult to tell what happened to those radioactive materials, whether they did actually impact on people, or whether they simply blew off and became sufficiently diluted some miles from the plant that nothing happened.

Now, I have given you a couple of copies of some graphs that I made, which are nothing more than graphs of the NRC monitoring data for the time period, March 31 through April 7, I summed the individual exposures for one particular TLD station for the entire period, March 31 through April 7, and then platted the sums against distance for the various sectors, and these data are from the ad hoc group report, the May 10 edition, and that is table 3.4 in that.

Superimposed on that is what the model ultimately used by the dose assessment group looks like inside ten miles, the data normalized to give on one graph a 10-millirem dose at 1 mile, and on the other graph a 20-millirem dose at 1 mile, and these normalization miles were chosen to approximately represent the high ends of the data at approximately 1 mile from the plant.

No background doses have been subtracted from these readings, and the background doses for that period would be approximately somewhere between 1 and 2 millirems, probably more like 2 millirems.

From one graph, the graph that has the high reading of 29.4 millirems at a half mile on the very top, for as far out as the data go, there is a reasonable fit with the model.

That is this particular graph. For the other one, even if one subtracts the 2 millirems, at least in the northwest sector, there is a rather surprising discrepancy between what the model predicts would happen, and what was actually measured by the data, and, of course, the northwest sector is right up toward Harrisburg, the State Capital, so the question now arises, certainly in my mind: Is that an appropriate model to use in those sectors where the dose does not even reasonably approximate the model?

I do not have a ready answer for that question. I do have a lot of questions about the data, a lot of which I find very disturbing.

I am very bothered by the fact that there were throughout the course of this accident, and apparently still are very, very few dosimeters out in the field, and especially why there are so few far from the plant, and where people are, in particular, in the neighborhood of Lancaster. In the neighborhood of York, there are very, very few dosimeters.

I think there is one dosimeter between the plant and Lancaster, and it has been that way approximately since March 28.

The data from the monitoring shows some rather surprising things.

They received no discussion at all really in the text, not the least of which is why the "control" background radiation data is in general higher than the readings found in the neighborhood of the plant.

This is a rather surprising finding; I suppose if one was really desperate, it could lead one to the conclusion that the plant is either forcing the radiation to fall way from the plant, or it is absorbing the radiation.

It would be nice if there were some discussion.

I am really bothered by an environmental monitoring program which puts the dosimeter inside a brick building, as was done in one case, and gives an erroneous reading that had to be corrected.

The environmental monitoring of MET ED does not give one much confidence that MET ED is capable of even measuring background radiation accurately. There is quite a variation from location to location, and report gives one no clue whatsoever as to whether or not these variations in background are indeed real, or whether there are functions of dosimeters, whether there are functions of the treatment of the dosimeters, or functions of perhaps the exact location of the dosimeter, where it is put out in the environment.

Mr. AMBRO. Dr. Kepford, I wonder if it might help you to proceed if you know that we believe that there were anomalous readings. There are some discrepancies, and we have asked DOE to discuss that in their testimony. Indeed, we hope they will go into that in depth. Perhaps you would like to accept that as background and proceed.

Dr. KEPFORD. Fine.

I think I should say that I do not have any spectacular estimate, or any other estimate which I can give you on what the actual population dose is.

The more I look at this data, the more I think that there are really no conclusions that can be drawn from it, except that most of the radiation exposure was probably missed, not only on the first 2 days of the accident, but it was missed through I think a misunderstanding of the local meteorological condition, certainly to the extent that the doses simply do not fall off with distance the way they are supposed to, and the fact that elevated doses extend quite a bit beyond the plant.

I had some weeks ago come up with a very rough estimate of 50,000 to 57,000 person-rem exposure. I do not think that is a terribly supportable exposure level, but I do not think either the exposure levels that are given are anymore supportable.

I think the data simply does not support it, and if there is any one message I would really like to get across to this committee, it would be to encourage you to somehow enforce upon NRC requirements to do an adequate job of radiation monitoring, far more than the 13.8 miles NRC was able to do.

It should be done much farther from the plant, and with far more numbers of dosimeters, better quality ones, better understanding of the data that is obtained.

I think one comment that is certainly valid with regard to the data, and that is that the data was simply not looked at while it was being gathered, and it was not looked at in a critical fashion to see whether or not the background data itself was any good at all.

I would certainly be very, very leery of the conclusions that can be drawn from data whereby the control locations, that is those that are supposed to the reading background give higher significant readings, significantly higher radiation readings than those closer in to the plant and that is data that goes back to the end of 1977, from this table.

Nothing was done about that data to try to figure out that discrepancy. I would like to leave you a copy of two documents: one is the response testimony of Mr. Sidney Porter at the Three Mile Island II licensing hearings responding to the intervenors' contention that there should be a more detailed monitoring system for you to look at in retrospect, and also a supplemental petition that I have filed on behalf of the intervenors in that proceeding, and the Environmental Coalition on Nuclear Power, requesting the NRC hold public hearings on this supposed water dumping that is supposed to take place, and requesting that the NRC at least get monitoring, adequate monitoring out to a distance of at least 40 miles from Three Mile Island.

Mr. AMBRO. Those will be received for the subcommittee files.

Dr. KEPFORD. I am convinced that it is possible that the worst may yet come from this accident, and that would be if and when the plant is opened up, and the possibility rises for particulate strontium-90 to get out though cleanouts from inside the plant.

If much strontium-90 gets out, the situation could be extremely serious, and from information I have got from Mr. Gerusky, who is here to testify, concentrations of strontium-90 in the reactor are high; there is probably a lot of it loose in the containment sump, and if that gets out in the particulate forms into the country, the results could be disastrous.

I think one of the things that has come through throughout the early course of this accident, that there is very, very little interest in buying farm products that have even the slightest hint of contamination, and I think we have to make sure none of that gets out.

Thank you.

Mr. AMBRO. Thank you, Dr. Kepford.

We will now hear from Dr. Nathaniel Hager, Jr., physicist and research scientist. We will develop questions for both of you as a panel.

But if you would proceed, Dr. Hager, at this time, that would be fine.

Please proceed.

STATEMENT OF DR. NATHANIEL HAGER, JR., PHYSICIST AND RESEARCH SCIENTIST

Dr. HAGER. Thank you, Mr. Chairman, and thank you, Mr. Walker, for the invitation to appear today.

I am a lifetime resident of Lancaster County, and I have been engaged in heat flow research for the last 25 years including work on energy conservation and solar energy.

I served for many years as director of radiological work for Lancaster County civil defense. I have no particular fondness for nuclear power, and I understand the fears that have been aroused by the TMI accident.

However, as a citizen with the best interests of our country in mind, I am concerned that present emotions might lead to incorrect decisions about the future of nuclear power, which decisions might turn out to be damaging.

Before chopping off the future of nuclear power, we must be sure this leads to a better world.

One thing needed is an objective assessment of the impact on people and environment in the Three Mile Island area, and I am happy to participate in the discussion of that topic.

My analysis of the Federal data, and data taken by local scientists assures me that there was no significant physical damage to the populace.

I believe there was some psychological damage heightened by inadequate or uncaredful communication, and inadequate educational background.

Because of the way God made the Earth, man has always inhaled, drunk, or eaten substances containing poisons, carcinogens and radioactive isotopes.

He has been exposed to all kinds of radiation, ultraviolet, infrared, microwave, gamma, beta, alpha, and X-ray.

Only recently in man's history has he developed instruments with sufficient sensitivity to permit detecting these potential hazards at the low levels found in nature.

When man does something which could alter his environment, these instruments are essential in keeping such alterations at such low limits that no harm is done.

Unfortunately the attempt to keep all these dangerous sounding things below safe limits is a complicated problem. The steps taken can lead to lower hazards and can lead one to increasing another.

This is the problem we face with nuclear power. There are two important things to understand about applying our sensitive instruments. First, the ability to measure hazards cannot produce a feeling of safety unless we know what safety is.

If we demand a zero measurement, then there is no such thing as safe, nor was there ever. I feel it to be a commonsense view that we can tolerate an increase in some hazard, if such increases are known to exist in nature without observable consequences.

Since Colorado gets about 150 millirems per year more radiation than Texas and Louisiana, and since I am not aware that Coloradans have ever been shown—

Mr. AMBRO. Well, they may be doing it there, and it is obvious man did not evolve with these kinds of communications systems.

Dr. HAGER. That is right. Since Colorado gets about 150 millirems per year more than Texas and Louisiana, and since I am not aware that Coloradans have ever been shown to be more subject to cancer

than Texans and Louisianans, I say 150 millirems per year is not alarming.

That is why I am not worried about the 1.5 millirems total dosage estimated for the 2 million people nearest Three Mile Island.

The second point about instrumentation: Reducing one hazard does not increase safety if this reduction must necessarily lead to increasing another hazard.

Our world is complicated. We cannot assume that changing one factor in our life will not affect other factors.

It is estimated by the National Academy of Sciences that an average of 100 persons per year could die from nuclear power between now and the year 2000.

Right now over 10,000 a year die from operation of coal plants. If we should shut down nuclear plants to make one kind of instrument read lower, then we will burn more coal, and other instruments will read higher, unless we give up the use of energy.

It may help people to understand one thing important about nuclear radiation. All types of nuclear radiation which can harm human tissues do so by breaking up individual atoms within these tissues. This same action, called ionization, also breaks up the atoms in the radiation detector. If it can harm humans or animals, it operates the detector.

There is no mysterious kind of nuclear radiation, which is undetected, and yet dangerous to people.

This is not true of chemical and biological accidents. There is no instrument which can demonstrate the absence of all kinds of chemical poisons, nor is there any instrument which can demonstrate the absence of all possible kinds of virus. There is plenty of room for mysterious happenings here.

I think if people understood this, they would not worry about the possible nuclear origin of the mystery of the dying cows. They would have known that no fatal dose of radiation could have slipped past the instruments, while there is no way to keep an eye on all other possibilities.

I would like to make a couple of comments about the offsite exposure to radiological effects. There are two ways in which people could have been exposed to radiological effects during the accident at Three Mile Island.

One is the prompt exposure to radioactive clouds, as they follow the direction of the wind from the plant, toward nearby populated areas. This exposure would have been detected by the dosimeters or survey instruments during the passage of the clouds.

Second, there is the residual exposure to radioactive substances inhaled, drunk, or eaten, and subsequently retained in the body. This exposure would have been measured by scanning the body after the passage of the clouds.

According to the information available to me, the prompt exposure of the radioactive clouds was small. The official interagency study estimates the average exposure to the 2 million people within the 50-mile radius was about $1\frac{1}{2}$ millirems. This is about the dose one gets during a 2-hour jet flight, or during a 10-hour visit to some areas in India or Brazil, or during a 3-week stay in a building made of brick or stone.

The scientists who estimated this $11\frac{1}{2}$ millirem value examined a large amount of data; where they found conflicts, they took the largest values. They assumed people stood outdoors full-time during the 10-day period after the accident without clothing. They did everything to make their estimate larger than fact, so there would be no possibility that people would later learn they got a larger dose than estimated.

The residual exposure of the radioactive substances in the body, or in the food chain, was almost nonexistent.

People were given whole-body scans with no positive results. Plants and animals were all found to be so clean, that scientists expressed surprise.

The most sensitive barometer is iodine in milk. The largest content I saw reported was about one-tenth of that found in fallout from a Chinese nuclear test explosion, and about three-thousandths of the approved safe level.

Therefore, both prompt and residual exposure were too small to produce symptoms in man or animal. It remains a theoretical debate about whether there might be 10, 1, or no extra cancer deaths to be added to the 325,000 expected for the 2 million people nearby. In view of the fact that the exposure estimates are probably too high, my guess is zero extra deaths, no matter whose theory is right.

Mr. AMBRO. Dr. Hager, we have your testimony, and I can assure you that we will incorporate all of it in the record.

I see though that you are coming close to the end of your time, so I leave to you the way you would like to proceed with the rest of it, and pick out the most salient portions, so you can permit the panel to question each of you.

Dr. HAGER. Thank you, sir. I already plan to omit quite a bit of what I have left.

The next topic I would like to discuss just for a few minutes has to do with communications which I believe heightened the trauma of the event. For many years, including the fallout debate in the early 1960's, I served as director of Lancaster County Civil Defense Radiological Effort, and I talked to a good number of the service clubs about the fallout problem.

I think our people have strong enough and smart enough minds to handle what really happened at Three Mile Island, but I am not so sure they were able to handle what they thought was happening.

From the fears and doubts expressed to me, and from what I read in local newspapers about mental upset, I think the accident was more than mildly traumatic for many, and I think much of the upset was due to inadequate and uncareful communications.

I found the people feared a nuclear bomb blast, not realizing the ingredients for such a thing were not there, and that such a blast was not possible.

I think they feared an H-bomb blast when they heard about the hydrogen bubble. I do not think anybody realized that hydrogen means H-bomb to people. I do not think people realize there is a big difference between a chemical hydrogen explosion and a fusion type hydrogen blast.

I was in Florida a few days after the accident, and I saw a headline which said "H-BOMB BLAST" in great big letters, in a tabloid, and

below that in almost as large letters, "MEGATONNAGE UNKNOWN." I thought that there was a good likelihood that those headlines were telephoned back to our area, and probably did a lot to cause panic.

Also, there have been statements that inadequate data had been taken during the first 3 or 4 days, and the dosage was probably much higher than reported. I even heard one speaker say that we do not know what the radiation level was during the first 72 hours, and that, instead of one possible cancer death, we may have as many as 1,200. These statements are just not true in my estimation. I have carefully studied a respectable body of dosimeter data covering the entire period from the instant of the accident, and I have worked over the data myself, and I do not find any discrepancies. Nor do I find any discrepancies in the extrapolations, which were only intended to be used outside of the area defined by the outermost dosimeters. This extrapolation method was not intended to be applied in the interior area.

The fulltime data from 30 dosimeters covering March 28, 29, and 30, the first 3 days, and full-time data from 77 dosimeters covering March 31 to April 6, were published jointly, as you know, and I conclude that these data are sound, and that people got substantially less than the 1.5 millirem average dose indicated by the report.

I feel that our local news media should be praised for understanding the potential for hurting their friends and neighbors. For example, TV 8 showed great sensitivity and strong leadership in trying to create calm after an alarming false announcement was made on other stations.

My point is that, both during and after the crisis, careless or even ruthless communications have been responsible for creating undue mental stress.

I am sure more people would suffer from mental scars than from cancer, and these scars could have been prevented by balanced and objective communications.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Hager follows:]

SUMMARY

Nathaniel E. Hager, Jr., Ph.D. (Physics), lifetime resident of Lancaster County.

Engaged in heat-flow research for past 25 years, including work in energy conservation and solar energy. Served for many years as director of radiological work for Lancaster County Civil Defense. Have no fondness for nuclear power and understand fears that have been aroused by TMI accident.

However, as citizen with best interest of our country in mind, am concerned that present emotions might lead to incorrect decisions about future of nuclear power which decisions might turn out to be damaging. Before chopping off the future of nuclear power we must be sure this leads to a better world. One thing needed is a nobjective assessment of impact on people and environment—today's topic.

My analysis of federal data and data taken by local scientists assure that there was no significant physical damage to the populace. I believe there was some psychological damage heightened by inadequate or uncareful communication and inadequate educational background.

SAFETY IN TODAY'S WORLD

Because of the way God made the earth, man has always inhaled, drunk, or eaten substances containing poisons, carcinogens, and radioactive isotopes. He

has been exposed to all kinds of radiation: ultraviolet infrared, microwave, gamma, beta, alpha, and x-ray.

Only recently in man's history has he developed instruments with sufficient sensitivity to permit detecting these potential hazards at the low levels found in nature. When man does something which could alter his environment, these instruments are essential to keeping such alteration at such low limits that no harm is done.

Unfortunately, the attempt to keep all of these dangerous-sounding things below safe limits is a complicated problem. The steps taken to lower one hazard can lead to increasing another.

This is the problem we face with nuclear power. There are two important things to understand about applying our sensitive instruments:

1. The ability to measure hazards cannot produce a feeling of safety unless we know what safe is. If we demand a zero measurement, then there is no such thing as safe—nor was there ever. I feel it to be a common-sense view that we can tolerate an increase in some hazard if such increases are known to exist in nature without observable consequences. Since Colorado gets about 150 millirems per year more than Texas and Louisiana, and since I am not aware that Coloradans have ever been shown to be more subject to cancer than Texans and Louisianans, I say 150 millirems per year is not alarming. That's why I am not worried about the 1.5-millirem total dose estimated for the 2 million people nearest Three Mile Island; the 1.5 millirems is $\frac{1}{100}$ th of the 150 millirems which I don't feel is alarming.

2. Reducing one hazard does not increase safety if this reduction must necessarily lead to increasing another hazard. Our world is complicated. We cannot assume that changing one factor in our lives will not affect other factors. It is estimated by the National Academy of Sciences that an average of about 100 persons per year could die from nuclear power between now and the year 2000. Right now over 10,000 per year die from operation of coal plants. If we shut down nuclear plants to make one kind of instrument read lower, then we will burn more coal and other instruments will read higher (unless we give up use of energy).

COMMENT ON THE MYSTERY OF NUCLEAR RADIATION

It may help people to understand one thing important about nuclear radiation. All types of nuclear radiation which can harm human tissues do so by breaking up individual atoms within these tissue. This same action, called ionization, also breaks up the atoms in a radiation detector. If it can harm humans, or animals, it operates the detector. There is no mysterious kind of nuclear radiation which is undetectable and yet dangerous to people.

This is not true of chemical and biological agents. There is no instrument which can demonstrate the absence of all kinds of chemical poison, nor is there any instrument which can demonstrate the absence of all possible kinds of virus. There is plenty of room for mysterious happenings here.

If people understood this, they would not have worried about possible nuclear origin of the mystery of the dying cows. They would know that a fatal dose of radiation could not slip past the instruments, while there is no way to keep an eye on all other possibilities.

OFF-SITE EXPOSURE TO RADIOLOGICAL EFFECTS

There were two ways in which people could have been exposed to radiological effects during the accident at Three Mile Island:

1. Prompt exposure to radioactive clouds as they followed the direction of the wind from the plant toward nearly populated areas; this exposure would have been detected by dosimeters or survey instruments during passage of the clouds.

2. Residual exposure to radioactive substances inhaled, drunk or eaten and subsequently retained in the body; this exposure would have been measured by scanning the body after passage of the clouds.

According to the information available to me the prompt exposure to radioactive clouds was small. The official interagency study estimates that the average exposure to the two million people within a 50-mile radius of the plant was about 1.5 millirems. This is about the dose one gets during a 2-hour jet flight, during a 5-day visit to Colorado, during a 10-hour visit to some areas in India and Brazil, or during a 3-week stay in a building made of brick or stone. The scientists who estimated this 1.5 millirem value examined a large amount of data; where they found conflicts, they took the largest values. They assumed people

stood outdoors fulltime during the 10-day period after the accident. They did everything to make their estimate larger than fact so there would be no possibility that people would later learn that they got a larger dose than estimated.

The residual exposure to radioactive substances in the body, or in the food chain, was almost non-existent. People were given whole-body scans with no positive results. Plants and animals were found to be so clean that scientists expressed surprise. The most sensitive barometer is iodine in milk. The largest content I saw reported was 40 picocuries per liter which is about one-tenth of that found in fallout from a Chinese test and about three-thousandth of the approved safe level.

Therefore, both prompt and residual exposure were too small to produce symptoms in man or animal. It remains a theoretical debate about whether there might be ten, one, or no extra cancer deaths to be added to the 325,000 expected for the nearby two million people. In view of the fact that the exposure estimates are probably too high, my guess is zero extra deaths no matter whose theory is right.

UNCAREFUL COMMUNICATIONS HEIGHTENED TRAUMA

For many years, including the period of the fallout debate in the early 1960's. I served as Director of the Radiological Division of Lancaster County Civil Defense; I talked to a good fraction of the service clubs in Lancaster County about the fallout problem. I think our people have strong enough and smart enough minds to handle what really happened at Three Mile Island. I am not sure they were able to handle what they thought was happening. From the fears and doubts expressed to me, and from what I read in the local papers about mental upset, I believe the accident was more than mildly traumatic for many. And I think much of the upset was due to inadequate and uncaredful communications.

The following are some of my thoughts on where the communications went wrong:

1. People feared a nuclear bomb blast. I tried to tell them this was impossible because the ingredients were not present. But they heard otherwise from other sources.

2. When they heard about the hydrogen bubble and the concern about its exploding, some thought "H-bomb blast!" I tried to explain the difference between a conventional chemical explosion of hydrogen gas and the nuclear-fusion type of blast. But a Miami newspaper which I saw during a business trip to Florida had a headline reading "H-BLAST" and subhead saying "MEGATONNAGE UNKNOWN". This type of headline was, no doubt, phoned back to our area and it probably helped to promote panic.

3. People were given reason to fear a meltdown, but I don't think it was explained that this takes time, hours, even after actively under way. There is time for evacuation. Some people who talked to me thought that a meltdown would occur in a flash.

4. People were told about the excitement when elevated radiation levels were detected. But they weren't told about the extent to which these readings were localized, nor were they told about how long they endured. Especially, I don't think they were told about all of the normal or near-normal readings that seem to have been the rule rather than the exception in the plant vicinity.

5. There have been statements that inadequate data were taken during the first three or four days, and that the doses were probably much higher than reported. I even heard one speaker say that we don't know what the radiation level was during the first 72 hours, and that, instead of one possible cancer death, we may have as many as 1,200 deaths. These statements are just not true. I have carefully studied a respectable body of dosimeter data covering the entire period from the instant of the accident. Fulltime data from 30 dosimeters covering March 28, 29, 30, and fulltime data from 77 dosimeters covering March 31, April 1, 2, 3, 4, 5, and 6 were published jointly by NRC, EPA, and HEW on May 10, 1979. I conclude that these data are sound and that people actually got substantially less than the 1.5 millirem average dose indicated by the report.

I took my own data in Lancaster on March 28, 29, and 30. I also took data in around Middletown on March 30. These data and data reported by a number of other area physicists are consistent with the dosimeter data shown in the government report.

6. I heard one expert dismiss the whole-body counts performed by NRC on area residents after the TMI accident; he said these counts indicate only whether

a certain amount of radiation material is still "irradiating you inside," not "what you got two weeks ago." This was distortion. It was not the purpose of the whole-body count to check on the dose obtained two weeks earlier; that dose had already been found to be insignificant from analysis of earlier dosimeter data. But the earlier dosimeter data did not give assurance that the body was free of contamination which could cause later trouble. Therefore, in the interest of thoroughness, the whole-body counts were performed to make sure people were free of such internal contamination; results of this count further completed the checks needed to make sure nobody was going to be injured. The scientist who dismissed the whole-body count undermined what comfort a badly stressed community might have derived from what were really very reassuring results.

7. Even the AAAS publication *Science* appears to be guilty of publishing data on radiation dose rates which are probably at least one order of magnitude too high according to my readings and according to the May 10 government report. They have not yet printed a correction to their values printed April 20th.

My point is this. Both during and after the crisis careless or even ruthless communications have been responsible for creating undue mental stress. I am sure more people will suffer from mental scars than from cancer. And these scars could have been presented by balanced and objective communication.

I feel that some of our local news media should be praised for understanding the potential for hurting their friends and neighbors; TV-8 showed great sensitivity and strong leadership in trying to create calm after an alarming false announcement was made on other stations.

ALTERNATIVES TO NUCLEAR POWER

Before we seriously consider abandoning nuclear power, we must soberly assess the following questions.

1. Is there some other viable source of energy available for the next few decades?

2. Is the proposed alternate really safer than nuclear?

3. Assuming there is no viable safer substitute, can we accept a decrease in the amount of energy we use?

As a physicist who has worked for 25 years on research related to energy conservation and solar energy, I do not see how we can get much help from solar or other renewable energy sources during the next few decades. Unfortunately, those most filled with hope about these proposed energy sources are those least prepared to understand their limitations. Recently the American Physical Society issued a report declaring that solar energy will not become significant for another 30 to 50 years. It is true that we can heat water with energy from the sun, and sunlight through the window helps warm our homes during sunny winter hours. But how do we use solar energy to run our transportation system, melt our steel, heat the skyscrapers of our cities, plow our crops, or operate the 80 million existing homes in our country?

Coal is presently looked upon as the most hopeful alternative to nuclear power, but it presents problems:

We don't like to send men below the surface to mine coal, but we don't like strip-mining either. Pollution and wastes are serious matters. Worst of all, it appears that coal is less safe than nuclear. At present it is estimated that generation of electricity with coal accounts for about 12,000 deaths per year. Estimates for nuclear generation between now and the year 2000 run between 100 and 400 deaths per year depending on viewpoint.

Can we accept a steady long term decline in availability of energy? Are we prepared to cut energy use in our country while energy-dependent industries continue to grow in other countries?

[From the Lancaster, Pa., New ERA, May 15, 1979]

LETTERS

DON'T ABANDON NUCLEAR

(By N. E. Hager, Jr., Ph. D.)

Editor, New Era: As a physicist who has spent 25 years doing research in areas involving heat transfer, solar energy, and energy conservation, I am concerned about the long range impact of the incident at Three Mile Island. I have

no great fondness for nuclear power and I understand the feelings of those who fear it.

I agree that we must take positive steps, such as improving the level of performance in the nuclear industry, and improving our understanding of the effects of nuclear radiation on human health. It is most important that our future nuclear policy be based on a realistic appraisal of the best information available and not on an emotional response to sensationalism.

I am convinced that we cannot abandon nuclear power at this time, or even slow its development, without paying a far higher price than is generally understood. Based on my own researches, and on those of others working in my field, I find no basis for believing that safer energy sources, or improved methods for reducing waste of energy, will come along fast enough to fill the gap.

It seems certain to me that closing down nuclear power plants will mean either increased dependence on foreign energy sources or unprecedented austerity. Either we will pay blackmail to the Arabs until our economy collapses or we will be forced to shut down energy-dependent industries until our economy collapses.

I urge everyone concerned about the nuclear power issue to consider the following positive suggestions:

1. Think carefully about the overall energy problem before adopting a position on nuclear power.
2. Be skeptical about representations of fact which you do not understand, especially if the source uses an emotional appeal or appears to be promoting a political viewpoint.
3. Get to work on energy conservation in your own life; saving energy reduces need for all types of power plants.
4. Encourage development of solar energy, but be very patient about its progress during the next few decades.
5. Support research on making both fossil and nuclear power safer.

[From the Lancaster, Pa., New ERA, May 16, 1979]

RADIATION WAS NORMAL

(By N. E. Hager, Jr., Ph. D.)

Editor, New Era: Because I am a physicist, and because of my long association with radiological activities of Lancaster County Civil Defense, I had requests for information during the earlier stages of the Three-Mile-Island problem. Not wanting to give advice without firsthand knowledge, I took my own data with a Nuclear Chicago Model 2652 portable Geiger counter.

This instrument was sufficiently sensitive to indicate the normal background radiation, and it was equipped with a thin mica window permitting observation of everything from gamma to soft beta and alpha radiation.

I took several readings at my home in Lancaster on Wednesday, March 28, 1979, and found nothing exceeding background from natural radioactivity. All day Thursday and Friday I continued to read normal background levels.

Finally, on the evening of Friday, March 30, 1979, after hearing that "large uncontrolled releases" occurred earlier in the day, I drove to Middletown to get some readings. Between 7:30 and 9:30 p.m., I took twenty to thirty readings near Middletown, in the business section of Middletown, and along Route 441. I took readings along the edge of the river adjacent to Three Mile Island. I even aimed the probe at the reactor building only a few hundred yards away.

None of these readings exceeded the normal background values which I have been obtaining in our area for the past twenty years. I concluded that any additional radiation above background was too small to measure and certainly did not exceed 0.01 to 0.02 millirem per hour.

I am making my data public because I hope they will be helpful to people in the Middletown area, especially those who may have read in the publication "Science" that the radiation levels were allegedly 100 times larger than I measured. The April 20th issue of "Science" said: "The 25,000 people who live within a 5-mile radius of the plant have been receiving radiation from the very beginning in doses that ranged from about 1 to 2 millirems per hour during the first week, to around 0.1 millirem per hour now."

I repeat the fact that my readings, taken well inside the 5-mile radius during the middle of the first week, did not exceed 0.01 to 0.02 millirem per hour.

I know that my instrument had to be working correctly because it never failed to indicate normal background radiation, and it never failed to respond to higher radiation levels produced temporarily by radioactive sources which I used for calibrating. Even 0.1 millirem per hour would have driven my instrument off-scale. Other local physicists have also reported readings substantially below "Science" 1-to-2-millirem-per-hour range during the first week inside the 5-mile radius.

It concerns me that data which appear to be incorrect have been printed in a respected place where they may influence important decisions. I am taking appropriate steps to resolve the discrepancy, and would appreciate hearing about additional data from other local scientists.

Mr. AMBRO. Thank you, Dr. Hager.

I would like to note for the record, as I said earlier, that Congressman Allen Ertel has now joined us, and if you would like to make an opening statement, we would be happy to have you do it.

Mr. ERTEL. Thank you very much. I have no opening statement. I am here to learn and to hear what the witnesses have to say and to find out what the true facts are over radiation.

Thank you very much.

Mr. AMBRO. Thank you.

Mr. Walker?

Mr. WALKER. Thank you, Mr. Chairman.

I have several questions, beginning with Dr. Kepford.

Dr. KEPFORD, in a previous hearing on Capitol Hill the other day you used the estimate of 50,000 mrem exposure levels for the population in the area, and I think that you base that upon the figures used this morning showing the aberration from the measurement data given us by the official dosimeters used in the process, and you had calculated that out.

This morning you are saying, I think, that the 50,000 mrem probably is not a very good figure, that you would think that the figure probably should be changed.

Did I interpret what you said correctly?

Dr. KEPFORD. I think what I am saying is that it is probably no more supportable than the other numbers.

I do not think any are any good, because I think the data is simply very, very poor.

Mr. WALKER. I understand. You are saying that the figures that have been projected out by the official agencies are also wrong. I think that your chart showing that aberration is something which very definitely should be looked into as the chairman has indicated. I think the subcommittee wants to do that.

The one thing I wanted to clarify though is that you mentioned that based upon that figure of 50,000 mrems, which is a rather significant figure, that hundreds of thousands of people were going to die of cancer in this area.

Are you saying now that figure of cancers is subject to change now based upon the lack of confidence in your 50,000 mrem figure?

Dr. KEPFORD. I think it is supportable saying nobody is going to die, or one person is going to die.

Mr. WALKER. OK.

But you had reduced it to numbers in your testimony the other day.

I am trying to find out whether or not those numbers have changed. I have not changed them. I have done a lot more looking at the data, and I simply cannot get much feeling that the data is valid enough to support any conclusion.

Are you still saying that your feeling is that we are going to have hundreds and thousands of additional deaths?

Dr. KEFFORD. No; I am not saying that we are or are not going to have hundreds and thousands, not at all.

We might. We simply do not know, we cannot say yes, we cannot say no.

There are a lot of funny things that happened during the course of this accident, and I would certainly hope that Mr. Gerusky who will be testifying later will help clear up one of them.

He certainly surprised me 2 or 3 weeks ago when in a public meeting in Newberrytown, Pa. he mentioned on the very early morning of March 28, that the containment structure was not isolated, when the initial radiation levels alarms were sounded, something like 7:30 in the morning, there was a 600 roentgen per hour dose rate in the top of the containment structure.

Some of those materials were getting out, and according to what Mr. Gerusky said, there was a projected—

Mr. WALKER. You are saying the materials got out of the containment?

Dr. KEFFORD. Out of containment and out of the reactor.

Mr. WALKER. When was this that materials escaped from containment?

Dr. KEFFORD. There was as I recall, this was at 7:30 Wednesday morning, March 28, and the projected dose rate in Goldsboro toward which the wind was blowing was 10 roentgen per hour.

Now, again, whether or not that dose rate was actually realized by people over there we do not know.

There of course was—

Mr. WALKER. We have monitoring equipment in Goldsboro though?

Dr. KEFFORD. There was at the time.

Mr. WALKER. As far as I know, there has always been a monitor in Goldsboro, that has always been my understanding.

Do you have reason to doubt that?

Dr. KEFFORD. I don't know. I am exceedingly puzzled again by the variability in this data, and I am simply wondering whether or not the monitoring system was adequate to detect anything as it was set up.

Mr. WALKER. I think you make an excellent point on that.

I do not quarrel with your point on that. I think we do have a lack of radiation monitoring, I think your point about the distance of that monitoring is a good point.

I think what we need to clarify is what this data is going to show, and that is the reason I wanted to follow through on some of your numbers.

Dr. KEFFORD. I would like to elaborate one more thing, assuming this data only goes up to April 7. Now, I had reason to go to Wilmington, Del., on April 16, and I did this with a portable Geiger counter, a civil defense survey meter, and in the middle of the afternoon as I

was driving through the town of Millerstown, which is about 30 miles northwest of Harrisburg, all of a sudden at the lowest sensitivity level, the Geiger counter went off scale, that is a half millirem per hour.

Now, of course, that is not a high level, but this is rather surprising because of the weather conditions at the time that made me quite surprised, and that is that there was a high pressure area moving in which means winds from the northwest, that is blowing more or less from Millerstown toward the plant, yet in Millerstown, that is where the high radiation levels were.

I suspect that there had been an inversion the night before, and that the plume—this is again the day after Easter Sunday when there was a relatively large iodine release—I suspect the plume moved up the river and was slowly being dissipated.

If that is the case, there was a reasonable exposure for a number of hours for a reasonably large population.

Mr. WALKER. What was the reading?

Are you saying your Geiger counter was at the half-millirem level, which is basically background level?

Dr. KEFFORD. No; it was at that time about 50 times background.

Mr. WALKER. What was the reading you were getting on that Geiger counter at that point in Millerstown?

Dr. KEFFORD. It was about a half-millirem per hour, right at the maximum reading on that scale.

Mr. WALKER. What you are saying is what you were measuring there at that time was a half-millirem per hour?

Dr. KEFFORD. That is correct, but again, if it had persisted for 6 or 8 or 10 hours or 12 hours, and this is 30 miles from the plant now, we are talking about a reasonable population dose over quite a period of time.

Mr. WALKER. Well, at 10 hours, you are talking about a 5-millirem exposure, if that continued for a 10-hour period.

Dr. KEFFORD. That is right.

Mr. WALKER. Just one final question, and I want to go to your chart here a minute.

Mr. WINN. Mr. Chairman, this is a very interesting line of questioning that Mr. Walker is following, and I would be glad to yield my 5 minutes to Mr. Walker.

Mr. WALKER. I thank the gentleman very much. You point out that the data that you put on your chart here matches pretty much with official estimates in the downtown, except for that aberration from the northwest. I think that was your testimony.

Dr. KEFFORD. That is one example. I think the others on that particular chart do not follow very well either, but obviously the northwest quadrant is the worse.

Mr. WALKER. If I understood you correctly, you said background was not added into this?

Dr. KEFFORD. That is correct.

Mr. WALKER. And it seems to me if you take the 1- to 2-millirem background, and move down the rest of those figures, they are in somewhat the same character as the rest of the chart, except for that area to the northwest?

Dr. KEFFORD. That is the worse offender.

Mr. WALKER. And I think that that makes an excellent point.

My question to you is, do you think that it is sufficiently good data to go in the direction of basing the assumptions on that one aberration?

In other words, is basing the assumptions for the entire population, a million or so people in this area, valid? In other words, we could only talk about the dose to our people from that aberration in a north-westerly direction, is that correct; the rest of the data seems to follow?

Dr. KEFFORD. That is correct. Well, I do not think I would be as confident about it as you are. I do not think the numbers go out far enough to really tell, but simply, this can be done, to simply move the scale up 2 millirems on this chart, and move the calculated curve up, too.

Mr. WALKER. I am simply looking at the data on your chart here, and let us say we move the line that you have on the chart for the official data. The directions that come down here westerly seem to follow that, except when you move into the northwest quadrant, the southerly seems to follow pretty closely that dosage.

Dr. KEFFORD. The south and southwest are awfully flat, a lot flatter than they should be; again, they are falling off with distance as the model predicts.

Again, this model was not used inside the 10-mile area.

This was used outside the 10-mile area. The reason I plotted it inside was to see if indeed the model fit the data inside the 10-mile region. From the one chart, it looks like it is a reasonable approximation, it does fit inside, so it is probably a good approximation outside.

Mr. WALKER. But your original estimate of 50,000-millirems exposure—

Dr. KEFFORD. It is not based strictly on assuming that the northwest quadrant was indicative of everything.

Mr. WALKER. It was not?

Dr. KEFFORD. It was not.

Mr. WALKER. It was based also on the rest of the flow on these two charts?

Dr. KEFFORD. Yes.

Mr. WALKER. Let me move to Dr. Hager, if I can, for just a moment. Would you agree that if we did have an exposure level in the vicinity of 50,000 millirems, that would be an extremely serious level in terms of the local population?

Dr. HAGER. I do not see that there would be any immediate harm to people, according to my understanding; the biological effects, instead of having 1 possible cancer death, you might have 10 possible cancer deaths over the next 30 years.

Mr. WALKER. Even at the level of 50,000 mrems, we would move from the potential of 1 cancer fatality to a potential level of 10?

Dr. HAGER. That is correct.

Mr. WALKER. That is directly attributable to a Three Mile Island accident?

Dr. HAGER. Yes.

Mr. WALKER. You mentioned in your testimony you did do some independent monitoring yourself.

Dr. HAGER. Yes.

Mr. WALKER. Was that independent monitoring done in the whole range around the plant?

Dr. HAGER. I will explain. I did monitor in the Lancaster area for the first 3 days, March 28, 29, and 30. And by the time the 30th came along, I was getting many phone calls for advice about what we should do; my school board wondered whether they should close the school. I did not want to make recommendations or give advice without first-hand knowledge, so I came to Middletown. I came on Friday evening, March 30; I made measurements in Middletown, up and down Route 441.

I aimed my probe right at the reactor, and I was on the mainland across from the island, and I found I could get nothing really discernible about background, even on that Friday, which was the day when the large uncontrolled releases were.

My Geiger counter is one I am very familiar with; it is sensitive to beta radiation. I calibrated it. It was reading background all along. It was sensitive enough to pick up background.

Mr. WALKER. If I understood your testimony correctly, you feel that your data was in line with what the Government is officially claiming?

Dr. HAGER. Yes. Also, I studied the Government's data very carefully, and I found that their background readings are very consistent except for aberrations in the spring of 1978 which were explained by the fallout from the Chinese bomb tests.

I could find no discrepancies either in the Teledyne data or the other contractors' data. Both of these sets of data agreed well with the NRC data where they overlapped. And I find the extrapolation is great: they used real data inside the 10-mile area, and then they used this extrapolation outside, and the extrapolation is not supposed to work inside where you have the real data.

Mr. WALKER. Are you not concerned about the data that Dr. Kepford has informed this subcommittee about, that shows an aberration to the northwest, as you got further away from the plant, all of a sudden, the radiation levels on that one dosimeter reading seems to have shot up, which indicates that the readings around the plant may not have reflected the total dosage of radiation, that got to the public.

Dr. HAGER. No, sir, I am not concerned at all.

I have been looking at data for 30 years, and I can tell good honest data as I see it, and it really hangs together. As Dr. Kepford said, they were not thinking about the data at the time they took it. I think that is the best indication of honest data, because if you are thinking about it, you can juggle the figures.

I really feel that everything is consistent, and I really also believe that the final estimate of the impact of these measurements was indeed on the conservative side. For example, they did not even take into account the fact that at least half of the people had left the area, so that the exposure to people was half of the 3,300 mrem-persons automatically because of that.

I think probably more likely, instead of having 3,000, we might have had 300 rem-persons.

I would certainly feel it went in that direction, rather than on the other side of the 3,000.

Mr. WALKER. I am through.

Thank you, Mr. Chairman.

Mr. AMBRO. Thank you, Mr. Walker, Mr. Ertel?

Mr. ERTEL. Thank you, Mr. Chairman. I am concerned about when you talk about these figures, and we are really not that concerned about total exposure to the total population.

What we are really concerned about is the exposure to one individual to how many rems.

That would be how detrimental it may be to that person.

If we take and spread that and do it on an average basis, what do we really care on an average basis, because we do not have average people.

We have people that are closer, further away, people that have more exposure, who have less exposure, so to use an average figure spread over an entire population makes no sense, and I noticed in your testimony, you indicated that over a, what was it, 50-mile radius?

Dr. HAGER. Yes, sir.

Mr. ERTEL. I am not sure I care about a person at the 50-mile periphery, if in fact that person at the 50-mile periphery received no exposure whatsoever.

Are we not interested in individuals who may have had exposures, high exposure, regardless of what that rate would be, and are not those the people we ought to be concerned about?

Dr. HAGER. I think we should look at it both ways. I have looked at it the other way too. I have looked at what the maximum exposure would be.

Mr. ERTEL. I was looking at your testimony, I did not see that, is that in there?

Dr. HAGER. The maximum exposure is given in all of the Government reports.

I did not make any measurement of that. I was not at the point where they had the maximum exposure. That was about 80 millirems, as I understand it, if somebody had been standing there naked for 24 hours a day, during the first week or so of the event, but I do not believe anybody was there, at least not under those conditions, so I really think the maximum exposure that anybody got was substantially less than that.

This is contended in the report, and I think that their analysis leading to that conclusion is correct.

If somebody had gotten 80 millirems, which I doubt, then the exposure that they got was still only the difference between living in one State instead of another. I think you have to take into account that, every year, the radiation we get from the materials in our body can be 30 millirems. Living in a brick house or a stone house instead of a wood house can give you 30 millirems.

A school made out of masonry materials that you send your children to, can cause them to get a larger dose.

Mr. ERTEL. You are talking about 30 millirems per year. Here we have a concentration.

Do we know when you concentrate that dosage within a time period may be less, what the effects will be, to give a comparison of 30 millirems per year which you may receive, in one place as compared to some place else, that again may or may not be valid, because you may be having a higher exposure rate for a shorter period of time.

I am just kind of curious why you would spread it over that period of time. I do not know if that is a very good scientific analysis.

Dr. HAGER. Let us look at one other one. I appreciate your questioning. But if you fly at 30,000 feet in a jet plane you get somewhere around a half millirem per hour, because you are above a good deal of the atmosphere.

If you take a 10-hour jet flight, which a lot of people do these days, you are getting 5 to 7 millirems in a relatively short time, maybe the same time that people here got similar exposures.

I do not think people worry about that, and I am not prepared to prove anything about it, but—

Mr. ERTEL. Let me stop you again. I am sorry to keep interrupting you.

You say people do not worry about it. Maybe we do not know enough to worry about it. Just because we do not worry about something does not mean it is not harmful.

I know a lot of people that smoke, and they do not worry about it.

Dr. HAGER. Right.

Mr. ERTEL. But I think we do have pretty hard scientific evidence that smoking does in fact increase the percentage of cancer, and there are some people on this panel that might see that. But I would hope that we could get down to some scientific basis, not what people perceive and so on, but maybe get to a base where we can have some analysis. That is what I am asking, maybe we could do that.

Dr. HAGER. I cannot give you an authoritative answer to your question, but it is my understanding that if you get a 7-millirem dose over a period of a week, or if you get it over a period of a year, that the effect is extremely small in either case, and I do not think anybody could ever prove there is a difference in the effect on people.

I have never heard of anything being done to establish the fact that there is a difference.

Mr. ERTEL. I was not here when you were both introduced.

Maybe we could start with Dr. Kepford, I would be interested in knowing your background, Dr. Kepford, what kind of background do you have, and what principal fields have you studied.

The same with you, Dr. Hager.

I would like to get that on the record. I think it would be important.

Dr. KEPFORD. I am a chemist, I have a Ph. D. in chemistry.

Mr. ERTEL. Where did you get it?

Dr. KEPFORD. The University of Calgary, Province of Alberta, Canada.

I worked for 2 years in East Hartford, Conn. in laboratories. I worked in Pennsylvania where I taught 2 years at the York Campus of Penn State.

I left there in 1971, I guess, and subsequently have been on the back of the nuclear industry.

I have been very, very deeply interested in the effects of radiation on human beings.

Mr. ERTEL. You say you have been on the backs of the nuclear industry?

Dr. KEPFORD. I have been a nuclear critic. I have been studying the problems of nuclear power, I think they are enormous and largely unsolved, and the problem of low-level radiation is one of them.

Mr. ERTEL. Have you done any experimental studies in low-level radiation?

Dr. KEPFORD. No; I have not. I have not done any work, nor been associated with an institution to get funding to do it.

I am very bothered though by the statements that I hear which refer to at least in my own mind as statements that I call "Utah all over again" statements, and that is that whatever is going on, it will not hurt us, it is the X-ray analogy.

The doses the people got around Three Mile Island from that accident were involuntary.

The $1\frac{1}{2}$ millirems, of whatever one gets when flying across the country, or for a week in Colorado, are voluntary, and that is a world of difference.

To hear that there is no imminent danger is an obfuscation.

If you are going to—

Mr. ERTEL. Dr. Kepford, I think I have a question here, if I may.

I asked you for your background. I am trying to keep this an orderly process. Can we continue with that?

Dr. KEPFORD. Yes, I have over the period of the last few years looked at the literature on the fundamental questions of radiation interactions with human beings, and I am really bothered that a lot of the fundamental questions have not been asked, and many of those that have been asked have been asked improperly, and the questionable experiments that have been carried out have been done very, very poorly.

Mr. ERTEL. Thank you very much, Dr. Kepford. Are you done with the analysis of your background? I want to give Dr. Hager a chance.

Any other training, experiments that you want to mention, any papers published?

Dr. KEPFORD. I have not submitted myself to any orthodox training. I think that gives me a much, much better overview of the subject.

Mr. ERTEL. What was your bachelor's degree in, Doctor?

Dr. KEPFORD. Chemistry.

Mr. ERTEL. Where?

Dr. KEPFORD. University of the Pacific, Stockton, Calif.

Mr. ERTEL. How about your master's?

Dr. KEPFORD. I did not get a master's. I went straight from the bachelor's to the Ph. D.

Mr. ERTEL. What was your doctoral thesis?

Dr. KEPFORD. It was a study of aromatic free radicals.

Mr. ERTEL. Dr. Hager, can you give us your background?

Dr. HAGER. Yes.

Mr. ERTEL. I did not mean to be impolite to you, but I want to get these things on the record I do not know either of you gentlemen, and I thought it would be possible to get both of them on the record.

Dr. HAGER. I got my bachelor's degree from Franklin and Marshall College, I spent 2 years with the U.S. Navy Submarine Forces during World War II. I went to Lehigh University where I got my master's degree in physics, I got my Ph. D. in physics from Lehigh in 1953; my thesis was in atomic physics. I analyzed the visible spectrum of the cobalt atom.

I then went to work with Vitro Corp. in West Orange, N.J., where I spent part of my time on a project involving bomb damage assessment in nuclear weapons.

Mr. ERTEL. Did that involve radiation?

Did it involve blast damage?

Dr. HAGER. It was both radiation and blast damage.

I then came to Lancaster, I have been working for the last 25 years in the subject of heat transfer research.

I have studied—

Mr. ERTEL. For whom?

Dr. HAGER. Armstrong Co. I work at the research center. In the course of this heat transfer research, I have spent most of my time recently developing energy conservation products. We have been putting energy conservation products on the market to reduce the need for powerplants.

I have worked in solar energy, and I have worked in Lancaster County Civil Defense for about 15 years.

I was director of the radiological division. During that time I published quite a bit of literature.

Mr. ERTEL. Have you done a dissertation or any scholarly papers on low radiation?

Dr. HAGER. I have done no work of my own on low level radiation.

All of my publications are in the field of heat transfer or energy conservation research.

Mr. ERTEL. Thank you.

Thank you, Mr. Chairman.

I know you have a lot more to say, and I am sorry I do not have the time to ask all of the rest of the questions.

Mr. AMBRO. Of course, I might say at the outset that, as with Mr. Winn, I come here with the concern of the subcommittee, but certainly with the help of Mr. Walker and Mr. Ertel in setting up these panels.

This is a public panel. I appreciate the questioning about your background, but what you say gives us the opportunity to highlight public concerns with respect to the welter of official witnesses to follow you.

If I can kind of sum up what you have said and done, Dr. Kepford, we discussed the readings, and I told you we would get into that. I think you said that the exposure levels which you have in front of you cannot at all be supported.

You want the NRC, as I understand it, to do a more effective job, to monitor beyond 13 miles to at least 40 miles, and with more dosimeters.

I think you suggested that you said the worst is yet to come from strontium-90, if it gets out, as you put it, from high concentrations.

Now, we will ask those specific questions because they reflect community perceptions. Are there any other highly visible issues that you think this panel should ask those who come behind you from the Nuclear Regulatory Commission, from DOE, from EPA, from the State agencies, or from the public utilities?

Dr. KEPFORD. Under the 1954 Atomic Energy Act, the NRC is committed with the task of protecting the health and safety of the public, and I think it would be appropriate for you to ask the representatives of the NRC why they did not do a better job in the neighborhood of the nuclear powerplants in regard to the programs.

Mr. AMBRO. I think questions like that should be more specific, because framed that way it becomes a value judgment.

Dr. KEPFORD. I think one thing that this data does show is that there was nowhere near enough monitoring, not far enough away from the plant.

Mr. AMBRO. I said that.

Dr. KEPFORD. Yes.

Mr. AMBRO. Anything else?

Dr. KEPFORD. I think not.

Mr. AMBRO. OK. Fine.

How about you, Dr. Hager?

Dr. HAGER. My thoughts lie in the direction of education and communication.

I believe that there should be a higher level of general education in the technological areas, because we are living in a scientific age, and I think it is as important to be conversant with some of the simple fundamentals of technology as it is to be able to speak our language and be able to handle mathematics.

I also think that in the area of communications, considerable attention should be given to having people be available on a standby alert basis at all times who are able to be transported immediately to the site of an incident, as soon as it is detected, in order to take over communications, and to supply information that people can have confidence in.

Those are my two main points.

Mr. AMBRO. I might say to you that while Members of Congress do indeed love to be in the beautiful Amish country on a Saturday, one of the functions of Congress is to investigate and from one of the ramifications of that is better dissemination of solid public evidence in order to, as you put it, educate, and hopefully, find a responsible and reasonable kind of course based on effective and accurate data, and that indeed is the reason why we are here. So having said that, I might say that we took a few more minutes with the public panel in order to assure that we asked the kinds of questions that are in the minds of the people who have an understanding of this accident. And now I want to thank both of you for your time and for your testimony.

Dr. KEPFORD. Thank you.

Dr. HAGER. Thank you.

Mr. AMBRO. I would now like to call our utility panel, Mr. Robert C. Arnold, vice president, Generation GPU Services Corp.; Dr. James Mudge, supervisor, Radiation Protection & Environmental Engineering, Metropolitan Edison Co.; Mr. Keith Woodard, consulting engineer, Pickard, Lowe, & Garrick, Inc.; and Mr. Syd Porter, Porter-Gertz, Consultants, Inc.

Gentlemen, you have heard that we swear witnesses at field hearings, and I would ask you to raise your right hand.

Do you swear to tell the truth, the whole truth and nothing but the truth, so help you God?

Mr. ARNOLD. I do.

Dr. MUDGE. I do.

Mr. WOODARD. I do.

Mr. PORTER. I do.

Mr. AMBRO. I leave it to the panel to determine the sequence of presentation.

Anyone who would like to proceed, if you will identify yourselves, please do so.

The panel has 15 minutes for an opening statement, and then we will go on to questions.

STATEMENTS OF ROBERT C. ARNOLD, VICE PRESIDENT—GENERATION, GPU SERVICES CORP.; DR. JAMES MUDGE, SUPERVISOR—RADIATION PROTECTION AND ENVIRONMENTAL ENGINEERING, METROPOLITAN EDISON CO.; KEITH WOODARD, CONSULTING ENGINEER—PICKARD, LOWE & GARRICK, INC.; AND SYDNEY PORTER, PRESIDENT OF PORTER-GERTZ CONSULTANTS, INC.

Mr. ARNOLD. Thank you, Mr. Chairman. We will certainly try to stay within our 15 minutes.

I am Robert C. Arnold, vice president of GPU Services Corp.

Since Friday of the week of the accident at Three Mile Island, I have been at the Island as the senior GPU official in charge of management of the recovery organization.

Mr. Chairman, we would like first to assure you of our sincere support and cooperation in the efforts of this committee to make known and to assess the impact of the Three Mile Island Unit 2 accident on the environment and nearby population.

To this end I have with me this morning Dr. James Mudge, supervisor of the radiation protection and environmental engineering section of the Metropolitan Edison Co. Dr. Mudge will provide a description of the Three Mile Island environmental monitoring program.

Mr. Keith Woodard, consulting engineer of Pickard, Lowe & Garrick, Inc. Mr. Woodard has been heavily involved in the Three Mile Island environmental monitoring program for many years. Since the accident, he has been involved in determining the airborne releases from the station and calculations of the resulting doses.

Mr. Sydney Porter, president of Porter-Gertz Consultants, Inc. Mr. Porter has been involved in the Three Mile Island environmental monitoring program since its inception.

Since the day of the accident, he has assisted in the measurement and assessment of liquid and gaseous releases from the station.

After some brief remarks, first by me and then by Dr. Mudge, we all will be available to respond to your questions.

The TMI plant design includes an external effluent monitoring system to determine the quantity of radioactive gaseous and liquid materials released from the plant.

Only extremely small quantities of these materials are released during routine operations. This monitoring system was in operation prior to and during the accident.

In addition, the environmental monitoring program, which will be described by Dr. Mudge, provides information for determining the impact of releases following the accident. Meteorological data are available from the onsite tower to support environmental analyses.

The only isotope of significance in liquid effluents associated with the accident has been iodine-131. About 0.23 Ci of this isotope has been

released in liquid effluents, most in the period March 31 through April 2, 1979.

Samples of river water collected downstream have shown no increase over normal background concentrations of radioactive materials except for four samples from the Columbia Water Treatment Plant which showed iodine-131 concentrations slightly above detectable limits on March 31 through April 2, and on May 12, 1979.

Measured concentration ranged from 0.4 to 1.5 pCi/l, less than 5 percent of the guidance for transient exposure being proposed by EPA's Office of Drinking Water.

Our evaluation of doses from liquid effluents indicates that doses have not exceeded NRC objectives determined to be as low as reasonably achievable for power reactors in normal operation (10 CFR 50, app. I) and that requirements of 10 CFR 20 have been met.

Calculations based on analyses of river water and other aquatic media indicate that no individual received more than a small fraction of 1 millirem to any organ and the population using river water received only a small fraction of a person-rem to any organ from liquid releases.

Airborne effluents of interest are in two categories—the first being those due to noble gases, and the second being those related to iodines and particulates.

Several hours following the accident, rapid increases in the noble gas effluent monitor data occurred, indicating that significant amounts of noble gas were being released to the environment.

Since the monitoring instrumentation is designed to measure extremely low levels of radioactive materials, the combination of high activity in the room where monitors are located and the apparent large quantity being released caused these monitors to indicate "off-scale," therefore, readings from area radiation monitors were used for estimating gas releases.

Measurements at the locations of the stationary environmental monitoring dosimeters confirmed doses estimated using the noble gas release estimates along with the atmospheric dispersion model.

The quantity of noble gases released is estimated to be about 12 million curies, virtually all of which was released in the first few days.

Our evaluation of the effects of those releases, both with respect to the peak offsite whole body dose and the population exposure, are in agreement with the Ad Hoc Population Dose Assessment Group.

Iodine samplers in the station ventilation exhaust systems were operational continuously throughout the accident and serve as a basis for release rate assessments for this isotope.

Less than 15 curies of iodine-131 have been released to the atmosphere through the end of May due to the accident.

Release rates were highest in the periods from March 28 through April 9, 1979 and from April 15 through April 20, 1979.

Exposure to iodine through the inhalation and grass-cow-milk pathways results in dose to the thyroid gland.

Our calculations for maximum thyroid dose due to inhalation and due to consumption of milk are in substantial agreement with the results of the Ad Hoc Population Dose Assessment Group.

I would now like to have Dr. Mudge proceed with a description of the radiological environmental monitoring program.

Mr. AMBRO. Before we do that, I note that our distinguished colleague, Congressman William F. Goodling, who represents York, Cumberland, and Adams Counties has joined us.

He has been most interested in these areas, and without objection, I would like to ask Congressman Goodling to come up and join us.

Dr. Mudge, you may proceed.

Dr. MUDGE. My name is James E. Mudge. I am employed as the supervisor Radiation Safety & Environmental Engineering, Metropolitan Edison Co.

In this capacity, I am responsible for implementation of the Three Mile Island Nuclear Station radiological environmental monitoring program—REMP—by Met-Ed's consultants, Teledyne Isotopes, Radiation Management Corp., and Porter-Gertz Consultants.

In my testimony I will briefly describe the scope of the REMP performed in the vicinity of TMINS, both before and after the TMI-2 accident on March 28, 1979.

A radiological environmental monitoring program for Three Mile Island Nuclear Station has been conducted by Metropolitan Edison Co. from June 1969, up until June 1974, so we have 5 years of background information prior to the operation of the plant.

June 5, 1974 marked the beginning of the operational phase of the program for unit 1. The operational phase for unit 2 began on March 28, 1978, which is the date this unit achieved initial criticality.

The objectives of the operational radiological environmental program are:

One. To determine whether any statistically significant increases occur in the concentration of radionuclides in critical pathways;

Two. To detect any buildup of long-lived radionuclides in the environment;

Three. To detect any change in ambient gamma radiation levels.

Four. To verify that radioactive releases are within allowable limits and the TMINS operation has no detrimental effects on the health and safety of the public or on the environment; and

Five. To fulfill the obligations of the radiological environmental surveillance sections of the environmental technical specifications.

In order to meet the stated objectives, samples for the operational REMP are taken from the aquatic, atmospheric, and terrestrial environments. Samples of various media are selected to obtain data for the evaluation of the radiation dose to man and important organisms.

Sample types are based on one, established critical pathways for the transfer of radionuclides through the environment to man—figure 1—and two, experience gained during the preoperational and earlier operational phases.

Sampling locations are determined from site meteorology, Susquehanna River hydrology, local demography, and land uses.

Sampling locations are divided into two classes—indicator and control. Indicator stations are those which are expected to show station effects, if any exist; control samples are collected at locations which are believed to be unaffected by station operations.

Fluctuations in the levels of radionuclides and direct radiation at indicator stations are evaluated with respect to analogous fluctuations at control stations, which are unrelated to station operations.

Indicator station data are also evaluated relative to background characteristics established prior to station operation. Additional samples beyond those required by the environmental technical specifications are collected, analyzed, and designated as management audit samples.

The analysis of samples and the analytical data generated during the program are routinely evaluated by the TMI project leader who is the liaison with Metropolitan Edison Co. personnel.

I believe if you will turn to figure 1, this presents an exposure of pathways to man.

Mr. AMBRO. If I may interrupt you for a moment, we will be rather pressed for time. If you could summarize, we would appreciate it, and get us to the questioning point.

I am sure many of the panel members would like to question you.

We will incorporate without objection in the record your statement.

Dr. MUDGE. All right. Very good.

Some of the points I would like to highlight in the testimony, are the sampling locations are divided into two classes, indicator and control. The indicator stations are those that show station effects, and the control samples are collected at locations which are believed to be unaffected by the stations' operation.

All sampling stations prior to 1974 would serve as background information.

Table I on page 6 summarizes information on Three Mile Island Nuclear Station operational REMP.

I believe if you will look at that, you will see in 1978 there were over 900 different types of samples collected within the year.

Appendix A explains the system, and the maps on A-1, A-2, and A-3 show their locations, and I believe you are interested in the sampling locations.

On March 29 an emergency REMP was implemented and the emergency REMP required in addition to all of the normal sampling an increased sampling and analysis frequency, the addition of new sampling stations.

After the accident, and this is all laid out in my prepared statement on page 3 in the last paragraph, where water samples were collected daily at nine locations.

I will not read any further. That concludes my remarks.

[The prepared statement of Dr. Mudge follows:]

TESTIMONY BEFORE SUBCOMMITTEE ON NATURAL RESOURCES AND ENVIRONMENT OF
HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

My name is James E. Mudge. I am employed as the Supervisor—Radiation Safety and Environmental Engineering for Metropolitan Edison Company. In this capacity I am responsible for implementation of the Three Mile Island Nuclear Station (TMINS) radiological environmental monitoring program (REMP) by Met-Ed's consultants, Teledyne Isotopes (TI), Radiation Management Corporation (RMC) and Porter-Gertz Consultants (PGC).

In my testimony I will briefly describe the scope of the REMP performed in the vicinity of TMINS, both before and after the TMI-2 accident on March 28, 1979.

A radiological environmental monitoring program (REMP) for Three Mile Island Nuclear Station (TMINS) has been conducted by Metropolitan Edison Company since June 1969. The REMP has a preoperational program and an operational program. Unit 1 achieved initial criticality on June 5, 1974, which marked the beginning of the operational phase of the REMP for Unit 1. The Operational REMP for Unit 2 began on March 28, 1978, when this unit achieved initial criticality.

In the operational phase of the REMP, radioanalytical data are collected for comparison to that generated in the preoperational phase. Differences between these two periods are compared to determine whether any station effects exist based on the magnitude and fluctuations of radioactivity levels determined in the preoperational phase.

The objectives of the operational radiological environmental program are:

1. To determine whether any statistically significant increases occur in the concentration of radionuclides in critical pathways;
2. To detect any buildup of long-lived radionuclides in the environment;
3. To detect any change in ambient gamma radiation levels;
4. To verify that radioactive releases are within allowable limits and that TMINS operation has no detrimental effects on the health and safety of the public or on the environment; and
5. To fulfill the obligations of the Radiological Environmental Surveillance sections of the Environmental Technical Specifications.

In order to meet the stated objectives, samples for the operational REMP are taken from the aquatic, atmospheric, and terrestrial environments. Samples of various media are selected to obtain data for the evaluation of the radiation dose to man and important organisms. Sample types are based on (1) established critical pathways for the transfer of radionuclides through the environment to man (Figure 1), and (2) experience gained during the preoperational and earlier operational phases. Sampling locations are determined from site meteorology, Susquehanna River hydrology, local demography and land uses.

Sampling locations are divided into two classes—indicator and control. Indicator stations are those which are expected to show station effects, if any exist; control samples are collected at locations which are believed to be unaffected by station operations. Fluctuations in the levels of radionuclides and direct radiation at indicator stations are evaluated with respect to analogous fluctuations at control stations, which are unrelated to station operations. Indicator station data are also evaluated relative to background characteristics established prior to station operation. Additional samples beyond those required by the Environmental Technical Specifications are collected, analyzed and designated as management audit samples. The analysis of samples and the analytical data generated during the program are routinely evaluated by the TI project leader who is the liaison with Metropolitan Edison Company personnel.

Table I summarizes information on the Three Mile Island Nuclear Station operational REMP. Appendix A explains the sample coding system which specifies sample type and relative locations at a glance. Table A-1 gives the pertinent information on individual sampling locations, prior to the TMI-2 accident, while Maps A-1, 2, and 3 show their geographic locations.

On March 29, 1979 an Emergency REMP was implemented. The Emergency REMP requires, in addition to all normal operational REMP procedures, an increased sampling and analysis frequency and the addition of new sampling stations. From Table 2, specific examples of the increased intensity are: (1) surface and drinking water, which prior to the accident were composited on a monthly and/or quarterly basis at seven locations, after the accident were collected daily at nine locations; (2) the thermoluminescent dosimeters (TLDs), which prior to the accident were placed at twenty locations every quarter, after the accident were collected and replaced every three days; (3) milk samples, radioiodine analyses, which prior to the accident were collected on a bimonthly or monthly frequency, after the accident were collected daily; (4) air particulate, gross beta analyses, which prior to the accident were done weekly, after the accident were increased to at least once every three days; (5) air iodine analyses, which prior to the accident were done weekly at four locations, after the accident were performed every three days at eight locations; and (6) fishes, aquatic sediment and aquatic plants, which prior to the accident were sampled on a semiannual frequency, after the accident were sampled weekly. Two days ago, for the first time since the accident occurred, we reduced the intensity of the emergency the REMP Data center to both the TMI Effluent/Environmental

Assessment Group and the Pennsylvania Bureau of Radiological Health. These groups are immediately advised by telephone of any significant results.

ES-2510

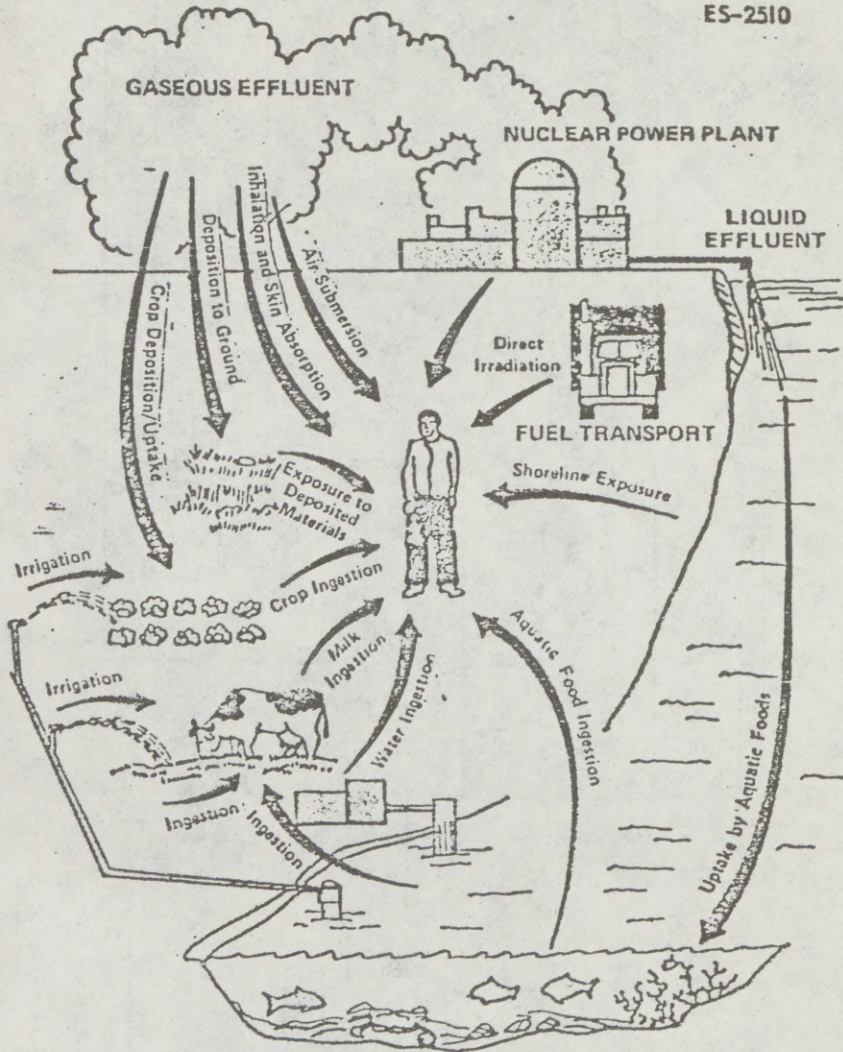


FIGURE 1.—Exposure pathways to man.

Figure 2

THREE MILE ISLAND NUCLEAR STATION
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM (REMP)
DATA FLOW

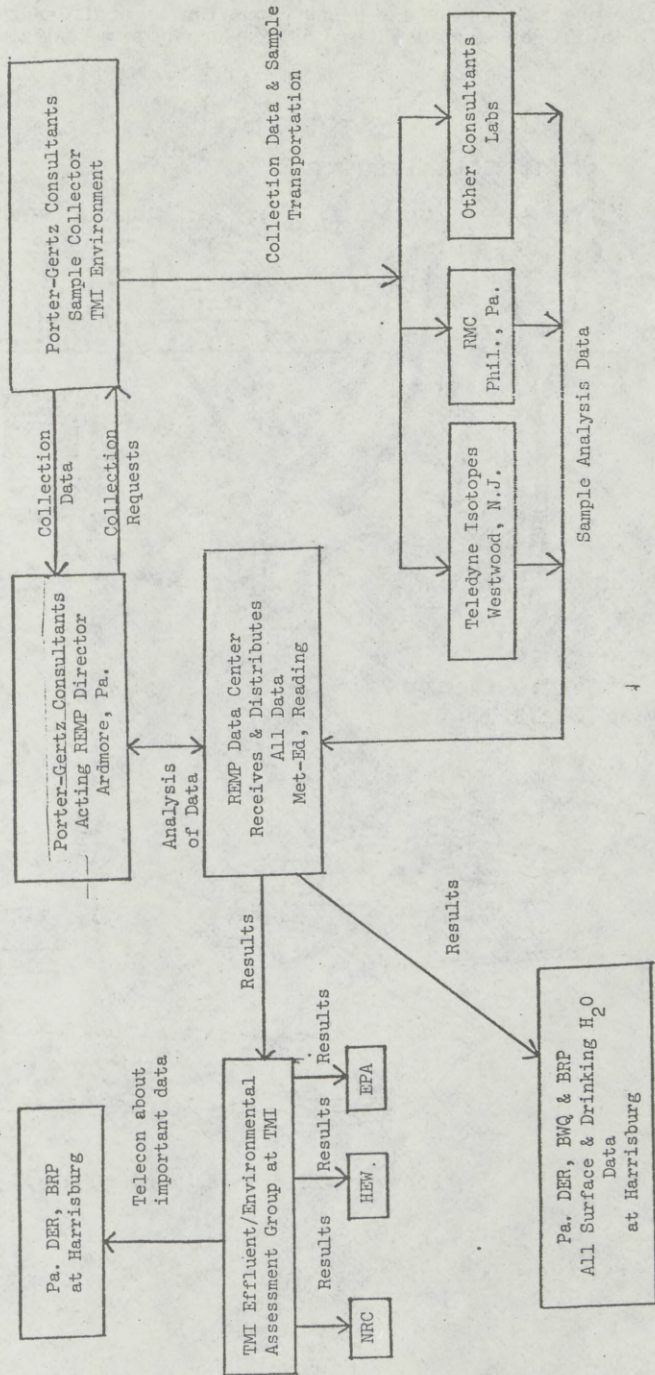


FIGURE 2

METROPOLITAN EDISON CO.

TABLE 1.—SYNOPSIS OF THE OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM FOR TMINS—JAN. 1 THROUGH DEC. 31, 1978

Sample type	Collection frequency	Sampling locations	Number of samples collected	Type	Analysis frequency	Number of samples analysed
Surface water/drinking water.	MC	7	82	I-131-----	MC	47
				Beta-----	MC	81
				Gamma-----	MC	81
				H-3-----	MC	81
				Sr-89-----	QC	16
				Sr-90-----	QC	16
				H-3-----	QC	28
Fish-----	SA	2	8	Sr-89-----	SA	8
				Sr-90-----	SA	8
				Gamma-----	SA	3
Sediment-----	SA	3	6	Sr-89-----	SA	6
				Sr-90-----	SA	6
				Gamma-----	SA	6
Air particulates-----	W	8	395	Beta-----	W	395
				Gamma-----	MC	24
				Gamma-----	QC	32
				Alpha-----	QC	8
				Sr-89-----	QC	8
				Sr-90-----	QC	8
Air iodine-----	W	4	197	I-131-----	W	197
Precipitation-----	M	4	48	Beta-----	M	48
				Gamma-----	QC	16
				H-3-----	QC	16
				Sr-89-----	SA	8
				Sr-90-----	SA	8
Milk-----	M	6	94	I-131-----	M, bi-M	92
				Gamma-----	M, bi-M	94
				Sr-89-----	QC	23
				Sr-90-----	QC	23
Green leafy vegetables...	A	5	6	Gamma-----	A	6
Dosimeters-----	Q	20	77	Gamma dose-	Q	77×4=308

The Emergency REMP requires, in addition to all operational REMP procedures, an increased sampling and analysis frequency and the addition of new analyses and sampling locations. The table below describes the Emergency REMP which started on March 29, 1979.

TABLE 2

Media	Indicator locations	Background locations	Sampling frequency	Analyses ¹
Air particulates-----	5	3	Every 3 days ² -----	Gross beta, gamma spec.
Air iodine-----	5	3	Every 3 days ² -----	Radioiodine.
Surface/drinking water-----	³ 5	2	Daily ⁴ -----	Gross beta, radioiodine.
Effluent water-----	1	0	Daily ⁴ -----	Tritium, gamma spec.
Precipitation (rain water)-----	2	2	As available ⁵ -----	Gamma spec.
Fishes-----	1	1	Weekly-----	Gamma spec, strontium.
Aquatic plants-----	2	1	Weekly (if available)-----	Gamma spec.
Aquatic sediment-----	2	1	Weekly-----	Gamma spec, strontium.
Milk-----	⁶ 4	1	Daily-----	Radioiodine, gamma spec.
Vegetation-----	4	1	Monthly-----	Radioiodine, gamma spec.
Soil-----	4	1	Monthly-----	Gamma spec.
Miscellaneous foodstuffs ⁷ -----	1	1	As available-----	Gamma spec.
TLD-----	15	5	Every 3 days ² -----	Dose rate.

¹ The listed analyses are performed on each sample and are additional to those performed in the operational REMP.
² Sampling periods were from Mar. 29 to 31, Mar. 31 to Apr. 3, and every 3 days thereafter until Apr. 24, 1979. As of Apr. 24, 1979 samples are collected weekly.

³ An indicator location was added on Apr. 22, 1979.

⁴ Sampling was done on Mar. 29, Mar. 31, and daily thereafter.

⁵ Precipitation was collected on Mar. 31, Apr. 5 and Apr. 27.

⁶ Milk is not always available from a goat farm due to its use by newborn goats.

⁷ Includes poultry, beef, eggs, pork, and game if available.

TABLE 3.—OFF-SITE EMERGENCY RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM; AS OF MAY 31, 1979

Media	Collection frequency ²	Analyses	Analyses frequency	Action level ³
Air particulates.....	Weekly.....	Gross beta.....	Each sample.....	Indicator >10X background.
Air iodine.....	Weekly.....	Radioiodine.....	Each sample.....	0.9 pCi/m. ⁴
Surface/drinking water.....	Daily.....	Radioiodine.....	Each sample.....	2 pCi/l.
		Gross beta.....	Weekly composite.....	Indicator >10X background.
		Tritium.....	Weekly composite.....	20,000 pCi/l.
		Gamma spec.....	Weekly composite.....	Indicator >10X background.
Effluent water.....	Daily.....	Radioiodine.....	Each sample.....	
		Gross beta.....		
		Tritium.....		
		Gamma spec.....		
Precipitation.....	Monthly.....	Radioiodine.....	Monthly.....	2 pCi/l.
		Gross beta.....		Indicator >10X background.
		Tritium.....		20,000 pCi/l.
		Gamma spec.....		Indicator >10X background.
Fishes.....	Semiannually (July and October).	Strontium.....	Each sample.....	Indicator >10X background.
	(July and October).	Gamma spec.....		Indicator >10X background.
Aquatic plants.....	Semiannually (July and October).	Gamma spec.....	Each sample.....	Indicator >10X background.
Aquatic sediment.....	Semiannually (July and October).	Gamma spec.....	Each sample.....	Indicator >10X background.
Milk ⁴	Weekly.....	Radioiodine.....	Each sample.....	5 pCi/l.
		Gamma spec.....	Each sample.....	Indicator >10X background.
Miscellaneous food stuffs.....	As available.....	Gamma spec.....	Each sample.....	
TLD.....	Monthly.....	Dose rate.....	Each sample.....	Indicator >10X background.

¹ The normal operational Radiological Environmental Monitoring Program required by the ETS continues to be maintained per table 1.

² Samples are collected only if available.

³ This level, if exceeded, by confirmed analyses, results in the implementation of the more intense surveillance program for that media and location as described in table 2, until the radioactivity levels are below the action level for 3 successive samples.

⁴ 1 milk location (goat farm at 1B1) is in excess of the action level and will be sampled daily if sufficient milk is available.

TABLE 4

THI - RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Sample Collection/Receipt Sheet

Surface Water

THI LAB NO.	STATION CODE	DATE START	DATE STOP	SAMPLE QUANTITY	COMMENTS
	TH-SW-15F1				
65224	TH-SW-15F1 Steelton	1	18:35 4-1-79	2 gal	Grab Finished H ₂ O
65330	TH-SW-8E1 Brunner Is.	10:00 3-31-79	16:30 4-1-79	2 gal	Hourly Composite Raw H ₂ O (Picked 16:50)
65327	TH-SW-7G1 Columbia		14:55 4-1-79	2 gal	Grab Raw H ₂ O
	TH-SW-15F1				
	TH-SW-15F1				
	TH-SW-15F1				
	TH-SW-15F1				
	TH-SW-15F1				Sampled At Launch Ramp
	TH-SW-15F1				Sampled Not On-Dam
65332	TH-SW-15F1 York H ₂ O		15:30 4-1-79	2 gal	Finished H ₂ O
65328	TH-SW-15F1 York H ₂ O	09:30 3-31-79	4-1-79 16:40	2 gal	Raw H ₂ O

Approved Metropolitan Edison Co.

B/H 4/3/79

Collected By R. Laughlin & R. Shae

Delivered By R. Shae

Received By D. Martin per Eee

Date Received 4/3/79

TABLE 5.—TELEDYNE ISOTOPES: REPORT OF ANALYSIS

Teledyne sample No.	Customer's identification	Stn. No.	Collection date				Nuclide	Activity (pCi/liter)	Nucl unit— Percent U/M	Mid-count time		Volume—Units		Lab.	
			Start		Stop					Date	Time	Ash	Weight		Percent
			Date	Time	Date	Time									
Ms. B. A. Good, Metropolitan Edison Co., P.O. Box 542, Reading, Pa. 19640															
Work order No. 3-3357 Customer P.O. No. M77121 CO 1 Date received 4/2/79 Delivery date 5/2/79															
WATER—DRINKING															
5334	TM-SW-15P1 GRAB fnshd	15F1				4/1	1835	I-131	<2	E-01	4/3	---	---	---	
								BE-7	<6	E-01	5/1	---	---	---	
								K-40	<1	E-02	5/1	---	---	---	
								MN-54	<5	E-00	5/1	---	---	---	
								CO-58	<6	E-00	5/1	---	---	---	
								FE-59	<2	E-01	5/1	---	---	---	
								CO-60	<5	E-00	5/1	---	---	---	
								ZN-65	<9	E-00	5/1	---	---	---	
								ZR-95	<7	E-00	5/1	---	---	---	
								RU-103	<8	E-00	5/1	---	---	---	
								RU-106	<5	E-01	5/1	---	---	---	
								I-131	<7	E-01	5/1	---	---	---	
								CS-134	<5	E-00	5/1	---	---	---	
								CS-137	<5	E-00	5/1	---	---	---	
								BA-140	<2	E-01	5/1	---	---	---	
								CE-141	<2	E-01	5/1	---	---	---	
								GE-144	<6	E-01	5/1	---	---	---	
								RA-226	<1	E-02	5/1	---	---	---	
								TH-228	<1	E-01	5/1	---	---	---	
								H-3	<1	10E-02	4/4	---	---	---	
								I-131	<2	E-01	4/3	---	---	---	
								BE-7	<8	E-01	5/1	---	---	---	
								K-40	<2	E-02	5/1	---	---	---	
								MN-54	<6	E-00	5/1	---	---	---	
								CO-58	<7	E-00	5/1	---	---	---	
								FE-59	<2	E-01	5/1	---	---	---	
								CO-60	<7	E-00	5/1	---	---	---	
								ZN-65	<1	E-01	5/1	---	---	---	
								ZR-95	<8	E-00	5/1	---	---	---	
								RU-103	<1	E-00	5/1	---	---	---	
								RU-106	<6	E-01	5/1	---	---	---	
								I-131	<9	E-01	5/1	---	---	---	
65336	TM-SF-15P1 GRAB fnshd	15F1				4/2	0930	I-131	<2	E-01	4/3	---	---	---	
								BE-7	<8	E-01	5/1	---	---	---	
								K-40	<2	E-02	5/1	---	---	---	
								MN-54	<6	E-00	5/1	---	---	---	
								CO-58	<7	E-00	5/1	---	---	---	
								FE-59	<2	E-01	5/1	---	---	---	
								CO-60	<7	E-00	5/1	---	---	---	
								ZN-65	<1	E-01	5/1	---	---	---	
								ZR-95	<8	E-00	5/1	---	---	---	
								RU-103	<1	E-00	5/1	---	---	---	
								RU-106	<6	E-01	5/1	---	---	---	
								I-131	<9	E-01	5/1	---	---	---	

APPENDIX A

SAMPLING LOCATIONS

SAMPLE IDENTIFICATION

Metropolitan Edison identifies samples by a three-part code. The first two letters are the power station identification code; in this case, TM. The next one to three letters are for the media sampled.

AI=Air Iodine
AP=Air Particulates
AQF=Fish
AQP=Aquatic Plants
AQS=Sediment
E=Soil
FPF=Fruit

FPL=Green Leafy Vegetables
ID=Immersion Dose (TLD)
M=Milk
RW=Precipitation
SW=Surface Water
V=Fodder Crops
MG=Milk (Goats)

The last four symbols are a location code based on direction and distance from the site. Of the last four symbols, the first two represent each of the 16 angular sectors of $22\frac{1}{2}$ degrees centered about the reactor site. Sector one is divided evenly by the north axis and the other sectors are numbered in a clockwise direction; i.e., 2=NNE, 3=NE, 4=ENE, 5=E, etc. The next digit is a letter which represents the radial distance from the plant:

S=Onsite location
A=0-1 miles offsite
B=1-2 miles offsite
D=3-4 miles offsite

E=4-5 miles offsite
F=5-10 miles offsite
G=10-20 miles offsite
H=L.T. 20 miles offsite

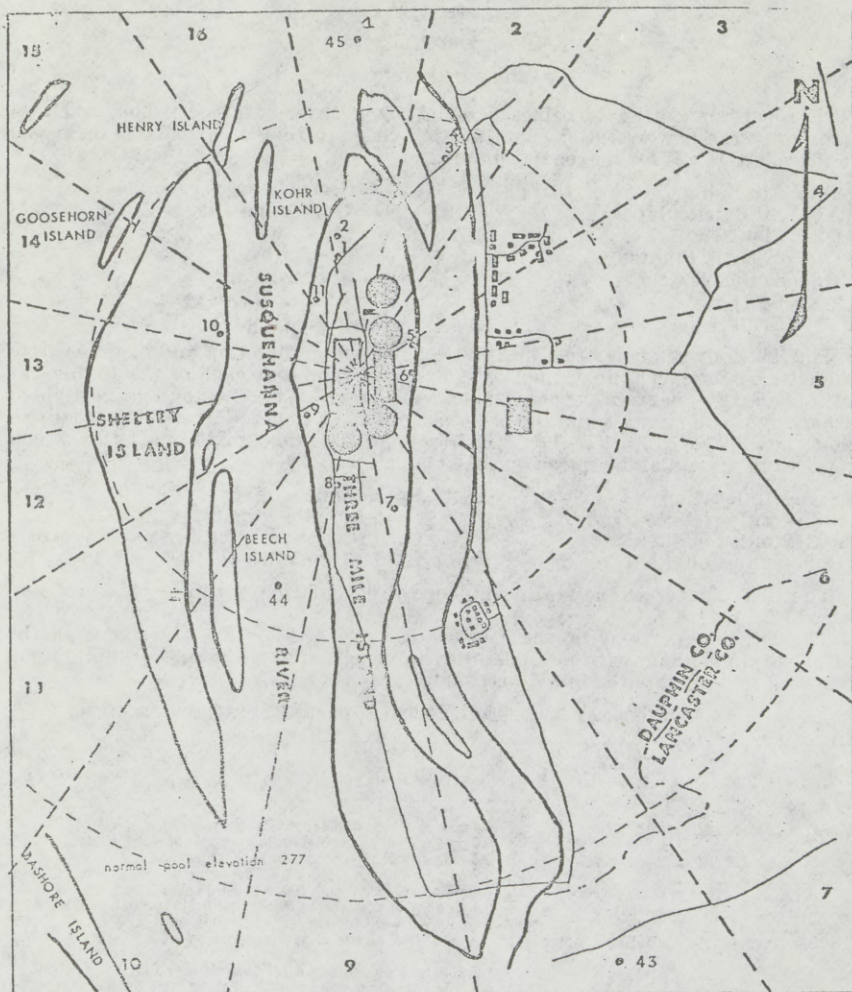
The last number is the station numerical designation within each sector and zone; e.g., 1, 2, * * *.

The location portions of these codes (i.e. 1S1, 3A1, etc.) are shown in the attached table along with more detailed information and a map coordinate number used to designate the individual samples.

TABLE A-1.—RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SAMPLING LOCATIONS

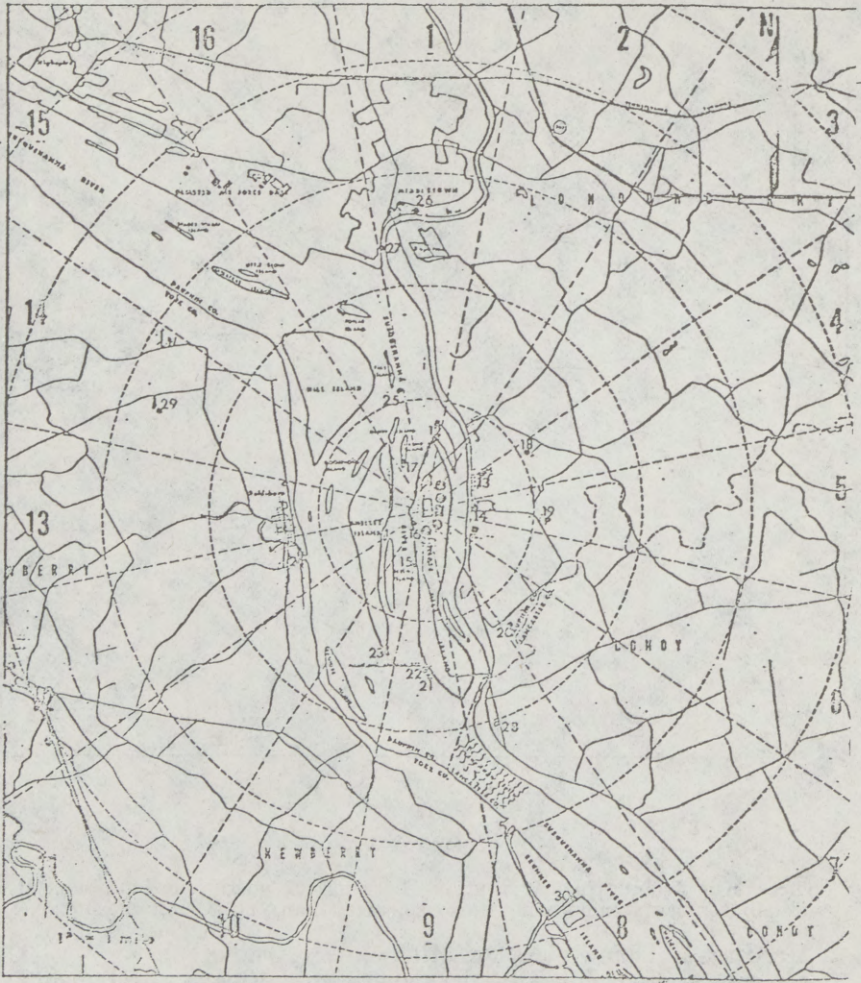
Sample medium	Location code	Map no.	Description ¹
AI, AP, ID.....	1S2	2	0.4 mile N of site, N. Weather Station.
ID.....	2S2	3	0.7 mile NNE of site on light pole in middle of North Bridge.
ID.....	4S2	5	0.3 mile ENE of site on top of dike, East fence.
ID.....	5S2	6	0.2 mile E of site on top of dike, East fence.
ID.....	9S2	8	0.4 mile S of site at South Beach of Three Mile Island.
ID.....	11S1	9	0.1 mile SW of site, west of Mechanical Draft Towers on dike.
ID.....	14S1	10	0.4 mile WNW of site at Shelly's Island picnic area.
ID.....	16S1	11	0.2 mile NNW of site at gate in fence on west side of Three Mile Island.
AQP, AQS.....	1A2	12	0.7 mile N of site at north tip of Three Mile Island.
ID.....	4A1	13	0.5 mile ENE of site on Laurel Rd., Met. Ed. pole No. 668-OL.
AI, AP, ID, RW.....	5A1	14	0.4 mile E of site on north side of Observation Center Bldg.
AQP, SW.....	9A2	15	0.5 mile S of site below Discharge Pipe.
ID.....	16A1	17	0.4 mile NNW of site on Kohr Island.
M.....	4B1	18	1.1 miles ENE of site, west of Gringrich Rd.
FPL, M.....	5B1	19	1.0 mile E of site on Peck Rd.
FBL, N.....	7B3	20	1.6 miles SE of site on east side of Conewago Creek.
AQP, AQP, AQS, SW.....	9B1	21	1.5 miles S of site, above York Haven Dam.
ID.....	10B1	23	1.1 miles SSW of site on south beach of Shelly's Island.
AP, ID.....	12B1	24	1.6 miles WSW of site adjacent to Fishing Creek.
AQF.....	16B1	25	1.1 miles NNW of site below Fall Island.
AI, AP, ID.....	1C1	26	2.6 miles N of site at Middletown Substation.
SW.....	1C3	27	2.3 miles N of site at Swatara Creek.
AI, AP, ID, RW.....	8C1	28	2.3 miles SSE of site.
FPL, M.....	14C1	29	2.7 miles WNW of site near intersection of Routes 262 and 392.
SW.....	8E1	30	4.1 miles SSE of site at Brunner Island.
AI, AP, ID, RW.....	7F1	34	9 miles SE of site at Drager Farm off Engle's Tollgate Rd.
SW.....	15F1	35	8.7 miles NW of site at Steelton Municipal Water Works.
FPL, M.....	2G1	36	2 miles NNE of Hershey on Rt. 39 Hummelstown.
ID.....	4G1	37	10 miles ENE of site at Lawn—Met. Ed. Pole No. J1813.
ID, SW.....	7G1	38	15 miles SE of site at Columbia Water Treatment Plant.
AP, ID.....	9G1	39	13 miles S of site in Met. Ed. York Load Dispatch Station.
AI, AP, ID, RW.....	15G1	40	15 miles NW of site at West Fairview Substation.
SW.....	8C2	43	2.3 miles SSE of site—York Haven Hydro.
AQS.....	10A1	44	0.8 mile SSW of site.
M.....	1B1	45	1.2 miles N of site—along Rt. 441.

¹ All distances are measured from a point that is midway between the Reactor Buildings of Units 1 and 2.



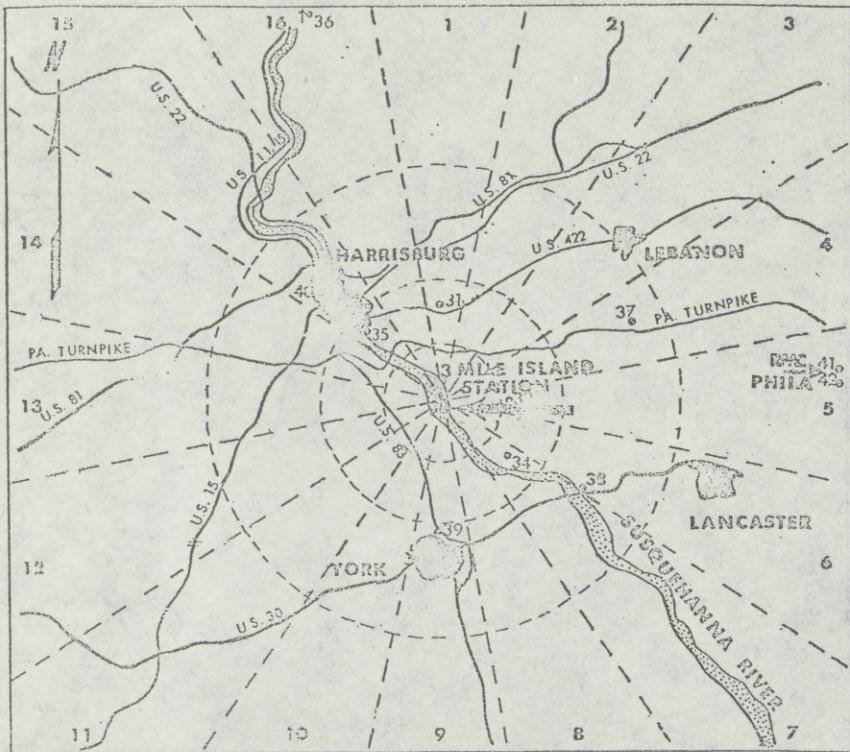
Map A-1

Three Mile Island Nuclear Station—Location of operational radiological environmental monitoring stations within the site boundaries.



Map A-2

Three Mile Island Nuclear Station—Location of operational radiological environmental monitoring stations within 5 miles of the site.



1" = APPROX. 10 MILES

Map A-3

Three Mile Island Nuclear Station—Location of operational radiological environmental monitoring stations greater than 5 miles from the site.

Mr. ERTEL. Thank you, Dr. Mudge, Mr. Arnold.

Do any other members of the panel want to make a statement?

Mr. ARNOLD. No, sir, we are ready for your questions.

Mr. ERTEL. Mr. Mudge, are you testifying as an expert on radiological and environmental monitoring?

Dr. MUDGE. I am testifying as the supervisor of safety radiation and environmental engineering. I have my Ph. D. from the Pennsylvania University, which I received in 1972.

From 1972 through 1973, I was employed by Texas Instruments. Two years after graduation from Penn State, I worked with Texas Instruments at the Indiana Point Nuclear Facility, in assessing the aquatic impact of that particular facility.

From 1974 until 1978, I was employed by Metropolitan Edison Co. as an environmental scientist, an engineer-3, and an engineer senior-1; my responsibility included a consortium of consultants to perform different kinds of monitoring programs, evaluation of bids, and so forth.

Mr. ERTEL. I guess directly, do you have any background in low-level radiation?

Dr. MUDGE. I have no background in low-level radiation.

My background in radiation, I worked on sodium-22 and -24, when I was doing my doctoral thesis.

Mr. ERTEL. All right. Thank you. I guess this is an interesting question that was picked up yesterday.

I was under the impression that they were told yesterday that the monitors had been blanked off as far as the iodine was concerned, because they were saturated by the noble gases.

If that is true, then how do you come up with any kind of measurement of the iodine which may be released?

Mr. ARNOLD. The in-plant monitoring system has two features to it.

There is the instantaneous readout on an iodine channel, and then that device for scanning charcoal filters which are actually collecting the iodine, so that one is able under normal situations to be monitoring the iodine releases by the rate of buildup in the collector.

That aspect of the monitoring equipment was blanked out, as it were—was overwhelmed by the amount of gaseous activity.

However, the sampling of the iodine being collected on the charcoal filter could still be removed from the sampling device and counted so that the accumulation of iodine over a given period of time were still able to be measured.

Mr. ERTEL. I have been advised the charcoal filters become less effective as they become saturated with iodine, is that correct?

Mr. ARNOLD. That is correct from a direction standpoint. We changed them out periodically during the conditions that we had.

Mr. ERTEL. Were they changed periodically during the 3-day period during the incident—I should say the accident?

Mr. ARNOLD. Yes, sir, they were.

Mr. ERTEL. How often were they changed, and were they saturated, and then did they become less effective during that period of time?

Mr. ARNOLD. I would suggest you have Mr. Porter respond to that.

Mr. PORTER. The charcoal filters were changed approximately once a day, sometimes $1\frac{1}{2}$ days. As far as the saturation, we had done careful studies on the charcoal, CP-100 charcoal, the characteristic of this is well known, and we had these checked for the flow rates that were going through them at the time, and for the species analysis of iodine going through them, we had better than 96 percent efficiency at all times during all collections, and this is documented by an independent analysis, SAI, who are experts in charcoal species analysis, and charcoal efficiency measurements.

Mr. ERTEL. I have a couple of questions about the radioactive water which you still have on the facility, and I guess Mr. Arnold would be the best to respond to those.

Mr. DeCamp, who is your chairman of the board—

Mr. ARNOLD. He is the president.

Mr. ERTEL [continuing]. Assured me that you would weigh all alternatives to dumping that water into the Susquehanna River. Regardless of whether you meet the monitoring tests, or the levels that NRC set for the dumping, he thought that it might be appropriate to

find a different way to dispose of that rather than in the Susquehanna, because people drink from the Susquehanna, there are dams downstream where there would be a collection of that water, etc.

Have you explored alternatives to the disposing of that radioactive water?

Mr. ARNOLD. Mr. Ertel, first of all, I would like to say that we are, I think, very sensitive, and also very concerned about the anxiety that exists with regard to discharge of that water.

We have not yet completed examining all of the possibilities that exist to discharge.

I would emphasize that the discharge of the water is not a necessary element to the cleanup of the water.

We think that there is a very high priority associated with cleaning that water.

We will make provision to hold the water in temporary tanks as is necessary to gain satisfaction on all parties concerned, I think that all alternatives have been adequately explored.

Mr. ERTEL. Well, I am not sure, Mr. Arnold, what other alternatives are you exploring for disposal of the water?

Mr. ARNOLD. I think the alternatives that exist are not for discharge immediately, but to reutilize it from the plant, the so-called recycled water, that should not be confused, though, with no discharge of it, since that would then become part of the water that is routinely discharged in some dilute manner.

The more or less permanent holding of it in hold-up tanks is obviously a technical possibility, the dumping of it in some other location, which would be difficult, I think, to understand where another location Susquehanna River, but that is part of what we are looking at, the utilization of some form that would tie it up permanently also would be examined.

Mr. ERTEL. To stay on that, and I will yield to my colleagues, will we have your assurance before any action is taken on that water, that there will be an announcement of what will be done with the water in sufficient time for the community to react?

Mr. ARNOLD. If the question relates to being sure that the communities are advised of what our plans are well in advance of the execution of those plans, so they can take whatever action they desire, I can give you assurance.

If the discharge is something that stretches out over some period of time, for example, if recycled, and then subsequently there is discharge in determining a time of a very small portion of that water, then the practicalities of the advanced notice could come into play.

Mr. ERTEL. I guess what we are worried about more than anything is a major discharge or change of position of that water.

Obviously Met Ed's credibility, as we are all aware, has suffered tremendously as a result of this accident, and therefore it seems to me to do something with that water, and then subsequently tell the community would not be beneficial for anyone.

Mr. ARNOLD. It certainly would not serve our interests, sir.

Mr. ERTEL. And I would hope that adequate notice would be given so that the community could take action if they felt it proper for the Congress.

I yield to my colleague, Mr. Walker.

Mr. WALKER. Thank you for yielding.

I would like to follow up a little bit on the water question too.

I think that is the most serious environmental quality question on the minds of the people in this area. It is the thing I am hearing the most about.

I think it is important to try to clarify what some of the fears are.

For instance, one of the main things we are concerned about is the fact that the company has indicated along the way, and NRC has confirmed, that the tritium in the water is something which cannot be taken out regardless of what techniques for cleaning up is used. Tritium is not something that present technology is able to take out, is that a correct statement?

Mr. ARNOLD. Yes, sir, that is correct.

Mr. WALKER. Could you tell me whether or not I am correct, that the tritium concentration overall in the water is something on the order of 1 microcurie per milliliter—is that a close approximation of what levels of tritium we have in the water?

Mr. ARNOLD. I think that probably is a somewhat higher concentration than we have in this water at this time.

I would suspect it is more like one-tenth of that value.

Mr. WALKER. You think it is closer to a tenth of that value?

Mr. ARNOLD. Yes, sir.

Mr. WALKER. Well, the question that arises on the part of many of the people in this area is that that would be considerably less than a safe level to be put in the drinking water, even at one-tenth of that, if it is in fact 1 microcurie per milliliter, my information is that would be 300 times what would be regarded as a safe drinking level.

If it is one-tenth of that, that would still be 30 times higher than what would be regarded as a safe drinking water level, and I think that the concern over the cleanup of that water, and possible dumping of it in the Susquehanna River, very much relates to that kind of a problem. People just are not willing to accept that kind of risk as a part of the cleanup procedure.

Mr. ARNOLD. Yes, sir, I understand that, and I think there are probably two things that are germane to discussion of that issue.

First of all, that nuclear plants routinely discharge tritium in the water that comes from normal operation of the plant.

Second, within the Susquehanna River—

Mr. WALKER. At levels 30 times as high as what is considered safe drinking water?

Mr. ARNOLD. No, sir, I think we need to again realize that is concentration of the waters, as they exist within the plant.

There would be dilution within the plant processing systems prior to that being discharged into the river, as well as the pollution that occurs in the river, and my recollection is that the levels that we would expect to add to the river are less than one-tenth the normal background levels of tritium that are presently in the Susquehanna River.

Mr. WALKER. That might be true after the cleanup procedure.

As I say, the assumption we are working on is that you cannot clean it out, is what you are saying is that you would dilute it, and you would depend upon the river to further dilute it, is that correct?

Mr. ARNOLD. Our requirements for discharge do not take into account river dilution.

That is another fact of the situation. Our discharge would have to meet discharge limits based upon the dilution that takes place in the plant processes.

Mr. WALKER. What would be the level, if you were to go ahead and discharge into the Susquehanna, which I hope will never happen, but if you were to go ahead and discharge into the Susquehanna River, at what level would be the tritium content be when it reaches the river? How many microcuries per milliliter?

Mr. ARNOLD. The minimum dilution that it would receive prior to going into the river would be 100 I would estimate, and it probably would be more in the order to 400 to 500 times.

In other words, it would be diluted by a factor of 400 to 500.

Obviously, the amount of dilution would make, it would be done prior to discharge, that is flexible on our part.

Mr. WALKER. That is what I am asking, in the cleanup, you have obviously evolved, as I understand, the cleanup procedure at this point.

That is a part of this, the whole technology you are putting in.

As I understand it, you have a cleanup procedure that NRC hopes to evaluate, and they may be evaluating it now, or within the next few days anyhow.

Mr. ARNOLD. Let me clarify that, Mr. Walker.

That will only apply to about 250,000 gallons of the wastewater that is in the auxiliary building.

I think another way of looking at the significance of the discharge of the tritium, is that if the tritium were discharged in one lump, as it were, was discharged as a shock to the river, I believe the calculations show that the maximum exposure to anyone using the river for drinking water, recreation, eating fish from the river, would be about four-tenths of a millirem, so the potential for exposure from those sources, we are not advocating, and we have no intention of making that kind of one hot discharge of the material, but that is it, I think the total integrated dose potential.

Mr. WALKER. Well, if you cannot provide the answer today this would be my last question. I would like a response provided for the record. What is the number of microcuries per millimeter that you would intend to discharge into the river? I would like to know how much tritium, in microcuries per millimeter, you would intend after the cleanup process to put into the river.

Mr. ARNOLD. I would like to supply that for the record subsequent to today's meeting, so we can be sure of our numbers.

[The information is available in subcommittee files.]

Mr. ERTEL. Mr. Ambro, any questions?

Mr. AMBRO. If you want to proceed on this line of questioning, do so.

I just want to ask questions which stem from the testimony of Dr. Kepford.

Dr. Kepford said you did not look at the data, did not understand it.

What is your response to that?

Mr. ARNOLD. I think that we as well as many agencies of the Government have looked very hard at the data.

I think we have a fairly good understanding of the significance of that data, the levels of uncertainty that are involved in the results,

and I guess I will say in summary, I do not agree with that judgment by Dr. Kepford.

Mr. AMBRO. What is the relationship between the responsibility that you have and other Federal agencies have in developing monitoring systems with respect to both distance and numbers?

Mr. ARNOLD. The Federal agencies' responsibility is to define the minimum requirements that must be fulfilled to measure the impact on the environment, of potential releases from the plant.

Our responsibility is to design and implement a monitoring program which as a minimum fulfills those Federal standards.

I think it is accurate to say that our system as designed, and as executed more than fulfills those minimum standards.

Mr. AMBRO. Well, at least I think that the kinds of data and information that we have gotten as a result of this accident are contradictory at best.

The point has been made that you go out 13 miles with your dosimeter readings. I do not think beyond that you have any stationary stations, most of them are mobile; is that correct?

Mr. ARNOLD. That is correct.

Mr. AMBRO. And the suggestion has been made that you go out 40 miles with additional stationary dosimeter stations.

What is your reaction to that?

Mr. ARNOLD. We would have no reluctance to increase the monitoring to that area, if it could be demonstrated it really provided any desirable additional information as to the potential impact on the environment.

I think the standards today, the standards established by the Federal agencies, have been on the basis that the monitoring that it provided coupled with the meteorological data that is available, is adequate for determining the doses to the population.

I would be happy to have Mr. Woodard, who is an expert in this area, and certainly I would not pose myself to be such, add to those comments.

Mr. AMBRO. I just wondered if before he responds, he has had the benefit of those charts developed by Dr. Kepford.

I think much of this concern stems from the kinds of graphs he has provided, including what someone called the aberration, which indicates your levels might be higher at a greater distance, depending upon wind conditions. And if indeed that is true, you might comment with that as a background in terms of the recommendations, to go out beyond the 13-mile limit.

Mr. WOODARD. No; we have not seen the curves prepared by Dr. Kepford.

We would like to have a copy of them.

One comment that I believe is pertinent here with regard to monitoring at large distances from a plant, say 40 or 50 miles, is that normally we expect the meteorological conditions, the diffusion meteorology to diminish the concentration of related materials, or spread them, if you will, with distance.

It has to happen; anytime the plume moves, it is also spreading. It cannot reconcentrate, so that we would expect, say, perhaps as much

as two orders of magnitude, a factor of 100 at least, dilution as you go down wind, say, 50 miles.

Now, as a result of such dilution, and in this event here, we know that the radiation levels in general around the population within 50 miles were very low, around 1 millirem average—in that range.

At greater distances, the incremental amount of radiation from the accident above the natural background starts to become a small part of the dosimeter reading, so that you run into an inaccuracy problem at those large distances. So I think we need to look closely before we put those dosimeters at large distances to find out if we would indeed obtain useful information.

Mr. AMBRO. We heard testimony last week from the Lieutenant Governor of this State, that one of his State officials told him, because he was informed by someone named Collins of the NRC, that the initial levels of emission were 1,200 millirems.

We do not know where that came from, even to this day, and we are not able to determine the validity of that.

We know as well that EPA's standard is 5,000 millirems for workers, and they are looking very closely to dropping that 500.

We know as well that there is contradictory attitudes based on whichever Ph. D. you talk to at the time as to the effects of even 1 millirem as opposed to 25,000 millirems.

The question at the outset is, were you receiving correct data, and did you understand it?

You said yes. Was all of this that we have heard prior to your testimony today, and in other meetings, understood? I still think the question is valid.

Now, what do you think you received in terms of data, and why do you think you understood it, if no one else did?

Mr. ARNOLD. Let me first address the 1,200 millirems.

The 1,200 millirems were the measurement taken in a helicopter about 600 feet directly over the plant, at about 8 o'clock in the morning of the 30th. It was in the plume; it may have been influenced by the culmination that would occur from the gas coming up the release stack.

That plume was followed, and by the time it reached the site boundary, it was down in the order of one-half the 1,200.

The helicopter monitoring continued to the point of dissipation of that plume, throughout that period; as well as the vast majority of the prior 2 days, the helicopter monitoring was available, both by us and by Federal agencies, and some of the Federal agencies in conjunction with the State agencies, we were measuring, and reporting to all parties concerned, both the airborne rems and the ground-level rems, those readings were being recorded by the emergency response, a group of the company in our control center. I think that we had good information on what the ground level measurements were in downwind directions.

We had the ability to follow the plume with the air monitoring, and we were passing that information on to the State and Federal agencies that were on the scene.

Mr. AMBRO. Well, now, you said at point of dissipation of the plume, what does that mean?

Mr. ARNOLD. The dispersion of the radioactive gas within the atmosphere. That incidentally was also a very short-term thing that occurred. It was not an ongoing release.

Mr. AMBRO. We do not have here ecological systems models for the movement of air based on all manner of wind conditions, do we?

Mr. ARNOLD. Let me have Mr. Woodard address that.

We do have that type of modeling available to the plant that is staffed for these kinds of actions.

Mr. AMBRO. If we have the models, do the models then receive pragmatic implementation by virtue of sightings in a comprehensive action of dosimeter stations? In other words, what we are saying here, if you follow it up with an airplane, I do not know which moves faster, depending on the kind of airplane.

Mr. ARNOLD. We used helicopters for that feature.

Mr. AMBRO. But it would seem to me it would have difficulty in following accurately that plume and its point of dissipation. Can you safely state here what the point of dissipation was, and what the residual effects were?

Mr. WOODARD. I am not familiar with the exact tracing of that exact plume during that day.

Mr. AMBRO. That is most significant.

Mr. WOODARD. The point that I always like to make in terms of diffusion meteorology, that the atmosphere is breaking the plume up in pieces. Sometimes the release comes over a short period of time, and we think of these as if they are instantaneous puffs. Such releases are considered to last less than a few minutes.

Now, the thing that is important is the integrated dose at ground level; at least we report these rates, so when we measure 1,200 millirems instantaneously, the integrated dose at ground level, for instance, from that 1,200-millirem instantaneous reading, was probably no more than a few millirem.

Now, the way we know that is by the TLD detectors that were located at ground level, which are stationary and provide an integrated dose.

Mr. AMBRO. I am sure I have consumed my time. I will sum up by veering off and point to a political problem.

If you are the Governor or the Lieutenant Governor of the State, and your initial report indicates there has been a puff, as you call it, without knowing there is a puff of 1,200 millirems, then you have got a frightening choice, a political choice to make, between on the one hand, saying to your aides, let us wait and see and pray, in effect covering it up, or on the other hand, going public immediately with an evacuation proposal, a plan, or a mandate. I must say that I think in terms of the realism of that situation, having been an executive myself in microcosm, that the officials of this State handled the situation as well as they could under the circumstances. Because while they might have panicked as a result of the indication that there might be an evacuation plan, that they walked that tightrope quite well, and a good deal more panic was averted, even in the face of that initial information. And to this point, I must say I am not satisfied we correctly and accurately understand the impact of what happened with respect to the puff, and succeeding puffs, so having said that, Mr. Chairman, I rest.

Mr. ERTEL. Mr. Winn?

Mr. WINN. Thank you, Mr. Chairman. Most of these questions, I suppose, would be aimed at Dr. Mudge.

Did the monitoring network provide full coverage in all sectors of the region, especially those of the heavy population?

Dr. MUDGE. Most of our sampling was at the 15-mile radius of the site, and concentrated in the east, and the southeast, covering population areas in that area.

Mr. WINN. Do you feel in retrospect that you had enough monitoring equipment?

Dr. MUDGE. I think the problem comes as to dissemination of equipment on hand to follow the gaseous plume immediately after the accident. Where do you put the equipment and for how long a period of time, it becomes a practical problem of resources, but I would say probably some additional equipment beyond 15 miles would be good. I think we have learned from the incident we do need some additional monitoring.

Mr. WINN. Along that line, how were the sites selected originally?

Dr. MUDGE. They were selected based upon the meteorology near the site and past meteorological data. Hydrological data helped in the selection of water sampling sites and the terrain in selecting the terrestrial locations.

I think Mr. Porter has something to add.

Mr. PORTER. To specifically answer your question about the dosimeters, these sites were chosen carefully in order to be able to assess the dose, what we call a maximum individual, that is a person that lives closest to the plant, and could possibly be the person with the highest integrated dose from the emission from the plant, so that was one of the first criteria.

One of the second criteria as Dr. Mudge stated, was to look at the meteorology to see if there was any definite patterns, so to speak, and Mr. Woodard can speak to that better than I can, because we have to seek out the data from his group, the meteorological data.

Another thing we did was to take a look at the national occurring background that mother nature gives us in these specific areas to make sure it was not so high, that we would have poor data.

A third thing that we had to look at was to make sure that we had TLD's in places where we would not have gross vandalism.

You do not hang it out so the neighborhood kids can pull it off the tree or something like that.

The fourth thing was to look at the data for the 4 years of pre-operational program, that is prior to operation of unit 1 plant, and to see if there were any anomalies in the data that was needed to be worked out, so all of these things went into determining the specific locations of the TLD stations.

Mr. WINN. Would you care to comment, Mr. Woodard?

Mr. WOODARD. Yes, in looking back after the accident, we have used these monitoring stations to follow and to estimate releases that were made, and I have one figure here from the ad hoc population dose assessment committee, it is a figure of 3-1, which does show the monitoring locations close to the plant, which are those that have the highest readings, and from which we determined the maximum exposed individuals, and I think we have found in our studies that a long list of

meterological data which we have averaged over 15-minute periods, that we are able to fill in very well, and to estimate the doses in all directions around the plant, within this grid as it existed.

Mr. WINN. There seems to be either a little discrepancy, or certainly difference of opinion on the meterological data that was available at the time, or that was secured later.

Do you have any comment on that?

Mr. WOODARD. I am not aware of any deficiencies.

The tower has provided averages continuously since the accident.

These readings were available in the control room as well as through computerized systems.

Mr. WINN. When we toured the plant yesterday, that question was asked several different ways, and it seems to me there was a little difference of opinion, not an argument, but the answers were not the same from the various men that were asked, let me put it that way, and obviously Dr. Kepford has a little different opinion here this morning in his testimony.

Mr. ARNOLD. I might say with regard to the answers in the tower yesterday, I am not aware I guess of the differences that existed, but certainly the meterological data was captured, it is a matter of record now, and we can certainly go back and identify what it was at the time subsequent to the accident.

Mr. WINN. Thank you, Mr. Chairman.

Mr. ERTEL. Mr. Goodling, do you have any questions you would like to address, since you are present with us, and certainly have a deep interest in this subject.

Mr. GOODLING. Mr. Chairman, since I am a visitor, I will not ask questions.

I would just like to indicate since I do have all of those heavily populated areas downwind, and directly west, I would hope the committee, when they are thinking about the health effects, would think about the mental effects, because those are the most imminent health effects at the present time. And in thinking about that, I would hope that you could do something in relationship to NRC's reporting, because probably the two most damaging things that took place as far as mental health is concerned, was the hydrogen bubble, which we heard about morning, noon, and night, on television and radio, and the second was the evacuation of 5 miles.

Two weeks ago NRC said they overreacted with the hydrogen bubble. Well, now my people had been put through that for 5, 6, 7 days, and now we find they overreacted, and yesterday, NRC said they overreacted to any evacuation.

It seems to me those two incidents are the most destructive as far as the mental health of the population is concerned. I would only say that last week we passed legislation in relationship to the mental health of the Vietnam war veterans. I think we should be thinking very seriously about doing the same for an incident such as this, and that we should make sure that our constituencies have an assurance that there will be an ongoing constant monitoring of the health factors involved here.

Mr. ERTEL. I thank the gentleman for his comments.

There have been studies set up for long-range to take care, or at least to evaluate those things.

I would like to close by asking Mr. Arnold, or somebody else here a question, I was not on the tour yesterday, but I was under the impression, Mr. Arnold, that you indicated the charcoal filtering and monitoring system, that in fact that those charcoals had been in there for a period of 3 days, and they were down to 50-percent efficiency. That seems to be a discrepancy between what allegedly the staff indicated you had told them that and what has been said here today.

I wonder if you might clarify that?

Mr. ARNOLD. I think the misunderstanding applies to two different systems. What we were talking about here this morning, was the sampling system, and the charcoal filters used to collect a sample.

In the discussion during the plant tour yesterday, I was describing the degree of depletion of the collection efficiency of the charcoal beds that are located in the auxiliary building and fuel building systems.

Mr. ERTEL. That is the filtering system itself?

Mr. ARNOLD. Yes.

Mr. ERTEL. Thank you.

I might suspect there may have been such a discrepancy.

Thank you very much. We thank the panel for being here and being forthright with us.

Mr. ARNOLD. We thank you, sir.

Mr. AMBRO. At this point we have the State and local government panel, composed of Mr. Thomas Gerusky, director of the Bureau of Radiation of the Pennsylvania Department of Environmental Resources; the Honorable Kenneth Brandt, member of the special committee to investigate TMI, Pennsylvania State Legislature; Mr. John Angstadt, director of public works, city of Lancaster, Penn.

And, gentlemen, we would like to welcome you to the field hearings conducted by the subcommittee of the Science and Technology Committee, and as is customary in field hearings, the witnesses are normally sworn, so I would like at this point to administer the oath.

Do you swear to tell the truth, the whole truth, and nothing but the truth, so help you God?

Mr. GERUSKY. I do.

Mr. BRANDT. I do.

Mr. ANGSTADT. I do.

Mr. AMBRO. Thank you very much.

I realize sometimes that it is offensive to have people sworn. I was a prosecutor for a long period of time, and many people always take objection at being sworn in, but I guess it is one of the formalities we have to go through.

We have allotted 10 minutes generally for each of you to make an opening statement, and then to go through questioning, and according to the schedule I have, Mr. Gerusky, you are first, and we would be happy to incorporate any written comments you have in the record, and if you have a prepared statement.

STATEMENT OF THOMAS GERUSKY, DIRECTOR OF THE BUREAU OF RADIATION PROTECTION OF THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES

Mr. GERUSKY. Mr. Chairman, I prepared some comments last night. I do not have written prepared comments for submissions.

I did not realize I was going to appear before this panel until Thursday, and I did not have a chance yesterday to have them typed.

Thank you for the opportunity to be here. Secretary Jones, who was supposed to be here, expresses his regrets that he is unable to be with you. He had a previous commitment of long standing that could not be cancelled.

I have been requested by Governor Thornburg to ask you if his testimony made earlier could be incorporated into the transcript of this hearing, so that his views could also be made available to other members of the panel. I do have a copy of his testimony.

Mr. AMBRO. We will be happy to incorporate it.

[The prepared statement of Governor Thornburg follows:]

PREPARED STATEMENT BY GOVERNOR DICK THORNBURGH

Mr. Chairman and members of the subcommittee:

I want to thank you for the opportunity to comment on something that "can't happen here," but almost did.

I'm sure you join me in praying that the events on Three Mile Island are never repeated—not at anytime, nor at any place on this Earth.

But as the Lord does, indeed, help those who would help themselves, we must do all within our means to understand this thing called nuclear power, to use and control it if we can . . . and to forsake it if we must.

I understand that the purpose of these hearings is to answer the question of control. This is as it should be, and I will attempt to help in any way I can.

Let me begin with some observations on what went wrong during our ten days of tension in Pennsylvania; what went right, and why.

The gathering, evaluation and communication of facts are indispensable to decision-makers in any situation—be they Little League coaches or five-star generals.

In the case of Three Mile Island, this task, and how it was handled, could easily have meant the difference between life and death.

This is why I must point first to the information problem—perhaps the toughest we faced in a very tough situation.

There are those who assumed, when I first mentioned this problem, that I was talking about the power company, and about self-appointed experts of various persuasions—and they were quite right.

There are those who assumed I was talking about the news media, the NRC and various officials, both elected and appointed—and they were partly right.

The media, the political establishment and the bureaucracy never behave as finely-tuned instruments, in perfect harmony and control—and certainly not in a crisis of such magnitude.

These institutions were sending a kaleidoscope of signals to my office, many of them helpful, many of them troublesome, and a few of them quite disturbing. Although there were notable exceptions, the signals we received from sources who were closest to the plant site were far more reliable than those that came from elsewhere.

There were indeed, some erroneous, some alarming and some irresponsible reports carried by the media.

There were also, on the other hand, many moments when reporters did a better job of putting events into perspective than did the officials who were shaping those events. If some press accounts were an occasional threat to those who might panic, most were a continuing check on those who might deceive. Their place in this emergency was indispensable.

In dealing with other institutions, I came to appreciate the problems news reporters were facing. The nuclear trade jargon, the clamor of competing experts, and the garble gap between Harrisburg and Washington all made it quite easy to understand how five different stories could come out of a single press conference, through no fault of the reporters involved.

My own staff people spent a great deal of their time acting as investigative reporters to me, and I felt they did well under the circumstances.

Throughout the crisis, I felt I was getting the best information available from the widest range of sources, and I still believe that. But this was only the beginning of our task.

The real problem was sifting out fact from fiction, hyperbole from analysis, candor from candor, and guesswork from solid reporting.

The company issued statements in the early days that proved to be something less than accurate, and its credibility as a reliable source of information eroded rather quickly.

My office continued, throughout the crisis, to monitor what company officials were saying, but we began to look elsewhere to determine what really was happening.

I sent our own state experts in radiation and nuclear engineering to the site—to give us a continuing technical assessment of the danger posed by the crippled reactor.

I asked Lt. Gov. Scranton—as my chief advisor on emergency management operations—to go into the plant, and bring back what was to become the first authentic layman's report on what it was like in there.

I wanted to know if the Met Ed technicians themselves were in a panic, and his description of the workers as calm and cool was reassuring, to say the least.

We also received advice and briefings, during the early days of the crisis, from Pennsylvania-based NRC inspectors, who were working at the site.

It was reported to us on a Thursday night that the danger appeared to be over.

I felt, at the time, that I had a fairly accurate picture of the hazard Pennsylvania was facing and the precautions we needed to consider. I was hopeful that the crisis was, indeed, passing us by.

But then came the morning of Friday, March 30. An "unplanned" burst of radioactive steam had been released into the air.

The Thursday report had been overly optimistic. The crisis escalated dramatically, and so did the clamor of off-site experts and second-guessers from around the world.

Our problems at the site were compounded by loose talk of a "massive" evacuation, confusion over how many hydrogen bubbles were in the reactor, and, eventually, that celebrated bulletin on an imminent "explosion"—all of which seemed to originate from sources who had yet to set foot in Pennsylvania, to say nothing of the plant itself.

These sources—both official and self-appointed—simply could not appreciate the complexity of what we were facing up there.

They may have meant well, but they were a burden.

As you know, it has been widely reported that even Harold Denton and Dr. Roger Mattson suggested evacuation early in the crisis—although neither of them made such a proposal to me or my staff.

What has not been widely reported is that both men were saying these things before they left the Washington area, and that both changed their minds after arriving at the plant site.

When Mr. Denton left us last week, he told the press, and I quote: "I guess I've learned that emergencies can only be managed by people at the site. They can't be managed back in Washington. I would not recommend that we attempt to manage accidents in the future from back in Bethesda."

Although Mr. Denton is more than capable I believe his remark applied not only to the fact-finding needs of decision-makers, but to the technical operations at the plant as well.

I feel that this point was, indeed, one of the most important lessons to be learned from the incident. I recommend that it be considered in any revisions to be made in our federal emergency response procedures.

This was why I asked President Carter to send us someone of Mr. Denton's calibre in the first place. We needed to merge management and technical expertise with on-site experience. The President responded quickly to this request, and Mr. Denton's arrival represented a turning point in the crisis.

We now were better able to offset an avalanche of misstatements and second-guessing from virtually everyone who had an opinion.

We did this with regular, daily briefings from a qualified person in the best position to know the truth—Harold Denton.

For my part, I did continue to cross-check Mr. Denton's observations against those of my own people.

We became convinced that he was a credible source, and we depended on him heavily in the final days of danger.

We also relied on the cooperation, advice and assistance of the White House. A three-way "hotline" telephone was installed to connect me and my staff with the President and his staff, and with Mr. Denton at the plant. That was put to good and frequent use.

There is, of course, no Republican or Democratic way to deal with a crisis of this type and magnitude. My first and only concern was for the health and safety of the people in the area, and partisan politics had to be put aside as we attempted to meet this most basic of all public trusts.

I was gratified that the White House responded in kind. The President's personal visit to the site—announced at one of the highest points of tension in the crisis—did much to calm and reassure our people.

The President's expressions of concern for our needs, both during the crisis, and during the long struggle to come, were welcome words for a Commonwealth that has much rebuilding to do.

I've taken this much time to describe the communications system we eventually developed because it had two very important functions in this crisis.

First, it was the key to our attempt to give the people a source of information in which they could have some confidence.

We regarded the public credibility of the Governor's Office as essential to our efforts to avoid a panic, as well as our efforts to implement, if necessary, an orderly evacuation.

Secondly, the facts, not suppositions or assumptions, had to be the basis for every move we made in this crisis.

I had to make decisions no other Governor has ever faced before, decisions which I pray that no one will ever face again.

I'm well aware that each of the choices I made along the way is fair game for those who now will say we did too much, those who now will say we didn't do enough, and those who now will say we erred in both directions.

I realize that this is inevitable. Frankly, I've initiated my own staff review of the entire course of the crisis, to determine how this kind of an incident might be handled in the future.

While that review is still in progress, I would like to give you an account of some of the more significant actions we took in this matter.

The moment I learned of the accident, I ordered the acceleration of an appraisal we had begun on the emergency preparedness system developed by the previous Administration in Pennsylvania.

It was a workable system, but we did find weaknesses—which we moved as quickly as possible to correct.

I also ordered our civil defense and National Guard units to assume an alert status, taking care, however, to avoid a show of helmets and sirens which might, in themselves, have caused a panic.

The March 30 decision to advise people living near the plant to stay indoors was based on a recommendation from the chairman of the Nuclear Regulatory Commission. The decision to rescind that advisory at midnight was also based on the chairman's recommendations.

My March 30 decision to advise pregnant women and preschool children to leave the area within five miles of the plant was prompted by an overnight escalation in the potential dangers the accident posed for them.

The chairman agreed, at that time, that this would be a "prudent" step to take as a "precautionary" move.

My decision to suggest that schools within that same area be closed for the day was a logistical one. It recognized the potential need for a general evacuation of the area, as well as the natural desire of families to keep their children together, regardless of age.

The decision to call on the best available health authorities—both public and private—to supplement the rest of my technical and professional advice, was another precautionary move which, in the end, helped us to keep things in perspective.

The toughest decision of all, however, was the one that I had to make 24 hours a day throughout this crisis.

That was, of course, the decision not to order an evacuation that would have been unprecedented in its nature—as well as its potential for harm.

I must tell you that the thought of evacuation first occurred to me at 7:50 a.m. the morning of March 28, and that it never left my mind for ten entire days.

I had to weigh the potential risks of Three Mile Island against the proven hazards of moving people under panic conditions.

No matter how well they are planned, massive evacuations can kill and injure people—especially the aged and the infirm, infants in incubators, other hospital patients, and even the able-bodied man—who, like the usher in a burning theater—happens to be in the wrong place at the wrong time.

I would not have hesitated to evacuate the entire area had it ever appeared to be the safest course.

I could not in good conscience, have ordered such a step with the facts at my disposal.

Finally, the decision to tell a very brave and tired group of women and children that they could, at last, go home again, was one that I will treasure for the rest of my life.

For I believe it ended that period when the worst fear of modern man almost come to pass in Central Pennsylvania.

I have since made other decisions and formed new opinions, of course, about the future of Pennsylvania, the safety of nuclear power, the adequacy of regulation, and our need for alternative energy sources.

I have asked the White House, and it has agreed to provide our state with all the appropriate assistance to address the problems we face in putting ourselves on the road to recovery.

As part of the process, I have asked for and received from the Small Business Administration a declaration of an economic disaster in the area.

I have also asked the Nuclear Regulatory Commission to inspect every reactor located within our borders in Pennsylvania, and to assure me, if it can, that the accident on Three Mile Island shall not be repeated.

Chairman Hendrie personally assured me that he would order these inspections to be conducted and completed without delay.

I have formed a cabinet level group, under the chairmanship of Lt. Gov. Scranton, to work closely with a federal team which has been sent to help us address the health, environmental, psychological and economic impact this incident may have on our Commonwealth for many years to come.

I have directed my staff to assess our need for an active monitoring program of our own—putting special emphasis on the training of state nuclear regulators and inspectors who could act as an independent backup to the federal teams.

Obviously, I see a need for better enforcement of existing regulatory standards. It appears that standards of efficiency and expertise were too often ignored or loosely-enforced on Three Mile Island.

I urge you to do all within your power to see that this never happens again.

I urge you to consider a revision of current standards to require the licensing of utility company executives, so that the presence of round-the-clock expertise at every nuclear power plant in the country might best be assured.

Much criticism has been directed at the utility company, and perhaps rightly so. But that criticism implies something about our licensing process as well.

I submit that no company should be authorized to run a nuclear power plant in this country unless its management staff—along with its operation staff—is certified as competent to meet the extraordinary public responsibilities involved.

It also is my hope that, in the future, our states will be given a greater voice in decisions affecting the placement and expansion of nuclear power within their borders.

As a corollary, I believe the states should have the clear authority, to inspect the operation of existing plants at any time, without prior notice.

A few nights ago, I asked the engineering profession in our Commonwealth to help us develop safe and reliable alternative sources of energy for our citizens, with a special emphasis on coal, which we have in abundance in Pennsylvania.

I now wonder what might have happened, if just a fraction of the billions we've spent on atomic power had gone, instead, into the search for clean and efficient ways in which to use the gifts of coal and other resources that lay beneath, above and around us all.

As I've said before, I have doubts about the future of nuclear power in our society, as well as the widely-held assumption that we can't meet our energy needs in other ways.

They're the kinds of doubts that you, as a subcommittee, will have to work very hard to overcome, if you're assuming that nuclear power not only is here to stay, but to expand, as well, into other communities across America.

Let me just say to you, in closing, that this was a painful time for the people of Central Pennsylvania.

It wasn't easy for me to look into the face of a child-bearing young woman, who had fled from her home, at my recommendation, to live on a stadium floor during the most anxious months of her life.

Not all the comfort in the world can erase that memory from this woman's consciousness—nor perhaps even that of her unborn son or daughter.

It wasn't easy to hear the plight of a dairy farmer, who saw generations of good and honorable service to his community, start draining away before unthinking signs that read, "We don't sell Pennsylvania milk."

Not all the safety assurances in the world—true as they were—could erase the crisis of confidence thrown upon that man, through no fault of his own.

And it wasn't easy to see a small town—struggling to survive the loss of its sons and daughters to the city—suddenly find that those who still love it face a choice of living in doubt, or leaving.

Not all the renown in the world can erase the awareness of these good people that something out there is powerful and strange and not entirely under control.

We must assure ourselves that it can, indeed, be controlled, or risk losing it as a promising answer to our energy needs.

There is no other choice.

Thank you, Mr. Chairman.

Mr. GERUSKY. My name is Thomas Gerusky, I am director of the Bureau of Radiation Protection of the Pennsylvania Department of Environmental Resources. I have directed that program since 1961. It was my understanding that you wish I discuss the environmental radiation program around Three Mile Island.

I will try to skip some of this.

Our program is similar to those at other nuclear powerplants in the United States, as is required by U.S. Nuclear Regulatory Commission regulations.

There are several things we do, but one is to measure external radiation levels at various locations surrounding the plant.

Only four dosimeters were placed at distances of 10 miles or beyond, which made it very difficult to determine exposure levels beyond the first few miles.

However, utilizing the data of HEW and EPA and that of NRC's ad hoc population dosage group, we were able to evaluate these disclosures, and you have been discussing that point.

The State environmental program is the same for each nuclear powerplant site in Pennsylvania. Two sites are monitored in addition to TMI. Surface water also is sampled at 25 locations throughout the State. The nuclear fuels processing plant in Apollo, Pa. and the preoperation monitoring programs at the Susquehanna were also included.

The program is a modest one, and it is designed as a check of the utility's program.

At TMI the program consists of offsite monitoring of air, water, vegetation, and fish. We have only four TLDs around the site, one at the observation building itself, and we have one in Goldsboro on the west side of the site, we have one in Middletown north of the site, and we have one at Falmouth south of the site.

A new TLD system had just been purchased and undergoing debugging at the time of the accident. It was planned to put out additional dosimeters. The program is one that is acceptable to the NRC, and we do have a small NRC contract for approximately \$30,000 per year to provide them with the data generated in our program.

During the accident, additional air, water, milk, vegetation, soil, and other samples were collected by the utility, by the Commonwealth, by

the DOE team which responded to our request for assistance, EPA HEW and NRC, and probably a lot of other people.

Unfortunately most of these programs were set up after March 30. There is no question that additional information would have been desired during the first 3 days; however, there was considerable monitoring using airborne and ground-level radiation survey meters.

All data from all sampling programs are being collated by EPA, under a directive from the White House.

Hopefully, information through April 15 will be available in the near future from EPA, but those pieces of data must be analyzed.

With specific reference to water monitoring, the department's bureau of water quality management, with the assistance of EPA, has established a comprehensive program.

The monitoring program for TMI, and the Susquehanna, below TMI is designed for the following purposes:

One, it serves materially as a warning system for downstream users; two, it provides historical count of quantity of discharges from TMI, to show what if any concentrations of radioactivity exists; three, it shows an independent backup to TMI and the TMI program and should provide some degree of public confidence in any decisions made concerning any discharges.

The system for early warning consists of a sodium iodine detector which has been installed at the TMI liquid release point. It will detect the activity down to 300 picocuries per liter on a continuous basis. Information will be plotted and should the concentration and the effluent exceed 300 picocuries per liter, an automatic telephone dialing system will alert personnel which will activate a response plan.

In developing the early warning system, the main goal is to protect the water supplies at Columbia in Lancaster.

If the telephone is activated, the water quality staffman, the staff manager will go to the site and obtain samples, and in consultation with our office and with others determine if a problem exists, and if that is the case, downstream users would be notified, and additional samples would be conducted and samples analyzed.

In addition to the early warning system, a continuous sampling device operates on a plain outfall and composite sample over a 24-hour period.

That sample is analyzed daily. A continuous sample will be installed to monitor the discharge at the stormwater basin at the east end of the island.

Upstream there will be sampling to determine background levels. The sites will be sampled every 2 hours and the samples will be composited once a day.

In addition, there is a biological monitoring program which concentrates on the radioactive materials 10,000 to 20,000 times in the matter of a few weeks.

Samples are also analyzed. The biological monitoring program is done with the assistance of the Philadelphia Academy of Natural Sciences.

While I have the opportunity, I would like to suggest the following, one, that comprehensive environmental radiation monitoring programs should be carried out by all States with major nuclear facilities.

Funding and assistance should be provided by the NRC or EPA. Environmental radiation monitoring is the only environmental monitoring program that is not supported by the Federal Government in a major way. The program should be designed to be more useful in evaluating exposures during emergency conditions.

Again, such programs should be designed on a national basis, run by the State and funded by the Federal Government.

Each nuclear powerplant in the country should be required to be tied into the DOE airborne radio analysis system at Livermore, Calif.

Computer readouts and helicopter surveys are very important.

A coordinated system as this would allow for more orderliness where evacuation is required.

Also, the Federal Atomic Energy Act should be amended to include more State participation in the construction and operational phases of the reactor. This must include the allowance of State nuclear engineers and health physicists to inspect the plant on a routine basis and to evaluate the environmental releases from the plant, and that each plant be required to have a direct line from the control room to the State agency responsible for radiation protection, so that normal commercial lines will not have to be used in an emergency.

Thank you.

Mr. ERTEL. Thank you very much for your statement. We will delay any questioning until we hear from the other two members of the Panel.

At this point we will hear from the Honorable Kenneth Brandt, member of the Special Committee To Investigate TMI, of the Pennsylvania State Legislature.

Please proceed, Mr. Brandt.

[The prepared statement of Mr. Brandt follows:]

PREPARED STATEMENT OF HON. KENNETH BRANDT

I would like to thank the Congressional Committee on Science and Technology for inviting me to appear this morning.

I also wish to thank the members for considering me an expert on the subject of environmental and health impacts on the populace of this area and the adequacy of monitoring at, around and away from the T.M.I. site.

Mr. Chairman, I am very concerned about the health aspects of the T.M.I. accident—concerned about the adequacy of monitoring and the truthfulness of the reports upon which the public was forced to rely.

The Pennsylvania House Select Committee investigating the T.M.I. incident has barely begun its work.

The resolution creating the Committee directs us to conduct a comprehensive inquiry into the nuclear accident to determine the need for additional safety and regulatory procedures, to study the effectiveness of existing civil defense, emergency preparedness and evacuation procedures and to determine methods for improving coordination between federal, state and local units of government in the event of nuclear accidents.

We are also to review the potential for health and safety hazards and to examine the role of nuclear power in meeting the energy needs of Pennsylvania.

We have taken testimony from Governor Thornburgh, Lt. Governor Scranton and Orin Henderson, Director of the state's Emergency Management Agency.

The Committee is presently investigating the problems of civil defense and evacuation preparedness.

At a hearing we conducted in Bainbridge, a village just two miles from the nuclear plant, the local officials told us that they had had no instructions as to the means of evacuating several hundred people out of a town on one two-lane highway.

The local residents who testified told us they received such conflicting reports, they had no idea what to believe or whom to believe. They opined that they could believe nothing told them by the state, NRC or Met-Ed officials from March 28 until Sunday or Monday of the following week. They also pointed out they were not given any directions as to whether to open schools that week or how to prepare for evacuation.

Some very informed local physicians and physicists testified at the Bainbridge hearing concerning the health and safety hazards of low-level radiation and possible health hazards of evacuation. The Committee chairman intends to ask them to appear before the Committee again when we begin the study of low-level radiation and other health hazards.

Your Committee investigation apparently has dealt with the science and technology aspects of the T.M.I. accident rather than the evacuation problems which our Committee has been studying.

Presently, we plan to begin investigating the health and safety problems of the accident as soon as the evacuation and civil defense areas have been thoroughly studied. Consequently, it will not be until mid or late July before we know more about this area of the nuclear industry.

After the Committee has gathered local and national expert testimony about the possible health hazards of the T.M.I. incident and any future nuclear accidents, we will be most happy to either appear before your Committee or submit written statements as to what this Committee has discovered.

I am honored to have been asked to chair a sub-committee which will look into the disposal of hazardous wastes from the plant.

Thank you again for asking me to appear today and I hope I have been of some help to your Committee's assignment.

I will be happy to answer any questions the Committee members may wish to ask.

STATEMENT OF HON. KENNETH BRANDT, MEMBER OF THE SPECIAL COMMITTEE TO INVESTIGATE TMI, OF THE PENNSYLVANIA STATE LEGISLATURE

MR. BRANDT. Thank you, Mr. Chairman.

In the opening remarks about being sworn, from one elected official to another, a lot of worse things than that can happen to us.

I have prepared remarks for you, and also a copy of the resolution that the House committee passed.

MR. ERTEL. The resolution will be incorporated in the record at this point.

In the House of Representatives,

Whereas, On March 28, 1979, a nuclear accident occurred at the Three Mile Island generating facility southeast of Harrisburg resulting in damage to the reactor core and facility equipment; and

Whereas, Unanticipated complications, including the accumulation of hydrogen, delayed the implementation of procedures to cool the reactor core; and

Whereas, the nuclear accident has created questions concerning the need for additional safety precautions at the Three Mile Island facility and other nuclear generating stations; and

Whereas, Existing emergency preparedness and civil defense programs, evacuation procedures and the use and coordination of Federal, State and local resources and personnel including the Pennsylvania National Guard should be thoroughly reviewed to increase the effectiveness of emergency management; and

Whereas, The nuclear accident has created public concern regarding the relationship between health and exposure to radiation; and

Whereas, There are health and safety reasons to decontaminate the stricken facility at Three Mile Island and to properly dispose of contaminated water, nuclear waste, and irreparable materiel; and

Whereas, It is necessary that a comprehensive inquiry be made into the Three Mile Island accident to determine the need for legislation and administrative initiatives in Pennsylvania and at the Federal level; therefore, be it

Resolved, That the Speaker of the House of Representatives appoint a select committee to examine matters related to the nuclear accident at the Three Mile Island facility. Four members, two of whom shall be from the Minority, shall be appointed from each of the following standing committees; the Agriculture Committee; the Business and Commerce Committee; the Consumer Affairs Committee; the Health and Welfare Committee; the Mines and Energy Management Committee; the Military and Veterans' Affairs Committee and the State Government Committee. Two additional members, not serving on the foregoing committees, shall be appointed. The Speaker shall designate the Chairman, who shall be from the Majority, two Vice Chairmen, one of whom, shall be from the Minority and the Secretary. The Majority Vice Chairman and the Secretary shall not be members of the foregoing standing committees; and be it further

Resolved, That the committee shall conduct a comprehensive inquiry into the nuclear accident at the Three Mile Island facility and into other related matters in order to review the need for additional safety and regulatory procedures, to study the effectiveness of existing civil defense, emergency preparedness and evacuation procedures; to determine methods for improving coordination between Federal, State and local units of government in the event of nuclear accidents; to review the potential for health and safety hazards; to examine the role of nuclear power in meeting the energy needs of the Commonwealth; and be it further

Resolved, That the committee may hold hearings, take testimony and make its inquiries at such places as it deems necessary. The committee may coordinate its inquiry, with those of any committee, agency, commission or department of the United States government and the Commonwealth of Pennsylvania. Each member of the committee shall have the power to administer oaths and affirmations to witnesses appearing before the committee; and be it further

Resolved, That within 30 calendar days after the committee has made its report, the chairman of the committee shall cause a record of all expenses incurred by the committee, or the members thereof, which are payable at Commonwealth expense, to be filed with the Speaker of the House and the Speaker shall cause the same to be entered in the journal thereof. No expenses incurred by the committee or any member thereof shall be reimbursable by the Chief Clerk unless such expense shall first have been included as an expense item in the record heretofore required: and be it further

Resolved, That the committee shall report its findings together with its recommendations to the House of Representatives not later than six months following the adoption of this resolution.

Mr. BRANDT. I think it is quite a unique situation that I as an individual, and not only as a member of the Pennsylvania House of Representatives, and member of this Select Committee on Three Mile Island, but also I was born and raised, and presently live, within a stone's throw, so to speak, of the island, and I have seen Three Mile Island developed from its first time.

I would like to tell you to where we are coming from as the Pennsylvania House of Representatives, the resolution was passed in the Pennsylvania House putting this committee together, and there are several areas that we are addressing.

We are looking into as we go about our hearings, and business of the committee, the issue of additional safety and regulatory procedures, to study the effectiveness of existing civil defense, emergency preparedness, and evacuation procedures, determine methods for improving coordination between the Federal, State, and local units of government, to review the potential for health and safety hazards, and to examine the role of nuclear power leading to the energy needs of the Commonwealth.

They are the four or five main issues that our committee is working on.

What our committee has done so far is that we have taken testimony such as has been presented in Washington from the Governor, from Warren Henderson, the State Emergency Management Committee.

We had one public hearing so far, this past Thursday evening, in the village of Bainbridge, less than 2 miles from the island itself, and the local officials told us that they had no instructions as to the means of evacuating several hundred people out of the town on just one two-lane highway.

So from further testimony, some very informed local physicians and physicists testified at the Bainbridge hearing concerning the health and safety hazards of low-level radiation, and possible health hazards of evacuation.

The committee intends to ask these individuals to reappear before the committee when we get into that specific area of health hazards, and on that point, which your committee is interested in primarily, I would like to address that issue at this moment.

We had a bill in the Pennsylvania House of Representatives—Mr. Gersky mentioned it, to some extent—that we be given the ability, and that is the ability of dollars to develop environmental resources to do some monitoring on our own, from that depth, and given those types of abilities.

The current issue which was addressed here just a few minutes ago was on the issue of water. I think that your committee is right on target in talking about that problem at this point.

We can talk about evacuation, we can talk about the need of nuclear energy, but what we are dealing with on Three Mile Island is not a nuclear powerplant, but is a waste-water treatment plant, and I think you are right on target in looking into this area.

I would like to close by telling you that our committee plans for the future is we plan to begin investigating the health and safety problems of the accident, we have as soon as we get through the civil defense procedures, which are already lined up; and after the Committee has gathered local and national expert testimony about the possible health hazards of TMI, and any future nuclear accidents, we would be most happy to share that information with your committee.

Again, thanks for the opportunity to present these views to you, and I would be happy to answer any questions.

Mr. ERTEL. Thank you very much. We are happy to have you with us, and we are certainly delighted to share that information.

Mr. BRANDT. Thank you.

Mr. ERTEL. We will now hear from Mr. John Angstadt, director of public works of the city of Lancaster, Pa.

STATEMENT OF JOHN ANGSTADT, DIRECTOR OF PUBLIC WORKS, LANCASTER, PA.

Mr. ANGSTADT. My name is John Angstadt, and I am the Director of public works of the city of Lancaster, Pa.

I am appearing here as the representative of the city of Lancaster at this hearing.

I would like to thank you for this opportunity to appear before your committee.

Quite naturally, the matter of the health and welfare of our citizens

was and continues to be a primary concern insofar as the events associated with the TMI accident are concerned.

Mayor Wohlsen would have preferred to present a statement personally. Unfortunately, his schedule did not permit it.

By way of further introduction, Lancaster is a city of approximately 60,000 people; it is located 23 miles southeast of the TMI plant.

My remarks will be divided into two parts, which in turn are based on two arbitrarily selected periods of time.

These periods cover the time frames, first, from the time of the TMI accident to about April 30; and second, from May 1 on, including the future timespan that is not yet established.

Considering the initial period from the TMI accident until about a month later, I feel there may well have been adverse effects upon the health of Lancaster residents, in two principal categories which are physical and mental.

I would attribute any physical effects' to the release of the radioactive contaminants in various forms from the plant during this period, although all monitoring performed in the city revealed no apparent radiation levels above background.

I think the committee will be able to understand our position very well, when I say that neither I, nor members of the city staff, are really qualified to evaluate the extent of any such effects.

I do feel more comfortable in commenting upon the mental health aspects of the period, which involve considerable stress for Lancaster residents. The accident obviously frightened many people in central Pennsylvania. This fear was compounded by the uncertainty, the conflicting reports, the nature of media coverage, and a whole range of similar activity.

Individual reactions ranged from a calm rational approach to a mild form of panic. Many people, including Lancaster residents, simply packed and left.

One must wonder what the reactions would be in the event of a real disaster of sizable proportions.

In view of the uncertainty and stress which people experienced during this period, it is appropriate to comment at this point upon the adequacy of monitoring. Before and immediately after the accident, apparently all monitoring was performed by Metropolitan Edison.

Increasingly in the days following the accident, other agencies mobilized for monitoring and testing purposes. The problem as we perceived it is this: Quite simply the city would not obtain the information it needed. I think the mayor has expressed that view in prior statements on several occasions.

NRC basically communicated to local officials through the news media. As testing programs developed, there was and still is too great a timelag before results become available.

The best independent approach for the present and future appears to be DER's system that continuously monitors effluent.

I believe that has already been referred to, and we feel the best people to comment on those systems are those that set them up.

In addressing the second period, including the immediate future, my concern again involves both the physical and mental health implications, with greatest emphasis on the former.

In this area, I can be quite specific. The city of Lancaster supplies about 105,000 people, including its 60,000 residents, with water taken from the Susquehanna River some 15 miles below the TMI facility.

Responsible residents of all categories including professional, senior citizens, mothers, fathers, all citizens, have expressed their deep concern to the city in the form of letters and telephone calls, about Met Ed's disposal plan.

City officials find themselves caught between conflicting claims that there will be serious long-term hazards, and that the discharge will present no significant hazard.

The ultimate question is, will the water that comes out of the faucets and showerheads in Lancaster be safe? Since the scientific community is split on this matter, who shall we believe?

We just cannot tolerate such a situation. It is the city's position that the burden of proving the water is safe rests with Metropolitan Edison.

Considering the health and welfare of the residents of the city of Lancaster, we oppose this planned discharge.

In terms of your subcommittee's interest, our intent is to preclude any further harmful effects. As you probably are aware, the city has filed suit against the NRC in Federal court to insure that the environmental and health considerations are fully explored in arriving at an ultimate decision on the discharge of this water from TMI.

In essence, the city of Lancaster desires clear and unequivocal assurances that the water it uses will be safe.

In conclusion, I would stress that public welfare and health, both mental and physical, have been our primary considerations.

I appreciate that a group such as yours is specifically considering that aspect of the TMI incident.

I regret the complex nature of the subject precludes a more precise analysis, but I do appreciate the opportunity to appear and to make a contribution to your effort.

Mr. AMBRO. Your prepared statement will be made a part of the record.

[The prepared statement of Mr. Angstadt follows:]

Good morning. As the representative from the City of Lancaster at this hearing, I would like to thank you for the opportunity to appear before your subcommittee. Quite naturally, the matter of the health and welfare of our citizens was and continues to be a primary concern insofar as the events associated with the TMI accident are concerned. Mayor Wohlsen would have preferred to present his statement personally; unfortunately his schedule did not permit it.

By way of further introduction, Lancaster is a city of approximately 60,000 people. It is located 23 miles southeast of the TMI plant.

My remarks will be divided into two parts which in turn are based on two arbitrarily selected periods of time. These periods cover the time frames from (1) the TMI accident to about April 30, and (2) from May 1 on, including a future time span that is not yet established.

Considering the initial period from the TMI accident until about a month later, I feel that there may well have been adverse effects upon the health of Lancaster residents in two principal categories: physical and mental. I would attribute any physical effects to the release of radioactive contaminants from the plant during this period, although all monitoring performed revealed no radiation levels above background. However, neither I nor members of my staff are qualified to evaluate the extent of such effects.

I do feel more comfortable in commenting upon the mental health aspects of the period, the greatest of which was stress for Lancaster residents. The accident obviously frightened many people in central Pennsylvania. This fear

was compounded by uncertainty, conflicting reports, the nature of media coverage and similar events already referred to. Individual reactions ranged from a calm, rational approach to a mild form of panic. Many people, including Lancaster residents, simply packed and left the area. One must wonder what the reactions would be in the event of a real disaster of sizeable proportions.

In view of the uncertainty and stress which people experienced during this period, it is appropriate to comment upon the adequacy of monitoring. Before and immediately after the accident, all monitoring was performed by Metropolitan Edison. Increasingly in the days following the accident, other agencies mobilized for monitoring and testing purposes. The problem as we perceived it was this:

(1) Quite simply the City could not obtain the information it needed. NRC communicated to local officials thru the news media.

(2) As testing programs developed there was too great a time lag before results became available.

The best independent approach for the present and future appears to be DER's system for continuous effluent monitoring; however, they are best qualified to describe and comment upon that system.

In addressing the second period, including the immediate future, my concern again involves both physical and mental health implications, with greatest emphasis on the former. In this area I can be quite specific. The City of Lancaster supplies about 105,000 people, including its 60,000 residents, with water taken from the Susquehanna River some 15 miles below the TMI facility; typically 65-76% of our water supply is obtained in this manner.

Metropolitan Edison has several categories of radioactive wastewater variously estimated at 700-800,000 gallons. With the approval of the Nuclear Regulatory Commission, it plans to dispose of that water after treatment by discharge into the Susquehanna River. Having survived the TMI accident, our community is now faced with the prospect of additional exposure to possible health hazards. Responsible residents including professionals, senior citizens, children, and mothers have expressed their deep concern to the City about Met Ed's disposal plan. City officials find ourselves caught between conflicting claims that there will be serious long-term hazards and that the discharge will present no significant hazard.

The ultimate question is 'will the water that comes out of the faucets and shower heads be safe?' Since the scientific community is split on this question, who should we believe? Obviously we cannot tolerate such a situation. It is the City's position that the burden of proving the water safe rests with Metropolitan Edison and the Nuclear Regulatory Commission.

Considering the health and welfare of the residents of the City of Lancaster and surrounding communities, we oppose this planned discharge. In terms of your subcommittee's interest, the intent is to preclude any further harmful effects. As you probably are aware, the City has filed suit against the Nuclear Regulatory Commission in Federal Court to insure that environmental and health considerations are fully explored in arriving at an ultimate decision on the discharge of this wastewater from TMI. In essence the City of Lancaster desires assurance that the water it uses will be safe.

In conclusion, I would stress that the public welfare and health, both mental and physical, have been our primary considerations. I appreciate that a group such as yours is specifically considering that aspect of the TMI incident. I regret that the complex nature of this subject has precluded a more precise analysis and definitive comment on my part, but I appreciate the opportunity to appear and make some contribution to your efforts.

Mr. AMBRO. I must say I compliment you for your statement. We are all caught between conflicting claims, in a split scientific community, and one of the underlying reasons why we are here is because, of course, we want to find out who we should blame.

Mr. WALKER. Thank you, Mr. Chairman.

I think that is very valuable for the purposes of this subcommittee, that these witnesses from the public arena, who dealt directly with the accident, are all saying something we heard over and over again this morning. There was inadequate monitoring, and that they contributed something else, that the inadequate monitoring also translated

into inadequate communication. Even the data that was being received was not being translated in a way that was helpful to the people who were trying to make decisions in regard to the incident.

I think if anything has come out today, it is probably the importance of environmental monitoring. It remains as a direct relationship to adverse health effects and certainly needs to be upgraded.

I would direct a couple of questions to Mr. Brandt, simply because his neighbors are affected by the whole incident, and it might help us to get some feeling as to the problems perceived by local residents.

What do you read as the greatest health fear of the people of the immediate area at the present time?

Mr. BRANDT. Well, the immediate health fear is the situation with the water. That affects nearly all of us downstream. You can talk about downwind, and all of that, but the Susquehanna still flows south, so that is where the water is going. I think the water holds one of the greatest fears; I think it is the issue of the unknown. They do not know what they are really dealing with.

Mr. WALKER. What would you read as the greatest environmental fear that they have?

Mr. BRANDT. It is in the radiation leakage from Three Mile Island; we had the issue of the animals in the past 2 weeks, within a few miles of the island, particularly in the Bainbridge area, people are talking about increased amounts of cancer cases in that area, and that is what its all about.

Mr. WALKER. One other thing, you mentioned in your testimony the health hazards of evacuation, there were a number of spokesmen in the course of the incident who called for immediate evacuation of all people within a 50-mile radius. Have you developed specifics as to the health effects and what other damage which would have been done by evacuation plans that you could share with us?

Mr. BRANDT. There was nothing really drawn out as far as evacuation.

No. 1, in my estimation, there were no evacuation plans as I have seen from Harrisburg or Lancaster.

Everything was dated after April 1. If you attempt to draw a circle—it is a 3-mile or 5-mile circle around Three Mile Island—I think the number of people you have to move, and put them into buses, the number of buses extend miles long, and I think March 28 through April 1, you could not have had a better weekend for an evacuation.

No. 1, there were a lot of people out of the area because there was nice weather, we had plenty of time to think about it, and it was the ideal situation.

What we have not looked at as far as evacuation, what if we had called for an evacuation at 2 o'clock in the morning, and there is a condition of 6 inches of snow outside and so forth, and those types of things.

The information we received from Warren Henderson, who was in charge of civil defense in Pennsylvania, said what they had were backup plans, but there was really never any test, or any type of a drill, to see if this could really work out.

Mr. WALKER. Thank you, Mr. Chairman. I have no further questions.

Mr. AMBRO. Thank you, Mr. Walker. Mr. Ertel?

Mr. ERTEL. Are you suggesting we have a drill of evacuation, so that we move all of these people out?

You said we never had a drill. That implies maybe we should have one.

Mr. BRANDT. That is one of the comments the civil defense director made before our committee, maybe not in total as far as moving people, but at least to get into the area of getting the State police, and the civil defense, and people like that as to what they intend to do if we have an evacuation.

Mr. ERTEL. Thank you.

I have some questions of Mr. Gerusky. I was interested in your comments, and the bottom line is a comment I have always heard everywhere, the State ought to run it, we ought to plan it, and the Federal Government ought to pay for it.

Have you ever given any consideration of letting somebody else pay the tab, rather than all of the taxpayers of the United States? For instance, why should not all of these comprehensive plans for an evacuation of a nuclear powerplant site be paid for by the utility? After all, they are the ones that put up the plant, rather than just all of these going to that big old well, and that big old pocketbook, which is the Federal Government.

Mr. GERUSKY. I have no problem with that. The problem is collecting the money and getting the legislation passed State by State.

I think if it is done at the Federal level, they collect funds from utilities for licensing purposes, if some of that money came back to the States for planning, for environmental monitoring, and I am beyond my responsibility, for emergency evacuation, and that has been proposed, I believe.

Mr. ERTEL. We could in effect require evacuation plans, and the testing of them, and require the utility to pay the expenses to the communities.

I am just—how can I justify saying to the people who have no nuclear power in their area whatsoever, and they do not get any nuclear power, it is a national issue, and they are paying for the evacuation programs of somebody else that they will never get anything from?

Why don't the utilities pay it?

Mr. GERUSKY. I have no problem with the utility paying it.

Mr. ERTEL. I am glad you do not. I think that the funding should be directed from a Federal agency to the States that has overview as to what the States are doing.

Somehow the funding has to go from the Federal Government, and back to the States; that there is a comprehensive program, and not a State-by-State program, with a variety of programs in existence, that is what my concern is.

Maybe there should be a Federal monitoring system, say to the State you have got to follow these criteria.

Mr. GERUSKY. That is right, a national program with minimum standards for monitoring around nuclear powerplants so everybody has the same program.

Mr. ERTEL. I agree we have to do something, except I was a little leery where we were going to put the final funding.

Mr. GERUSKY. A lot of funds are passed between the utility and the Nuclear Regulatory Commission in their licensing process, and in their inspection programs.

I think some of those funds could be used for that purpose.

Mr. ERTEL. Thank you very much. I have no further questions.

Mr. AMBRO. Thank you, Mr. Ertel. I have no questions.

Mr. Winn?

Mr. WINN. Thank you, Mr. Chairman. I just have one little statement and then one question.

I would like to point out that the utilities are usually owned by thousands of small shareholders and stockholders, and so you are right back to the same place, no matter who pays for it, whether it is a taxpayer of the United States, or shareholder of the utility, basically he is paying for whatever additional funding is needed.

I would like to ask Mr. Brandt, are you aware of any printed or advertised or publicized evaluation plans of any type in your district, in your area?

Mr. BRANDT. Yes; I am aware. I have a copy right here of an evacuation plan of Lancaster that civil defense put together for the 5- and 10- and 20-mile ranges out of Three Mile Island.

Mr. WINN. I wonder if some of the rest of us may have that.

I would like to have that submitted for the record. I think that would be interesting to people all over the country.

Mr. BRANDT. I will be glad to do that.

[The evacuation plan follows:]

Lancaster County

Emergency Evacuation Plan

Three Mile Island

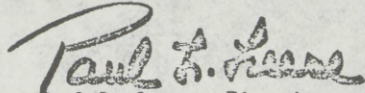


EMERGENCY MANAGEMENT AGENCY

April 4, 1979

To the Commissioners:

Attached is the Lancaster County evacuation plan for a 5 mile, 10 mile, and 20 mile radius segment of the county around the Fixed Nuclear Facility at Three Mile Island. As planning progresses, this document will be revised to incorporate additional detail.

A handwritten signature in dark ink, reading "Paul L. Leese". The signature is fluid and cursive, with the first name "Paul" being the most prominent.

Paul L. Leese, Director
Emergency Management Agency

DISTRIBUTIONEMERGENCY MANAGEMENT DIRECTORS

Conoy Township
East Donegal Township
West Donegal Township
East Hempfield Township
West Hempfield Township
Manor Township
Mount Joy Township
Penn Township
Rapho Township

Columbia Borough
East Petersburg Borough
Elizabethtown Borough
Manheim Borough
Marietta Borough
Mount Joy Borough
Mountville Borough

COUNTY CIVIL DEFENSE DIRECTORS

Berks
Bucks
Chester
Cumberland
Dauphin
Delaware
Lebanon
Montgomery
Perry
Philadelphia
York
Cecil County, Maryland

DCPA Region II

PEMA (2)

Lancaster Red Cross

Lancaster City C.D. Director

Troop "J" Penna State Police

Medical Coordinator

Mass Care Coordinator

Commissioners (3)

Penna National Guard - 103rd Medical Battalion

BACKGROUND

This plan establishes procedures for evacuation of portions of Lancaster County, if such evacuation should be required.

On March 28, 1979 an accident occurred at the Fixed Nuclear Facility at Three Mile Island. This accident posed a threat to the health and safety of the people of Lancaster County in the form of nuclear radiation and resultant contamination of an undetermined area in the western portion of Lancaster County. As a result of the accident, the Governor of Pennsylvania ordered the preparation of incremental plans to evacuate areas of 5 miles, 10 miles and 20 miles in radius from the site of the accident. These areas include:

- a. 5 Mile Radius: Conoy Township and West Donegal Township. Total population in this area is approximately 7,000 people.
- b. 10 Mile Radius: Local jurisdictions listed above plus Mount Joy and East Donegal Townships and Elizabethtown Borough. Total population in this area is approximately 20,000.
- c. 20 Mile Radius: Those local jurisdictions listed above plus Rapho, Penn, East Hempfield, West Hempfield and Manor Townships; plus Columbia, East Petersburg, Mountville, Mount Joy, Marietta and Manheim Boroughs. Total population is approximately 110,000.

I N D E X

- I. CONCEPT OF OPERATIONS
- II. COUNTY RESPONSIBILITIES
- III. SUPPORTING COUNTY RESPONSIBILITIES
- IV. PENNSYLVANIA STATE POLICE
- V. MILITARY SUPPORTING FORCES
- VI. BUS COMPANIES
- VII. LOCAL RESPONSIBILITIES
- VIII. EMERGENCY PUBLIC INFORMATION
- IX. EVACUATION ROUTES
- X. MEDICAL
- XI. MASS CARE

- ANNEX A FIVE MILE NEWS RELEASE
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- ANNEX G STATE POLICE PLAN - LIMITED DISTRIBUTION
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LANCASTER COUNTY

I. CONCEPT OF OPERATIONS

Lancaster County conducts evacuation of a 5 mile, 10 mile, and 20 mile radius of Three Mile Island on order of Governor of Pennsylvania. Supporting counties (Bucks, Berks, Chester, Delaware, Montgomery, Philadelphia and Cecil County, Maryland) provide nursing care bed space, ambulances, medical communications, mass care staging areas and mass care centers. Penna State Police is augmented and controls traffic flow and security. Penna National Guard augments security forces in evacuated areas and provide logistic support on major routes.

Operation to be conducted in four phases:

PHASE I - ALERT:

Movement of support forces from outside of county. Alert of local forces; appropriate EBS announcement.

PHASE II - MOBILIZATION:

Prepositioning of ambulances, buses, traffic control posts, security augmentation, establishment of mass care centers, staging areas and full manning of County EOC and supporting county EOCs; municipalities in evacuation area assemble emergency forces personnel; appropriate EBS announcement.

PHASE III - EVACUATION OF INVALIDS:

Evacuation of Invalids from nursing homes, residences, and hospitals; continued development of staging areas and mass care centers; appropriate EBS announcement.

PHASE IV - EVACUATION OF POPULACE:

And security of evacuated areas; operation of traffic control plan; operation of mass care centers; fire and police remain in place and take shelter on order or based on dosimeter readings.

All routes will be used. PSP, medical and logistical support priority will be to routes 222N, Turnpike E, 23E, 322E, 340E, 30E and 272/222S. Basic reliance will be on private automobile and for the residual population we will use buses. We will depend on the expertise of the Penna State Police in traffic control. It is anticipated that coordination of the traffic flow can be achieved by shunting traffic to avoid choke points with appropriate announcement made by county EOC through radio and television.

Bus evacuation will be accomplished (except in Columbia) by school buses along existing school bus routes. If the children are in school at time evacuation is ordered, they will be

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returned to their home, and one hour later the route will be run again picking up people with no access to private transportation. Loads will be consolidated at schools and dispatched on evacuation routes. In Columbia the local Emergency Management Director will arrange for bus transportation. The County Medical Staff will arrange for and execute bus evacuation of ambulatory patients at the two (2) hospitals and nursing homes in the 20 mile area. The County Medical Staff will also arrange for and execute ambulance evacuation of non ambulatory patients from hospitals and nursing homes and from residences. One train (capacity 600) will report to Elizabethtown Station to take passengers to Downingtown or Whitford in Chester County. Chester County will pick up and take to Mass Care Centers.

MASS CARE AVAILABLE:

- a. Route 222N through staging areas at spaces, municipal stadium, Route 61, Reading for 10,000 spaces in Berks County.
- b. Turnpike East and 23E at G.E. plant next to Valley Forge Memorial Park for 10,000 spaces in Montgomery county and 5,000 spaces in Bucks county.
- c. Route 30E at Park City for 10,000 - 12,000 spaces in Lancaster county and at Exton mall in Chester county for 10,000 spaces in Chester county and 5,000 in Delaware county.
- d. Limited mass care is available in Cecil county but maximum effort will be to direct mass care requirements to the routes in a, b, & c above.

LANCASTER COUNTY

II. COUNTY RESPONSIBILITIES

A. GENERAL

// Overall responsibility for implementation of this plan rests with the Lancaster County Commissioners; although the decision to implement will be made only by the Governor of Pennsylvania. Actions to be taken after the implementation order has been issued include:

1. Coordinate State Police, medical and logistical support of evacuation routes.
2. Develop assets of ambulances, hospital beds, nursing home beds in Bucks, Chester, Montgomery, Berks, Delaware and Philadelphia counties in Pennsylvania.
3. Coordinate with above counties and Cecil County, Md. mass care facilities.
4. Determine total requirements and report shortfall to State.

B. PHASES

PHASE I - ALERT

Release EBS announcement as appropriate.

Alert all local municipalities and existing nets in accordance with warning plan.

Alert PSP, PA Natl. Guard, PennDot, County Staff.

Notify hospitals, nursing homes (extended care facilities).

Notify Berks, Chester, Montgomery, Bucks, Delaware, Philadelphia and Cecil County, Maryland.

PHASE II - ALERT

Release EBS announcement as appropriate.

Notify all local municipalities in accordance with warning plan.

Notify PSP, PA Natl. Guard, PennDot, County Staff.

Request from surrounding counties dispatch of ambulances, crews, and medical communications vehicle.

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II. COUNTY RESPONSIBILITIES (CONT'D)

Request availability and location of bed spaces from supporting counties.

Make tentative assignments for medical evacuees.

Request PSP, PA Natl. Guard, PennDot to establish route support.

Red Cross to establish mass care centers, and staging area at Park City.

Move ambulances to nursing homes and invalid homes to be evacuated with destination instructions.

Move buses to municipalities which have requested such support.

PHASE III - EVACUATE INVALIDS

Release EBS announcement as appropriate.

Direct evacuation of invalids.

Require reports of progress.

PHASE IV - EVACUATE POPULACE

Release EBS announcement as appropriate.

Direct evacuation of populace.

Require reports of progress.

Coordinate with supporting counties as operation progresses to keep loading of shelters in line with plan.

Request PSP to take necessary action to accomplish plans by traffic control measures.

C. COORDINATIVE RESPONSIBILITIES

1. Direction & Control, Warning and Communications

Paul Leese, Lancaster County Emergency Management Agency Director.

2. Transportation

John Eberly, Lancaster County Transportation Coordinator.

3. Mass Care

Clyde E. Brown, Mass Care Coordinator.

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II. COUNTY RESPONSIBILITIES (CONT')4. Medical

Clyde E. Brown, Medical Coordinator

5. Traffic Control and Security

Pennsylvania State Police - Captain Kerr

III. SUPPORTING COUNTY RESPONSIBILITIES (BY AGREEMENT)

- A. Provision of ambulances and crew to Lancaster County route turnpike west to Lebanon-Lancaster exit, south on route 72 to Manheim Auto Auction one mile south of Manheim Borough.

<u>County</u>	<u>Ambulance support</u>
Berks	17
Montgomery	30
Chester	19
Bucks	20
Delaware	20
Philadelphia	10

- B. Provision of medical communications vehicle at Manheim Auto Auction one mile south of Manheim borough on route 72. Route 72 to be taken to Turnpike west to Lebanon-Lancaster Exit on route 72S.

- C. Provision of nursing home (extended care facility)

Berks	100
Montgomery	100
Chester	200

Counties are requested to report the Lancaster County Medical Coordinator, Tim Brown, the location of bed spaces available.

- D. Operation of Mass Care Staging Area

1. Lancaster County - Park City Mall - NW of Lancaster on Route 30

Assign motorists and buses to mass care shelters in Eastern Lancaster County.

2. Berks County - Municipal Stadium - Route 61 off route 222N

Assign motorists and buses and mass care shelters in Eastern Lancaster County

3. Montgomery County - GE plant opposite Valley Forge National Park from Turnpike East and 23E

Assign motorists and buses to mass care center in Montgomery County and Bucks County.

4. Chester County - Exton Mall on Route 30 just east of Downingtown

Assign motorists and buses to mass care centers in Chester County, Delaware County and Philadelphia County as needed.

5. Mass Care Facilities:

III. SUPPORTING COUNTY RESPONSIBILITIES (CONT'D)

Host counties provide space in mass care facilities as shown:

<u>County</u>	<u>20 Mile Radius Evacuation</u>
Lancaster	12,000
Berks	10,000
Montgomery	10,000
Chester	10,000
Bucks	5,000
Delaware	5,000
Philadelphia	
Cecil County, Md.	2,000
	54,000

E. TRAIN MOVEMENT

A train movement of 600 people (with EMT Team) is scheduled from Elizabethtown to either Downingtown or Whitford, Chester County is requested to pick up and process to mass care centers in Chester and Delaware County.

C-1, April 8, 1979

IV. PENNSYLVANIA STATE POLICE (PSP)

A. Responsibility - Primary

1. Crowd and traffic control
2. Security

- a. Personal
- b. Home
- c. Business

B. Action

1. General

- a. Upon notification of an incident at TML, or request for a precautionary evacuation, PSP will send a representative to Lancaster County EOC.
- b. PSP, in conjunction with county and local police will establish main evacuation routes. Evacuation routes will be supported by National Guard and Medical personnel (gas, water, mechanical assistance, medical assistance).
- c. PSP will coordinate with PennDOT to have signs posted which evacuees of areas with available facilities (i.e., location, of staging areas, mass care facilities, etc.)
- d. PSP, in consultation with PennDOT and County Emergency Management Coordinator will determine where signs will be located and what they will say.

2. Alert

- a. PSP will assign personnel at various points as determined by them in order to monitor traffic flow.
- b. Reports of any problems will be sent to EOC (hourly reports will be required).
- c. Communications will be provided by PSP for monitoring their check points.
- d. PSP will monitor flow and redirect traffic if necessary and advise Lancaster EOC as to additional procedures to increase evacuation flow.

3. PHASE I. - Prior to expected time evacuation is to start, PSP will have their personnel in place (i.e., along evacuation routes, in staging areas, etc.)

PSP will give priority to ambulances, invalids, and those vehicles where more than one passenger is involved.

PSP will coordinate with Penna National Guard to see that fuel tankers are in place along evacuation routes. PSP will then relay information to EOC. EOC will be kept informed of all actions.

4. PHASE II. - Once evacuation is under way, PSP will be responsible for insuring continuous movement away from the area.

Coordination with and relay of information to the EOC is essential.

5. PHASE III. - Ambulances are to be given priority where ever possible. They should not be detained at traffic lights, intersections, etc.
6. PHASE IV. - PSP, utilizing all communications sources will check adjustments to traffic flow to insure proper loading of mass care centers and equal distributions of traffic.

Reports of approximate number of vehicles and ~~rate~~ of vehicular traffic will be reported to EOC.

V. - MILITARY SUPPORTING FORCES

1. In coordination with local police and PSP, Military support will provide on main evacuation routes assistance in the form of gas tanker, tow trucks and water tankers.
2. Military Support Forces will provide ambulances to assist in evacuation of areas designated by the Medical Coordinator on County Staff.
3. Commander, Military Support Forces, will respond to requests for assistance from County Medical Coordinator.
4. Military Support Forces will provide the following security detachments to reinforce localities in the numbers listed below:

Boroughs

Elizabethtown	10 men
Mount Joy	none
Manheim	none
Marietta	10 men
East Petersburg	none
Columbia	20 men
Mountville	to be determined
Washington	to be determined

Townships

Conoy	2 men
West Donegal	10 men - 2 vehicles
Mount Joy	10 men - 4 vehicles
East Donegal	3 men
Rapho	State Police responsibility
Penn	10 men - 2 vehicles
East Hempfield	to be determined
West Hempfield	10 men
Manor	to be determined

VI. BUS COMPANIES

County transportation coordinator will assess and determine needs for buses to be used in the event of evacuation.

County transportation coordinator will have a list of the number of vehicles available, their locations, capacity and amount of time in which all vehicles can be on the road. This list will contain the names, addresses, and telephone numbers of bus company owners.

County buses will be under the direction of the transportation coordinator, who will have the responsibility for dispensing buses to needed locations.

VII.. LOCAL RESPONSIBILITIES

- A. General - Preparatory actions to be taken by municipalities within 20 mile radius of TMI:
 1. Make census of invalids outside of medical facilities. Report to County Medical Coordinator (tele. # 299-5561).
 2. Determine personnel and equipment augmentation needed by municipal necessary for security of area to be evacuated. Report to County EMA (tele. # 299-8373).
 3. Determine bus requirements which cannot be supplied by normal school or commercial bus provider. Report to County Transportation Coordinator (tele. # 299-8373).
 4. Mark invalids' homes and rooms. A 6" blue square is suggested.
 5. Establish evacuation responsibilities of available forces.
 6. Request resources needed from County Emergency Management Agency.
 7. Municipalities should be prepared to accept National Guard or Reserve forces in their jurisdiction to assist in any manner deemed necessary by local authorities (i.e., traffic control, security, detainment, protection from rioters, looters, etc.).
- B. Specific
 1. PHASE I. - Alert

Alert personnel necessary for evacuation
Check assignments and revise where necessary
Check facilities and equipment
 2. PHASE II. -

Mobilize personnel
Issue last minute instructions
 3. PHASE III.

Assist medical evacuation
 4. PHASE IV.
 - a. Evacuate by door to door contact as well as use of audible signals, loudspeakers, etc. County will make radio and TV releases and announcements. If such announcement is needed to fit local problem, request then through County Public Information Officer (tele. # 299-8376, Stanley Newkirk)

- b. Notify County EMA when evacuation is complete. Give estimate as to percent of population who refused to evacuate.
- c. Secure evacuated areas and provide fire suppression support.
- d. Instruct personnel who stay behind to take cover upon notification by county or based on dosimeter readings or monitoring stations in area.

VIII. EMERGENCY PUBLIC INFORMATIONA. RESPONSIBILITY

The Lancaster County Emergency Management Department is responsible for preparing and issuing all emergency public information within the county.

B. MESSAGES

Public information messages that are to be used for evacuation of a 5, 10, and 20 mile area of Lancaster County are presented in the plan as follows:

Annex A - 5 miles
B - 10 miles
C - 20 miles

C. EMERGENCY BROADCAST SYSTEM (EBS)

The primary CPCS (Common Program Central Station) in Lancaster County is WLPA 1490 AM.

IX. EVACUATION ROUTES:

Evacuation routes to be utilized in the event of an evacuation of portions of Lancaster County are shown in annex D.

X. MEDICAL

Medical Coordinator (MC) is responsible for evacuation of patients, ambulatory and non-ambulatory, from acute care facilities, long term care facilities and invalids in private home; Medical Coordinator is also responsible for medical care of all evacuees in mass care shelters.

Medical Coordinator will determine locations of patients, by category, requiring transportation; will provide the necessary number of ambulances and buses to effect patient transport; and will establish a pool of physicians and allied health care personnel for evacuation process, staging area and mass care shelters.

Details of medical operations are at Annex H.

IX. MASS CARE

Mass Care Coordinator (MCC) is responsible for determining and designating shelter areas to accomodate up to 18,300 evacuees. MCC is responsible for selection, organization, activation and operation of staging area(s) for receiving evacuees and for processing those persons. Responsibility includes assignment of evacuees to shelters and routing of persons to those shelters. MCC is responsible for providing logistical support for evacuees while in shelters. Mcc will insure that there is a variable evacuee locator plan.

Details of mass care operations are at Annex I.

C-1, April 8, 1979

5-MILE

RELEASE THIS INFORMATION ONLY WHEN EVACUATION ORDER IS GIVENAUTHENTICATOR: PEMA T.M.I. OPERATION

ALL PERSONS RESIDING IN THE CONOY AND WEST DONEGAL TOWNSHIP ARE
HEREBY DIRECTED TO PREPARE TO EVACUATE OR RELOCATE. THE PRINCIPAL
METHOD OF TRANSPORTATION DURING THE EVACUATION WILL BE PRIVATE VEHICLES.

USE YOUR PRIVATE VEHICLES TO TRANSPORT YOUR FAMILY AND TAKE A NEIGHBOR
IF POSSIBLE. SCHOOL BUSES WILL ALSO BE USED TO EVACUATE PEOPLE. THE
BUSES WILL FOLLOW THEIR USUAL ROUTES TO PICK UP PEOPLE WHO HAVE NO PRI-
VATE TRANSPORTATION ONE HOUR AFTER THEY HAVE RETURNED ALL CHILDREN HOME
FROM SCHOOL. DO NOT GO TO SCHOOL TO PICK UP YOUR CHILDREN.

SECURE HOME AND PROPERTY BEFORE LEAVING HOME, TURN DOWN HEAT, TURN OFF ALL
LIGHTS, TAKE PETS ALONG TO SHELTER. SHOULD YOU HAVE AN INVALID PERSON IN
YOUR HOME, MAKE SURE THAT YOUR FIRE COMPANY IS NOTIFIED SO THAT HELP IS
AVAILABLE FOR REMOVAL.

ALL YOUR NEEDS WILL BE PROVIDED AT THE SHELTER. HOWEVER, TAKE BEDDING AND
NECESSARY MEDICATIONS.

IF YOU ARE EVACUATING IN YOUR OWN VEHICLE PROCEED TO ELIZABETHTOWN TO BE
DIRECTED TO A SHELTER AREA.

CONOY FIRE COMPANY IS. . . BAINBRIDGE.....	653-2001
CONOY TOWNSHIP CIVIL DEFENSE DIRECTOR, GUY KOSER.....	426-3907
WEST DONEGAL TWP. CIVIL DEFENSE DIRECTOR, JAMES KONDRAS.....	653-1664
ELIZABETHTOWN BORO CIVIL DEFENSE DIRECTOR, HAROLD CAROTTO...	367-7012
ELIZABETHTOWN FIRE COMPANY	653-2001
LANCASTER COUNTY CIVIL DEFENSE	299-8373

THIS IS A FIVE MILE RADIUS FROM THREE MILE ISLAND EVACUATION PLAN

ANNEX A

AUTHENTICATOR: PEMA T.M.I. OPERATION

THE PRINCIPAL METHOD OF TRANSPORTATION DURING EVACUATION WILL BE PRIVATE VEHICLES. USE YOUR PRIVATE VEHICLES TO TRANSPORT YOUR FAMILY AND TAKE A NEIGHBOR IF POSSIBLE. SCHOOL BUSES WILL ALSO BE USED TO EVACUATE PEOPLE. THE BUSES WILL FOLLOW THEIR USUAL ROUTES TO PICK UP PEOPLE WHO HAVE NO PRIVATE TRANSPORTATION ONE HOUR AFTER THEY HAVE RETURNED ALL CHILDREN HOME FROM SCHOOL. DO NOT GO TO SCHOOL TO PICK UP YOUR CHILDREN.

ALL YOUR NEEDS WILL BE PROVIDED AT THE SHELTER. HOWEVER, TAKE
BEDDING AND NECESSARY MEDICATIONS.

CONOY FIRE COMPANY, BAINBRIDGE 653-2001
CONOY TWP, C.D.DIRECTOR - GUY KOSER 426-3907
WEST DONEGAL TWP, C.D.DIRECTOR - JAMES KONDRAS 653-1664
MOUNT JOY TWP, C.D.DIRECTOR - EUGENE ALTLAND 653-2130
MOUNT JOY TWP.FIRE COMPANY 653-2001
EAST DONEGAL TWP. C.D.DIRECTOR-
GEORGE W. GLATTAKER SR. 426-3860
EAST DONEGAL TWP. FIRE COMPANY 653-2001/299-550
ELIZABETHTOWN BORO.C.D.DIRECTOR
HAROLD CAROTTO 367-7012
ELIZABETHTOWN BORO.FIRE COMPANY 653-2001
LANCASTER COUNTY CIVIL DEFENSE 299-8373

"THIS IS THE TEN MILE RADIUS FROM THREE MILE ISLAND EVACUATION PLAN".

ANNEX-B

ANNEX C - SPECIAL INSTRUCTIONS

Attached to Annex C. is Attachment 1. This is to be displayed on television to provide the name and telephone number of key local officials. At the radio station it can be used as reference in response to telephone calls received from the public.

CONOY TWP. FIRE COMPANY	653-2001
CONOY TWP. C.D.DIRECTOR - GUY KOSER	426-3907
WEST DONEGAL TWP.C.D.DIRECTOR - JAMES KONDROS	653-1664
WEST DONEGAL FIRE COMPANY	653-2001
MOUNT JOY TWP. FIRE COMPANY	653-2001
MOUNT JOY TWP.C.D.DIRECTOR-H.Eugene Altland	653-2130
EAST DONEGAL TWP.FIRE COMPANY	653-2001
EAST DONEGAL TWP. C.D.DIRECTOR,GEORGE W. GLATTACKER, Jr.	426-3860
RAPHO TWP. FIRE COMPANY	299-5501
RAPHO TWP. C.D.DIRECTOR, MORRIS SHAFFER	665-2411
PENN TWP. FIRE COMPANY	299-5501
PENN TWP.C.D.DIRECTOR, MORRIS SHAFFER	665-2411
EAST HEMPFIELD TWP. FIRE COMPANY	299-5501
EAST HEMPFIELD TWP.C.D.DIRECTOR, REID GRAYBILL	898-8242
MANHEIM BORO. FIRE COMPANY	299-5501
MANHEIM BORO. C.D.DIRECTOR, MORRIS SHAFFER	665-2411
WASHINGTON BORO. FIRE COMPANY	299-5501
WASHINGTON BORO C.D.DIRECTOR, RUSSEL ESHELMAN	684-8120
ELIZABETHTOWN BORO. FIRE COMPANY	653-2001
ELIZABETHTOWN C.D.DIRECTOR, Harold CAROTTO	367-7012
Manor Twp. FIRE COMPANY	299-5501
MANOR TWP. C.D.DIRECTOR . . . RUSSEL ESHELMAN	684-8120
COLUMBIA BORO. FIRE COMPANY	653-2001
COLUMBIA BORO. C.D.DIRECTOR, KENNETH BARNINGER	684-6876
EAST PETERSBURG FIRE COMPANY	299-5501
EAST PETERSBURG C.D.DIRECTOR, FRED HAMMERSAND	569-1471
MOUNTVILLE BORO FIRE COMPANY	299-5501
MOUNTVILLE C.D.DIRECTOR (NONE)	XXXXXX
MARIETTA BORO FIRE COMPANY	299-5501
MARIETTA BORO C.D.DIRECTOR . . . WILLIAM BRECKLINE	426-1247
WEST HEMPFIELD FIRE COMPANY	299-5501
WEST HEMPFIELD TWP.C.D. DIRECTOR Louis Gable	285-5633

"THIS IS A 20 MILE RADIUS FROM TREE MILE ISLAND EVACUATION PLAN".

20 MILE

RELEASE THIS INFORMATION ONLY WHEN AN EVACUATION ORDER IS GIVEN.

AUTHENTICATOR: PEMA TMI OPERATION

ALL PERSONS RESIDING IN THE CONOY - WEST DONEGAL - MOUNT JOY - EAST DONEGAL - RAPHO - PENN - EAST HEMPFIELD - WEST HEMPFIELD - MANOR TOWNSHIPS - PIUS ELIZABETHTOWN BORO - COLUMBIA BORO - EAST PETERSBURG BORO - MOUNT JOY BORO - MOUNTVILLE BORO - MARIETTA BORO - MANHEIM BORO ARE HEREBY DIRECTED TO PREPARE TO EVACUATE OR RELOCATE.

THE PRINCIPAL METHOD OF TRANSPORTATION DURING EVACUATION WILL BE PRIVATE VEHICLES. USE YOUR PRIVATE VEHICLES TO TRANSPORT YOUR FAMILY AND TAKE A NEIGHBOR IF POSSIBLE. SCHOOL BUSES WILL ALSO BE USED TO EVACUATE PEOPLE. THE BUSES WILL FOLLOW THEIR USUAL ROUTES TO PICK UP PEOPLE WHO HAVE NO TRANSPORTATION ONE HOUR AFTER THEY HAVE RETURNED ALL CHILDREN HOME FROM SCHOOL. DO NOT GO TO SCHOOL TO PICK UP YOUR CHILDREN.

SECURE HOME AND PROPERTY BEFORE LEAVING HOME. TURN DOWN HEAT - TURN OFF ALL LIGHTS - TAKE PETS ALONG TO SHELTER. SHOULD YOU HAVE AN INVALID PERSON IN YOUR HOME MAKE SURE THAT YOUR FIRE COMPANY IS NOTIFIED SO THAT HELP IS AVAILABLE FOR THEIR REMOVAL.

ALL YOUR NEEDS WILL BE PROVIDED AT THE SHELTER. HOWEVER, TAKE BEDDING AND NECESSARY MEDICATIONS

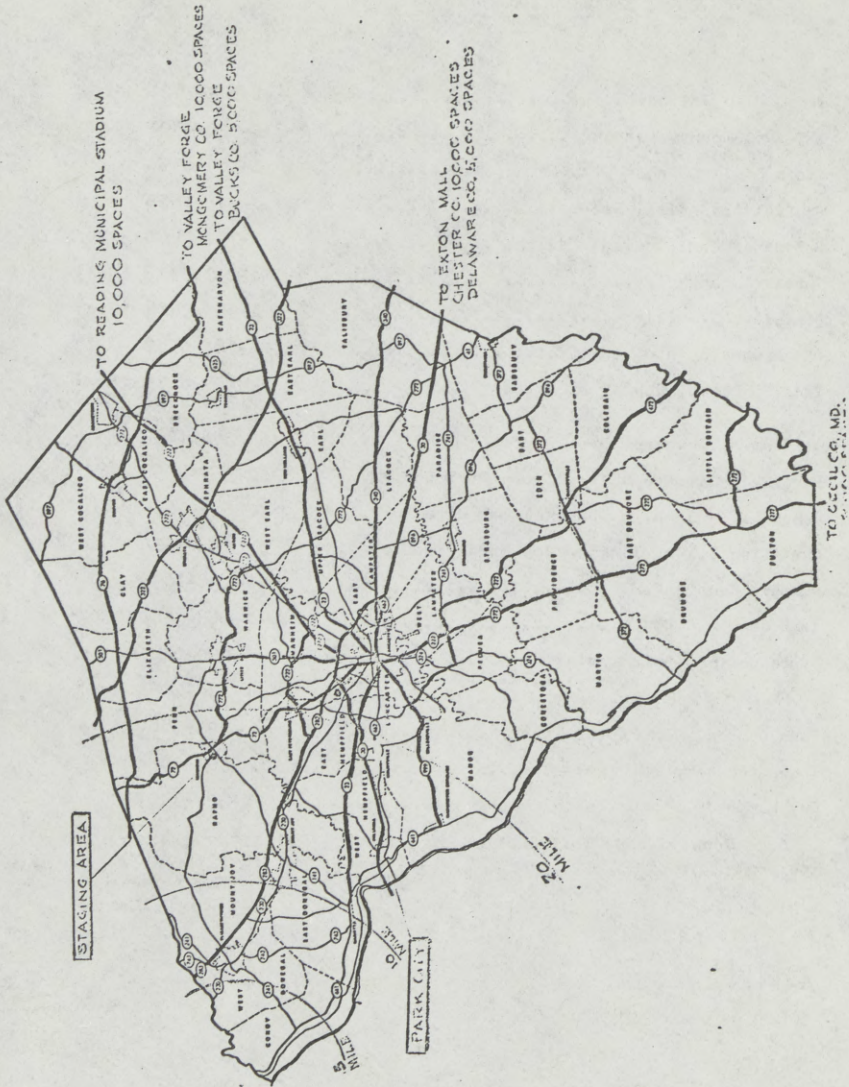
RESIDENTS OF THE FOLLOWING LOCALITIES ARE REQUESTED TO USE THE LEBANON/LANCASTER ENTRANCE TO THE TURNPIKE EAST FOR WHICH THERE IS NO TOLL:

ELIZABETHTOWN
MOUNT JOY BOROUGH AND TOWNSHIP
RAPHO TOWNSHIP
PENN TOWNSHIP
MANHEIM BOROUGH
EAST PETERSBURG BOROUGH

ANNEX-C

RESIDENTS OF OTHER LOCALITIES TO BE EVACUATED WHO NEED MASS CARE ASSISTANCE SHOULD PROCEED TO THE EAST THROUGH THE PARK CITY AREA. RESIDENTS WHO DO NOT NEED MASS CARE ASSISTANCE MAY PROCEED BY THEIR MOST DIRECT ROUTE TO 222N, TURNPIKE E, 23E, 322E, 340E, 30E AND 272/222S.

ANNEX-C



ANNEX-"D"

TELEPHONE NUMBERS

Three Mile Island	1-944-7621
MET-ED Company, Reading	1-215-929-3601
State Civil Defense Duty Officer	1-783-8150
Central Area Civil Defense	1-374-2055
Bureau of Radiological Health	1-787-2480/3720/4314
Thomas Gerusky	XXXXXXXXXX (Res)
Margaret A. Reilly	XXXXXXXXXX (Res)
DER Meteorologist	1-787-6547
Paul L. Leese, County Director	299-8373 (Bus)
	XXXXXXXXXX (Res)
William M. Connors, Dep. Director & RDO	394-1034
Harold J. Carotto, E'town Boro Director	1-367-4558
James S. Kondras, W. Donegal Twp Director ...	653-1664
Christian S. Charles, Mt. Joy Boro Director ..	653-5514
Dauphin County C.D.	1-238-1693
York County C.D.	1-848-3304/3301
State Police -- Lancaster	299-0441
York	1-764-1181
Harrisburg	1-234-4051
Penn Central, Lancaster Tower	393-3880
Lancaster Airport Tower	569-0004
Guy M. Koser, Conoy Twp Director	1-426-3907
Berks County EMD, Phil Shulich	1-215-374-4800
TIM BROWN	374-4809
TOM RAMETTA	299-5561
	299-5561

ANNEX-E

FEDERAL PERSONNEL

Joe Frizzell (DCPA Region II) - Holiday Inn North 393-0771/165

Jim Hensley " " " " " 393-0771/169

Francis Shauder " " " " " 393-0771/167

PEMA

Bob Hetz, Eastern Area Director - Brunswick Motor 397-4801/623

P.P&L. CO., Steve Seiford 569-6331
 or 569-6531

POSTAL INSPECTOR 299-1571

RRTA ..Reed Rodman 397-4246
 (Buses - approximately 30) xxxxxxx (Res)

RUMOR CONTROL CENTER 397-4894

EMD DIRECTORS (LANC. CO.)(5 mile)

Harold Carotto, E'Town Boro 1-367-7012(EOG)
 1-367-6666(Bus)
 XXXXXXXX (Res)

James Kondras, W. Donegal Twp. XXXXXXXX (Res)

H. Eugene Altland, Mt. Joy Twp. 653-2100(EOG)
 XXXXXXXX (Res)

Guy M. Koser, Conoy Twp. XXXXXXXX (Res)

(10 mile)

Christ Charles, Mt. Joy Boro 653-8183(Bus)
 XXXXXXXX (Res)

George Glattacker, Sr., E. Donegal Twp. 1-426-1752(Bus)
 XXXXXXXX (Res)

William Breckline, Marietta Boro XXXXXXXX (Bus & Res)

(20 mile)

Morris Shaffer, Manheim Boro XXXXXXXX (Bus & Res)
 Rapho & Penn

Russell Eshleman, Manor Twp 397-4769(Bus)
 XXXXXXXX (Res)

Kenneth Barninger, Columbia Boro 872-5461(Bus)
 XXXXXXXX (Res)

Fred Hammersand, E. Petersburg Boro 397-7661(Bus)
 XXXXXXXX (Res)

Reid Graybill, E. Hempfield Twp. 397-4934(Bus)
 XXXXXXXX (Res)

Louis Gable, W. Hempfield Twp. XXXXXXXX (Res)

NATIONAL GUARD ————— 392-8115
 MAJOR BERTZ

January 1979

CONTACTS FOR NEWS RELEASESA. NEWSPAPERS

Lancaster News Papers	291-8600 8601 8602
<u>a. Lancaster Intelligencer Journal</u>	
William R. Schultz, Editor	291-8650
William Cody, News	291-8622
<u>b. Lancaster New Era</u>	
Daniel Cherry, Editor	291-8750
Robert J. Kozak, News	291-8733
<u>c. Sunday News</u>	
Harold J. Eager, Editor	291-8686
Dave Honnigan, News	291-8692

B. RADIO STATIONS

WDAC	284-4123
WGL PA WGL AM & FM - WNCE	397-0333
WGSA AM (Ephrata 1-733-2226)	397-1310
WIOV - 105 (Ephrata 1-733-1310)	397-1310
WSBA AM & FM (York 1-764-1155)	393-1155
WLAN AM & FM	394-7261
(Not operating 0200 to 0500)	

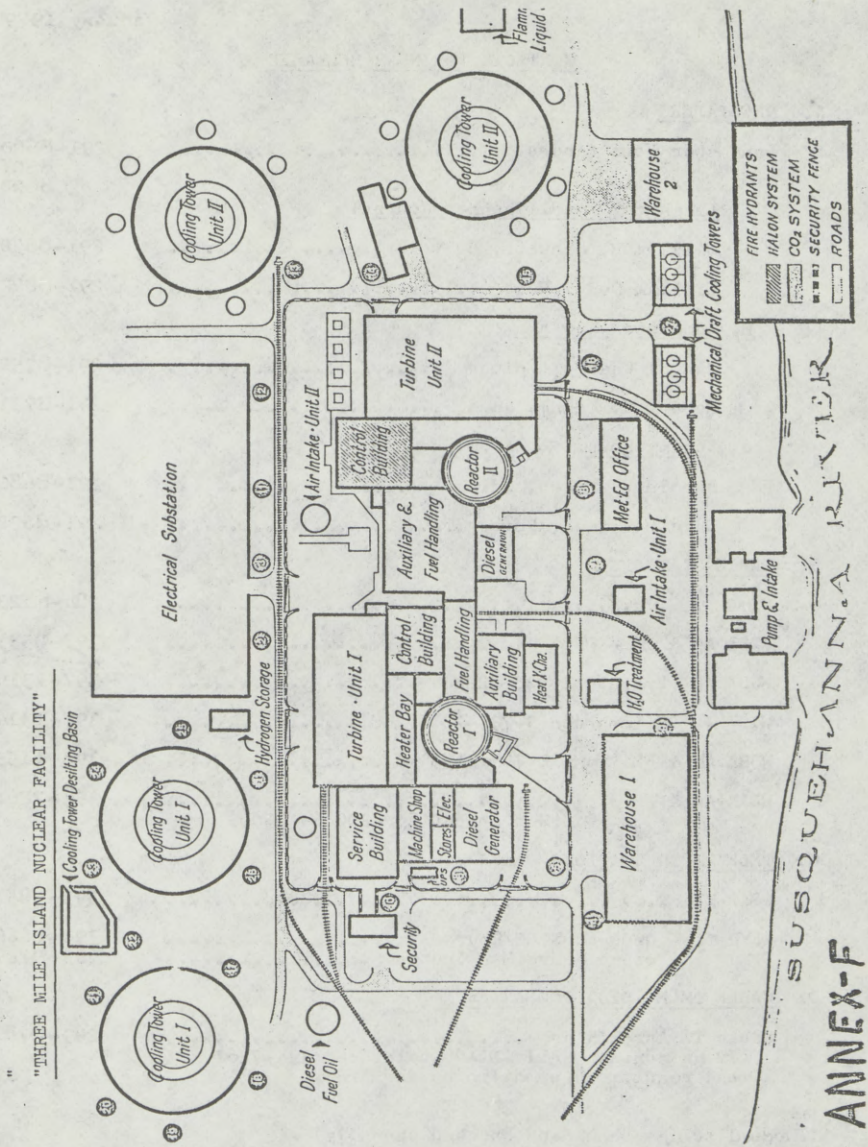
C. TELEVISION STATIONS

WGAL-TV	393-5851
WLYH-TV - 0900 to 1700 hours	393-2666
other hours Mt. Gretna	393-9729

D. CABLE TELEVISION COMPANIES

Cable TV Associates	299-0781
(If no contact call "WLAN" telephone 394-7261 and request information be forward)	

(These listings should be checked annually)



ANNEX H--MEDICAL

PURPOSE:

TO EVACUATE PATIENTS, GUESTS, AND INVALIDS FROM HOSPITALS, EXTENDED CARE FACILITIES, NURSING HOMES, AND PRIVATE HOMES. IN ADDITION, TO PROVIDE MEDICAL CARE, FOOD AND SHELTER FOR THESE INDIVIDUALS DURING THE EMERGENCY.

CONCEPT OF OPERATIONS:

AMBULANCES WILL BE DISPATCHED TO THE MANHEIM AUTO AUCTION, THEN SENT IN CONVOY ACCORDING TO ASSIGNMENTS. EACH CONVOY WILL HAVE AT LEAST ONE AMBULANCE THAT IS ABLE TO MAINTAIN COMMUNICATIONS. UPON ARRIVAL AND LOADING EACH CONVOY WILL BE ROUTED TO ITS DESTINATION(S). AFTER UNLOADING, LOCAL AMBULANCES AND NATIONAL GUARD AMBULANCES WILL RETURN TO THE LANCASTER COUNTY STAGING AREA (MANHEIM AUTO AUCTION). AMBULANCES THAT ARE SUPPLEMENTAL (OUT-OF-COUNTY) WILL BE DIRECTED TO RETURN TO THEIR HOME LOCATIONS AND REMAIN ON STAND-BY STATUS.

KEY PERSONS TO BE NOTIFIED:

Jim Brener.....291-7631 (tone & voice pager)
 John Hoffman.....291-7833 (tone only pager)
 Bill Lease.....291-7835 (tone only pager)
 John Singleton.....291-7837 (tone only pager)

APPENDICES:

- 1--Requirements and Distributions
- 2--ALS Rezoning

(1) FACILITY	APPENDIX 1 TO ANNEX H	PATIENT REQUIREMENTS ambu- ambula- lance tory	VEHICULAR RESOURCES	PATIENT DESTINATION	VEHICULAR ROUTING
I HOSPITALS					
COLUMBIA HOSPITAL 684-2841	17 17 6 ICU 33? varies daily	1-40 PASSENGER RRTA 4 ARMY 1 LOCAL 3 LOCAL (MMTA, WEST END, WARWICK)	EPHRATA HOSPITAL	RT. 72 SOUTH TO RT. 30 WEST; TAKE COLUMBIA 3RD ST. EXIT; FOLLOW BLUE "B" SIGN TO HOSPITAL	
ELIZABETHTOWN CHILDREN'S	17 0 varies daily	OWN SPECIAL VAN	NA	NA	

II. NURSING HOMES, BOARDING HOMES, GUEST HOMES

BAILEY NURSING HOME 367-1377 ELIZABETHTOWN	6 24 Total 30	HAVE OWN BUS; 2 FOREIGN AMBULANCES 1 BAILEY AMBULANCE	COATESVILLE VA; REMAINDER POTTSTOWN	
BRERETON MANOR 872-2403 MOUNTVILLE	0 14 Total	2-40 PASSENGER RRTA'S (BUS #2)	F&M	
BRINTON MANOR MOUNTVILLE	0 14 Total	2-40 PASSENGER RRTA'S (BUS #1)	F&M	
CHERRY STREET HOME 684-2038 COLUMBIA	0 21 Total	2-40 PASSENGER RRTA'S (BUS #1)	F&M	
DUNNER HOUSE 665-2336 MANHEIM	0 10 Total	1-40 PASSENGER RRTA	F&M	
DISSINGERS FOSTER 898-8072 LANDISVILLE	0 5 Total	1-18 PASSENGER MINIBUS JOHNSON	F&M	
HEATHERBANK 755-3069 COLUMBIA (FACILITY #684-7555)	29 137 Total 166	4-45 PASSENGER CTC BUSES; 15 FOREIGN AMBULANCES 1 TRUCK FOR EQUIP.	COATESVILLE VA	
HOME FOR RETIRED LADIES 426-3108 MOUNT JOY	0 6 Total	18-22 PASSENGER JOHNSON	F&M	

(2) FACILITY	PATIENT REQUIREMENTS		VEHICULAR RESOURCES	PATIENT DESTINATION	VEHICULAR ROUTING
HOOVER BOARDING HOUSE 426-3108 1 MILE SOUTH OF F BRIDGE	ACE. 0	ARY. 11	1-49 PASSENGER CTC BUS	P&M	
	Total				
LANCASTER JUNCTION BOARDING HOME 665-6939			TAKEN CARE OF BY FACILITY		
LEHMAN GUEST & NURSING HOME 367-1831	3	42	PRIVATE CONTRACT	SELF EVAC TO AUDOBON VILLA, LITITZ	RT. 72 SOUTH TO RT. 30 WEST; EXIT COLUMBIA 3RD ST; TURN RT. UP HILL AND RT. AGAIN AT KINDER- HOOK ROAD TO STOP SIGN. TURN RIGHT; HOME ON LEFT; 745 CHIQUE HILL RD.
	Total 45				
MASONIC HOME 367-1121	283 NO MOVE ANTICIPATED	422	NA	NA	NA
	Total 705				
MOUNT HOPE 665-6365 MANHEIM	59	6	1- 18 PASSENGER MINI BUS 5 ARMY AMBULANCES 10 LOCAL AMBULANCES 10 Foreign Ambulances	BERGKIRCHEN POTTSTOWN	RT. 72 THRU MANHEIM, LEFT ON CIDER PRESS RD. TO MOUNT HOPE RD.; TURN LEFT; RD #3 ON LEFT
	Total 65				
PLEASANT VIEW MANHEIM	86	62	(62 ARY. ON 2-40 PASSENGER HRTA BUSES; 86 ACE. ON 43 FOREIGN AMBULANCES	POCOPPIN CHESTER CO	RT. 72 NORTH CENTER OF MANHEIM TURN RIGHT ON HIGH STREET. LEFT ON PENNYN RD.; HOME RD #5 ON LEFT
	Total 148				
ST. ANNE'S HOME COLUMBIA	70	50	1-49 PASSENGER CTC BUS 7 ARMY, 1LOCAL, AND 20 FOREIGN AMBULANCES	COATESVILLE	RT. 72 SOUTH TO RT. 30 WEST; TAKE COLUMBIA PROSPECT RD. EXIT; LEFT AT STOP; TURN LEFT RT. 462; HOME ON LEFT RD #2
	Total 120				

(3) FACILITY	PATIENT REQUIREMENTS	VEHICULAR RESOURCES	PATIENT DESTINATION	VEHICULAR ROUTING
SCHAIR FARMS 653-8484 MOUNTVILLE	ACE. 0	ARY. 22 Total	2-40 PASSENGER RRTA (BUS #2)	
SCHOCK PRESBY. HOME 653-2058	0	19 Total	TAKEN CARE OF BY FACILITY	NA NA
SHADY LAWN 285-4001 MOUNTVILLE	0	10 Total	2-40 PASSENGER RRTA'S (BUS #1)	F&M
SUNSET HAVEN GUEST MT. JOY	0	2 Total	PICK UP BY BUS #1 ABOVE	F&M
TRINITY HOUSE 684-4441 COLUMBIA	0	15 Total	1-49 PASSENGER CTC BUS	F&M
WIGGINS MOUNTVILLE	0	10 Total	2-40 PASSENGER RRTA'S (BUS #1)	F&M

FLOW CHART - INVALIDS IN PRIVATE HOMES

AMBULANCE ASSOCIATION	# OF PEOPLE TO BE PICKED UP	# OF AMBULANCES	PICK UP & MEET LOCAL PERSONNEL AT: (AMBULANCES ARE ALL <u>LOCAL</u> UNITS)
BAINBRIDGE	9	4	441 GAS STATION (ACROSS STREET CAR WASH AND RESTAURANT)
ELIZABETHTOWN	22	11	FIRE STATION ON MARKET STREET OF TOWN (ALSO RT. 230)
MAYTOWN	3	2	441 AND 743 HERR MARKET
MARIETTA	4	2	441 AT MARKET BASKET (IN BACK OF LACY'S LOUNGE)
RHEEMS	2	1	283 RHEEMS EXIT
JOY BORO	9	5	RT. 230 - 2ND RED LIGHT AT POST OFFICE ON RIGHT
COLUMBIA	17	9	RT. 462 GLADFELTERS FIELD
MT. JOY TWP.	5	3	RT. 283 RHEEMS AND E-TOWN EXIT, GO RIGHT 1 MILE TO FIRE STATION
MOUNTVILLE	3	2	RT. 462 STOP LIGHT, RESSLER'S PARKING LOT
MANHEIM	9	5	RT. 72 AT MANHEIM FIRE HOUSE
HEMPFIELD LANDISVILLE	0	0	LANDISVILLE FIRE HOUSE ON HARRISBURG PIKE
WASHINGTON BORO	1	1	RT. 999 AND 441 AT PLAYGROUND
WEST END	3	2	RT. 999 AT BARN DOOR

APPENDIX 2 TO ANNEX H

Advanced Life Support Services Zoning for Lancaster County April 2, 1979

Rheems - go to Manheim area.

Mount Joy - stay in area.

Elizabethtown - stay in area.

Christiana - stay in area.

West End - go to Dutch Dell/WDAG/Carters Ins.

Maytown - go to Norlance area to cover as BLS.

Columbia Fire Police Ambulance go to E-Town as BLS.

West End- would cover the following areas as an ALS unit: Providence Twp., Wakefield, Quarryville.

Christiana as ALS: Gordonville, Whitehorse.

Ephrata ALS: New Holland, Fivepointville, Rheemstown, Reinholds, Rothsville.

Osteopathic ALS: Part of Lancaster City & Strasburg, Willow Street.

Lancaster General ALS: Part of Lancaster City & Manheim Twp., Warwick.

St. Joseph ALS: Part of Lancaster City & Conestoga, West End, Washington Borough

Rheems ALS: Brickerville, Hempfield.

Mount Joy ALS: Maytown, Marietta, Columbia, Bainbridge.

Elizabethtown ALS: Rheems, Elizabethtown.

1 - BLS for City.

ANNEX I - MASS CAREPURPOSE

TO PROVIDE PUBLIC SHELTER TO PERSONS WHO OTHERWISE WOULD HAVE NO PLACE TO STAY DURING THE PERIOD OF EVACUATION.

CONCEPT OF OPERATION

PERSONS WITHOUT A PLACE TO STAY WILL PROCEED TO A STAGING AREA AT THE PARK CITY SHOPPING MALL NORTHWEST OF LANCASTER CITY. THEY WILL BE PROCESSED, REGISTERED AND ROUTED TO A DISTRIBUTION CENTER. THEY WILL THEN BE REPROCESSED AND ASSIGNED TO INDIVIDUAL MASS CARE SHELTERS, AT WHICH THEY WILL BE PROVIDED FOOD AND BASIC NECESSITIES. DUAL REGISTRATIONS WILL BE CORRELATED TO ASSURE ACCOUNTABILITY OF ALL EVACUEES.

KEY PERSONNEL TO BE CONTACTED

LINDA WENGER 291-7638
 (NUMBER INDICATES BEEPER. DIAL, WAIT FOR TONE, GIVE MESSAGE.)
 LAWRENCE RECLA 291-7665
 TOM MERCER 291-7649
 DON FLICK 291-7830

APPENDICES

- 1 - Staging
- 2 - Shelter Operations
- 3 - Shelter Logistics

APPENDIX 1 TO ANNEX I

STAGING OPERATIONS

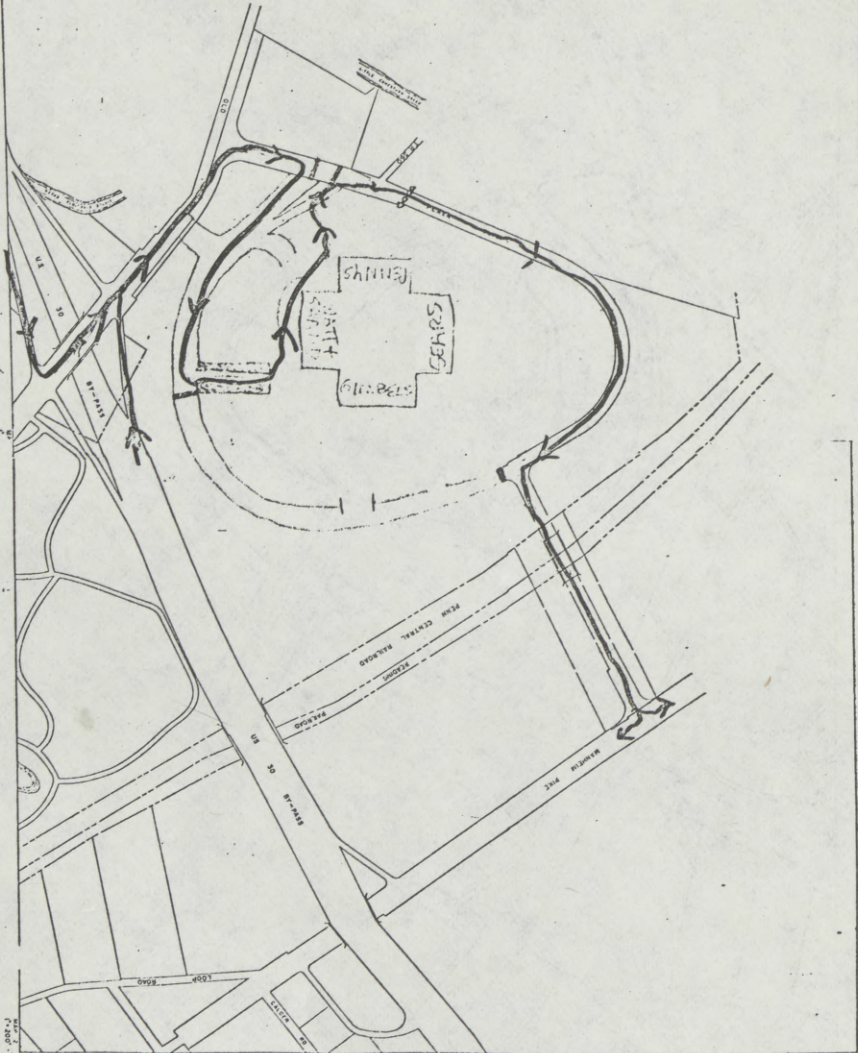
PERSONS WITH AUTOMOBILES WILL BE PROCESSED FOR SHELTER ASSIGNMENTS THROUGH PARK CITY. THE PARK CITY SHOPPING MALL WILL BE QUADRANTED OFF WITH THE ASSISTANCE OF THE LANCASTER CITY AND MANHEIM TOWNSHIP POLICE DEPARTMENTS. CARS WILL BE ROUTED THROUGH THE PARKING AREA WITH THE ASSISTANCE OF THE LANCASTER COUNTY REACT TEAM. CARS WILL BE PROCESSED FOR THE PURPOSE OF COUNTING INDIVIDUALS, ASSIGNING DISTRIBUTION CENTERS AND MAINTAINING A RECORD OF WHO AND WHERE PERSONS WERE PLACED. ROUTES ARE DEFINED ON ENCLOSED MAPS. FACILITY CAN HANDLE APPROXIMATELY 4,200 CARS ACCOUNTING FOR 18,300 PERSONS. ALTERNATE SPECIALITY ROUTES HAVE BEEN DESIGNATED FOR THE USE OF BUSES AND/OR SPECIAL CASES, I.E. ELDERLY, EMOTIONALLY DISORIENTED ETC.. ALL ARRANGEMENTS HAVE BEEN FORMULATED IN CONJUNCTION WITH THE PARK CITY ASSOCIATES. SPECIAL CONSIDERATIONS HAVE BEEN GIVEN TO EMERGENCIES THAT MAY ARISE IN WHICH FIRE, MEDICAL, FUEL, WATER AND TOWING ARE NEEDED AND SUPPLIERS DEFINED.

TABS

- a. ROUTING MAP (CLEAR WEATHER)
- b. ROUTING MAP (INCLEMENT WEATHER)
- c. TIME TABLE OF OPERATIONS

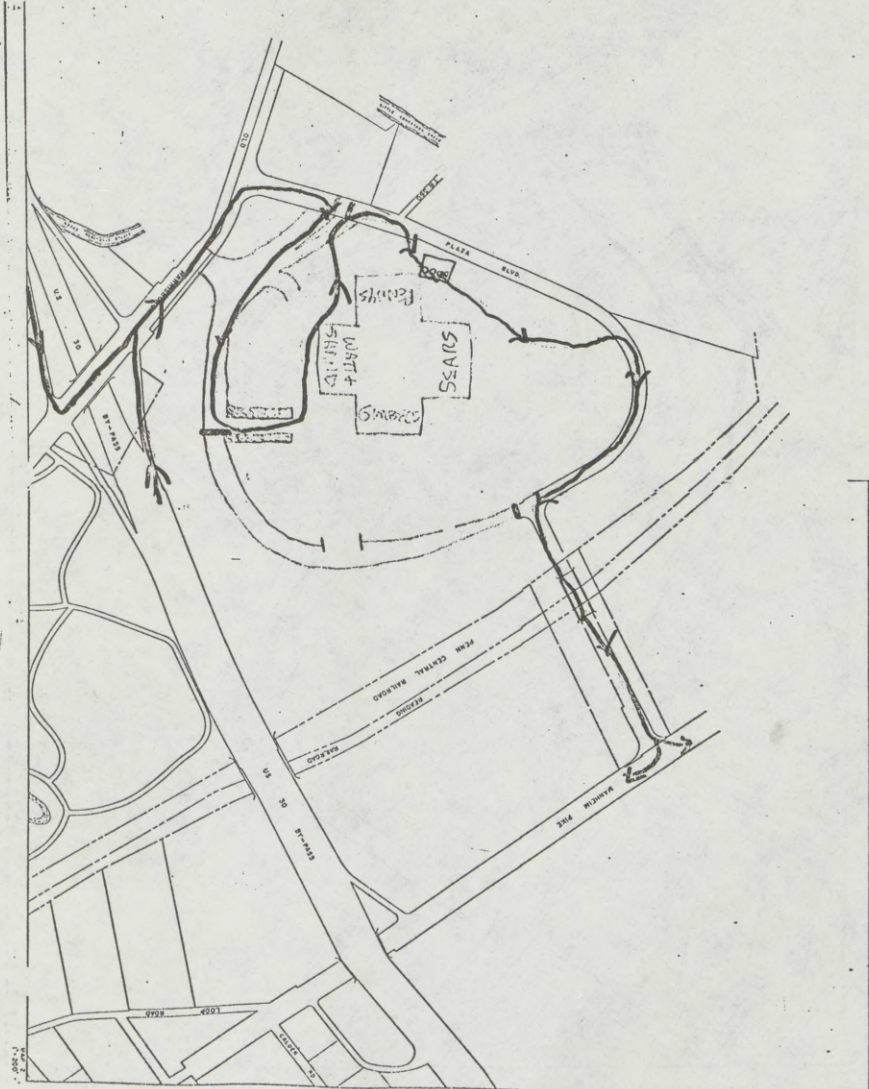
TAB - a

CLEAR WEATHER TRAFFIC FLOW PATTERN



TAB - b

INCLEMENT WEATHER TRAFFIC FLOW PATTERN



TIME SEQUENCE OF EVENTS AT PARK CITY STAGING AREAH-4

1. Seal off Park City at Manheim Pike, Swarr Run Road, Weis Markets access road, traffic light entrance on Harrisburg Pike and the main entrance on Harrisburg Pike.
2. Park City Coordinator and Assistant and REACT officials arrive at PC. Tractor and driver arrive to begin placing of barrels.

H

1. ANNOUNCEMENT TO PUBLIC

H 10

1. Bus and driver who have been located at Lancaster Shopping Center since the announcement begin to ship volunteers to Oak City.

H 11

1. RC volunteer will be briefed, given materials and a job assignment and will be stationed to begin the processing of the evacuees.

H 12

1. State police will open Route 30 exit ramps onto Harrisburg Pike and the staging process will begin

H (estimate 20 hours, eight hours for the actual processing)

1. Processing completed.
2. Stand by for orders from shelters as to capacity.

APPENDIX 2 TO ANNEX I

SHELTER OPERATIONS

AS PERSONS ARE RECEIVED FROM THE STAGING AREA THEY WILL BE REGISTERED AT A DISTRIBUTION CENTER AND RE-ROUTED TO AN INDIVIDUAL SHELTER. SHELTER CAPACITIES ARE DEFINED IN TAB a. REGISTRATIONS WILL BE CORROLATED WITH REGISTRATIONS FROM STAGINGS AREA AND FILED ON COMPUTER TO FACILITATE LOCATION OF ANY PERSON WHO HAS GONE THROUGH THE PROCESS. ONCE ASSIGNED TO A SPECIFIC SHELTER, PERSONS WILL HAVE THEIR NEEDS MET. SHELTERS WILL BE MANAGED BY SCHOOL PRINCIPALS (CALL UP LIST ATTACHED AS TAB b). AS LONG AS A SHELTER IS IN OPERATION DAILY RECORDS WILL BE MAINTAINED AND PLACED ON FILE WITH THE PERSON DIRECTING THE SHELTER PHASE OF THE OPERATION (TAB c). AVAILABLE WILL BE FACILITIES FOR MEDICAL ASSISTANCE, BOTH PHYSICAL AND EMOTIONAL. AS A BACK-UP SYSTEM FOR SHELTER ASSIGNMENTS, CHURCHES IN THE AREA HAVE BEEN CONTACTED & WILL BE USED AS SATELLITE SHELTERS AND AS A SOURCE OF MANPOWER TO MAN THE SHELTERS.

TABS

- a - SHELTER CAPACITIES
- b - SHELTER MANAGERS
- c - SHELTER MANAGER RESPONSIBILITIES
- d - DAILY SHELTER REPORT FORM

TAB 2

2

SHELTER CAPACITIES

PHASE I

LS1.....	LAMPETER STRASBURG HIGH SCHOOL.....	1000
LS2.....	L.S. MARTIN MEYLIN MIDDLE SCHOOL.....	1000
LS4.....	WILLOW STREET VO TECH SCHOOL.....	1000
	TOTAL.....	3000

EL1.....	ELANCO HIGH SCHOOL.....	1000
ELL.....	ELANCO JUNIOR HIGH.....	1000
	TOTAL.....	2000

SO1.....	SOLANCO HIGH SCHOOL.....	1000
SO2.....	SWIFT MIDDLE SCHOOL.....	1000
SO3.....	QUARRYVILLE MIDDLE SCHOOL.....	1000
	TOTAL.....	3000

TOTAL 6400ALERT TO PHASE II- - -TOTAL 8000 MOVE TO PHASE II

PHASE II

LS3.....	PENN MANOR MARTICVILLE MIDDLE SCHOOL.....	1000
PV1.....	PEQUEA VALLEY HIGH SCHOOL.....	1000
PV2.....	PEQUEA VALLEY MIDDLE SCHOOL.....	1000
	TOTAL.....	3000

TOTAL 10400 ALERT TO PHASE III --- TOTAL 11000 MOVE TO PHASE III

PHASE III

CO1.....	COCALICO HIGH SCHOOL.....	1000
CO1.....	COCALICO MIDDLE SCHOOL.....	1000
	TOTAL.....	2000

CV1.....	CONESTOGA VALLEY HIGH SCHOOL.....	1000
CV2.....	BROWNSTOWN VO TECH SCHOOL.....	1000
	TOTAL.....	2000

TOTAL 14200 ALERT TO PHASE IV - - - TOTAL 15000 MOVE TO PHASE IV

PHASE IV

EPH1.....	EPHRATA HIGH SCHOOL.....	1000
EPH2.....	EPHRATA JUNIOR HIGH SCHOOL.....	1000
	TOTAL.....	2000

TOTAL 166000 ALERT TO PHASE V --- TOTAL 17000 MOVE TO PHASE V

PHASE V

EC2.....	ELANCO N.H. ELEMENTARY SCHOOL.....	500
PV3.....	PEQUEA VALLEY SALISBURY TWP ELE SCHOOL.....	500
PV2.....	PEQUEA VALLEY PARADISE ELE SCHOOL.....	500
LS2.....	LAMPETER STRASBURG HANS ELE SCHOOL.....	1300
	TOTAL.....	1300

CUMULATIVE TOTAL LOW: 18200

CUMULATIVE TOTAL HI: 18300

COMPUTER SYMBOLS FOR SHELTER AREAS

TAB b - SHELTER MANAGERS

<u>SYMBOL</u>	<u>SCHOOL</u>	<u>CONTACT PERSON</u>	<u>COMPUTER NUMBER</u>
CO1	Cocalico High School	Clifford L. Behrendt	010
CO1	Cocalico Middle School	(215) 267-5571	011
CV1	Conestoga Valley High School	Robert W. Rill	110
		(717) 397-2421	
CV2	Brownstown Vo-Tech	J. Irwin Shelly	111
		(717) 665-7700	
EL1	ELANCO High School	Robert P. Simon	210
EL1	ELANCO Junior High School	(717) 354-4031	211
EL2	ELANCO N. H. Elementary		212
EPH1	Ephrata High School	C. Daniel Biemesderfer	310
EPH2	Ephrata Junior High School	(717) 733-7961	311
F&M	Franklin & Marshall College	Dick Kneedler	410
		(717) 291-3939	
LS1	Lampeter-Strasburg High School	Dr. Melvin E. Rosier	510
LS1	L.S. Martin Keylin Middle School	(717) 464-3311	511
LS2	L.S. Hans Herr Elementary School		512
LS3	Penn Manor Marticville Middle School	Dr. Elmer J. Berkebile	513
		(717) 872-5481	
LS4	Willow Street Vo-Tech	John L. Riddel, Jr.	514
		(717) 464-3311	
PV1	Pequea Valley High School	Reginald S. Remley	610
PV1	Pequea Valley Middle School	(717) 763-8283	611
PV2	P.V. Paradise Elementary		612
PV3	P.V. Salisbury Twp. Elementary		613
SO1	Solanco High School	Dr. Curtis L. Rohm	710
SO2	Solanco Middle School (Swift)	(717) 736-2151	711
SO3	Solanco Middle School (Quarryville)		712

TAB c

SHELTER MANAGER RESPONSIBILITIES

6

1. Open the shelter facility immediately upon notice by coordinator (superintendent).
2. Set up the secretary with the function of registration process keeping. This person must register every evacuee (names, address, necessary medication information, date arrived, date departed), providing name tags if possible.
3. Make an operations map of the building, designating each area. Post the map.
4. Allocate space for people, keeping in mind that it is critically important for families to be kept together.
5. Establish schedules. Inform all the people of the schedules for sleeping, meals, quiet time, etc.
6. Nurses need to be recruited from among the evacuees and scheduled for help on a rotating schedule. EMT's will be provided (if there are no nurses among your evacuees contact the district shelter coordinator)
7. Appoint a person to coordinate your kitchen help. Have that person prepare coffee and sandwiches immediately, if possible. No home-canned food is allowed for general consumption. Have that person contact our general food administrator, Don Flick at 393-2343.
8. Appoint a volunteer coordinator from among the evacuees to make up a list of other volunteers for kitchen help, maintenance, etc. It is important to give the people something useful to do.
9. If a shelter is open for more than 24 hours hold an election to select an Advisory Committee whose purpose is liaison between evacuees and you.
10. Inform the evacuees that the first night's sleeping will be without cots. Hopefully cots will be provided by the second evening.
11. Establish and inform evacuees of safety and fire regulations.
12. Establish appropriate times, places, and equipment for recreation for all necessary ages.
13. Encourage people to keep valuable items locked in their cars.
14. All pets must be kept in the cars of their owners.
15. Oversee the maintenance of your shelters.
16. When reporters visit the shelter, inform them that they may not use interviews or pictures of the evacuees without their written consent.
17. In addition to local fire and police protection, Civil Defense will also provide these services.

GENERAL INSTRUCTIONS: YOUR MAIN RESPONSIBILITY IS TO DELEGATE FUNCTIONS - NOT TO DO THE WORK. IN DEALING WITH EVACUEES YOUR TONE MUST BE SYMPATHETIC BUT YOU MUST BE FIRM.

TAB d

//

THE AMERICAN RED CROSS
LANCASTER CO. CHAPTER

DAILY SHELTER RECORD AND REPORT

Region _____

Shelter Location _____

Report No. _____

No. Persons Sheltered:

At Start of Day _____ At End of Day _____

No. Persons Fed:

Breakfast _____ Lunch _____ Supper _____

No. Persons requiring medical, nursing, or first aid treatment:

Sent to Hospital _____

Treated in shelter emergency aid station _____th

Comments: _____

Any Physical Damages/Defects: _____

Shelter Manager

April, 1979
421-38-196

APPENDIX 3 TO ANNEX I

SHELTER LOGISTICS

SHELTERS WILL BE MAINTAINED BY THEIR INDIVIDUAL MANAGERS, WHICH WILL BE THE PRINCIPALS OF EACH SCHOOL (SEE APPENDIX 2 TAB b.) THE NORMAL STAFF WILL PROVIDE THE MAJORITY OF THE REQUIRED SERVICES WHILE BEING SUPPORTED BY SHELTER RESIDENTS AND VOLUNTEER AIDES. FOOD AND SUPPLIES WILL BE DISTRIBUTED FROM TWO LOCATIONS. SANITARY CONDITIONS AND REMOVAL ARE ALSO ARRANGED WITH THE SCHOOL DISTRICTS. FOOD SUPPLIERS (SEE TAB a) WILL BE RESPONSIBLE ALONG WITH THE FOOD MANAGER FOR FORMULATION OF DISTRIBUTION CENTERS AND THE MOVEMENTS OF SUPPLIES. EACH SHELTER WILL HAVE WITHIN IT ITS OWN FOOD PREPARATION FACILITIES AND NO FOOD WILL BE REQUIRED OUT OF SHELTER PREPARATION.

TABS

- a - FOOD SUPPLIERS
- b - FOOD SUPPLIES AND BACK-UP

TAB a - SUPPLIERS, FOOD

FOOD MANAGER - DON FLICK

SNACKS

INFANT NEEDS (DIAPERS)

CANNED FOODS (ANY KIND OF FOOD ALONG WITH SANITARY SUPPLIES)

DAIRY PRODUCTS

MEATS

BREAD

SODA & VARIOUS DRINKS

FRESH FRUIT

MCDONALDS(Steve Arnold - 397-0543 or Page #665-8287)

ANDERSON(Don McCollough - 299-2381 or 569-2505)

BABY DY-DEE(Garry Coleman - 397-3576 or 397-4365)

MILLER & HARTMAN ... (Bill Brewer - 397-8261)

KUNZLERS(Chris Kunzler - 299-6301 or 464-4385)

COCO COLA(Dick Cammaus 393-0631)

PENN DAIRIES(Newt Jones - 394-5601)

MICHAEL'S BAKERY ... (Michael Wood - 687-6368 or 569-1727)

GERALD HORN(394-4311 or 393-9756)
(FRUIT & FOOD STORAGE)

ARBY'S PARK CITY ... (Kushal Pal - 569-7874)

THERE ARE TWO DEPOTS TO BE LOCATED IN THE EPHRATA & LAMPETER-
STRASBURG AREAS. CONFORMATION ON THE EXACT LOCATION IS TO BE
MADE LATER

Mr. WINN. Thank you very much, Mr. Chairman.

Mr. AMBRO. Thank you, Mr. Winn, and thank you, gentlemen; I appreciate your frankness and your testimony, and your answers to our questions; we will do our best to resolve your problems.

At this point I would like to ask the committee's and the audience's indulgence for making a change in the hearing agenda, and that change is this, that the Assistant Secretary for Environment, Ruth Clusen, who is with us from the Department of Energy, has consented to shifting her testimony so that we could break for lunch at this point; we will try to be as brief as possible, and then come back with Mr. Richard Vollmer and Mr. Erich W. Bretthauer. That will be two things; it will provide us with a welcome break, and we will come back with a lot more consistency with respect to the panel and continuity with respect to the questioning. So at this point, we will break for as short a time as we possibly can to have lunch and then return.

[Whereupon, the subcommittee was in luncheon recess.]

AFTER RECESS

Mr. AMBRO. I would like to reconvene the subcommittee and proceed with the hearings, and call up the Honorable Ruth Clusen, Assistant Secretary for Environment, U.S. Department of Energy, along with Mr. Richard Vollmer, Assistant Director for Site Analysis, Office of Nuclear Reactor Safety, NRC; and Mr. Erich W. Bretthauer, Director Monitoring Operations Division, Environmental Monitoring and Support Laboratory, Las Vegas, Nev.

If you will, Madam Secretary, we will proceed at your convenience. Do you have a prepared statement?

STATEMENT OF RUTH C. CLUSEN, ASSISTANT SECRETARY FOR ENVIRONMENT, DEPARTMENT OF ENERGY

Ms. CLUSEN. Thank you.

Yes; I do have a prepared statement, which I would like to file for the record.

In addition to this, I previously sent the committee a report done by my office, describing DOE's response to the Three Mile Island accident.

I think there is little in my testimony which has not been covered by other witnesses, either now or previously. Therefore, I intend to focus on some major points contained in the statement.

The capability which we have through a predetermined plan for such accidents made it possible for early arrival on the scene.

I think a great deal of media and public attention has been given to what is sometimes classed as a slow Federal response. As far as the Department of Energy is concerned, as well as the other Federal agencies who are a part of the radiological response effort by an inter-agency agreement, it should be pointed out that monitoring and surveillance flights were taking place the afternoon of the first day. So I think there is something of a misconception about the length of time after the accident before monitoring began.

I would also like to underscore the fact that DOE responded in accord with a predetermined plan. It does have gaps in it and can be

made more sufficient, but essentially the staff members from DOE and the other agencies involved in the emergency response were following a step-by-step predetermined plan, and that is one of the factors that made a fast response possible.

I also think it is not well known that the staff members from my office established a command post with a senior DOE official up in Pennsylvania, very early the first day, with communications linked to many other parts of the system including the State of Pennsylvania, and to our emergency command center at Germantown, Md.

All of this is an effort on my part to indicate that there was a coordinated Federal effort which should give assurance to the people in the State of Pennsylvania that we were very much involved in this unfortunate incident.

I think I will close on that point, and will be glad to respond to your questions.

Mr. AMBRO. Well, I would say that what you did was most commendable in terms of summarizing the testimony.

I think we will make the entire statement and report a part of the record without objection, and develop questions right after both Mr. Bretthauer and Mr. Vollmer present us with their statements, if that is all right with the subcommittee.

Ms. CLUSEN. Thank you.

[The prepared statement of Ms. Clusen follows:]

PREPARED STATEMENT OF RUTH C. CLUSEN, ASSISTANT SECRETARY FOR
ENVIRONMENT, DEPARTMENT OF ENERGY

Mr. Chairman and Members of the Subcommittee I am pleased to testify before your Subcommittee about the Department of Energy's response to the Three Mile Island (TMI) accident.

Before I describe our activities, let me first give you a little of the background which enabled us to respond promptly and efficiently.

BACKGROUND

In 1961, an interagency committee of Federal representatives developed an Interagency Radiological Assistance Plan (IRAP) as a means of providing rapid and effective assistance in the event of a peacetime radiological incident. The IRAP provides:

a. the means for participating Federal agencies to coordinate radiological emergency related activities with those of state and local health, police, fire, and civil defense agencies;

b. the application of existing Federal, state, and local capabilities, responsibilities, and relationships in such a manner as to provide the most effective emergency action available for the protection of the public health and safety from radiological hazards;

c. the procedures to assure effective coordination of Federal, state, and local agency responses to radiological incidents, and the use of available resources that may be needed to carry on radiological assistance operations; and

d. a compilation of the functions and capabilities that the signatory agencies will contribute in the event of an accident.

Federal agencies that are members of the IRAP are:

- Defense Civil Preparedness Agency
- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Health, Education, and Welfare
- Department of Labor
- Department of Transportation
- Department of Energy

Environmental Protection Agency
 Interstate Commerce Commission
 National Aeronautics and Space Administration
 Nuclear Regulatory Commission
 Postal Service

There is also a formal agreement between DOE and NRC providing for mutual cooperation and assistance in responding to emergencies under their respective jurisdictions.

It is also worth noting that as part of a continuing DOE safety program to measure and record radiation levels around nuclear facilities, an airborne radiological survey of about 2000 square Kilometers of the area surrounding the Three Mile Station was made for the NRC in August 1976. The survey provided a preoperational radiological map which constitutes one base against which the impacts of an accident or continued routine operations can be compared.

Let me turn now to the events of late March and early April 1979.

REQUEST FOR ASSISTANCE

On Wednesday, March 28, 1979, at 7:10 am, the Department of Energy's Radiological Assistance Team (RAT) at the Brookhaven National Laboratory, received a call from the TMI plant alerting them to an incident that morning and a possible need for radiological assistance. Immediate preparations were begun to assemble the team workers and obtain transportation on a U.S. Coast Guard helicopter. At 8:45 am the Brookhaven Area Office manager notified the DOE Emergency Operations Center in Germantown, Maryland about the alert.

Following the 8:45 am alert and subsequent telephone alerts for assistance to the DOE Emergency Operations Center from the State of Pennsylvania and the NRC Emergency Center, the Department's Emergency Action Coordination Team (EACT) was convened. The requests from Pennsylvania and the NRC were made in accordance with the Interagency plan I described earlier.

EACT is comprised of senior officials representing the various organizational components of the Department of Energy that would be involved in a DOE response to a major radiological emergency. EACT agreed to provide all possible assistance at TMI and, when requested by NRC at 11:00 am, directed the deployment of the Radiological Assistance Team from Brookhaven National Laboratory, and the Aerial Measurement System/Nuclear Emergency Search Team (AMS/NEST) from Andrews Air Force Base, which were on the scene by early afternoon of March 28, 1979. The RAT team assisted the State of Pennsylvania by taking vegetation, soil and air samples and by making direct radiation measurements in a 10-mile radius surrounding the reactor site. The AMS/NEST team was tracking, measuring, and characterizing the radiation level in the plume created by plant discharges. These data were immediately provided to the State of Pennsylvania and the NRC to assist in determining the hazard to the public.

Due to the number of Federal and state agencies and DOE laboratories and contractors involved, a senior Department of Energy representative from DOE Headquarters was dispatched on the evening of March 28 to the Command Post to become the on-scene official in charge of DOE elements. On March 31, the Director of EACT sent two senior staff members from the Office of Military Applications to the site to coordinate the development of relocation plans for both DOE staff and the NRC staff located at the Three Mile Island site. If such an action had been necessary, detailed arrangements were developed for relocation to the U.S. Army War College at Carlisle Barracks, Pennsylvania. These arrangements were approved within the U.S. Army staff on the evening of March 31, 1979.

RESPONSE

DOE immediately augmented its Emergency Operations Center (EOC) in Germantown, Maryland, to a fully staffed round-the-clock activity providing for safety and logistics support and for response to requests for further assistance or information. NRC provided a liaison representative to the EOC.

A local DOE Command Post was established during the afternoon of March 28 at the Capital City Airport in New Cumberland, Pennsylvania, located about seven miles northwest of the Three Mile Island Station. This was the central point of communications with the DOE Emergency Operations Center. The response involved a number of Department of Energy field operations including

Las Vegas Operations Office, and RAT Teams from Brookhaven National Laboratory, Chicago Operations, and Oak Ridge Operations.

On Thursday and Friday, March 30 and 31, the exact nature and possible consequences of the accident were unclear. In order to effectively manage and coordinate the deployment of large numbers of health physics monitors and aerial survey activities in an operation of this magnitude, a dedicated communications and support network was needed. The Nevada Operations Office was asked to provide its portable communications system that is packaged in airline cargo containers. Through a previously coordinated plan between DOE and AT&T, immediate liaison was established with the AT&T Long Lines Command Center to provide installation of dedicated telephone circuits and a connection to the DOE communications system. The advance party that arrived March 28 and 29 had limited radio network, but by early Sunday, April 1, all of the DOE Radiological Assistance Teams were radio linked. In the event of a sudden release of high level radioactivity, aircraft monitoring information could be relayed to state evacuation coordinators, and ground teams could be repositioned to assist with decontamination and other monitoring needs.

During the first few days, the DOE onsite representatives became aware of the value of having the environmental data collected by a number of agencies assembled and displayed in a clearly understandable form. This would enable state and NRC officials to have a coordinated picture of the radiological monitoring results. All participating Federal and state agencies doing monitoring were invited to a meeting on the evening of March 30, 1979, at the DOE Command Post where results of the environmental monitoring data and means for reducing and displaying it were discussed.

On March 31, 1979, Mr. Tom Gerusky, Director of the Bureau of Radiation Protection in Pennsylvania's Department of Environmental Resources requested that DOE take the lead in assembling, analyzing and presenting all the environmental monitoring data. By April 1, 1979, daily meetings were scheduled at the Command Post at 5:00 pm. These meetings provided for an exchange of information and a forum to discuss and resolve problems that arose in radiation monitoring activities.

Monitoring activities were operated from the DOE Command Post. Supporting staff from Department of Energy Headquarters and field offices were on hand to assist in directing the field activities of the many participating contractors. These included the EG&G, Inc., AMS/NEST offices in Las Vegas and Andrews AFB, Lawrence Livermore Laboratory (LLL), Bettis Atomic Power Laboratory (BAPL), Knolls Atomic Power Laboratory (KAPL), the DOE Environmental Measurements Laboratory (EML), the Pittsburgh Naval Reactors Office (PNR), and Schenectady Naval Reactors Office (SNR), the Oak Ridge National Laboratory (ORNL), Argonne National Laboratory (ANL), the Savannah River Laboratory (SRL), and the Mound Laboratory. In addition to operating the monitoring activities from the Command Post, DOE also provided logistical support for other Federal agencies including the Defense Civil Preparedness Agency (DPCA), National Oceanic and Atmospheric Administration (NOAA), and the Environmental Protection Agency (EPA). The support included:

Installation of radio and telephone communications, including coordination with the AT&T Long Lines Command Center for special NRC, State of Pennsylvania, and DOE telephone requirements.

Manning the Command Post to provide rapid telephone and radio communications of data and information between field units and with DOE Headquarters.

Coordination of shipping and radiochemical analyses of reactor coolant and containment air samples at DOE facilities.

Manning of telephone "hot" lines for communicating results of radiation monitoring and radiochemical analyses to the Pennsylvania Department of Environmental Resources and NRC.

The processing, compilation, and analysis of all radiation data in response to a request from the Pennsylvania Department of Environmental Resources.

Documentary and scientific photography.

Medical consultation in response to a request from the Secretary of Health, State of Pennsylvania.

RADIATION MONITORING

Initial aerial measurements flights were flown at the request of the NRC. The aerial radiological measurements obtained provided rapid confirmation of airborne releases. They revealed that a radioactive plume was measurable at

least sixteen miles north of TMI with exposure levels of 0.2 milliroentgens per hour at seven miles and 0.1 milliroentgen per hour at sixteen miles. The on-board gamma spectrometer indicated radioactive xenon gas, xenon-133, to be the predominant contributing isotope. Xenon is a noble gas; radioactive xenon presents a direct radiation field to persons near or within the plume but does not leave residual contamination once the plume has dissipated radioactive iodine, e.g., iodine-131, concentration was below the minimum detectable activity (MDA) for the on-board system.

Regular flight schedules for airborne monitoring were established at approximately three hour intervals around the clock. The only deviation from this schedule resulted from adverse weather conditions which precluded safe helicopter operations. To support this 24-hour-per-day operation, supplementary aircraft and personnel were supplied by the U.S. Air Force 1st Helicopter Squadron based at Andrews AFB in Washington, D.C.

After approximately one week of continuous operations, the flight schedule was changed to 0600 through 2100 each day at three hour intervals, with standby crews capable of response within an hour. During the second week, when all routine flights showed only negligible traces of man-made radiation, the flight schedule was reduced to two flights per day, with additional flights on request as needed.

To provide continuing and timely resolution of the monitoring data obtained by aerial flights, DOE committed, on a full time basis during the initial week of the incident, and later as needed, its Atmospheric Release Advisory Capability (ARAC) computerized system located at Lawrence Livermore Laboratory. Representative outlines of airborne radioactive concentration distributions, i.e., plumes, were calculated and presented in graphic form, using the radioactive monitoring data and local meteorological data obtained from regional airports, and state and Federal weather services. These results were used to guide ground monitoring teams and to assist in assessments of potential radiation dose. All data flights were planned from the ARAC plume predictions and from operating conditions at the reactor. One flight parameter characteristic for almost all flights was a one mile radius circle flown around TMI (centered at #2 Reactor) at an altitude of 500 feet. A hand-held gamma survey meter was used and the direction of the plume was determined by the aircraft navigational systems.

Field laboratories were established at the Capital City Airport DOE Command Post to measure the radioactivity that was collected from environmental soil, grass, and surface water samples, as well as gas and particulate samples taken by airborne and ground monitoring teams. Each laboratory was equipped with sensitive, high efficiency, lithium drifted germanium detectors and multi-channel gamma spectrum analyzers for measuring and identifying the amount of radioactivity, and identifying specific radioelements. These field laboratories were staffed by radiochemists from DOE laboratories.

Environmental samples were collected in areas near the plant, and within areas over which the plume of discharges had remained for the longest period. Special care was exercised to assure that if radioactivity from the plume had been deposited on the ground, the sampling method would pick it up. Charcoal filters in high volume air samplers were used to collect ground level samples of air from the plume. From March 28 onward, over 800 samples were collected and analyzed. Iodine-131 was found in a few air and grass samples at levels only slightly above the minimum detectable activity. For air, the minimum detectable activity was 2% of the total amount that NRC regulations considers safe for continuous occupancy by the general public. Levels of cesium-137 found in a few soil samples were characteristics of the cesium-137 found in world-wide fallout levels remaining from atmospheric nuclear tests.

The date, time, and specific location of all of the environmental samples, as well as the results of the laboratory analyses, were recorded and copies of these data have been supplied to the Pennsylvania State Department of Environmental Resources, and to the Federal EPA, FDA, and NRC.

FINDINGS

The analyses of environmental samples, as well as gamma spectrum analyses of the plume, support the conclusion that the predominant radionuclide in airborne discharges was the inert gas, xenon-133, with a small amount of iodine-131 also present. This conclusion is supported by the measured composition of stack

discharge gases, and the analyses of the airborne radioactivity in the containment reported by the reactor operator.

DOE contributed in an indirect way to various data analyses made after the TMI accident. For example, several estimates of the external whole body radiation exposure to the population from the nuclear accident at the Three Mile Island Station have been made. A preliminary assessment for the period March 28 through April 7, 1979, was published on May 10, 1979, by an Ad Hoc Population Dose Assessment Group comprised of representatives from NRC, HEW, and EPA, with assistance from DOE. The estimates of collective dose range from 1,600 to 5,300 person-rem, with a best estimate of 3,300 person-rem. DOE's estimates are similar. The highest estimates, although based on conservative assumptions, appear to be insignificant compared to the approximately 200,000 person-rem exposure that the same 2.1 million population would receive in a year from natural background radiation. The maximum dose any individual off-site would have received was estimated at less than 100 millirem. This is about what an individual receives from background in a year. Risk estimates based on the TMI population exposure yield 0 to 1 additional case of cancer in a lifetime in this population, whereas the normal expectation for approximately 2 million nonexposed people would be in excess of 300,000 cases of cancer in a lifetime.

EMERGENCY PREPAREDNESS

I would like to discuss briefly the general subject of emergency preparedness and DOE's role in this regard. Early involvement by DOE in the Three Mile Island incident was facilitated by the existence of a tested interagency plan—IRAP—to which DOE brought both an organizational approach and its assets, including unique capabilities of the national laboratories and other facilities and activities. Support from all elements of DOE was quick and unhesitating—from eighteen DOE and contractor employees the first day to a peak of over one hundred personnel, backed by an estimated one thousand employees contributing effort at their home stations as needed. I would be remiss, however, if I failed to indicate the strong reliance on, and outstanding cooperation from the state and Federal agencies involved, as well as from certain groups such as AT&T. The main point here is that in most cases, DOE already had a working relationship with these agencies and groups which served to expedite the organizational structure needed at the Three Mile Island Station and to develop the initiative required to obtain proper results. As you are aware, the Department had also developed and altered its reserve Federal and contractor resources and was prepared to bring them to bear as needed. DOE has also instituted an evaluation of its response to the incident so as to assess our strengths and deficiencies as a guide to improvement in responding to such incidents in the future. Such considerations will, of course, be tempered by the results of the various TMI reviews now in progress. Following such reviews, DOE will engage in more detailed examination of several areas of concern which have been brought into greater focus by the TMI incident: the responsiveness of Federal-state planning in handling major emergencies from the start of the incident, the adequacy of environmental monitoring instrumentation, methodology and systems; the logistics and other aspects of protective actions: considerations, governing decontamination of the environment; and other related health and safety issues. These activities will of necessity require coordination with other agencies, and I expect that the ongoing TMI reviews will in large measure govern the relative emphasis given to each of the above issues.

Mr. Chairman, this concludes my statement. I will be glad to answer any questions you may have.

POPULATION DOSE and HEALTH IMPACT
OF THE ACCIDENT AT THE
THREE MILE ISLAND NUCLEAR STATION

(a preliminary assessment for the period
March 28 through April 7, 1979)

Ad Hoc Population Dose Assessment Group

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May 10, 1979

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PREFACE

This report was prepared by technical staff members of the Nuclear Regulatory Commission (NRC), the Department of Health, Education and Welfare (HEW) and the Environmental Protection Agency (EPA), who constitute an Ad Hoc Population Dose Assessment Group. It is an assessment of the health impact on the approximately 2 million offsite residents within 50 miles of the Three Mile Island Nuclear Station from the dose received by the entire population (collective dose). The Ad Hoc Group has examined in detail the available data for the period up to and including April 7, 1979. Based on a preliminary review of data from periods beyond April 7, it appears that the collective dose will not be significantly increased by extending the period past April 7.

The dose and health effects estimates are based primarily on thermoluminescent dosimeters placed at specific onsite and offsite locations. The dosimeters measure the cumulative radiation exposure that occurred at these locations. They permit the most direct evaluation of dose to the offsite population from radionuclides (radioactive materials) released to the environment.

The report also addresses several areas of concern about the types of radionuclides released, about the contribution to population exposure due to beta radiation (which does not penetrate the clothing and skin) emitted from the released radionuclides, about the degree of coverage afforded by available radiation measurements, and about the range of health effects that may result from the estimated collective dose.

Based on the current assessment, the Ad Hoc Group concludes 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 numerical statement of this conclusion is developed in the report. The Ad Hoc Group is not aware of any radiation measurements made during this period that would alter this basic conclusion, although refinement of the numerical estimates can be expected as the data are updated and verified. The members of the Ad Hoc Group concur that the manner in which the collective dose estimates were computed was conservative (overestimated the actual dose). The uncertainties in the collective dose estimates and health effects are not large enough to alter the Group's basic conclusion, that is, the risk is minimal.

ACKNOWLEDGMENTS

The Ad Hoc Group acknowledges the assistance of Ted Schoenberg of the Department of Energy and Andy Hull of Brookhaven National Laboratory in providing the data and analysis presented in Appendices A and B. We also acknowledge the contributions of the following individuals:

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Food and Drug Administration	-	Charles Coyle Dean Elbert Richard Kisielewski
Environmental Protection Agency	-	Philip Cuny Jane Latta

POPULATION DOSE AND HEALTH IMPACT OF THE ACCIDENT AT THE
THREE MILE ISLAND NUCLEAR STATION
(a preliminary assessment for the period
March 28 through April 7, 1979)

Summary and Discussion of Findings

An interagency team from the Nuclear Regulatory Commission (NRC), the Department of Health, Education and Welfare (HEW) and the Environmental Protection Agency (EPA) has estimated the collective radiation dose received by the approximately 2 million people residing within 50 miles of the Three Mile Island Nuclear Station resulting from the accident of March 28, 1979. The estimates are for the period from March 28 through April 7, 1979, during which releases occurred that resulted in exposure to the offsite population. The principal dose estimate is based upon ground-level radiation measurements from thermoluminescent dosimeters located within 15 miles of the site. These estimates assume that the accumulated exposure recorded by the dosimeters was from gamma radiation (that is, penetrating radiation that contributes dose to the internal body organs). The data were obtained from dosimeters placed by Metropolitan Edison Company before the accident (as part of their normal environmental surveillance program), from dosimeters placed by Metropolitan Edison after the

accident and covering the period to April 6, and from dosimeters placed by NRC from noon of March 31 through the afternoon of April 7, 1979. These measurement programs are continuing. The results for the period beyond April 7, 1979 have not been fully examined. An additional dose estimate developed by the Department of Energy using aerial monitoring that commenced about 4 p.m. on March 28, 1979 is also included. A variety of other data helpful in assessing relatively minor components of collective dose was also reviewed.

The collective dose to the total population within a 50-mile radius of the plant has been estimated to be 3300 person-rem. This is an average of four separate estimates that are 1600, 2800, 3300, and 5300 person-rem. The range of the collective dose values is due to different methods of extrapolating from the limited number of dosimeter measurements. An estimate provided by the Department of Energy (2000 person-rem) also falls within this range. The average dose to an individual in this population is 1.5 mrem (using the 3300 person-rem average value).

The projected number of excess fatal cancers due to the accident that could occur over the remaining lifetime of the population within 50 miles is approximately one. Had the accident not occurred, the number of fatal cancers that would be normally expected in a population of this size over its remaining lifetime is estimated to be 325,000. The projected total number of excess health effects, including all cases of cancer (fatal and non-fatal) and genetic ill health to all future generations, is approximately two.

These health effects estimates were derived from central risk estimates within the ranges presented in the 1972 report of the Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR) of the National Academy of Sciences. Preliminary information on the recently updated version of this report indicates that these estimates will not be significantly changed.

It should be noted that there exist a few members of the scientific community who believe the risk factors may be as much as two to ten times greater than the estimates of the 1972 BEIR report. There also is a minority of the scientific community who believe that the estimates in the 1972 BEIR report are two to ten times larger than they should be for low doses of gamma and beta radiation.

The maximum dose that an individual located offsite in a populated area might receive is less than 100 mrem. This estimate is based on the cumulative dose (83 mrem) recorded by an offsite dosimeter at 0.5 mile east-northeast of the site and assumes that the individual remained outdoors at that location for the entire period from March 28 through April 7. The estimated dose applies only to individuals in the immediate vicinity of the dosimeter site. The potential risk of fatal cancer to an individual receiving a dose of 100 mrem is about 1 in 50,000. This should be compared to the normal risk to that individual of fatal cancer from all causes of about 1 in 7.

An individual was identified who had been on an island (Hill Island) 1.1 miles north-northwest of the site during a part of the period of higher exposure.

The best estimate of the dose to this individual for the 10-hour period he was on Hill Island (March 28 and March 29) is 37 mrem.

A number of questions concerning this analysis are posed and briefly answered below. More detailed discussions are included in the body of the report.

What radionuclides were in the environment?

The principal radionuclides released to the environment were the radioactive xenons and some iodine-131. Measurements made by the Department of Energy in the environment, measurement of the contents of the waste gas tanks, of the gases in the containment building and the actual gas released to the environment confirmed that the principal radionuclide released was xenon-133. Xenon-133 is a noble gas (which is chemically non-reactive) and does not persist in the environment after it disperses in the air. It has a short half-life of 5.3 days and produces both gamma and beta radiation. The risk to people from xenon-133 is primarily from external exposure to the gamma radiation, which penetrates the body and exposes the internal organs.

What were the highest radiation exposures measured outside the plant buildings?

Some of the Metropolitan Edison dosimeters located on or near the Three Mile Island Nuclear Station site during the first day of the accident recorded net cumulative doses as high as 1020 mrem. These recorded exposure readings

do not apply directly to individuals located offsite. However, the onsite dosimeter readings were included in the procedure for projecting doses to the offsite population. This procedure is described in the report.

What is meant by collective dose (person-rem)?

The collective dose is a measure of the total radiation dose which was received by the entire population within a 50-mile radius of the Three Mile Island site. It is obtained by multiplying the number of people in a given area by the dose estimated for that area and adding all these contributions.

Were the radiation measurements adequate to determine population health effects?

The extensive environmental monitoring and food sampling were adequate to characterize the nature of the radionuclides released and the concentrations of radionuclides in those media. The measurements performed by Department of Energy (aerial survey) and Metropolitan Edison and Nuclear Regulatory Commission (ground level dosimeters) are sufficient to characterize the magnitude of the collective dose and therefore the long-term health effects. However, a single precise value for the collective dose cannot be assigned because of the limited number of fixed ground level dosimeters deployed during the accident.

How conservative were the collective dose estimates?

In projecting the collective dose from the thermoluminescent dosimeter exposures, several simplifying assumptions were made that ignored factors that are known to reduce exposure. In each case, these assumptions introduced significant overestimates of actual doses to the population. This was done to ensure that the estimates erred on the high side. The three main factors that fall into this category are:

- (1) No reduction was made to account for shielding by buildings when people remained indoors.
- (2) No reduction was made to account for the population known to have relocated from areas close to the nuclear power plant site as recommended by the Governor of Pennsylvania, or who otherwise left the area.
- (3) No reduction was made to account for the fact that the actual dose absorbed by the internal body organs is less than the dose assumed using the net dosimeter exposure.

What is the contribution of beta radiation to the total dose?

Beta radiation contributes to radiation dose by inhalation and skin absorption. The total beta plus gamma radiation dose to the skin from xenon-133 is

estimated to be about 4 times the dose to the internal body organs from gamma radiation. This additional skin dose could result in a small increase in the total potential health effects (about 0.2 health effect) due to skin cancer. The increase in total fatal cancers over that estimated for external exposure from gamma radiation alone would be about 0.01 fatal skin cancer. This contribution would be considerably decreased by clothing. The dose to the lungs from inhalation of xenon-133 for both beta and gamma radiation increases the dose to the lungs by 6 percent over that received by external exposure.

What radionuclides were found in milk and food and what are their significance?

Iodine-131 was detected in milk samples during the period March 31 through April 4. The maximum concentration measured in milk (41 pCi/liter in goat's milk, 36 pCi/liter in cow's milk) was 300 times lower than the level at which the Food and Drug Administration (FDA) would recommend that cows be removed from contaminated pasture. Cesium-137 was also detected in milk, but at concentrations expected from residual fallout from previous atmospheric weapons testing. No reactor-produced radioactivity has been found in any of the 377 food samples collected between March 29 and April 30 by the FDA.

Why have the estimates of radiation dose changed?

The original Ad Hoc Group estimate of collective dose (1800 person-rem) presented on April 4 at the hearings before the Senate Subcommittee on Health

and Scientific Research covered the period from March 28 through April 2. The data used for this estimate were obtained from preliminary results for Metropolitan Edison offsite dosimeters for the period March 28 through March 31 and preliminary results for NRC dosimeters for April 1 and 2. On April 10, the estimate of 2500 person-rem presented to the Senate Subcommittee on Nuclear Regulation by NRC Chairman Hendrie included the time period from March 28 through April 7. The data base for this estimate included additional NRC dosimetry results for April 3 through 7. The Ad Hoc Group's preliminary report of April 15 stated a value of 3500 person-rem for the time period from March 28 through April 7. This value resulted from better information on the dosimeter measurements and an improved procedure for analyzing the measurements.

The current report states an average value of 3300 person-rem (with a range of 1600 to 5300 person-rem) for the time period from March 28 through April 7. Additional dosimeter data were available and better methods were used to determine the collective dose. Also, the onsite dosimeter measurements are all included in the analysis.

The original estimate of maximum dose (80 mrem) to an individual presented on April 4 increased to 85 mrem in the April 15 preliminary report as a consequence of adding the contribution from April 2 to April 7. This estimate has now been revised slightly to 83 mrem, which is presented as less than 100 mrem so as not to imply more precision than this estimate warrants. New information on dosimeter readings on or very near the site was received after the initial analysis.

It was also learned that an individual was present on one of the nearby islands (Hill Island) for a total of 10 hours during the period March 28 to March 29. The best estimate of the dose which may have been received by the individual is 37 mrem. The text includes a range of dose estimates for that individual.

Will these estimates of dose change again?

The dose and health effects estimates contained in this report are based on the dosimeter results for the period March 28 to April 7, 1979. There still remain some questions concerning interpretation of the dosimeter results. For example, the best values for subtracting background from the Nuclear Regulatory Commission dosimeters have not been determined. Recently available data from additional dosimeters exposed during the March 28 to April 7 period have been reviewed briefly, but could not be included in the calculations in time for this report. The actual contribution to collective dose from the period after April 7, if any, has not been fully assessed. Therefore, the numerical dose values may be subject to some modification.

The Ad Hoc Group feels that these factors represent only minor corrections to the present estimates. In any case, none of the above refinements should cause an increase in any of the current estimates that would alter the basic conclusion regarding the health impact due to the Three Mile Island accident.

1. INTRODUCTION

The Ad Hoc Population Dose Assessment Group was formed from individuals assigned by their respective agencies to the NRC Incident Response Center on Monday, April 2, 1979. The Ad Hoc Group's objective was to obtain an estimate of the public health consequences of this accident to the offsite population and submit the results to each of the constituent agencies for their use.

Because of the urgency to prepare estimates of the health impact for presentation at the April 4, 1979 hearings before the Senate Subcommittee on Health and Scientific Research, the group had to rely upon very early data that were available at the NRC Incident Response Center or easily obtained through existing communication channels with the Federal coordination center adjacent to the Three Mile Island site. An interim report was prepared on April 15, 1979, which extended the estimate through April 7, 1979. The current report is an update of that analysis. The Ad Hoc Group has also had a chance to review its earlier calculations and analyze the data in a more systematic fashion.

2. NATURE OF THE RADIOACTIVE MATERIALS RELEASED

The principal radioactive materials released to the environment appear to be xenon-133 (half-life 5.3 days) and xenon-135 (half-life 9.2 hours) and traces of radioactive iodine, primarily iodine-131 (half-life 8.0 days). This is substantiated by consideration of the known course of events, knowledge that the effluents were released through high efficiency particulate filters and charcoal absorbers, and from subsequent environmental measurements in the diffusing plume of radioactive material (see Appendix B). Based on the physical and chemical nature of these radionuclides they would not be released from the plant under the conditions of the TMI accident. Radionuclides in particulate form such as strontium-90, uranium isotopes, and plutonium would either have been retained in the fuel or if released from the fuel would remain in the coolant water. To our knowledge, these nuclides have not been detected either in the environment (above pre-existing levels of natural background or world-wide fallout) in the vicinity of Three Mile Island (TMI) or in the reactor containment atmosphere or gas decay tanks. Some of the radioactive krypton isotopes such as krypton-87, (half-life 76 min), krypton-85m (half-life 4.5 hours) and krypton-88 (half-life 2.8 hours) may also have been released. However, these are all relatively short-lived radionuclides and none of the reported gamma-ray spectral analyses detected any measurable quantities of these krypton isotopes.

Appendix B describes the environmental surveillance activities of the Department of Energy which measured the radionuclides in the environment from the release.

3. DOSE ASSESSMENT FROM EXTERNAL EXPOSUREA. Thermoluminescent Dosimeter Data

The available thermoluminescent dosimeter (TLD) data were used as the basis for this evaluation. They provide the best available dosimetry information for the following reasons:

1. The TLD's placed by the licensee as part of the environmental radiation surveillance program for routine operation were the only devices for measuring radiation exposure that were placed at fixed locations throughout the course of the accident, including the first 3 days.
2. The TLD's are exposure-integrating devices and measure total exposure rather than exposure rate.
3. The TLD's used are said to measure exposures as low as about 1 mR.
(See the following description of the TLD's.)

At the time of the accident, Metropolitan Edison had environmental TLD's in place at a total of 20 onsite and offsite locations. These locations are described in Table 3-1. The site locations are given in Figures 3-1 through 3-3. Except for three locations (10B1, 14S1, and 16A1), these TLD's had been exposed since December 27, 1978, to measure the environmental radiation exposure

during the first quarter of 1979. The three locations, 10B1, 14S1, and 16A1, on islands in the Susquehanna River, had been exposed since September 27, 1978.

All 20 of the Metropolitan Edison locations had environmental TLD's manufactured and read by Teledyne Isotopes. These Teledyne Isotopes environmental dosimeters are rectangular Teflon wafers impregnated with 25% $\text{CaSO}_4:\text{Dy}$ phosphor contained in black polyethylene pouches in rectangular holders with copper filters to make the energy response more uniform ("flatten" the energy response). After exposure in the environment, measurements of the exposure are made on each of four separate areas of the dosimeter. The average of these four readings is used in the calculations. In the product bulletins, these dosimeters are said to have a "minimum sensitivity" of 0.5 mR and to have a "maximum error (1 standard deviation)" of " ± 0.2 mR or $\pm 3\%$, whichever is greater" for measurement of exposure from cobalt-60 gamma radiation.

At 10 of their 20 locations, Metropolitan Edison had duplicate dosimeters which were supplied and read by Radiation Management Corporation (RMC) as quality control checks. These 10 locations are indicated in Table 3-1. The suffix "Q" added to the station code indicates data from RMC TLD's at the Metropolitan Edison locations. Two RMC model UD-200S dosimeters were used at each location. Each dosimeter contains two $\text{CaSO}_4:\text{Tm}$ TLD phosphor elements inside a plastic and metal shield to flatten the energy response. Thus, four readings (two dosimeters; two readings per dosimeter) of the exposure of the RMC dosimeters

are obtained for each location. The "sensitivity" of these dosimeters is said to be about 0.5 mR.

On March 31, NRC placed TLD's at 37 locations and on April 5, an additional 10 dosimeters were placed at various schools. The locations of these dosimeters are described in Table 3-2. The site locations are shown in Figures 3-4 and 3-5. These dosimeters were also supplied and read by Radiation Management Corporation (RMC) but are different from the TLD's supplied by RMC to Metropolitan Edison. The RMC dosimeters used by NRC are either the RMC model UD801 dosimeter or the model UD804 environmental dosimeter. Each of the UD801 dosimeters contains two $\text{Li}_2\text{B}_4\text{O}_7\text{:Cu,Ag}$ phosphor elements and two $\text{CaSO}_4\text{:Tm}$ phosphor elements. One $\text{Li}_2\text{B}_4\text{O}_7$ element has an open window (to minimize attenuation of beta radiation) and the other a 280 mg/cm^2 filter; one of the CaSO_4 elements also has a 280 mg/cm^2 filter, while the second has a 700 mg/cm^2 filter of lead to flatten the energy response. The UD801 dosimeters are said to have a "sensitivity, whole body" of "1 mR - 2000 R." Each of the UD804 environmental dosimeters contains three $\text{CaSO}_4\text{:Tm}$ phosphor elements, with a lead filter to flatten the energy response; thus, three readings are obtained from each of these dosimeters. These UD804 environmental dosimeters are said by RMC to have a "sensitivity" of "1 mR-200 R (30 keV-10 MeV)." Starting on April 1, 1979, at each NRC site, two dosimeters were changed daily; thus, either 6 or 8 dosimeter readings (depending on the dosimeter type) were obtained for each location each day, depending on which type of dosimeter was used. In addition, beginning on April 1, 1979, two dosimeters were left at each location for longer exposures than the period considered in this report.

Exposures measured at Metropolitan Edison TLD stations (including both Teledyne Isotopes and RMC data) are listed in Table 3-3. These Metropolitan Edison data include exposures from the time of the accident on March 28, 1979, to April 6, 1979. Exposures measured at NRC stations are listed in Table 3-4 for the time periods from March 31, 1979 (when the NRC dosimeters were first placed at these locations), until April 7, 1979. Each entry in Tables 3-3 and 3-4 is an average of multiple readings of the exposure at that location for that time period together with the standard deviation of the multiple readings.

Exposures measured at Metropolitan Edison locations during 1978 are listed in Table 3-5 (Teledyne Isotopes data) and Table 3-6 (RMC data). These data provide an estimate of the background exposures.

All exposure (mR) measurements are based on calibrations with cesium-137 sources. Samples of each type of TLD placed by the various organizations around the TMI site have been collected and exposed to known sources of xenon-133 at the National Bureau of Standards. Preliminary results indicate that the energy response of the Metropolitan Edison and NRC TLD's to the gamma radiation from a xenon-133 source varies from about 25% less than the calibration value to about 30% greater than the calibration value. These experiments were not designed to be, nor should they be interpreted as being, a precise calibration of the TLD's under actual field conditions or for the exact spectrum of radiation that was emitted during the course of the accident.

Since the spectrum incident upon the dosimeters is not known, and since the calibration of the dosimeters to xenon-133 radiation is still tentative, these correction factors were not applied to the dosimeter measurements. However, the external exposure calibration does confirm that the dosimeters are sufficiently sensitive to the xenon-133 radiation that their response at low energies would not introduce a significant uncertainty in the dose or health impact estimates.

Table 3-1. METROPOLITAN EDISON TLD STATION LOCATIONS

STATION CODE	LOCATION DESCRIPTION*
1S2**	0.4 miles N of site at N Weather Station
1C1	2.6 miles N of site at Middletown Substation
2S2	0.7 miles NNE of site on light pole in middle of North Bridge
4S2**	0.3 miles ENE of site on top of dike, East Fence
4A1	0.5 miles ENE of site on Laurel Rd., Met. Ed. pole #668-OL
4G1**	10 miles ENE of site at Lawn - Met. Ed. Pole #J1813
5S2**	0.2 miles E of site on top of dike, East Fence
5A1**	0.4 miles E of site on north side of Observation Center Building
7F1**	9 miles SE of site at Drager Farm off Engle's Tollgate Road
7G1	15 miles SE of site at Columbia Water Treatment Plant
8C1**	2.3 miles SSE of site
9S2	0.4 miles S of site at South Beach of Three Mile Island
9G1	13 miles S of site in Met. Ed. York Load Dispatch Station
10B1	1.1 miles SSW of site on south beach of Shelley Island
11S1**	0.1 miles SW of site on dike west of Mechanical Draft Towers
12B1	1.6 miles WSW of site adjacent to Fishing Creek
14S1	0.4 miles WNW of site at Shelley Island picnic area
15G1**	15 miles NW of site at West Fairview Substation
16S1**	0.2 miles NNW of site at gate in fence on west side of Three Mile Island
16A1	0.4 miles NNW of site on Kohr Island

* All distances measured from a point midway between the Reactor Buildings of Units One and Two. All 20 stations had Teledyne-Isotopes Environmental TLD's.

** Stations with RMC TLD's. Data obtained with RMC TLD's at these locations are designated by adding the letter "Q" as a suffix to the station code.

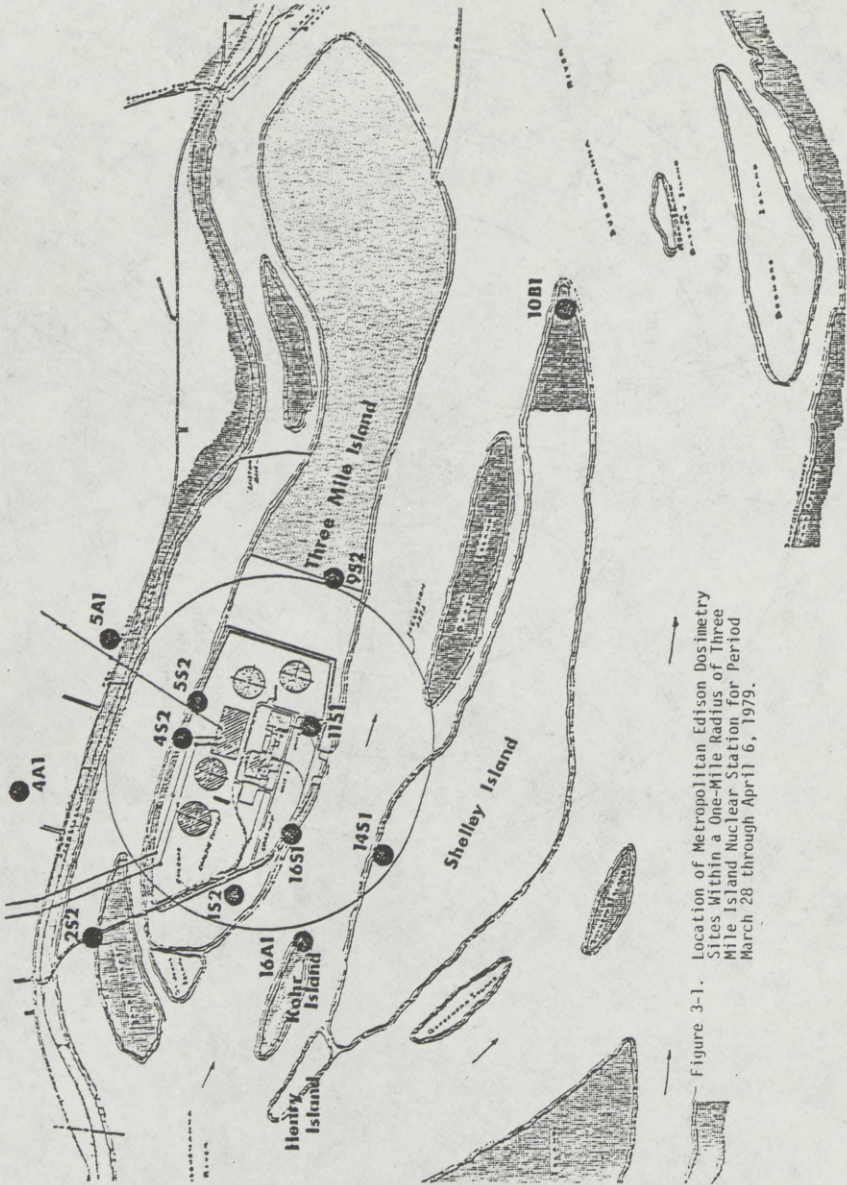


Figure 3-1. Location of Metropolitan Edison Dosimetry Sites Within a One-Mile Radius of Three Mile Island Nuclear Station for Period March 28 through April 6, 1979.

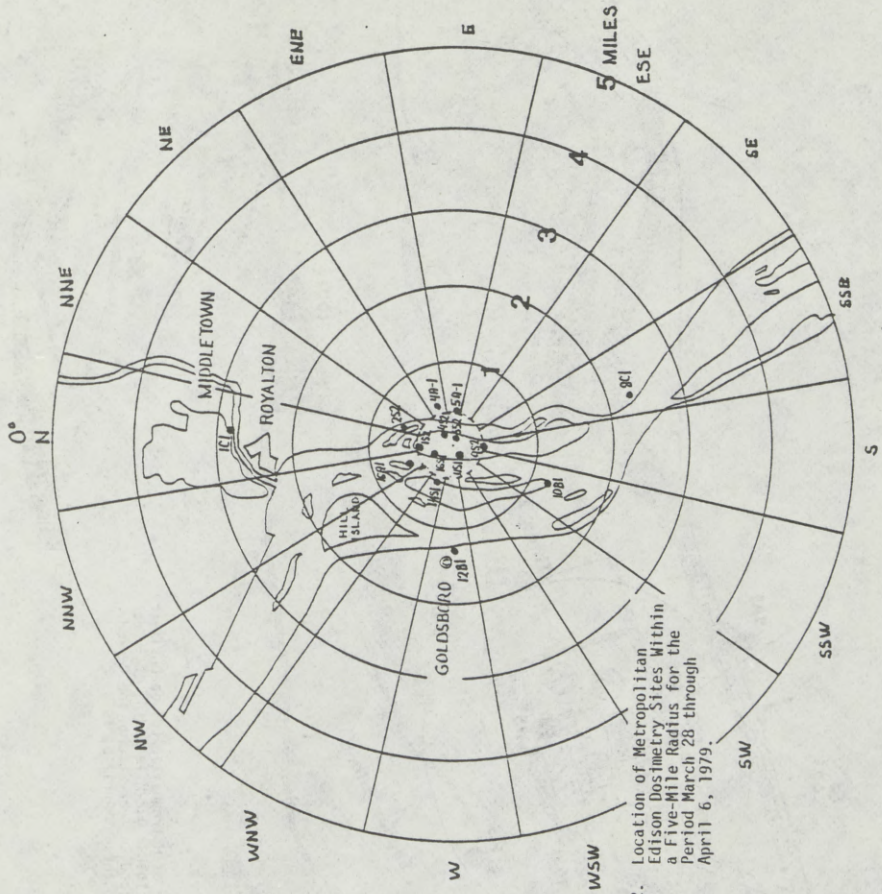


Figure 3-2. Location of Metropolitan Edison Dosimetry Sites Within a Five-Mile Radius for the Period March 28 through April 6, 1979.

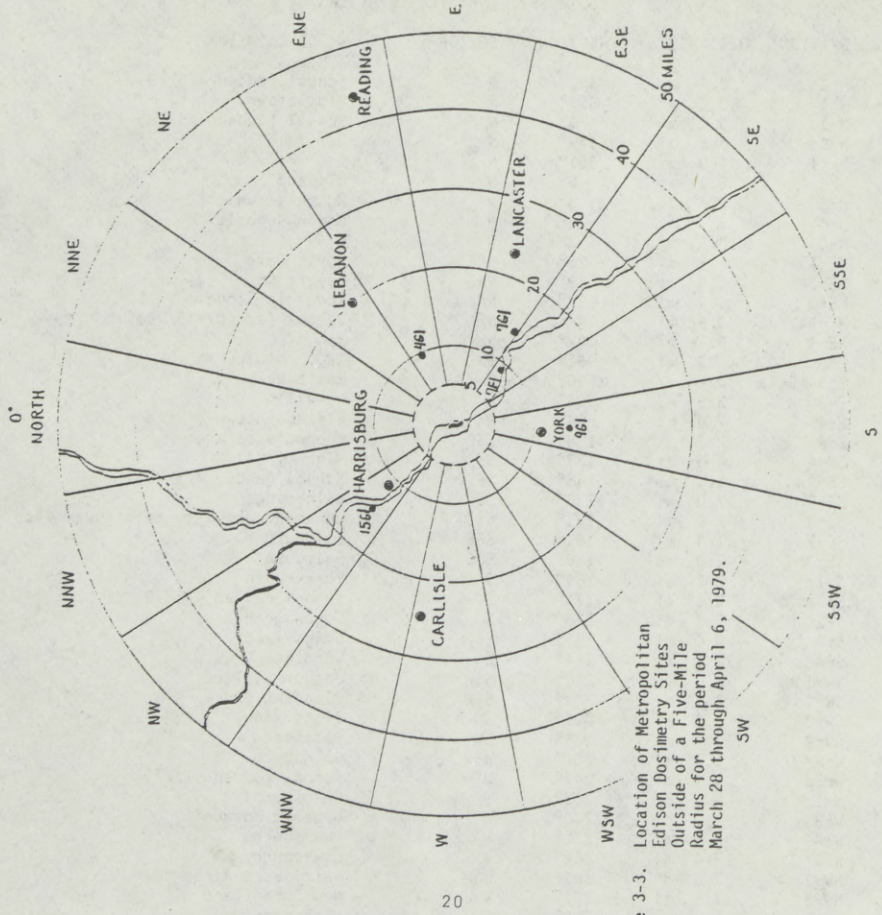
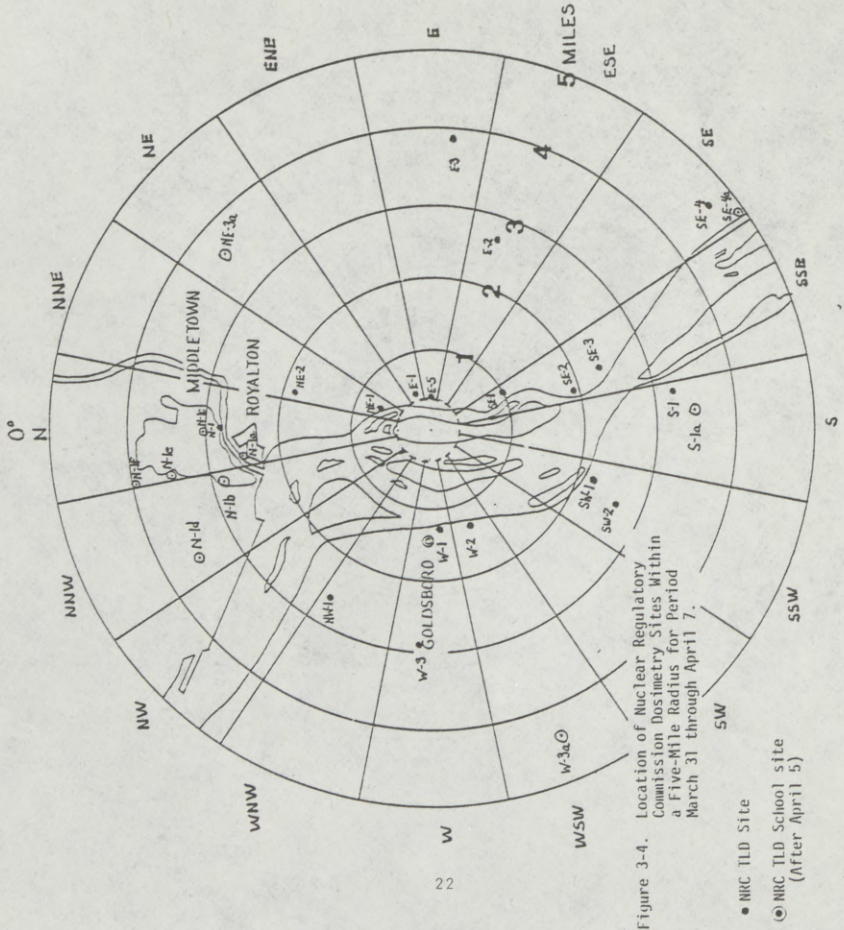


Figure 3-3.
Location of Metropolitan
Edison Dosimetry Sites
Outside of a Five-Mile
Radius for the period
March 28 through April 6, 1979.

Table 3-2. NRC TLD LOCATIONS

STATION	DISTANCE	DIRECTION	SECTOR	DESCRIPTION
N-1a	2.4 mi	356°	N	School (added 4/5/79)
N-1	2.6 mi	358°	N	Middletown
N-1c	3.0 mi	0°	N	School (added 4/5/79)
N-1e	3.5 mi	349°	N	" "
N-1f	4.0 mi	351°	N	" "
N-2	5.1 mi	0°	N	Clifton
N-3	7.4 mi	6°	N	Hummelstown
N-4	9.3 mi	0°	N	Union Deposit
N-5	12.6 mi	3°	N	-
NE-1	.8 mi	25°	NNE	North Gate
NE-2	1.8 mi	19°	NNE	Geyers Ch
NE-3	3.1 mi	17°	NNE	Township School
NE-3a	3.6 mi	44°	NE	School (added 4/5/79)
NE-4	6.7 mi	47°	NE	-
E-1	.5 mi	61°	ENE	1200' N of E-1a
E-5 (E-1a)	0.4 mi	90°	E	Residence
E-3	3.9 mi	94°	E	Newville
E-4	7.0 mi	94°	E	Elizabethtown
E-2	2.7 mi	110°	ESE	Unpopulated area
SE-4	4.6 mi	137°	SE	Highway 441
SE-4a	5.0 mi	146°	SE	School (added 4/5/79)
SE-5	7.0 mi	135°	SE	Bainbridge
SE-1	1.0 mi	151°	SSE	Unnamed community on Highway 441
SE-2	1.9 mi	162°	SSE	Falmouth
SE-3	2.3 mi	160°	SSE	Falmouth
S-1	3.2 mi	169°	S	York Haven
S-1a	3.35 mi	173°	S	School (added 4/5/79)
S-2	5.3 mi	178°	S	Conewago Hts
S-3	9.0 mi	181°	S	Emigsville
S-4	12.0 mi	184°	S	Woodland View
SW-1	2.2 mi	200°	SSW	Bashore Island
SW-2	2.6 mi	203°	SSW	Pleasant Grove
SW-3	8.3 mi	225°	SW	Zions View
SW-4	10.4 mi	225°	SW	Eastmont
W-2	1.3 mi	252°	WSW	Goldsboro
W-3a	4.4 mi	247°	WSW	School (added 4/5/79)
W-1	1.3 mi	263°	W	Goldsboro
W-3	2.9 mi	270°	W	Unnamed community
W-4	5.9 mi	272°	W	Lewisberry
W-5	7.4 mi	262°	W	Lewisberry
NW-1	2.6 mi	303°	WNW	Harrisburg Airport
NW-3	7.4 mi	297°	WNW	New Cumberland
NW-2	5.9 mi	310°	NW	Highspire
NW-4	9.6 mi	306°	NW	Harrisburg
NW-5	13.8 mi	312°	NW	Harrisburg
N-1b	2.75 mi	346°	NNW	School (added 4/5/79)
N-1d	3.5 mi	333°	NNW	" "



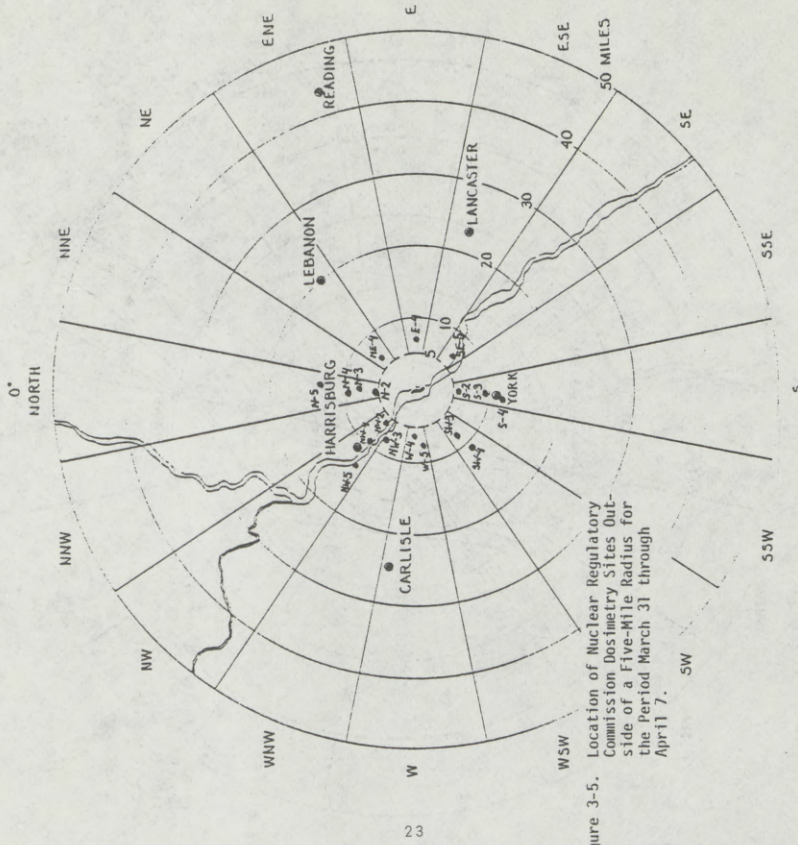


Table 3-3. METROPOLITAN EDISON TLD DATA - RADIATION EXPOSURES
FOR PERIODS ENDING 04/06/79

Station ⁽¹⁾	Exposure Period			
	12/27/78 -03/29/79	03/29/79 -03/31/79	03/31/79 -04/03/79	04/03/79 -04/06/79
mR $\pm$ std. deviation per exposure period (includes background)				
1C1	20.1 $\pm$ 1.3	3.2 $\pm$ 0.7	1.4 $\pm$ 0.4	0.5 $\pm$ 0.1
7F1	24.1 $\pm$ 1.8	1.1 $\pm$ 0.1	0.5 $\pm$ 0.5	0.9 $\pm$ 0.1
7FIQ	23.3 $\pm$ 0.5	0.8 $\pm$ 0.2	1.5 $\pm$ 0.2	0.9 $\pm$ 0.0
15G1	18.4 $\pm$ 2.0	1.9 $\pm$ 0.3	-0.7 $\pm$ 0.1	0.5 $\pm$ 0.0
15G1Q	17.6 $\pm$ 0.6	1.1 $\pm$ 0.1	0.8 $\pm$ 0.1	0.7 $\pm$ 0.2
12B1	16.3 $\pm$ 0.9	9.4 $\pm$ 1.6	0.2 $\pm$ 0.3	1.2 $\pm$ 0.2
9G1	21.3 $\pm$ 1.4	1.4 $\pm$ 0.1	0.1 $\pm$ 0.2	0.6 $\pm$ 0.1
5A1	18.6 $\pm$ 1.0	8.3 $\pm$ 2.8 ⁽³⁾	7.7 $\pm$ 2.5	3.0 $\pm$ 1.2
5A1Q	16.1 $\pm$ 1.3	5.4 $\pm$ 1.0	5.2 $\pm$ 0.9	2.0 $\pm$ 0.6
4A1	20.2 $\pm$ 1.3	34.3 $\pm$ 8.6	41.4 $\pm$ 8.5	2.2 $\pm$ 0.4
2S2	43.7 $\pm$ 4.4	32.5 $\pm$ 5.6	3.4 $\pm$ 0.6	0.9 $\pm$ 0.2
1S2	97.9 $\pm$ 1.9	20.0 $\pm$ 3.4	-0.1 $\pm$ 0.1	0.6 $\pm$ 0.1
1S2Q	95.7 $\pm$ 5.0	15.3 $\pm$ 3.2	1.3 $\pm$ 0.1	0.8 $\pm$ 0.1
16S1	1044.2 $\pm$ 128.2	83.7 $\pm$ 17.5	7.0 $\pm$ 0.7	1.5 $\pm$ 0.3
16S1Q	929.4 $\pm$ 90.5	61.6 $\pm$ 12.2	5.6 $\pm$ 1.0	1.3 $\pm$ 0.5
11S1	216.0 $\pm$ 24.1	107.1 $\pm$ 12.7	45.0 $\pm$ 15.2	21.8 $\pm$ 7.3
11S1Q	168.5 $\pm$ 15.6	75.7 $\pm$ 12.7	35.2 $\pm$ 3.3	14.2 $\pm$ 1.1
9S2	25.0 $\pm$ 3.0	25.3 $\pm$ 2.6	4.6 $\pm$ 1.0	1.8 $\pm$ 0.3
4S2	35.5 $\pm$ 4.3	124.3 $\pm$ 32.7	28.0 $\pm$ 9.1	7.9 $\pm$ 2.3
4S2Q	31.4 $\pm$ 1.6	71.4 $\pm$ 13.0	21.3 $\pm$ 6.6	4.7 $\pm$ 0.4
5S2	30.5 $\pm$ 1.3	49.3 $\pm$ 11.2	26.7 $\pm$ 5.3	15.5 $\pm$ 5.0
5S2Q	27.7 $\pm$ 4.0	36.6 $\pm$ 0.8	21.2 $\pm$ 3.1	11.5 $\pm$ 2.4
4G1	17.2 $\pm$ 2.1	1.2 $\pm$ 0.2	0.6 $\pm$ 0.2	0.6 $\pm$ 0.1
4G1Q	17.7 $\pm$ 0.1	0.6 $\pm$ 0.1	1.4 $\pm$ 0.1	0.7 $\pm$ 0.1
8C1	13.0 $\pm$ 0.3	10.7 $\pm$ 1.6	1.7 $\pm$ 1.1	1.3 $\pm$ 0.4
8C1Q	12.6 $\pm$ 0.6	8.4 $\pm$ 1.0	2.6 $\pm$ 0.2	1.1 $\pm$ 0.1
7G1	25.8 $\pm$ 0.6	1.0 $\pm$ 0.1	-0.5 $\pm$ 0.0	0.8 $\pm$ 0.0
16A1	907.7 $\pm$ 49.4 ⁽²⁾	45.1 $\pm$ 2.1	1.7 $\pm$ 1.1	0.9 $\pm$ 0.1
	453.4 $\pm$ 12.2 ⁽²⁾			
14S1	131.2 $\pm$ 20.6 ⁽²⁾	48.8 $\pm$ 8.6	9.5 $\pm$ 4.3	1.5 $\pm$ 0.4
	148.3 $\pm$ 9.7 ⁽²⁾			
10B1	40.6 $\pm$ 3.5 ⁽²⁾	14.9 $\pm$ 0.9	0.4 $\pm$ 0.3	1.1 $\pm$ 0.2
	36.6 $\pm$ 1.3 ⁽²⁾			

(1) Suffix "Q" indicates RMC data; otherwise data are from Teledyne Isotopes.

(2) Results for 6-month exposure period 09/27/78-03/29/79.

(3) Additional values for 5A1: 7.8 $\pm$ 1.5, 7.4 $\pm$ 1.2.

Table 3-4. NRC TLD DATA-RADIATION EXPOSURES FOR PERIODS
FROM 03/31/79 to 04/07/79 (includes background)

Station	3/31-4/1 mR	4/1-4/2 mR	4/2-4/3 mR	4/3-4/4 mR	4/4-4/5 mR	4/5-4/6 mR	4/6-4/7 mR
N-1	1.0 ± .1	.3	.37 ± .08	.32 ± .08	.28 ± .08	.32 ± .04	.43 ± .05
N-2	(wet)	.3	.45 ± .05	.40 ± .06	.33 ± .08	.48 ± .15	.40 ± .05
N-3	1.2 ± .3	.3	.43 ± .05	.32 ± .08	.34 ± .09	.47 ± .05	.50 ± .11
N-4	1.0 ± .1	.3	.48 ± .08	.33 ± .05	.37 ± .05	.42 ± .02	.48 ± .10
N-5	(wet)	.3	.58 ± .08	.37 ± .05	.35 ± .05	.48 ± .10	.52 ± .08
NE-1	7.0 ± 2.1	.2	.45 ± .08	.32 ± .04	.45 ± .05	.38 ± .04	.45 ± .08
NE-2	(wet)	.3	.48 ± .09	.37 ± .10	.33 ± .08	.47 ± .10	.47 ± .12
NE-3	1.6 ± .5	.3	.42 ± .09	.38 ± .08	.37 ± .08	.46 ± .05	.45 ± .10
NE-4	2.1 ± .5	.3	.37 ± .05	.38 ± .04	.33 ± .05	.40 ± .09	.43 ± .05
E-1	25.0 ± 8.1	.4	.53 ± .1	.32 ± .04	2.6 ± .60	.50 ± .09	.48 ± .08
E-5(E-1a)	8.4 ± 4.6	.3	.73 ± .2	.38 ± .08	1.7 ± .45	1.2 ± .27	.32 ± .04
E-2	4.3 ± .5	.3	.55 ± .7	.55 ± .10	.38 ± .08	.45 ± .10	.35 ± .08
E-3	2.1 ± .4	.4	.42 ± .1	.40 ± .06	.50 ± .06	.48 ± .08	.32 ± .08
E-4	2.5 ± .4	.3	.4 ± .1	.35 ± .14	.43 ± .19	.42 ± .04	.22 ± .04
SF-1	10.1 ± 2.0	.3	9.1 ± 1.6	.43 ± .10	.92 ± .19	.40 ± .00	.55 ± .06
SF-2	3.5 ± .5	.3	4.4 ± .7	.87 ± .16	.38 ± .08	.35 ± .05	.25 ± .05

Table 3-4. (Continued)

Station	3/31-4/1 mR	4/1-4/2 mR	4/2-4/3 mR	4/3-4/4 mR	4/4-4/5 mR	4/5-4/6 mR	4/6-4/7 mR
SE-3	2.3 ± .6	.3	2.8 ± .7	.57 ± .10	.45 ± .05	.40 ± .06	.25 ± .05
SE-4	3.0 ± .4	.3	2.1 ± .4	.30 ± .06	.53 ± .08	.47 ± .08	.25 ± .05
SE-5	2.5 ± .7	.3	.13 ± .1	.42 ± .04	.37 ± .08	.62 ± .31	.38 ± .13
S-1	1.6 ± .1	.4	2.2 ± .4	1.1 ± .05	.37 ± .05	.35 ± .05	.40 ± .00
S-2	1.0 ± .2	.4	1.5 ± .2	.52 ± .08	.32 ± .10	.35 ± .05	.43 ± .08
S-3	1.2 ± .3	.4	1.5 ± .3	.47 ± .05	.40 ± .06	.40 ± .06	.55 ± .10
S-4	1.2 ± .2	.3	1.4 ± .2	.33 ± .05	.45 ± .10	.55 ± .18	.42 ± .08
SW-1	.9 ± .1	.8	1.2 ± .3	1.1 ± .18	.37 ± .08	.37 ± .10	.45 ± .05
SW-2	.9 ± .2	.5	1.3 ± .3	.37 ± .12	.30 ± .09	.43 ± .08	.38 ± .08
SW-3	1.1 ± .3	.4	.78 ± .1	.65 ± .10	.45 ± .10	.38 ± .08	.42 ± .02
SW-4	.9 ± .1	.5	.75 ± .1	.62 ± .10	.45 ± .14	.50 ± .14	.50 ± .09
W-1	3.0 ± 1.9	1.2	1.4 ± .24	1.7 ± .35	1.3 ± .29	.57 ± .10	.48 ± .08
W-2	.9 ± .1	.5	1. ± .1	.62 ± .04	.72 ± .04	.37 ± .08	.38 ± .08
W-3	1.1 ± .1	.5	.78 ± .2	1.1 ± .15	.42 ± .08	.38 ± .08	.47 ± .08
W-4	1.0 ± .2	.4	.67 ± .1	.42 ± .10	.45 ± .14	.45 ± .05	.57 ± .08
W-5	1.2 ± .2	.6	.4 ± .15	.65 ± .12	.60 ± .13	.40 ± .06	.57 ± .14

Table 3-4. (Continued)

Station	3/31-4/1 mR	4/1-4/2 mR	4/2-4/3 mR	4/3-4/4 mR	4/4-4/5 mR	4/5-4/6 mR	4/6-4/7 mR
NW-1	.9 ± .2	1.7	1.3 ± .25	.30 ± .06	.38 ± .08	.52 ± .12	.53 ± .04
NW-2	1.2 ± .5	.4	.62 ± .08	.40 ± .15	.33 ± .05	.35 ± .05	.38 ± .08
NW-3	1.4 ± .7	.8	.63 ± .12	.40 ± .25	.38 ± .04	.40 ± .09	.42 ± .05
NW-4	5.5 ± 1.8	.3	.4 ± .06	.30 ± .06	.37 ± .08	.32 ± .04	.45 ± .10
NW-5	4.6 ± 2.	.4	.42 ± .04	.42 ± .21	.32 ± .04	.48 ± .08	.45 ± .05
S-1a	Not in Service until 4/5/79						
SF-4a	" "	" "	" "	" "	" "	.35 ± .05	.43 ± .
W-3a	" "	" "	" "	" "	" "	.33 ± .05	.25 ± .05
NE-3a	" "	" "	" "	" "	" "	.65 ± .39	.45 ± .10
N-1a	" "	" "	" "	" "	" "	.38 ± .08	.57 ± .08
N-1b	" "	" "	" "	" "	" "	.50 ± .19	.47 ± .04
N-1c	" "	" "	" "	" "	" "	.40 ± .06	.50 ± .06
N-1d	" "	" "	" "	" "	" "	.40 ± .09	.45 ± .08
N-1e	" "	" "	" "	" "	" "	.35 ± .05	.50 ± .06
N-1f	" "	" "	" "	" "	" "	.40 ± .06	.44 ± .08
	" "	" "	" "	" "	" "	.47 ± .15	.37 ± .08

Table 3-5. METROPOLITAN EDISON COMPANY: TELEDYNE ISOTOPES DOSIMETERS
TLD RADIATION EXPOSURE RATES - 1978

Results in Units of mR/Standard month⁽¹⁾

STATION NO.	12-30-77 to 03-29-78	03-29-78 to 06-28-78	06-28-78 to 09-30-78	09-30-78 to 12-27-78	AVERAGE $\pm 2\sigma$
Control Locations					
TM-ID-7F1	6.57 $\pm$ 0.17	11.9 $\pm$ 0.3	7.30 $\pm$ 0.43	7.50 $\pm$ 0.20	8.32 $\pm$ 4.84
TM-ID-4G1	5.30 $\pm$ 0.30	8.53 $\pm$ 0.40	5.77 $\pm$ 0.13	5.90 $\pm$ 0.33	6.38 $\pm$ 2.92
TM-ID-9G1	5.60 $\pm$ 0.13	9.47 $\pm$ 0.50	6.00 $\pm$ 0.20	5.97 $\pm$ 0.13	6.76 $\pm$ 3.64
TM-ID-15G1	5.13 $\pm$ 0.10	8.73 $\pm$ 0.43	5.57 $\pm$ 0.23	5.63 $\pm$ 0.50	6.27 $\pm$ 3.32
TM-ID-7G1	15.8 $\pm$ 0.7	10.4 $\pm$ 0.5	7.13 $\pm$ 0.63	7.20 $\pm$ 0.10	10.1 $\pm$ 8.2
Indicator Locations					
TM-ID-1S2	4.67 $\pm$ 0.13	7.37 $\pm$ 0.47	5.03 $\pm$ 0.13	5.37 $\pm$ 0.20	5.61 $\pm$ 2.42
TM-ID-2S2	4.07 $\pm$ 0.13	6.03 $\pm$ 0.17	4.73 $\pm$ 0.33	4.20 $\pm$ 0.20	4.76 $\pm$ 1.80
TM-ID-4S2	4.80 $\pm$ 0.20	8.07 $\pm$ 0.27	5.17 $\pm$ 0.13	4.33 $\pm$ 0.27	5.59 $\pm$ 3.38
TM-ID-5S2	4.30 $\pm$ 0.13	8.00 $\pm$ 0.27	5.03 $\pm$ 0.40	4.23 $\pm$ 0.10	5.39 $\pm$ 3.56
TM-ID-8C1	3.50 $\pm$ 0.23	5.57 $\pm$ 0.30	4.10 $\pm$ 0.17	3.50 $\pm$ 0.13	4.17 $\pm$ 1.96
TM-ID-9S2	4.67 $\pm$ 0.10	8.53 $\pm$ 0.33	5.57 $\pm$ 0.20	5.67 $\pm$ 0.37	6.11 $\pm$ 3.34
TM-ID-11S1**	5.07 $\pm$ 0.20	17.0 $\pm$ 0.4	6.50 $\pm$ 0.27	5.60 $\pm$ 0.10	8.54 $\pm$ 10.3
TM-ID-14S1**	2.17 $\pm$ 0.13	12.2 $\pm$ 0.4	5.77 $\pm$ 0.73	*	6.71 $\pm$ 10.2
TM-ID-16S1	6.40 $\pm$ 0.27	19.4 $\pm$ 0.7	6.93 $\pm$ 0.40	5.60 $\pm$ 0.27	9.58 $\pm$ 12.2
TM-ID-4A1	4.60 $\pm$ 0.20	7.57 $\pm$ 0.13	5.03 $\pm$ 0.20	5.13 $\pm$ 0.30	5.58 $\pm$ 2.68
TM-ID-5A1	4.60 $\pm$ 0.17	7.47 $\pm$ 0.17	4.57 $\pm$ 0.27	4.63 $\pm$ 0.23	5.32 $\pm$ 2.88
TM-ID-16A1	2.03 $\pm$ 0.07	7.83 $\pm$ 0.37	5.13 $\pm$ 0.23	*	5.00 $\pm$ 5.80
TM-ID-10B1	1.97 $\pm$ 0.20	9.43 $\pm$ 0.37	6.57 $\pm$ 0.10	*	5.99 $\pm$ 7.52
TM-ID-12B1	3.57 $\pm$ 0.07	6.40 $\pm$ 0.30	4.03 $\pm$ 0.27	4.10 $\pm$ 0.10	4.53 $\pm$ 2.54
TM-ID-1C1	4.10 $\pm$ 0.20	6.43 $\pm$ 0.23	4.13 $\pm$ 0.30	4.33 $\pm$ 0.27	4.75 $\pm$ 2.26
Average $\pm 2\sigma$	4.95 $\pm$ 5.70	9.32 $\pm$ 7.04	5.50 $\pm$ 2.00	5.23 $\pm$ 2.18	

(1) Standard month = 30.4 days; values originally reported as 1 mrem/standard month assuming 1 mrem = 1 mR.

* TLDs were left in field.

** Originally reported, erroneously, as Stations 11S2 and 14S2.

Table 3-6. METROPOLITAN EDISON COMPANY: RADIATION MANAGEMENT CORPORATION DOSIMETERS
TLD RADIATION EXPOSURE RATES - 1978
Results in Units of mR/standard month⁽³⁾

STATION NUMBER	12-30-77 to 3-29-78	3-29-78 to 6-28-78	6-28-78 to 9-27-78	9-27-78 to 12-27-78	AVERAGE $\pm 2\sigma$
Control Locations					
TM-IDM-7FIQ	6.15 $\pm$ 0.73	7.60 $\pm$ 0.67	7.79 $\pm$ 0.29	8.04 $\pm$ 0.45	7.40 $\pm$ 1.70
TM-IDM-4GIQ	4.94 $\pm$ 0.52	5.95 $\pm$ 0.38	5.68 $\pm$ 0.46	6.37 $\pm$ 0.77	5.74 $\pm$ 1.20
TM-IDM-15GIQ	4.70 $\pm$ 0.40	5.61 $\pm$ 0.38	5.65 $\pm$ 0.45	6.47 $\pm$ 0.50	5.61 $\pm$ 1.45
Indicator Locations					
TM-IDM-152Q	5.71 $\pm$ 0.34	5.32 $\pm$ 0.31	5.31 $\pm$ 0.42	5.82 $\pm$ 0.27	5.54 $\pm$ 0.53
TM-IDM-452Q	4.91 $\pm$ 0.44	5.69 $\pm$ 0.24	5.55 $\pm$ 0.51	5.05 $\pm$ 0.43	5.30 $\pm$ 0.76
TM-IDM-552Q	4.32 $\pm$ 0.21	5.15 $\pm$ 0.56	5.47 $\pm$ 0.32	5.44 $\pm$ 0.44	5.10 $\pm$ 1.07
TM-IDM-1151Q	5.35 $\pm$ 0.45	9.72 $\pm$ 0.88	6.75 $\pm$ 0.52	6.09 $\pm$ 0.23	6.98 $\pm$ 1.92
TM-IDM-1651Q	3.93 $\pm$ 0.27	12.09 $\pm$ 1.31	6.68 $\pm$ 0.75	6.02 $\pm$ 0.61	7.18 $\pm$ 6.95
TM-IDM-5A1Q	4.57 $\pm$ 0.16	5.18 $\pm$ 0.38	4.88 $\pm$ 0.28	5.60 $\pm$ 0.17	5.06 $\pm$ 0.88
TM-IDM-8C1Q	(1)	4.07 $\pm$ 0.16	(2)	4.35 $\pm$ 0.31	4.21 $\pm$ 0.40
TM-IDM-4A1Q	4.56 $\pm$ 0.60	(2)	(2)	(2)	4.56
TM-IDM-851Q	(2)	(2)	4.04 $\pm$ 0.21	(2)	4.04
Average $\pm 2\sigma$	4.91 $\pm$ 1.33	6.64 $\pm$ 4.96	5.78 $\pm$ 2.11	5.93 $\pm$ 1.96	

(1) "TLDs stolen."

(2) "No sample received."

(3) Standard month = 30.4 days; originally reported as "mmem/standard month" assuming 1 mrem = 1 mR.

(4) Originally reported, erroneously, as value for Station "1152".

B. OFFSITE POPULATION COLLECTIVE DOSE ESTIMATE

1. Introduction

The collective dose for the population within 50 miles of the plant was calculated for the time period of March 28 to April 7, using two independent procedures. The first procedure utilized the empirical distribution of TLD dose data within each direction sector. Doses at distances between those locations with measured values were estimated by interpolation. A power law method was used to extrapolate when necessary. The second procedure utilized onsite meteorological data in conjunction with the TLD readings to estimate the distribution of dose within a 50-mile radius of the facility. The distribution of dose and population were then used to obtain the collective dose.

The population data used for the dose estimates were the 1980 projected offsite population distribution as presented in the Final Safety Analysis Report (FSAR).⁽¹⁾ These population distributions are contained in Tables 3-7 and 3-8 covering radii of 0-10 miles and 10-50 miles respectively.

2. Dosimeter Background Correction

The TLD exposure data reported in Tables 3-3 and 3-4 include a background due to terrestrial radiation, cosmic radiation and other sources unrelated to plant releases. In order to estimate the net exposure due to plant emission, this background must be subtracted from the total TLD exposure. The background

⁽¹⁾ Final Safety Analysis Report, Three Mile Island Nuclear Station, Unit 2, Vol-1, Chapter 2, Figures 2.1-5 and 2.1-10

Table 3-7. PROJECTED 1980 POPULATION DISTRIBUTION, 0-10 MILES
THREE MILE ISLAND NUCLEAR STATION, UNIT 2
(FROM FIG. 2.1-5 of FSAR)

Sector	Distance (Miles)						
	<u>0 - 1</u>	<u>1 - 2</u>	<u>2 - 3</u>	<u>3 - 4</u>	<u>4 - 5</u>	<u>5 - 10</u>	<u>0 - 10</u>
N	19	212	3,970	3,772	415	11,840	20,228
NNE	55	75	169	480	373	11,223	12,375
NE	42	134	271	428	186	2,246	3,307
ENE	58	55	186	461	262	1,567	2,589
E	42	60	39	137	552	10,431	11,261
ESE	6	36	149	214	236	2,809	3,450
SE	6	94	67	203	395	2,095	2,860
SSE	88	197	117	78	43	3,840	4,363
S	0	0	136	817	1,317	12,190	14,460
SSW	84	98	584	217	752	6,883	8,618
SW	84	104	181	562	219	4,297	5,447
WSW	29	273	117	796	237	2,961	4,413
W	36	369	36	331	571	7,155	8,498
WNW	22	106	253	197	235	11,823	12,636
NW	39	106	64	41	1,177	29,482	30,909
NNW	<u>48</u>	<u>98</u>	<u>1,240</u>	<u>942</u>	<u>1,921</u>	<u>16,632</u>	<u>20,881</u>
	<u>658</u>	<u>2,017</u>	<u>7,579</u>	<u>9,676</u>	<u>8,891</u>	<u>137,474</u>	<u>166,295</u>

Table 3-8. PROJECTED 1980 POPULATION DISTRIBUTION, 10-50 MILES
THREE MILE ISLAND NUCLEAR STATION, UNIT 2
(FROM FIG. 2.1-10 of FSAR)

<u>Sector</u>	<u>Distance (Miles)</u>				<u>Total</u>
	<u>10-20</u>	<u>20-30</u>	<u>30-40</u>	<u>40-50</u>	<u>10-50</u>
N	12,663	9,005	8,941	47,588	78,197
NNE	18,240	6,826	14,478	45,115	84,659
NE	39,726	38,979	9,546	62,345	150,596
ENE	10,205	14,757	45,445	177,672	248,079
E	18,853	62,028	42,445	38,754	162,080
ESE	34,339	124,988	27,822	42,737	229,886
SE	20,152	10,000	10,600	26,958	67,710
SSE	44,204	10,774	15,097	66,763	136,838
S	111,002	14,648	13,477	75,781	214,908
SSW	31,917	44,031	18,596	37,729	132,273
SW	11,801	19,931	25,536	18,979	76,247
WSW	5,882	7,996	8,948	23,010	45,836
W	21,769	35,025	10,370	20,602	87,766
WNW	70,460	14,188	5,333	3,681	93,662
NW	99,593	9,308	9,970	12,630	131,501
NNW	<u>26,482</u>	<u>10,517</u>	<u>7,256</u>	<u>12,866</u>	<u>57,121</u>
Total	<u>577,288</u>	<u>433,001</u>	<u>273,860</u>	<u>713,210</u>	<u>1,997,359</u>

0-10 mile population 166,295

0-50 mile population 2,163,654

varies from station to station and also depends on the type of TLD being used. Each set of TLD data requires its own appropriate background estimate.

The background value for each Metropolitan Edison Station with Teledyne Isotopes dosimeters in Table 3-3 was estimated on the basis of data collected with similar dosimeters for the period December 30, 1977 - March 29, 1978, as shown in Table 3-5. Inherent in the use of these data is the assumption that there were no significant plant releases during that time period. Since the first quarter of 1978 is used as the background for the first quarter of 1979, any seasonal effect on background should be minimized. An exception was made for station 7G1, which is inside a brick building at the Columbia water treatment plant. Since the first quarter exposure for 1978 (15.8 mR/std. mo.) was substantially greater than that for the subsequent quarters, the exposure for the most recent quarter (7.20 mR/std. mo. for the last quarter of 1978) was used in order not to overestimate the background.

As mentioned previously, Metropolitan Edison utilized RMC dosimeters at several sites as a quality control check on the Teledyne Isotope dosimeters. The RMC results for 1978 (Table 3-6) are in reasonable agreement with those of Teledyne Isotopes for 1978 (Table 3-5) with the possible exception of the second quarter of 1978 which is a period during which fallout from a Chinese nuclear test made a substantial contribution to the measured exposures.

Also, as mentioned previously, the NRC dosimeters which were also analyzed by RMC are not identical to either the Teledyne Isotopes (TI) or the RMC TLD's used for Metropolitan Edison. Since these TLD's were not deployed prior to the incident there are no previous data to provide background estimates for these particular dosimeters at the NRC locations. The assumption was made that the backgrounds for those locations which are located near the Metropolitan Edison stations are the same as for the TI TLD's at those locations. Pairs of Metropolitan Edison and NRC dosimeters with similar locations are: N-1 and 1C1, SE-5 and 7F1, NW-5 and 15G1, W-2 and 12B1, S-4 and 9G1, E-1a (E-5) and 5A1, E-1 and 4A1, NE-1 and 2S2, and SE-3 and 8C1. The background for the remaining NRC stations was estimated as the mean of the Metropolitan Edison/TI stations for the first quarter of 1978 (except that the value for the last quarter of 1978 was used for station 7G1). These values probably underestimate the background for the NRC dosimeters and therefore result in an overestimate of the plant's contribution to reported dose readings.

3. Conversion from TLD Exposure to Dose*

The net exposure at each TLD location was estimated by subtracting an appropriate background for that station and time period from the TLD exposure. This net exposure (mR) was converted to dose equivalent (mrem) assuming a conversion factor of 1 mrem/mR. In some cases duplicate dosimeters were placed at particular locations. In such instances, the dose for that location and period was estimated as the mean of the doses based on each dosimeter exposure.

* The term "dose" is used for brevity rather than the more precise term "dose equivalent."

4. Standard Grid and Population Data

The region surrounding the plant is represented on a circular grid centered at a point midway between the reactor buildings. This standard grid contains 16 sectors (N clockwise through NNW) centered on the appropriate direction. Each sector is divided into segments at standard distances of 2000 ft (.379 mi), 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 miles. The 2000-ft distance corresponds to the radius of the exclusion area for the plant. Tables 3-7 and 3-8 show the estimated 1980 population for each sector segment for distances 0-10 miles and 10-50 miles respectively.

5. Dose Estimation for Locations Within the Standard Grid

The first step in estimating doses based on the TLD measurements for each period is to estimate the doses at each location on the standard grid. This was accomplished by an interpolation which was equivalent to plotting the measured doses for each sector on logarithmic coordinate graph paper and joining the measured values by straight line segments. The intersection of each line segment with a standard distance for the grid was taken as the dose at that distance. In instances where the net dose calculated for a location was not greater than zero, this method could not be used. In such cases, linear interpolation was used to estimate the doses at standard distances.

Doses at distances beyond the outermost dosimeter or within the innermost dosimeter were estimated by extrapolation using the assumption that the

dispersion in a sector is proportional to distance to the (-1.5) power.^{(2)*} A DOE analysis concludes that their airborne measurements and the TLD data suggest a more rapid decrease of exposure with distance, more consistent with an exponential function or a power function with an exponent of (-2) (Appendix A). The (-1.5) power assumption is therefore conservative, yielding a higher collective dose.

Doses for the standard distances in sectors in which no measurements were made were estimated by interpolating linearly between the dose values of the adjacent sectors for which measured data were available.

The mean dose within each sector segment was estimated by weighting the dose, $H(r)$, by the area within the sector

$$\bar{H} = \frac{\int_{r_1}^{r_2} H(r) r dr}{\int_{r_1}^{r_2} r dr}$$

where $\bar{H}$ is the mean dose, $H(r)$ is the dose as a function of distance, r , and r_1 and r_2 are the inner and outer radii of the sector segment, respectively.

(2) M. Smith (Ed.) "Recommended Guide for the Prediction of the Dispersion of Airborne Effluents," American Society of Mechanical Engineers, New York (1968), p. 44-46. This reference shows that the airborne concentration varies as r^{-p} where p can vary from 1.4 (stable conditions) to 1.8 (very unstable conditions). The value $p = 1.5$ approximates a daily average value.

* An empirical test was performed to check the sensitivity of this parameter. Changing the power to (-1.3) and (-1.7) changed the collective dose calculated (+17%) and (-9%) respectively.

The collective dose for each sector segment is the product of the corresponding mean dose and the population as given in Tables 3-7 and 3-8. The sum of the collective doses for all sector segments and periods is the total collective dose for the entire assessment area for the total period under consideration.

6. Collective dose calculations*

Four approaches were used in estimating the total collective dose for the period March 28-April 7. Each utilizes data from the Metropolitan Edison TLD stations for the period March 28 through March 31, since there were no NRC TLD's in place before March 31.

For the first calculational approach, all Metropolitan Edison data for the period March 28-March 31 were used for estimating the collective dose for the periods March 28-29 and March 29-31 (3200 person-rem). The NRC data, which are all from offsite locations, provided the data for the periods from April 1 through April 7. The increase in total collective dose with time using this approach is shown in Figure 3-6. Note that there is a significant contribution to the collective dose (1100 person-rem) from the first NRC period (3/31-4/1) and that there is a continuing steady contribution each day for the remaining periods. A strength of this method is that it utilizes the

* A copy of the computer program for generating the collective doses is available from Christopher Nelson, Environmental Protection Agency, Office of Radiation Programs (ANR-461) Washington, D.C. 20460.

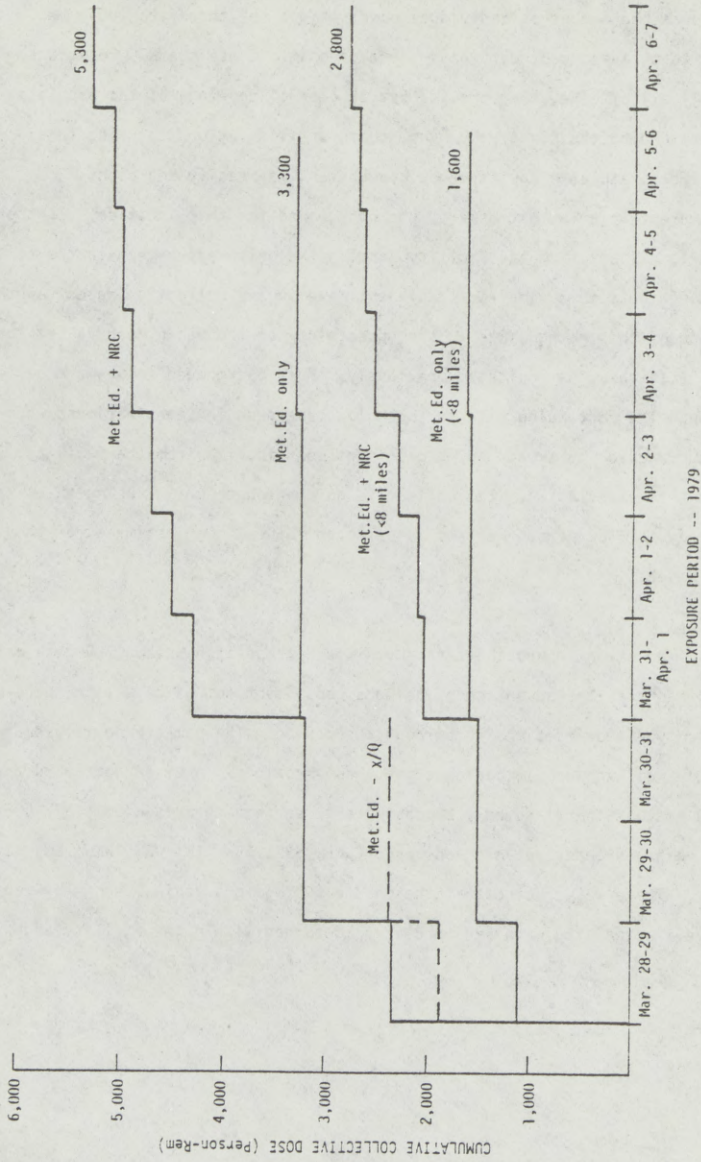


Figure 3-6. Increase in Collective Dose as a Function of Time for Various Calculation Strategies

maximum possible number of individual observations and therefore would be expected to be least dependent on any one of them. Since the NRC locations are nearly all offsite, they provide better general coverage of the populated areas surrounding the plant. However, there are limitations to using this method. For example, a positive net measurement may easily represent nothing more than a low estimate of the background for that location. If the location is distant from the facility, and is the only measurement in the sector, it can contribute to a significant overestimate in the collective dose. Another limitation of this method lies in the uncertainty of the background values for the NRC locations. As indicated previously, these background values are believed to be low. The continuing rise in the collective dose in later periods, when there is no reason to expect any significant contribution from the facility, confirms this expectation. The collective dose through April 7 using this methodology is 5300 person-rem and is believed to be a high estimate for the reasons given.

The second approach is based on the Metropolitan Edison TLD data only. This approach has the advantage of using a consistent set of data with the same dosimeter type and locations throughout the period. The background values are reasonably well known by experience for these stations. A disadvantage to this approach is that there are only 20 dosimeters, so that three sectors (NE, ESE, W) have no measurements at all and seven (NNE, SSE, SSW, SW, WSW, WNW, NW) have only one. There was concern that the onsite TLD's might be influenced by radiation levels associated with radionuclides contained within the facility and

would therefore not be appropriate for estimating offsite doses. This, however, does not appear to be the case. These dosimeters around the periphery of Three Mile Island show a variation from time period to time period, which would not be expected if they were appreciably affected by contained onsite radiation sources. Onsite radiation monitoring with hand-held radiation monitors also confirms the absence of a significant "direct radiation" component except very close to the containment or auxiliary buildings. The total collective dose through April 6 using this approach is 3300 person-rem. April 6 becomes the cutoff point in this method because of the 3-day dosimeter cycle under which the Metropolitan Edison TLD's were deployed and read out.

A third approach is based on a subset of the dosimeters used in the first method. Those locations outside 8 miles were dropped from the analysis, eliminating 5 Metropolitan Edison and 7 NRC stations. This has the advantage of minimizing the effect of exposure uncertainties at those locations which are least likely to have been exposed to radioactive material from the facility. The disadvantage is that a significant dose at a distance greater than 8 miles in a direction where there are no other dosimeters nearer to the facility will be missed completely. Note that this substantially reduces both the March 28-31 Metropolitan Edison dosimeter contribution to the collective dose and the contribution from the first day of NRC observations. The total collective dose through April 7 using this approach is 2800 person-rem.

The fourth approach is based on using those Metropolitan Edison TLD data from locations that are not more than 8 miles from the facility. Again the method has the advantage of a consistent base of data for the entire period and the disadvantage of making a small data base even smaller. The effect of eliminating the distant stations is to reduce the collective dose calculated for the period. Using approach four, the collective dose through April 6 is 1600 person-rem.

Time did not permit the inclusion in the dose calculations of the Metropolitan Edison - RMC TLD data (which provide independent measurements of the exposure at 10 of the Metropolitan Edison TLD locations). Inspection of these RMC results, in Tables 3-3 and 3-6, indicates that including them in the calculations would lower the calculated collective dose values.

Given the limited number of observations (especially for the period March 28-31, when it would appear that most of the collective dose was delivered) it is evident that any approach to assessing the collective dose depends strongly on a relatively small number of measurements. No amount of sophisticated analysis can change this fundamental limitation. On the other hand, it is also clear that the data do allow reasonable estimates of the collective dose to be made.

7. Calculations Employing Meteorological Dispersion Factors

Computed values of the meteorological dispersion factor (χ/Q) for the time period of March 28, 4:00 a.m. through March 29, 8:00 a.m. and March 29,

8:00 a.m. through March 31, 4:00 a.m. were used to estimate collective dose. This method was intended to serve as an independent check on the methods described earlier. These values of χ/Q calculated hourly were time-averaged over these periods for each distance and direction segment.*

The dose H (mrem) for time interval, Δt , is calculated from the following equation:

$$H = \left(\frac{\chi}{Q}\right) Q (DF) \Delta t$$

where

- H dose received over the time interval, Δt (mrem)
- Q source (Ci/sec)
- (χ/Q) meteorological dispersion factor (sec/m³)
- DF dose factor (mrem m³/Ci sec)
- Δt length of time interval (sec).

Assuming that the release rate, Q , is constant over time interval, Δt , the quotient, $H/(\chi/Q)$, is constant for each sector section since the product, $Q(DF)\Delta t$, is also constant. Doses based on exposures appearing in Table 3-3 for the first two time periods were divided by the corresponding χ/Q values determined by interpolation of the meteorological data. These quotients were then averaged for each time period. Multiplication of these two average $H/(\chi/Q)$

* These data and calculations are available if requested. Contact Dr. F. Congel, U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (P-712), Washington, D.C. 20555.

values by the appropriate x/Q value at different sector segments for the two time intervals yielded an estimate of the dose at those locations for each time interval. The total collective dose was estimated by multiplying the sector segment population by dose at the inner boundary. Since the inner boundary dose is always larger than the outer boundary dose for each sector segment, a conservative estimate of collective dose is obtained.

The total 0-50 mile collective dose for the first and second period was 1900 person-rem and 680 person-rem, respectively, for a total value of about 2600 person-rem. This value lies in the middle of the range of values estimated in the preceding section (see Figure 3-6).

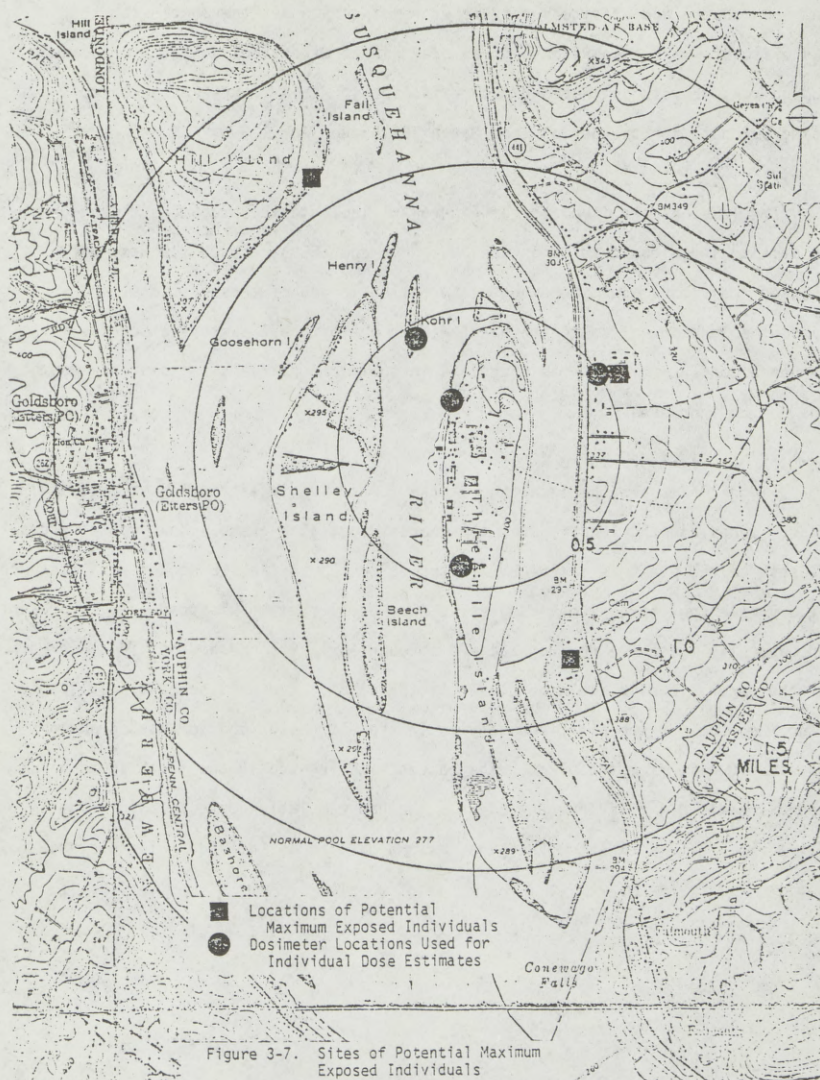
C. OFFSITE MAXIMUM DOSE TO AN INDIVIDUAL

The estimated maximum dose to an individual depends upon the local meteorological conditions, namely, wind direction, wind speed, and plume dispersion characteristics. The known meteorological conditions throughout the accident period indicate that there were three predominant directions in which radioactive material released from the plant would be expected to be found. These directions were characteristic of the near-field 0-5 mile dispersion values (x/Q), as well as the far-field 5-50 mile, dispersion values. In addition to the meteorological considerations, TLD's placed at locations within and beyond the site boundaries, airborne measurements of plume exposure by helicopter flights made by the Department of Energy (DOE) after the onset of the accident and throughout the period,

and both onsite and offsite survey meter readings support the conclusion that the effluents were dispersed in three predominant directions. Figure A-1 (see Appendix A) depicts estimated exposure isopleths. This figure was prepared using DOE data for the period from March 28 through April 3.

The lobes of the isopleths of Figure A-1 indicate the predominant exposures to offsite individuals to be in the NNW, ENE, and SSE sectors. The maximum exposed individual would be expected to reside in one of these sectors, and also at a location close to the plant within one of these sectors since the airborne concentration of radionuclides in the plume decreases as distance from the source increases.

Figure 3-7 shows the locations of the TLD's used in estimating maximum individual doses and the locations of the nearest populated areas. The populated area closest to the plant is in the ENE sector. The TLD in the ENE sector at a distance of 0.5 mile registered a net cumulative dose of 83 mrem. This dose value represents an upper limit for the period March 28 through April 7 since no individual member of the general public could be closer to the plant. The next nearest populated land mass outside the plant boundary is in the SSE sector and is located approximately 0.8 mile from the plant. The nearest TLD located in the south sector is approximately 0.4 mile from the plant. The net cumulative dose at this location is 41 mrem. It is expected that the maximum dose to an individual in this area (SSE



sector) would be less than the 41 mrem because the populated area is twice as far from the plant as is the detector location.

The nearest offsite area in the NNW sector is Kohr Island. However, Kohr Island was uninhabited during the period following the accident.* On April 19, 1979, inspectors from the NRC Office of Inspection and Enforcement received reports that as many as three people may have been on Hill Island (about 1 mile NNW of the TMI Island plant) on March 28 or 29. Through subsequent inquiries, NRC was only able to confirm that one individual was on the Island. He was interviewed and stated that he was the only individual present on the island following the accident and was working on a summer cottage. He was present nine and one-half hours (from 11:00 am to 4:30 pm on March 28 and from 11:00 am to 3:00 pm on March 29).

The potential dose to an individual at that particular location on Hill Island was estimated from TLD's that were close to the TMI facility and in the same direction sector (NNW) as the island. The following data were used to estimate the exposure at Hill Island (1.1 miles NNW).

* This is based upon surveys conducted by the Metropolitan Edison Company staff and NRC Office of Inspection and Enforcement personnel.

	<u>Dose (mrem)</u>	Metropolitan Edison	
		<u>Distance</u> <u>(miles)</u>	<u>Station Code</u> <u>(see Table 3-1)</u>
4:00 a.m. 3/28 -	1020*	0.20	16S1
12:10 p.m. 3/29	440	0.42	16A1
	900	0.42	16A1
12:10 p.m. 3/29 -	83	0.20	16S1
10:45 a.m. 3/31	45	0.42	16A1

The discrepancy (900 versus 440 mrem) between the two TLD dosimeter values for the initial time period was investigated, but could not be explained. However, based on an examination of the meteorological dispersion during that time period and the dosimeters at site 16S1*, it appears that the 440 mrem value is more plausible. Using the 440 mrem value, the extrapolated dose at the cottage location on Hill Island would be about 150 mrem for the first time period. The dose at Hill Island for the second time period would be about 18 mrem.

Since the person was not present on the island during the entire period (from the time of the accident until 10:45 on March 31), the exposure has to be reduced accordingly. This "occupancy factor" is determined by assuming that the exposure rate was constant for each time period and as follows: The individual was present for about 5.5 hours on March 28 and slightly more than 1

* A second quality assurance dosimeter placed by Radiation Management Corporation (RMC) at this location (16S1) for the same period gave a net result of 917 mrem. This supports the magnitude of the dose at this site.

hour on March 29 until the first TLD's were replaced at 12:10 p.m. The total individual exposure time was 7 hours for the first time period. It was assumed that the releases started at about 7:00 a.m. March 28, and continued at a uniform rate until the TLD's were replaced at 12:10 p.m. on March 29 for a total TLD exposure time of 29 hours for the first time period. The second time period began at 12:10 p.m. March 29, and ended 10:45 a.m. on March 31, for a total TLD exposure time of 47 hours. The individual on Hill Island was exposed during the second time period for 3 hours. Using the actual occupancy time on the island, the estimated individual exposure becomes approximately 37 mrem.

If the higher initial period TLD reading (900 mrem) was used, the individual's dose would be estimated at about 180 mrem. If the two TLD's with the large discrepancy are averaged (670 mrem), the individual's dose would be estimated at about 93 mrem. However, it appears that the most probable estimate of dose to the individual is 37 mrem.

4. POTENTIAL HEALTH IMPACT OF EXTERNAL EXPOSURE

A. Health Effects from Low-Level Radiation

The health risks from low-level radiation are derived by assuming that the effects observed at high doses from high dose rates can be directly and linearly extrapolated to low doses delivered at very much lower dose rates. It is also assumed that there is no absolutely safe dose (or threshold) below which there is no health risk. These assumptions result in a linear, non-threshold, dose-rate-independent dose-effect relationship. This relationship is generally* believed to overestimate the health risk from low-level beta and gamma radiation doses (1-3).

*

The 1972 BEIR Committee (3) noted that (p. 88): "...Expectations based on linear extrapolation from the known effects in man of larger doses delivered at high dose rates in the range of rising dose-incidence relationship may well overestimate the risks of low-LET radiation at low dose rates and may, therefore, be regarded as upper limits of risk for low-level low-LET irradiation. The lower limit, depending on the shape of the dose-incidence curve for low-LET radiation and the efficiency of repair processes in counteracting carcinogenic effects, could be appreciably smaller (the possibility of zero is not excluded by the data). On the other hand, because there is greater killing of susceptible cells at high doses and high dose rates, extrapolation based on effects observed under these exposure conditions may be postulated to underestimate the risks of irradiation at low doses and low dose rates."

There are a few recent studies that suggest that the risks of low-level ionizing radiation might be greater than predicted from linear extrapolation from high doses. However, the results of these studies have not been generally accepted by the scientific community. It is important to consider both studies that present higher risk estimates and studies that present lower risk estimates together with the complete body of scientific literature on the effects of ionizing radiation rather than relying on the results of a single, or even a few, studies.

- (1) International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection Adopted January 13, 1977" ICRP Publication 26, Pergamon Press, Oxford (1977) Section E pp 6-7.
- (2) National Council on Radiation Protection and Measurements, "Review of the Current State of Radiation Protection Philosophy." NCRP Report No. 43, NCRP, Washington, D.C. (January 15, 1975) p.4.
- (3) Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR) "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," National Academy of Sciences - National Research Council, Washington, D.C. November 1972, Chapter VII, Section IV pp 87-88.

Somatic Effects

Somatic radiation effects are those effects that may appear in the irradiated individual. The primary somatic effect observed following high doses of radiation is an increase in cancer deaths (cancer mortality). The risk of cancer per unit dose of radiation can be expressed in an absolute sense or in relative (comparative) sense. The absolute risk is the difference in risk between an exposed (irradiated) population and an unirradiated population of similar characteristics. Under the linear dose-effect relationship, the absolute risk may be expressed as the increased number of radiation-related cases of cancer per year in an exposed population per unit of dose; for example, 10 deaths per year per million people exposed per rem (10 deaths/year per 10^6 person-rem).

The relative risk is the ratio between the risk of the irradiated population and the unirradiated population. It is usually stated as a fraction or multiple of the natural risk for that particular effect; for example, 0.5% per year. In order to convert the relative risk into units comparable to the absolute risk, it is necessary to multiply the relative risk by the natural cancer mortality rate for each type of cancer (cancer deaths per year/ 10^5 people); for example, for total cancer mortality the death rate is approximately 2000 deaths per year per 1,000,000 people; therefore:

$$\frac{0.005(0.5\%)}{\text{rem}} \times \frac{2000 \text{ cancer deaths}}{10^6 \text{ person-years}} = \frac{10 \text{ cancer deaths/year}}{10^6 \text{ person-rem}}$$

The risk of cancer may not increase immediately after irradiation. It can require several years before the risk becomes increased (typically 2-20 years, depending upon the cancer type and age of the person irradiated*). This

* For in utero (in the womb) irradiation there may be no latent period [(3) p. 171].

time interval between irradiation and the appearance of cancer is called the latent period. Following this latent period, there is a period where there is an increased risk of cancer in an irradiated population. In order to estimate the total risk of cancer from a single dose of radiation, it is necessary to multiply either the absolute risk or the relative risk by the duration (length) of this period. The exact length of the period of increased risk is not known for most radiation-induced cancers. Therefore, two assumptions have been made concerning this: Assumption A is that the risk remains elevated for 30 years following the latent period and then drops to zero, assumption B is that the risk remains elevated for the remainder of the individual's lifetime. The risks of fatal cancer from radiation exposure, estimated from the data in the 1972 BEIR Report⁽³⁾ for both relative risks and absolute risks and for Assumptions A and B, are shown in Table 4-1.

Genetic Effects

It is firmly established that ionizing radiation can cause genetic mutations and other anomalies in animals. These effects can be manifested as congenital anomalies (birth defects) or hereditary abnormalities in descendants of an irradiated parent or parents. However, the exact numerical value for the risk of genetic injury from low doses in man is uncertain. The genetic effects estimated in the 1972 Report of the Advisory Committee on the Biological Effects of Ionizing Radiation⁽³⁾ are based upon estimates that the radiation dose which would double the natural incidence of genetic anomalies (doubling dose) is between 20 and 200 rem (20,000 and 200,000 mrem). The lower the doubling dose, the

Table 4-1. RADIATION-INDUCED CANCER MORTALITY ESTIMATED IN THE 1972 BEIR REPORT (3)

	1972 BEIR Report Estimates		Derived Risk	
	Annual number of deaths resulting from exposure of the U.S. population to a radiation dose rate of 0.1 rem [100 millirem] per year (a)		Number of Cancer Deaths per 10 ⁶ person-rem (b)	
	Absolute Risk Model	Relative Risk Model	Absolute Risk Model	Relative Risk Model
Leukemia	516	738	26	37
Other Fatal Cancers (c)	1210	2436	61	123
Assumption A: (d)	1485	8340	75	421
Assumption B: (e)				
Total (Range) (e)	1726-2001	3174-9078	87-101	160-458
Nominal Range (f)	1700-2000	3200-9100	90-100	160-460
		Geometric mean $(95 \times 310)^{1/2}$	= 200 (172)	

(a) 1967 U.S. population = 197,863,000. Collective Dose Rate = $(198 \times 10^6 \text{ people}) \times (0.1 \text{ rem/yr}) = 19.8 \times 10^6$ person-rem/year. From Table 3-3 (Relative Risk and Table 3-4 (Absolute Risk) of the 1972 BEIR Report (3) pp. 172-173.

(b) 1972 BEIR Values (Cancer deaths/year) divided by the collective dose rate of 19.8 [10⁶ person-rem]/year.

(c) Assumption A: 30-year period of elevated risk following irradiation.

(d) Assumption B: Lifetime period of elevated risk following irradiation.

(e) Low estimate = Leukemia Risk + Assumption A for other fatal cancers.

High estimate = Leukemia Risk + Assumption B for other fatal cancers.

(f) Preceding values rounded to two significant figures.

greater the risk from a given radiation dose. Table 4-2 summarizes the calculation of the genetic risk per unit radiation dose from the data given in the 1972 BEIR report. This calculation was based upon the 1967 birth rate of approximately 18.2 births per year per 1,000 people. The use of the 1976 birth rate of 14.2 births per year per 1,000 people would give lower risks per person-rem by a factor of $14.2/18.2$ or about 0.8.

B. Comparison of Doses to Individuals from the TMI Accident with Natural Background Radiation and its Variability

Man is continually exposed to ionizing radiation which occurs naturally. There are three primary sources of this natural radiation "background": (1) solar and galactic cosmic radiation, (2) long-lived radionuclides in the earth's crust (primordial radionuclides) and (3) radionuclides formed in the upper atmosphere from the interactions of the cosmic radiation with gases in the atmosphere (cosmogenic radionuclides). The magnitude and variation in the radiation dose from these natural radiation sources provides one baseline for comparing the doses and the potential health impact from the Three Mile Island accident.

Estimates of the dose from background radiation at several locations in the United States are shown in Table 4-3. None of these values are measured values but they are generally consistent with reported measurements. (4-5)

(4) D.T. Oakley, "Natural Radiation Exposure in the United States," EPA Report ORP/SID 72-1, U.S. Environmental Protection Agency, Washington, D.C. (1972).

(5) National Council on Radiation Protection and Measurements, "Natural Background Radiation in the United States" NCRP Report No. 45, NCRP, Washington, D.C., November 15, 1975.

Table 4-2. ESTIMATES OF GENETIC EFFECTS OF LOW-LEVEL IONIZING RADIATION

Disease Classification	Natural Incidence (per 10^6 live births)	Effects per 10^6 live births (a) of 5 rem per generation (b)	Estimated Risk per 10^6 person-rem (c)
		First Generation	Equilibrium
Dominant diseases	10,000	50 to 500	250 to 2500
Chromosomal and recessive diseases	10,000	relatively slight	6 to 60
Congenital anomalies	15,000	very slow increase	relatively slight
Anomalies expressed later	10,000	5 to 500	50 to 5,000
Constitutional and degenerative diseases	15,000		0.6 to 60
TOTAL	60,000	60 to 1000	300 to 7500
Risk per 10^6 people	1,200 ^(d) /year		7 to 120
		Geometric Mean	$(36 \times 900)^{1/2} = 200$ (180)

(a) From the 1972 BEIR Report (3), Table 4 p. 57 which is believed to be erroneously titled. This table, like the preceding tables 2-3 pp. 54-55, is believed to be for a population of one million "live births" not for a population of one million. The range of values corresponds to assumed doubling doses between 20 rem (high values) and 200 rem (lower values).

(b) A generation is assumed to be 30 years.

(c) Risk per 10^6 person-rem = (cases/ 10^6 live births) $\times$ (30 years/5 rem) $\times$ (4×10^6 live births/year per 2×10^8 people) = $0.12 \times$ cases/ 10^6 live births.

(d) Cases/ 10^6 live births $\times$ (4×10^6 live births per year/ 2×10^8 people).

Table 4-3

Estimates of Natural "Background" Radiation Levels in the United States

Location	Annual Dose Rate (mrem/year)			Total
	Cosmic Radiation ^(a)	Terrestrial Radiation ^(a)	Internal Radiation ^(b)	
Atlanta, Georgia	44.7	57.2	28	130
Denver, Colorado	74.9	89.7	28	193
HARRISBURG, PA.	42.0	45.6	28	116*
Las Vegas, Nev.	49.6	19.9	28	98
New York, NY	41.0	45.6	28	115
PENNSYLVANIA	42.6 ^(c)	36.2 ^(c)	28	107
Washington, DC	41.3	35.4	28	105
UNITED STATES ^(d)	40-160	0-120	28	70-310

(a) From [(4) Table A-1]

(b) Based upon total for soft tissue (gonads) doses from [(5) Tables 42 and 43, p. 104].

(c) From [(4) Table A-2]

(d) From [(4), Table 15, p. 34]

* The value used elsewhere in this report is 125 mrem/year which is based upon the Final Environmental Statement for the Three Mile Island Facility (AEC, 1972, Section VD 7, p. V-28). As neither value represents direct measurements and ambient radiation dose rates are expected to vary by at least 25% between locations within a 50-mile radius, these estimates are essentially identical.

Table 4-4 compares the estimated individual doses from the Three Mile Island accident to some of the variations in annual radiation doses from background radiation. It should be noted, however, that the "background" doses are delivered continuously, whereas the accident doses were delivered over a period of a few days. The possible significance of this higher dose rate is discussed in a following section on dose-rate effects. It should also be noted that the "average" doses to individuals within 10 and within 50 miles of the site are numerical averages obtained by dividing the collective population doses by the size of enclosed population. Clearly, some individuals received more than this dose and others less, depending upon wind direction and distance from the TMI site.

C. Existing Cancer Rates and Risks

Cancer is the second leading cause of death (next to heart disease) in the United States [(6) p. 14]]. The Vital Statistics of the United States, 1976 shows that there were 377,312 deaths in the U.S. from cancer, which corresponds to a rate of about 180 cancer deaths per 100,000 people per year [(6) p. 14]. Cancer deaths accounted for approximately one-fifth (0.198) of all deaths in the U.S. in 1976. The existing cancer rate provides an indication of the possibility of detecting any potential increase in cancer incidence due to the Three Mile Island accident.

(6) From American Cancer Society, "Cancer Facts and Figures - 1979," Reproduced by permission of the American Cancer Society who retains copyright. Subsequent quotations should acknowledge the American Cancer Society as the source of these values.

Table 4-4

Comparison of Individual Doses from the Three Mile Island Accident
With Variations in Natural Background Radiation Doses

THREE MILE ISLAND ACCIDENT	CUMULATIVE TOTAL BODY DOSES DELIVERED THRU 4/7/79
Individual remaining out-of-doors at location of highest estimated offsite dose	less than 100 mrem
Average dose to a typical individual within:	
50 miles of site	1.5 mrem
10 miles of the site	8 mrem
(These values correspond to the 3,300 person-rem collective dose estimate)	
NATURAL BACKGROUND VARIATION	ESTIMATED DIFFERENCE IN ANNUAL DOSES
Living in Denver, Colorado compared to Harrisburg, PA (from Table 4-4)	+ 80 mrem/yr
Living in a brick house instead of a wood frame house [Yeates data in (4) Table 16, p. 35]	+ 14 mrem/yr
Added dose from potassium-40 due to being male instead of female (There is 25% less potassium in women than men [(5), p. 106])	+ 4.8 mrem/yr

The cancer death rate for the State of Pennsylvania estimated by The American Cancer Society [(6) p. 12] is 208 deaths per year per 100,000 people (2.08×10^{-3}). Portions of the State of Maryland are also located within 50 miles of the TMI site. Maryland has a lower estimated rate (179 per 100,000) which is closer to the estimated U.S. rate of 180 per 100,000 [(6) p. 12]. Applying the U.S. or Pennsylvania values to the 2,164,000 people estimated to reside within 50 miles of the Three Mile Island site gives an approximate estimate of 3,900 (U.S.) to 4,500 (Pa) deaths per year for the existing cancer death rate for that population. Table 4-5 shows the estimated incidence (number of new cases) and death rate for the U.S. population for selected types of cancers.

The American Cancer Society [(6) p. 14] estimates that, out of 100,000 people, 25,000 will eventually develop cancer and, of these 25,000, about 15,000 will eventually die of cancer. This gives an estimate of the risk of cancer death of 0.15.* Applying this approximate statistic to the population within 50 miles of the Three Mile Island site indicates that approximately 325,000 people in that area would normally die of cancer.

* This has a range between 0.15 and 0.17 depending upon the source of the data and the year to which it applies.

Table 4-5

Estimated New Cancer Cases and Deaths in the
United States for 1979 (Existing Rates)

Specific Cancers	Estimated* New Cases	Estimated* Deaths	Deaths/Cases ^(a)
Digestive Organs	182,900	105,150	0.57
Lung	112,000	97,500	0.87
Bone	1,900	1,750	0.92
Skin	13,600 ^(b)	4,300 ^(b)	0.32
Breast	106,900	34,500	0.32
Genital Organs	143,500	44,800	0.31
Leukemia	21,500	15,400	0.72
Thyroid	9,000	1,000	0.11
All Sites*	765,000	395,000	0.52
(including cancers not listed above)			

(a) If cancer rates and the population (and its age composition) were constant this ratio would be a measure of the probability of dying from having specified types of cancer. As neither existing cancer rates nor the U.S. population and its age breakdown are constant, this is only an approximate measure of severity of cancers at a particular site.

(b) This only for melanoma, a rare skin cancer with a high mortality rate (for skin cancers).

* From American Cancer Society, "Cancer Facts and Figures-1979" p. 10. Reproduced by permission of the copyright holder, the American Cancer Society. All subsequent quotations of these values should acknowledge the American Cancer Society as the source of these estimates.

D. Summary of the Health Impact to the Exposed Population

Table 4-6 shows the estimated potential health effects from the Three Mile Island Nuclear Accident.* The central estimate is associated with the mean value of the collective dose (3300 person-rem) delivered to the population within 50 miles of the reactor. These estimates consider fatal cancers, non-fatal cancers and genetic ill-health to all future generations. The projected total number of fatal cancers is less than 1 (0.7). The additional number of non-fatal cancers is also less than 1 (0.7). The additional number of genetic effects for all generations is also less than 1 (0.7). The total number of health effects is approximately 2. The ranges given in Table 4-6 represent the extreme values considering both the range of the collective dose estimates and the range of risk estimates given in the 1972 BEIR report. All of these values are small compared to either the existing annual incidence of similar effects or the potential effects estimated to result from the natural background radiation. The total collective dose from natural background to the population within 50 miles of the Three Mile Island site is estimated to be about 270,000 person-rem per year ($0.125 \text{ rem per year} \times 2,164,000 \text{ persons}$). The potential health consequences of the natural radiation exposure are shown in Table 4-7. Comparing the total potential health impact of the accident with the estimated lifetime natural risk indicates that these effects, if they were to occur, would not be discernible. The uncertainties in the risk from low-level ionizing radiation would not alter this conclusion.

* An independent EPA assessment of the potential health effects corresponding to an earlier collective dose estimate of 2000 [1800] person-rem is presented in Appendix E.

Table 4-6. PROJECTED POTENTIAL HEALTH IMPACT OF THE THREE MILE ISLAND ACCIDENT
TO THE OFFSITE POPULATION WITHIN 50 MILES

Effect	Estimated Number who would normally develop effect	Potential Impact of Natural Background Radiation	Potential Lifetime Impact of Population Dose from the TMI Accident from March 28, 1979 through April 7, 1979	
			Range (a)	Central Estimate (b)
Fatal Cancers	325,000 (c)	1,700 - 9,000 (d)	0.15 - 2.4 (e)	0.7
Non-Fatal Cancers	216,000 (f)	1,700 - 9,000 (d,g)	0.15 - 2.4 (c,f)	0.7
Genetic Effects first generation	78,000 (h)	60 - 970 (i)	(0.01 - 0.64) (j)	-
all future generations	-		0.05 - 4.8 (k)	0.7
All Health Effects			0.4 - 10 (l)	2.0 (l)

Footnotes next page

Footnotes for Table 4-6

- (a) This represents the extreme range of health effects estimates considering both the range of the collective dose estimates and the range of the estimates of the risks of low-level ionizing radiation as estimated in the 1972 BEIR Report (3).
- (b) The central estimate is based upon taking the geometric mean (square root of the product) of the upper and lower bounds of the dose-to-health-risk conversion factors from Table 4-1 and multiplying this by the mean estimate of the population dose (3,300).
- (c) Based upon the American Cancer Society projection that the risk of cancer death is 0.15 ($0.15 \times 2,164,000 = 324,600$).
- (d) Based upon multiplying the annual rates in Table 4-7 by 70 years, the mean life span.
- (e) Based upon multiplying the lower range estimate of the population dose ($1,600 \text{ person-rem}$) by the lower range of the absolute radiation-induced cancer risk (90×10^{-6}) and the upper range estimate of the population dose (5,300) by upper range of the relative radiation-induced cancer risk (460×10^{-6}).
- (f) Based upon the difference between the American Cancer Society projection of the risk of getting cancer (0.25) and the risk of dying of cancer (0.15). The value given is the product of this difference ($0.25 - 0.15 = 0.10$) and the size of the population (2,164,000).
- (g) Based upon the assumption that there are twice as many cancers as there are cancer fatalities.
- (h) Based upon the natural annual incidence of genetic effects ($1,200 \text{ per year per } 10^6 \text{ population}$) from table 4-2 times an assumed reproductive period of 30 years.
- (i) Based upon multiplying the risk to the first generation from table 4-2 by an assumed reproductive period of 30 years and by the natural background dose rate of $270,500 \text{ person-rem per year}$.
- (j) Based upon multiplying the lower bound of first generation risk (7×10^{-6}) from Table 4-2 by the lower bound of the collective dose estimate ($1,600 \text{ person-rem}$) and multiplying the upper bound of the first generation risk (120×10^{-6}) from Table 4-2 by the upper bound of the collective dose estimate (5,300 person-rem). The first generation risk is included in the risk to all generations and therefore, should not be separately added into the total.
- (k) Based upon the procedure described in (j) but using the equilibrium risk bounds rather than the first generation risk.
- (l) This is done for the convenience of providing an estimate of the total potential health impact. Technically, the effects are not equivalent and cannot be added.

Table 4-7. PROJECTED ANNUAL IMPACT OF NATURAL BACKGROUND RADIATION EXPOSURE ON THE POPULATION RESIDING WITHIN 50 MILES OF THE THREE MILE ISLAND SITE

Effect	Estimated Existing Rate (per year)	Estimated Impact of Natural Background Radiation ^(a) (per year)	Estimated Percentage of Existing Rate Which Might be Caused by Natural Background Radiation
Fatal Cancers	3,900	Absolute risk 24-27 Relative risk 43-124 ^(b) Central Estimate 54	0.6-0.7% 1.1-3.2% 1.4%
Spontaneous Mutations (Genetic Effects)	2,600 ^(c)	10-245 Central Estimate 54 ^(b)	0.4-9.4% 2.1%

(a) Assumed to be 125 millirem (0.125 rem) per year to the 2,163,654 people projected (1980) to live within 50 miles. This gives a collective dose rate of 270,500 person-rem per year.

(b) The central estimate is obtained from the geometric mean of the risk estimates.

(c) 1,200 per year per 10^6 people (from Table 4-2) x 2.163 million people.

E. Potential Added Risk to Maximum Individual

The added lifetime risk of fatal cancer to the hypothetical maximum exposed individual from the accident is 2.0×10^{-5} (0.00002). This is based upon a presumed 100 mrem dose rather than the estimated values. This added risk (0.00002) is extremely small compared to the normal risk (0.15) to an individual of dying from cancer. It is also small (1.1 percent) compared to the potential lifetime fatal cancer risk that would be associated with natural background radiation using the same dose-to-health effect relationships as used for the accident impact.

F. Dose Rate Effects

The estimated maximum dose to a hypothetical individual (less than 100 mrem) is numerically approximately the same as the annual dose from natural background radiation to residents in the Harrisburg area (115-125 mrem/yr). There has been some concern that, because this dose was delivered in 1 week instead of 1 year, the biological effects of this accident would be greater than from natural background radiation. This presumes that radiation delivered at a higher rate is more dangerous than radiation delivered at lower rates (that there is a "dose-rate effect").

If there were such a "dose-rate effect," then the linear extrapolation of the number of effects observed at high doses and dose rates would overestimate

the risk per unit dose at low doses and low dose rates.* This is because the estimates of the health effects of low-level radiation are derived from observations made at much higher doses and dose-rates than experienced during the Three Mile Island Accident. The estimates of the health impact of the Three Mile Island accident have not included any additional factors to account for reductions due to a dose-rate effect. However, a factor of 3 was used by the 1972 BEIR Committee for genetic effects in their report [(3) p. 53, p. 61 (Note 4)].

* One estimate indicates that somatic effects (cancer) might be overestimated at low doses by a factor of 2 to 4. United Nations Scientific Committee on The Effects of Atomic Radiation, "Sources and Effects of Ionizing Radiation - 1977 Report", UNSCEAR, United Nations, N.Y., N.Y. (1977), Annex G, p. 366, paragraph 36.

5. OTHER SOURCES OF EXPOSUREA. Skin Doses and Health Risks from Beta and Gamma Radiation

The contribution of beta radiation from xenon-133 is not included in the doses calculated in Section 3 or the health effects computed in Section 4. Those sections dealt only with external exposure to gamma radiation. Considerations that must be taken into account in assessing the beta radiation contribution include:

- (1) The range of beta particles (electrons) in air is short. The maximum energy (0.35 MeV; average energy 0.12 MeV) of the beta particle from xenon-133, for example, has a maximum range in air of only 30 inches; therefore, an individual must be standing in or very near the xenon-133 plume to be exposed to beta radiation. The time that any individual would be so exposed is not known.
- (2) The beta radiation would be stopped by clothing.
- (3) At the present time, the sensitivity or response of the thermoluminescent dosimeters to beta irradiation is not known (it is assumed to be zero).*
- (4) The composition of the radioactive gases in the plume is not well known for most of the locations of interest.

* If there were a significant beta dose contribution to the dose recorded by the thermoluminescent dosimeters (TLDs), then the total body dose estimated from the TLD readings would have to be reduced to allow for this non-penetrating beta dose contribution. The beta skin dose is estimated in this section from a theoretical ratio of the beta dose to the gamma dose. If the "gamma" dose recorded by the TLDs is too high because it includes a beta dose contribution, then the beta skin dose estimated from the beta/gamma ratio would also be overestimated.

- (5) The principal health consequences of skin irradiation is skin cancer, which is not a predominant form of radiation-induced fatal cancer.

Although the beta radiation dose cannot be assessed by direct measurement during the accident, it can be estimated from the technical literature. The depth dose from xenon-133 electrons and beta particles decreases by a factor of 0.39 at a skin depth of 0.005 cm or 50 μm (an areal density in tissue of 0.005 g/cm^2). This depth is approximately the thickness of the non-living protective layer of skin.⁽¹⁻²⁾ The depth dose to internal organs from these beta particles is essentially zero. The beta particle skin dose rate at the 50 μm depth per unit of xenon-133 concentration in air, estimated from the depth-dose calculations of Berger⁽³⁾ is 4.7×10^8 mrem/yr per μCi xenon-133/ cm^3 compared to estimates of the gamma-ray total body dose of 1.90×10^8 mrem/yr per μCi xenon-133/ cm^3 ,⁽⁴⁾ or approximately a factor of 2.5 higher. The gamma-ray skin dose rate is 2.55×10^8 mrem/yr per μCi xenon-133/ cm^3 .⁽⁴⁾ Therefore, the combined beta and gamma "skin" dose rate is 7.25×10^8 mrem/yr per μCi xenon-133/ cm^3 , or a factor of 3.8 times the total body gamma-ray dose rate. Table 5-1

- (1)"Recommendations of the International Commission on Radiological Protection Adopted January 27, 1977," ICRP Publication 26. Pergamon Press, Oxford, England, paragraphs (63) and (64), p. 13.
- (2)National Council on Radiation Protection and Measurements, "Krypton-85 in the Atmosphere - Accumulation, Biological Significance, and Control Technology," NCRP Report No. 44, National Council on Radiation Protection and Measurements, Washington, D.C., July 1, 1979. Table 13, p. 30.
- (3)M.J. Berger, "Beta-ray dose in tissue-equivalent material immersed in a radioactive cloud," Health Physics, vol. 26 (1): 1-12 (January 1974).
- (4)D.C. Kocher, "Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities," U.S. Nuclear Regulatory Commission Contract Report NUREG/CR-0494 (Oak Ridge National Laboratory Report ORNL/NUREG/TM-283), April 1979.

provides the ratio of the beta plus gamma skin dose to the total body gamma dose for the principal radionuclides measured at offsite locations. For a total body gamma dose of approximately 100 mrem, the beta plus gamma dose from xenon-133 would be about 380 mrem (for a 50 mm skin depth), if the individual were exposed in the plume out-of-doors without benefit of shelter or clothing for the entire period.

The 1972 report of the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation⁽⁵⁾ does not provide numerical estimates of the risk at low doses for skin cancers. Skin cancers from radiation exposure reported in this report are associated with doses above 230,000 mrem in rats and above 450,000 mrem in humans. This latter dose is sufficient to cause visible effects on the skin and is more than a factor of 1,000 greater than the estimated total (beta and gamma) skin dose (380 mrem) to any exposed individual, even neglecting shielding by clothing or by being indoors.

The International Commission on Radiological Protection (ICRP) considers skin to be less likely to develop fatal cancers after irradiation than other tissues⁽¹⁾. They recommend a lifetime occupational dose limit for skin of 2,000,000 mrem⁽¹⁾ or 5,000 mrem per year for members of the general public [(1) p. 25]. It is also significant that the ICRP has considered the organ at the highest risk (critical organ) for exposure to radioactive noble gases, such as xenon-133, to be the total body and not the skin or lung⁽⁶⁾.

(5) Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR), "The Effects on Populations of Exposure to Low-Levels of Ionizing Radiation", National Academy of Sciences - National Research Council (1972) pp 132-135.

(6) "Recommendations of the International Commission on Radiological Protection. Report of Committee II on Permissible Dose for Internal Radiation," ICRP Publication 2, Pergamon Press, Oxford, England, 1959.

Table 5-1. RATIO OF SKIN DOSE TO TOTAL BODY GAMMA DOSE

	<u>Skin Dose (beta + gamma)</u> <u>Total Body Gamma Dose</u>
xenon-133	3.44
xenon-133m	6.45
xenon-135	2.85
iodine-131	1.70

Note: The skin dose is calculated to a depth of 70 μm , which corresponds to the average skin depth recommended by the International Commission on Radiological Protection. The values for xenon-133 in the text are calculated to the minimum depth of 50 μm . This difference is responsible for the difference between the factor of 3.8 for xenon-133 in the text and the factor of 3.44 given above.

The technical methodology used for this calculation is presented in Appendix C.

The ICRP⁽⁷⁾ has recommended a fatal skin cancer risk value of 10^{-6} per rem (1 per 10^6 person-rem). This is in good agreement with risk values of 0.5×10^{-6} /rem for fatal skin cancer obtained from data in the UNSCEAR Report⁽⁸⁾, as shown in Appendix D. Because the skin dose from xenon-133 is a factor of 3.44 higher than the total body dose, the ratio of the total fatal skin cancer risk from beta and gamma irradiation to the total risk of fatal cancers due to total body gamma irradiation would be:

$$\frac{3.44 \text{ skin dose}}{\text{total body dose}} \times 1.0 \times 10^{-6} \frac{\text{skin cancer deaths}}{\text{person-rem}} \times 3.3 \times 10^3 \text{ person-rem} = 0.01 \text{ fatal skin cancer.}$$

The ratio of fatal skin cancers to all skin cancers is approximately 0.06⁽⁸⁾. Assuming that this ratio (morbidity to mortality) is also true for radiation-induced skin cancers, the total number of skin cancers might be $0.01/0.06 = 0.2$ (0.17).

B. Inhalation Dose to the Lung

Radioactive noble gases irradiate the lung in two ways: (1) from penetrating gamma radiation from external sources and (2) by beta and gamma radiation emitted by radioactive gases inhaled into the lung. As is the case with

(7) International Commission on Radiological Protection, "Statement from the 1978 Stockholm Meeting of the International Commission on Radiological Protection," *Annals of the ICRP*, Volume 2, Number 1 (1978).

(8) United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), "Sources and Effects of Ionizing Radiation," 1977 Report, United Nations, N.Y. (1977), Annex G, Radiation Carcinogenesis in man. Section H. pp. 411-412.

skin irradiation by beta radiation, inhalation of radioactive gases can only occur when the individual is actually located within the radioactive plume. Irradiation of the lung by gamma radiation from radioactive gases outside of the body can occur even though the individual is not actually within the radioactive plume. This external dose contribution to the radiation dose to the lung is included in the previous evaluation of the total body dose. The potential health effects from lung irradiation due to external gamma irradiation are also included in the evaluation of the cancer risk from total body irradiation. In that evaluation, it was assumed that the lung dose from external gamma radiation was equal to the total body dose. More refined calculations show that, for xenon-133, the lung dose is about 25% less than the total body dose⁽⁴⁾.

The dose to the lung from inhaled radioactive xenons is only a small fraction (2.8 to 7.3 percent) of the dose to the total body from external gamma radiation as shown in Table 5-2. It is not possible to determine whether or not and how long anyone was actually breathing the radioactive xenon gas. The above fraction is the maximum contribution that would occur if all the total body dose resulted from immersion in the xenon gas.

The risk of a fatal lung cancer per unit dose is about one-fifth (0.22) of the total fatal cancer risk (see Appendix D). the total number of estimated fatal cancers would only be increased slightly. The magnitude of this increase (for xenon-133 inhalation) would be about a 1 percent increase

Table 5-2. RELATIVE CONTRIBUTIONS OF OTHER NOBLE-GAS DOSES COMPARED TO THE GAMMA TOTAL BODY DOSE FROM RADIOACTIVE XENON GASES

Radionuclide	Beta Skin Dose (surface)	Fraction of Gamma Whole Body Dose					Internal Whole Body Dose from Gases Dissolved in Body Fluids in Equilibrium	
		Beta Skin Dose to 1000 μ m (1 mm)	Lung Dose From Inhalation		Total	Beta		Gamma Total
			Beta	Gamma				
Xenon-133	2.71	0.00016	0.039	0.017	0.057	0.0045	0.002	0.0065
Xenon-133m	-	-	-	0.073	0.073	-	0.009	0.009
Xenon-135	1.83	0.165	0.027	0.0022	0.029	0.003	0.001	0.004

Derived from J.L. Russell and F.L. Galpin, "Comparison of Techniques for Calculating Doses to the Whole Body and to the Lungs from Radioactive Noble Gases," in Radiation Protection Standards: Quo Vadis (W.P. Howell and J.P. Corley, compilers), Proceedings of the Sixth Annual Health Physics Society Topical Symposium, Richland, Washington, November 1971.

in the total number of fatal cancers ($0.0566 \times 0.22 = 0.012$). This contribution is small compared to the other uncertainties in the health impact analysis, especially considering the assumption that all individuals were totally immersed in the cloud. Small quantities of noble gases may also be dissolved in body fluid (blood) and irradiate the body internally. However, the dose contribution from this dose contribution is less than 1 percent of the total body dose as shown in Table 5-2.

C. Airborne Radioiodine Concentrations and Associated Inhalation Doses

Metropolitan Edison has, as part of its routine radiological environmental monitoring program, air particulate and radioiodine samplers in the TMI plant vicinity. The NRC Office of Inspection and Enforcement also monitored the air in the vicinity of TMI for radionuclides including radioiodine. To obtain an estimate of thyroid dose, it was conservatively assumed that a child was present at the Observation Center ("Trailer City") from the time the accident began until April 5, 1979. The dose to a child's thyroid was calculated using the methods and parameters given in reference⁽⁹⁾.

At two points during this time period, Metropolitan Edison measured a higher concentration of radioiodine at an offsite location other than the Observation Center. It was conservatively assumed that these concentrations existed at

(9)U.S. Nuclear Regulatory Commission, Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Rev. 1, October 1977.

the Observation Center for dose calculational purposes. Only iodine-131 was used to calculate the dose since iodine-133 data were not available at the time of the calculation. The data and doses are summarized below.

<u>Location</u> (0.5 mi SSE)	<u>Time</u> <u>Period</u>	<u>Iodine-131</u> <u>Concentration</u> (pCi/m ³)	<u>Child Thyroid</u> <u>Dose</u> (mrem)
Observation Center (Met. Ed.)	3/21-28/79	0.30	0.094
	3/29-31/79	20.	1.8
	3/31-4/3/79	1.4	0.19
Trailer City (NRC)	4/1 - 4/79	<0.90	0.12
	4/5/79	1.6	<u>0.071</u>
	TOTAL		2.3

D. Thyroid Dose from Ingestion of Iodine-131 in Milk

A large number of milk samples were collected during the period March 28 through April 4, 1979 from farms and dairies throughout the area surrounding the accident site by the Pennsylvania Department of Environmental Resources, the Food and Drug Administration and Metropolitan Edison. Aliquots of several of these were also analyzed by the Environmental Protection Agency. A summary of the reported results is given below:

<u>Milk Samples (March 24 to April 4)</u>	<u>Pennsylvania</u>	<u>FDA</u>	<u>EPA</u>	<u>Metropolitan</u> <u>Edison</u>
Number of analyses performed	133	106	4	21
Number of positive results	7	41	2	18
Average value of positive results (pCi/liter)	15	20	17	7
Range of positive results (pCi/liter)	11-20	13-36	10-24	1-41
Average minimum detectable concentration (pCi/liter)	<20	<10	<10	<1

Additional milk samples collected between April 4 and April 17 were below detectable levels. Eight out of 80 samples were positive between April 18-20 with a range of 15 to 36 pCi/liter. A summary of all Food and Drug Administration samples collected from March 30 to April 29 is given in Table 5-3.

The highest concentration of iodine-131 observed in any sample of milk was 41 pCi/liter (in goat's milk). This was reported by the Metropolitan Edison Company. The total dose to the thyroid of an infant who drank 1 liter of milk per day having a peak radioiodine concentration of 41 pCi/liter would be 5 mrem. This is derived from the protective action guide that relates peak concentration of radioiodine in milk of 12,000 pCi/liter to a 1.5 rem dose to the thyroid⁽¹⁰⁾. Under these conditions, an adult drinking the same milk would receive a lifetime thyroid dose of 0.5 mrem, based on a thyroid weight 10 times greater than the infant (20 g versus 2 g).

Cesium-137 was also detected in some of the milk samples at levels generally less than 25 pCi/liter. The maximum reported level was 37 pCi/liter. The presence of this radionuclide is probably due to fallout produced from previous atmospheric testing. Review of results from pasteurized milk samples analyzed for the previous year from Pittsburgh and Philadelphia by EPA shows the presence of cesium-137 for several samples during that period. The levels were less than 12 pCi/liter.

(10) Food and Drug Administration, U.S. Department of Health Education, and Welfare, "Accidental Radioactive Contamination of Human and Animal Feeds and Potassium Iodide as a Thyroid-Blocking Agent in a Radiation Emergency," FEDERAL REGISTER, December 15, 1978 (43 FR 58790).

The Pittsburgh and Philadelphia samples represent milk samples composited from more than one source; the samples collected during the Three Mile Island incident represent specific farms and dairies which exhibit greater variability than composite samples.

Table 5-3. IODINE-131 LEVELS IN MILK (pCi/liter)
(FOOD AND DRUG ADMINISTRATION MEASUREMENTS)

<u>Date (1979)</u>	<u>Number of Samples</u>	<u>Number of Positive Samples*</u>	<u>Min.</u>	<u>Max.</u>	<u>Range</u>	<u>Positive Sample Average</u>
03-31	10	4	18	30	12	25
04-01	18	14	13	36	23	20
04-02	24	12	14	30	16	18
04-03	24	5	16	25	9	20
04-04	24	6	13	22	9	18
04-05	26					
04-06	26					
04-07	28					
04-08	19					
04-09	26					
04-10	20					
04-11	23					
04-12	23					
04-13	25					
04-14	21					
04-15	18					
04-16	30					
04-17	26					
04-18	26	4	15	24	9	19
04-19	31	3	19	29	10	22
04-20	23	1	36	36	0	36
04-21	17					
04-22	18					
04-23	23					
04-24	27					
04-25	28					
04-26	34					
04-27	30					
04-28	28					
04-29	26					

*Minimum detectable concentration is 10 pCi/liter.

APPENDIX A

Department of Energy (DOE) Estimate of External Whole Body Radiation Exposure to the Population Around the Three Mile Island (TMI) Nuclear Power Station.

A collective dose estimate in the vicinity of the Three Mile Island Nuclear Power Station for the period March 28 through April 10, 1979 has been prepared. It is based principally upon the average of measurements of the radiation exposure rates in the plume made during helicopter flights, supplemented by plant meteorological information, including projections of the plume location.

Subsequent to an earlier estimate of the collective dose of 1700 person-rem, TLD data obtained by Metropolitan Edison (as supplied by NRC) made it apparent that a substantial portion of the exposure must have occurred during the first day after the incident, prior to the time that regular helicopter measurements were initiated. A projection of the probable exposure rate in the plume during this interval has been made from the many measurements obtained during the period March 30 through April 9. The principal radionuclide in the plume during this period was xenon-133. The concentration of xenon-133 was estimated from the measured exposure rate and then extrapolated back for the period March 28 through March 29. An exposure rate for this early period was then projected by considering the exposure attributable to the shorter-lived radionuclides which could have

been present (assuming that there was an equilibrium mixture of fission product gases present at the time of the incident) in the plume at that time.

Ground level exposure rates were assigned to each sector for hourly intervals during the first 48 hours; average exposure rates were assigned to each sector for each daily interval thereafter. An exponentially decreasing relationship for plume exposure rate with distance was observed using the data obtained with the helicopter. This was compared to curves with $1/R$, $1/R^{1.5}$ and $1/R^2$ behavior. The exponential relationship leads to a smaller collective dose estimate than do these other curves. The available TLD data for stations which were at varying distances in a given sector also suggest a rapid decrease of exposure with distance, consistent with $1/R^2$ or the observed decreasing exponential relationship.

The DOE assessment of the external whole body collective dose to the population around the Three Mile Island (TMI) nuclear power station was based on over 200 aerial radiation measurements taken in the center of the plume of airborne discharges. These measurements were taken from helicopters, using Geiger-Mueller survey instruments with probes having open, low density windows, to enable measurements of the gamma radiation exposure, plus any contribution from high energy beta radiation. The radiation survey probe was held external to the helicopter(s) to minimize attenuation of any radiation. The measurements were made at various distances out to 20 miles from the TMI plant. At various distances, the helicopter was maneuvered to find the maximum radiation exposure rate, and this maximum value was used in the calculation of collective dose within that particular sector.

The geographical region within a 50-mile radius of the plant was subdivided into sectors, and the collective dose within each was calculated based on the measured radiation exposure rates, records of the helicopter location for each measurement, the path of the plume, the duration of its passage, predictions of its course and speed from current meteorological data, and population figures for each segment projected for the 1980 census. A factor of 2 reduction of the measured exposure rate was selected by DOE to account for the aircraft being within the plume, whereas an exposed person would be located on the ground surface. This estimate would apply only if all members of the population were out-of-doors during the entire duration of passage of the plume. The exposure rates at distances beyond 10 miles from the plant were extrapolated from a curve drawn through the exposure measurements as a function of distance within 10 miles of the plant, since exposure rates beyond 10 miles were generally too low to measure. Figures A-1 and A-2 show accumulated exposure profiles for the 0-2 mile and the 0-10 mile radii, respectively, for the average exposure to individuals on the ground remaining outdoors during the entire period of March 28 to April 3.

The collective dose to external radiation within the 50-mile radius using the above data and assumptions was approximately 2000 person-rem (+ 500 or - 1,000 person-rem) through April 3, 1979. DOE estimates that the increase in collective dose for the period April 3 through April 10, 1979 would be a total of approximately 50 person-rem. Table A-1 provides the contributions to the collective dose for distances out to 50 miles. The maximum estimated exposure would be 200 ± 50 (mR) to an individual located about one mile north-northwest

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of the station continuously for the entire week following the TMI occurrence (see Figure A-1). This location corresponds to Hill Island. There is also a populated region within the 100 mR isoexposure curve that extends up to 3.5 miles north of Three Mile Island and slightly inland on the eastern bank of the Susquehanna River. Individuals in this region located outdoors for the entire week could also have received about 100 mrem.

This assessment overestimates the actual exposure because of the following:

- (a) No reduction of the radiation exposure was made for shielding of individuals during periods they were inside.
- (b) The maximum doses measured in the plume were applied to the entire sector affected.
- (c) An expected significant over-response of the Geiger-Mueller survey instrument. DOE has supplied the Ad Hoc Group with preliminary calibration curves for the Geiger-Mueller survey instrument used in the helicopter which show a significant over-response for the xenon-133 gamma-ray energy (81 keV) of at least a factor of 3 as compared to the energy at which the instrument was calibrated (660 keV, Cs-137). The exposures and collective dose presented in Appendix A have not been adjusted for this calibration.

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While the data presented in Appendix A are useful estimates of the relative exposure patterns during the period March 28 to April 3, the Ad Hoc Group cannot draw quantitative conclusions on the exposure levels from the present data, until a complete calibration of the Geiger-Mueller survey instrument is performed.

Table A-1. Collective Dose to Population 0-50 miles from
Three Mile Island Nuclear Station March 28 through
April 3, 1979 (Department of Energy Aerial Radiation
Survey)

<u>Radius (Mile)</u>	<u>Collective Dose Person-Rem**</u>	<u>Total Population*</u>	<u>Average Individual Exposure (mR)</u>
0-1	51.2	658	77.8
1-2	66.7	2,017	33.1
2-3	482.2	7,579	63.3
3-4	352.2	9,676	36.4
4-5	76.4	8,891	8.6
5-10	810.0	137,474	5.9
10-20	137.4	577,288	0.24
20-30	27.3	433,001	0.063
30-40	1.9	273,857	0.0069
40-50	0.3	713,210	0.00048
TOTAL	2,005.7 (2,000)	2,165,651	0.92 (0.9)

* Estimated population for 1980, by 22.50 sectors and distance obtained from FSAR for Three Mile Island II.

**Based on projected ground level exposure rates under the plume of radioactive gas, which were assumed to have been one-half of those found during the helicopter flights within it.

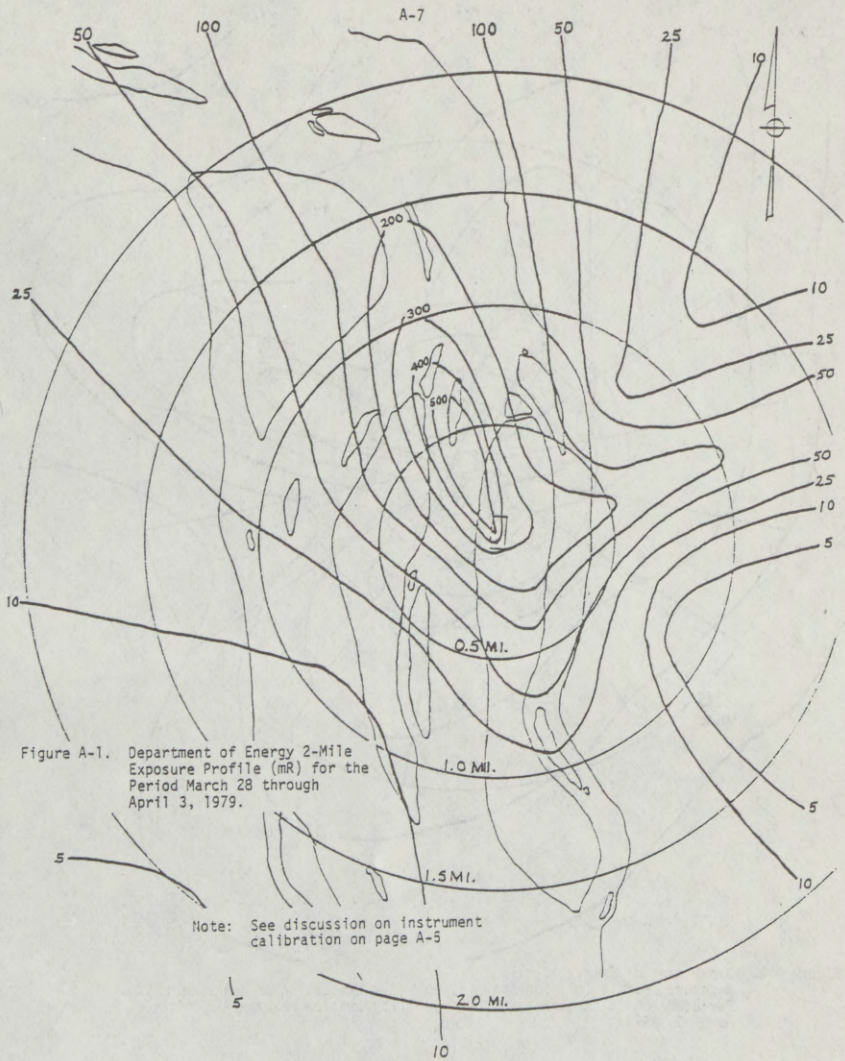


Figure A-1. Department of Energy 2-Mile Exposure Profile (mR) for the Period March 28 through April 3, 1979.

Note: See discussion on instrument calibration on page A-5

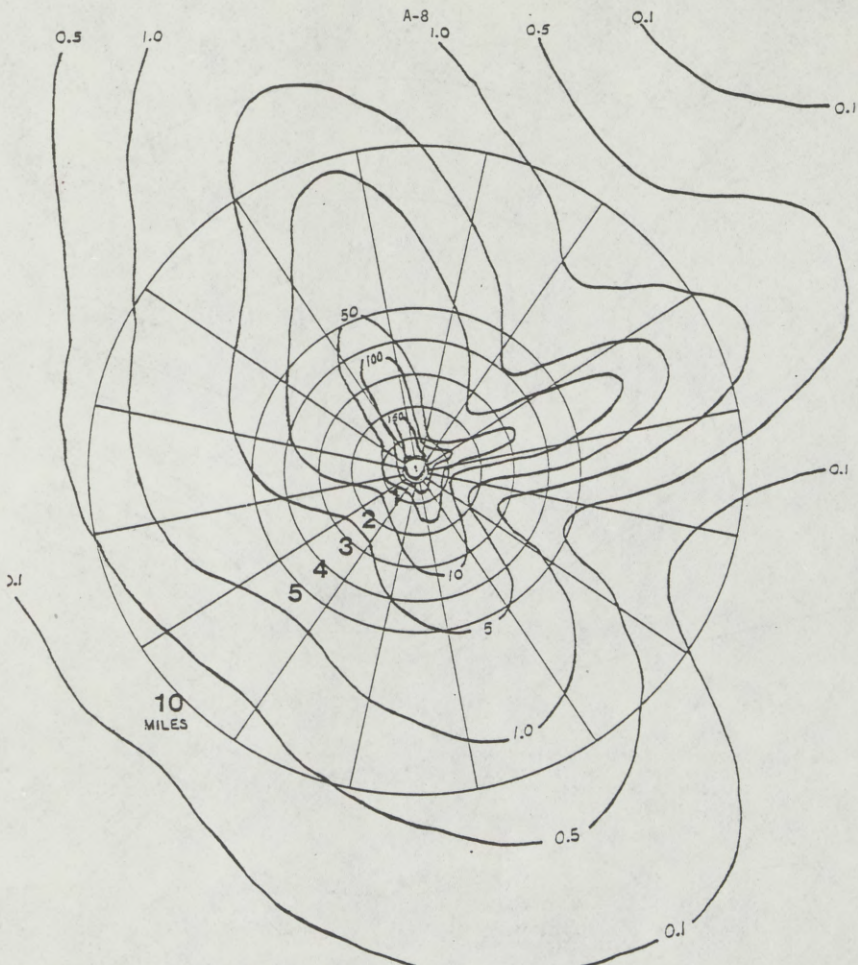


Figure A-2. Department of Energy 10-Mile Exposure Profile (mR) for the Period March 28 through April 3, 1979.

Note: See discussion on instrument calibration on page A-5

APPENDIX B

Department of Energy (DOE) Environmental Deposition Measurements in the Area Surrounding the Three Mile Island Nuclear Power Station.

Following the accident at the Three Mile Island Nuclear Station, the DOE established the following environmental monitoring activities starting as of 4:00 p.m. on March 28, at the request of the Commonwealth of Pennsylvania, in accordance with the DOE Radiological Emergency Assistance Program:

- (a) Helicopter surveys to locate and measure gamma and beta radiation in the airborne discharges.
- (b) Ground vehicle radiation surveys in the path of airborne discharges, including some in-situ radionuclide identification by gamma spectrum analysis.
- (c) Collection of environmental soil, grass, surface water, and air samples in the path taken by airborne discharges.
- (d) Gamma spectrum analyses of these environmental samples to detect, identify and quantify any radionuclides present.

- (e) Evaluation and interpretation of survey and analytical data to estimate population exposure.

DOE established three field laboratories for analyzing samples of soil, surface water, grass, and air for gamma-emitting radionuclides. These laboratories were located at the Capitol City Airport. Each utilized a sensitive, high efficiency lithium drifted germanium detector and multi-channel gamma spectrum analyzer. One set of each was brought in and manned by radiochemists from the Brookhaven National Laboratory, Bettis Atomic Power Laboratory, and Knolls Atomic Power Laboratory. Environmental samples were collected by crews from these laboratories, with specific attention to locations near the plant, and to areas over which the plume of discharges from the plant had persisted, and was known to have touched down. Attention was also given to assuring that the sampling method would establish if any radioactivity from the plume had been deposited on the ground. The soil, grass and water specimens were skimmed from the largest surface areas practicable to fill Marinelli geometry containers in order to optimize the sensitivity of the analyses, and thereby increase the likelihood of detection. The air samples were taken by silver-treated silica gel samplers flown into the plume to ensure capture of any non-ionic radioiodine present. Charcoal filters were used in ground sampling larger volumes of air in the plume.

The total number of samples collected and analyzed starting on March 29 has been in excess of 800. The detection sensitivity achieved (minimum

detectable activity (MDA)) for iodine-131 was less than one nCi/m^2 for soil and vegetation, 4×10^{-7} $\mu\text{Ci/ml}$ for water, and 3×10^{-12} $\mu\text{Ci/ml}$ for air. Even lower MDA's were achieved on many samples by longer counting periods, by further idealizing of geometry, and when background radiation was lower. These measures enabled sensitivities as low as 0.5 nCi/m^2 for soil, 0.02 nCi/m^2 for grass and 1×10^{-8} $\mu\text{Ci/ml}$ for water. The gamma spectrum measured for each sample was examined in its entirety to detect any photopeaks. The detection sensitivity of this equipment was sufficient to reveal any uranium in the air in the range of allowable occupational concentrations, if any had been present.

The analyses of these environmental samples revealed the presence of iodine-131 in about 3 percent of all samples collected, at barely over the detection limit, when the greater sensitivities were achieved. Table B-1 summarizes these analytical results. In a few soil samples, cesium-137 radioactivity was detected as expected at levels normally found due to world-wide fallout from previous atmospheric testing.

The silver-treated silica gel air samplers which had been flown through the plume, and the charcoal air sample filters used for the high volume ground level samples in the path of the plume, were returned to Brookhaven National Laboratory for further analysis to detect the presence of beta, or alpha emitters by other techniques. However, such species are considered entirely unlikely since the properties of the chemical species in which such radio-nuclides exist are known to promote retention within the reactor fuel and/or

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Table B-1
SUMMARY OF ANALYTICAL RESULTS FOR IODINE-131 IN SAMPLES COLLECTED
AND ANALYZED BY DOE

	Sample Type	No. of Samples Collected	No. of Samples less than MDA*	No. of Samples greater than MDA*	Range of Positive Values
Period from	Stagnant Surface Water	122	122	0	-
3/28-	Rain Water	0	0	0	-
4/6	Vegetation	236	234	2	0.1-0.3 nCi/m ²
	Soil	225	224	1	0.3 nCi/m ²
	Air	19	11	8	7 x 10 ⁻¹² to 3 x 10 ⁻¹¹ μ Ci/cc
Period from	Stagnant Surface Water	60	60	0	-
4/7 -	Rain Water	17	17	0	-
4/16	Vegetation	78	69	9	0.05 to 0.7 nCi/m ²
	Soil	27	27	0	-
	Air	23	11	12	6 x 10 ⁻¹² to 9 x 10 ⁻¹¹ μ Ci/cc

*Minimum detectable activity (concentration)

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coolant. Containment air samples analyzed on March 30 did not reveal the presence of any such nuclides.

Direct in-situ measurements of radioactivity on the ground were also made by the DOE Environmental Monitoring Laboratory (EML) using two large volume, pressurized ionization chambers, and a gamma spectrometer using a high efficiency Lithium drifted Germanium detector. These systems enable detection of variations in radiation levels from natural or man-made radioactivity of a fraction of a microrentgen per hour. These vehicle mounted systems were deliberately moved to locations where those few environmental grass samples were taken which, when analyzed in the laboratory indicated iodine-131 at concentrations just above the MDA. These EML measurements confirmed both the concentrations measured in the laboratory, and the identification of the specific radionuclide iodine-131. Other measurements by the EML systems also confirmed the generally negative results found in the laboratory analyses of the environmental soil, water and grass samples.

The date, time and specific location of all of the environmental samples, as well as the results of the laboratory analyses are recorded in the Technical Work Record books of the DOE team.

The results of these analyses of the environmental samples, as well as gamma spectrum analyses of the plume made by the EML mobile system, support the conclusion that the predominant radionuclide in the airborne discharges

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was the inert gas xenon-133, with a small amount of iodine-131 also present. This conclusion is supported by information received from the NRC licensee (Metropolitan Edison) concerning the measured composition of stack discharges, and the analyses of the airborne radioactive material in the containment.

APPENDIX C

EVALUATION OF SKIN DOSE FACTORS

Radionuclide	Total	Dose Rate at Body Surface (a,b)		Dose Factor (mrem/yr per $\mu\text{Ci/cc}$) Electron		Effective Skin Dose (70 μm)		Total (g)
		Photon	Electron	Depth Dose Factor (c)		Electron (e)	Photon (a,f)	
				50 μm (d)	70 μm (d)			
Xenon-133	1.90E08	3.86E08	1.22E09	0.392	0.327	3.99E08	2.55E08	6.54E08
Xenon-133m	1.69E08	1.66E08	1.28E09	0.753	0.667	8.54E08	2.38E08	1.09E09
Xenon-135	1.41E09	2.15E09	2.83E09	0.869	0.823	2.33E09	1.69E09	4.02E09
Iodine-131	2.12E09	3.31E09	1.71E09	0.750	0.692	1.18E09	2.55E09	3.73E09

Note: 3.86×10^8 . Divide by 24 hrs/day $\times 365.24$ days/yr = 8,766 hrs/yr to get hourly dose rates in mrem/hr per $\mu\text{Ci/cc}$.

- (a) Values from D. C. Kocher, "Dose-Rate Conversion Factors for External Exposure to Photon and Electron Radiation from Radionuclides Occurring from Routine Releases from Nuclear Fuel Cycle Facilities" Oak Ridge National Laboratory Report (ORNL/NUREG/TM-283) prepared for the Nuclear Regulatory Commission, NRC Report NUREG/CR-0494 (April 1979)
- (b) Kocher, Appendix C, p. 94.
- (c) Ratio of depth dose at $z = \text{thickness} \times 1 \text{ g/cm}^3 \times 10^{-4} \text{ cm}/\mu\text{m}$ to $z = 0.000 \text{ g/cm}^2$ from M. J. Berger, "Beta-Ray Dose in Tissue Equivalent Material Immersed in a Radioactive Cloud," Health Physics, 26(1): pp. 1-12 (January 1974). Tables 6 and 7 using values with leakage correction.
- (d) International Commission on Radiological Protection (ICRP Publication No. 26, "Recommendations of the International Commission on Radiological Protection adopted January 17, 1977," Pergamon Press, Oxford (1977) paragraph (64) p. 13. The 50 μm value is recommended as the average thickness of the outer "protective" layer of the skin and 70 μm is recommended as the average depth to be used for evaluating skin dose.
- (e) Product of body surface electron dose factor and depth dose factor for 70 μm thickness.
- (f) From Kocher Appendix C p. 106.
- (g) Sum of two preceding values.

APPENDIX D

Estimated Risk of Specific Radiation Induced Cancers
Based on the UNSCEAR 1977 (see Reference (8), page 70), Annex G

Cancer Type	Population	Estimated Absolute Risk Cases Per 10 ⁶ Person-rem	Estimated General Population Mortality Risk from 1977 UNSCEAR Report Deaths per 10 ⁶ Person-rem
Breast (pp 385-394)	Adolescent Women Women (all ages)	440 (36-1500) 180 (140-230)	30 (20-35) (a)
Lung (pp 394-399)	Adult Males	50 (20-150)	50 (20-150) (b)
Skin (pp 411-412)	Adults	5 (2-10)	0.5 (0.2-1.0) (c)
Thyroid (pp 377-385)		100 (50-150)	10 (5-15) (d)
Leukemia (pp 370-377)	Adults	25 (15-30)	25 (15-30) (e)
Bone Cancer (pp 399-401)	Adults	3 (2-5)	3 (2-5) (e)
Brain Cancer (p 406)	Fetus child	50 (neg-145) 20 (9-39)	20 (9-39) (e)
Salivary Glands (pp 406-407)	child	10 (5-20)	5 (3-10) (f)
Sinus Mucosa		3 (2-5)	3 (2-5) (e)
Digestive Organs		-	12 (10-15) (e)
Estimated Total Risk (pp. 413-414)		450 (400-500) (f)	230 (200-250) (f)

(a) Assumes 30% mortality and 50% of the general population is female
 (b) Assumes 100% mortality and equal risk for women
 (c) Assumes 10% mortality (UNSCEAR gives this value as 6%)
 (d) Assumes 10% mortality
 (e) Assumes 100% mortality
 (f) Assumes 50% mortality

APPENDIX E

Letter from William H. Ellett, EPA to Harold T. Peterson, NRC dated April 16, 1979 Regarding EPA Risk Estimates Associated with TMI Accident.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 16 1979

Mr. Harold T. Peterson, Jr.
Health Physicist
Nuclear Regulatory Commission
5650 Nicholson Lane, Room 209
Rockville, MD 20852

Dear Mr. Peterson:

As agreed in our phone discussion April 12, 1979, I am forwarding copies of the risk estimates made by BAB during the Three Mile Island Nuclear Emergency. In using the risk estimates, please remember:

1. Somatic and genetic risk coefficients are derived from the BEIR Report, p. 171.
2. The somatic risk estimates were derived from a modified version of the CAIRD computer code. The modification makes it possible to perform individual analysis of each cohort in an exposed population. Each cohort is followed until its extinction and all deaths from radiation exposure enumerated. A weighted sum of the deaths from each of these analyses is then calculated. The weights are determined by the age distribution of the exposed population at the time of exposure. In this particular analysis, each individual in every cohort was assumed to receive a single one rem dose. The total exposed population was assumed to be 100,000 persons and distributed in age like the 1970 U.S. population. Numbers therefore will resemble BEIR estimates but not be identical.
3. Estimates of thyroid risk were developed outside of BEIR estimates. The estimates are for ^{131}I specifically and are about a factor of 10 lower than would be estimated for x-ray or some other (short half life) radioiodines.

We did not attempt to estimate risk to other specific organs since there were no apparent organ exposures as such. Likewise, we did not attempt to estimate skin cancer risk because the variance of

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the risk estimate is so great that no realistic estimate can be made at this time. In addition, the uncertainty in incidence as compared to the risk of fatal skin cancer further complicates the picture.

Sincerely yours,



William H. Ellett, Ph.D.
Chief, Bioeffects Analysis Branch
Criteria and Standards Division (ANR-460)
Office of Radiation Programs

2 Enclosures

April 2, 1979

Risk Associated with the PAGs

In terms of the average adult individual, a 1 rem whole body exposure carries with it a lifetime cancer risk of between 10 to 20 fatal cancers per 100,000 adults exposed, and there is an equivalent level of risk of a nonfatal cancer and of an associated serious genetic effect. For children less than ten years of age, the risk of this exposure is highly uncertain ranging from 10 to 200 fatal cancers per 100,000 children exposed. A 1 rem thyroid exposure due to radioiodine has a corresponding potential thyroid cancer risk of about 2 cases per 100,000 for children and about 1 case per 100,000 for adults. Perhaps 10% to 20% of these thyroid cancers would be fatal. Based on 1970 U.S. population statistics, about 20% of the general population is less than ten years of age.

For internal organs other than thyroid, 1 rem of organ exposure has a potential lifetime cancer risk of about 4 per 100,000. The mortality rate of these cancers varies as a function of the specific organ; for lung and bone marrow the mortality is assumed to be 100 per cent; for different organs it may be less.

These cancer risks for members of the general population represent the chance that a cancer will occur in the individual's lifetime. If the cancer is fatal, the individual lifespan is shortened by an amount ranging from 14 to 30 years depending on the risk model assumed.

Prepared by:

W. H. Ellett and N. S. Nelson
Criteria & Standards Division
Office of Radiation Programs
U.S. Environmental Protection Agency

EPA Risk Estimates for Three Mile Island--April 3, 1979

These risk estimates are based on the linear non-threshold assumption that any dose of ionizing radiation increases the probability of cancer induction. The ages and sex distribution of the population at risk are assumed to be similar to those in the 1970 U.S. population.

As of April 3, 1979, whole body doses to the Pennsylvania population residing in the Three Mile Island area have been estimated as no more than 2,000 person-rem. Using the risk coefficients developed by the 1972 BEIR Committee and published by EPA, the estimated lifetime risk of fatal cancer among exposed adults ranges from 0.16 to 0.32 depending on the specifics of the risk model employed. For children less than ten years of age the risk estimates are more uncertain. Assuming 20 percent of the exposed population is this young, then lifetime risk of fatal cancer ranges from 0.04 to 0.8. In addition to the estimated risk of fatal cancer discussed above, the estimated incidence of non-fatal cancers would also be increased by a like amount.

Estimates of risk due to possible genetic effects vary widely and cannot be estimated with any certainty. Genetic risks, based on the 1972 BEIR Committee Report, average about 20 effects per 10^5 person-rem with a range of 4 to 100 effects per 10^5 person-rem. About 20% of the effects would be expected to occur in the first generation post-exposure.

The 2000 person-rem exposure in the Pennsylvania population might thus lead to 0.4 genetic effects (range 0.08 to 2.0) with 0.08 effects (range 0.025 to 0.4) in the first generation post-exposure.

Prepared by:

W. H. Ellett and N. S. Nelson
Criteria & Standards Division
Office of Radiation Programs
U. S. Environmental Protection Agency

Mr. AMBRO. Mr. Bretthauer, you may proceed. Do you have a prepared statement?

STATEMENT OF ERICH W. BRETTHAUER, DIRECTOR, MONITORING OPERATIONS DIVISION, ENVIRONMENTAL MONITORING & SUPPORT LABORATORY, LAS VEGAS, NEV.

Mr. BRETTHAUER. I do have a prepared statement; you should have copies of it.

Mr. AMBRO. We are getting them now.

While we are passing them out, I will say to you, if you would like to present it, that would be perfectly all right, and we can make the entire statement a part of the record.

Mr. BRETTHAUER. I would propose to do exactly that.

EPA has been involved in monitoring radiation since the formation of the agency in December of 1970. I believe I will go on and read my statement.

[The prepared statement was read as follows:]

STATEMENT OF ERICH W. BRETTHAUER, DIRECTOR, MONITORING OPERATIONS DIVISION, ENVIRONMENTAL MONITORING & SUPPORT LABORATORIES, LAS VEGAS, NEV.

EPA has been involved in the monitoring of radiation since formation of the Agency in December 1970. One of the organizational components which became part of EPA was a Public Health Service Laboratory in Las Vegas, Nevada. This Laboratory has been responsible for monitoring environmental radiation for the U.S. nuclear testing program since 1954. This monitoring program documents exposure to humans and animals via air, water and food from radioactive debris originating from nuclear testing in Nevada, as well as the six other sites in the U.S. where nuclear testing has been conducted. This monitoring program is currently staffed with 52 scientists and technicians. The team has responded to many ventings of radioactive debris into the environment at the Nevada Test Site and is well trained and equipped to perform emergency as well as long-term environmental monitoring.

Deployment of EPA environmental monitoring stations around Three Mile Island was initiated on 3/31/79. Eleven monitoring stations were operational 4/1/79. Fourteen additional stations became operational on 4/2/79 and by 4/3/79 a total of 31 monitoring stations were operational. This network consisted of twelve stations on a three mile radius from the reactor with 30 degree spacing, ten stations on a six to seven mile radius spaced as nearly as possible between the inner ring stations, and nine stations at the following cities and towns beyond seven miles from the reactor: Bellaire, Manchester, Carlisle, Hummelstown, Campbelltown, York, Hershey, Lebanon, and Lancaster.

Each station contained an air sampler of approximately 10 c.f.m. capacity (400 cubic meters per day) with a glass fiber prefilter for collecting particulate material and a charcoal cartridge intended primarily for collecting radioactive gases i.e. the radioisotope iodine-131 (^{131}I). The charcoal cartridges collect radioactive noble gases to some extent, but not quantitatively. Samples were collected on a daily basis and analyzed by gamma spectroscopy using a GeLi detector. These analyses were performed at a temporary EPA laboratory in Harrisburg. A few of the samples were shipped by air express to Las Vegas for analysis. The minimum detectable activity for ^{131}I in these samples was 0.15 picocurie per cubic meter (pCi/m^3) (a picocurie is a millionth of a millionth of a curie which is a basic term of disintegration rate of radioactive material). The minimum detectability for ^{131}I was lowered to 0.04 pCi/m^3 on 5/7/79. All filters, were counted for gross alpha and gross beta activity at the Las Vegas Laboratory.

Gamma rate recorders and thermo-luminescent dosimeters (TLDs) were also installed at all monitoring stations. TLDs were also issued to approximately fifty residents living near the monitoring stations. The gamma rate recorders measure gamma radiation as a function of time while the thermoluminescent

dosimeters measure cumulative gamma radiation. The TLDs are relatively insensitive to beta radiation. An EPA twin engine aircraft with instrumentation to monitor radiation was available on site for the period 3/31/79 to 4/10/79 to perform airborne sample collection and tracking.

As it was determined on 4/1/79 that the principal releases from the reactor were noble gases, principally ^{133}Xe , intricate noble gas sampling gear and instrumentation to measure ^{133}Xe and ^{85}Kr were air freighted to Harrisburg from Las Vegas. Deployment of noble gas sampling stations began on 4/3/79. One of these samplers was placed in the plume on 4/4/79 and again on 4/5/79 and a 1-2 hour sample taken for analysis. Three continuous noble gas monitoring stations were operational on 4/4/79. These stations were at a three to six mile radius from the reactor at approximately 120 degree spacing.

As there had been no provisions to measure tritium emanations from the reactor, a mobile tritium sampler was positioned in the radioactive plume on 4/4/79, and an air sample collected for tritium measurement. Nine additional samples for atmospheric tritium measurements were taken in the plume at later dates.

EPA began sampling of the Susquehanna River on 3/30. Surface grab samples were collected at the Conowingo Dam and at the Columbia Bridge on the Susquehanna twice daily. The River sampling program was refined on 4/1/79 to complement monitoring by the Commonwealth of Pennsylvania. Based upon physical dynamics of the Susquehanna River and the proximity to drinking water intakes at Wrightsville and Columbia, three additional stations were established on 4/2/79 at the Columbia Bridge location and two additional stations at the Conowingo Dam location. Priority samples were screened at the EPA Laboratory in Harrisburg followed by high sensitivity analysis at the EPA Laboratory in Las Vegas.

EPA began sampling in the Chesapeake Bay on 3/30. Four locations on the Bay were sampled twice daily and the samples analyzed as were the Susquehanna River samples. Sampling on the Chesapeake Bay was discontinued 4/7/79.

In conjunction with the Commonwealth of Pennsylvania, a program for sampling drinking water was developed. Over 100 sources of drinking water were identified within twenty miles of TMI. Of these, 21 were surface water supplies and were, therefore, designated as priority sampling sites. Samples from these priority sources were gamma scanned for gross contamination at the EPA Laboratory in Harrisburg, where the detection limit for ^{131}I was 70 pCi/l. This detection limit was too high to comply with the maximum concentration level for continuous exposure of ^{131}I through drinking water of 3 pCi/l, or the guidance for transient exposure being proposed by EPA's office of drinking water of 36 pCi/l. To measure the necessary sensitivity level all samples were sent to the EPA Laboratory Montgomery, AL, for analysis. The detection limits were targeted at 15 pCi/l for ^{131}I . On 4/6/79 daily drinking water sampling was discontinued except for major drinking water supplies on the Susquehanna River, i.e., Lancaster, Columbia and Wrightsville. Daily sampling at Columbia and Wrightsville was discontinued on 4/8/79 and Brunner Island added as an additional sampling location. Daily sampling continues at this time at the Lancaster and Brunner Island sources. All samples are analyzed by the EPA Laboratory in Las Vegas.

Daily sampling by the Commonwealth of Pennsylvania was also instituted on effluent discharges from TMI on 4/4/79. These samples are analyzed by EPA's Harrisburg Laboratory.

A continuous ^{131}I monitor was installed 4/12/79 on the principal discharge of the reactor. This monitor should provide an early alert of a significant ^{131}I discharge to the Susquehanna River.

Milk sampling was initiated on 4/5/79 with the establishment of nine dairy farms for daily sampling. Up until that time milk sampling had been conducted by the Commonwealth of Pennsylvania, FDA and Metropolitan Edison. The EPA sampling program was designed to complement efforts of these organizations. The minimum detectability of ^{131}I in those milk samples analyzed by EPA was 20 pCi/liter.

The routine environmental program for the Middletown plant, or any other nuclear facility must assess the radiation exposure of the general population via four principal pathways. These are: integrated whole body exposure as measured by some type of dosimeter (usually TLDs), internal exposure resulting from inhalation of airborne radioactivity, and ingestion of drinking water and contaminated milk or other food products.

The monitoring system operated by the licensee prior to the accident addressed all of the above exposure routes.

1. A TLD network comprised of 20 stations was in routine operation. At 10 of these locations the Commonwealth of Pennsylvania also placed TLDs for Quality Control purposes.

2. Air monitoring stations were in place at eight locations concentrated in the predominate down-wind direction. Through a contract with NRC, Pennsylvania was operating air sampling instrumentation at two sites. All air samplers were equipped with prefilters for collection of particulate materials and charcoal cartridges for collection of reactive gases.

3. Drinking water was routinely analyzed from locations within 15 miles utilizing intake from the Susquehanna River. The detection limit for ^{131}I (the fission product radionuclide with the lowest permissible concentration) is approximately 0.5 pCi/l compared to the drinking water standard for continuous ingestion of 3pCi/l.

4. Milk samples were routinely collected from five farms and analyzed to a level of 0.5 pCi/l for ^{131}I . Radiostrontium analyses were also performed regularly. Split samples of both milk and water were analyzed by the Commonwealth of Pennsylvania.

In addition to the environmental monitoring of the area around the site, there are in-plant systems which continuously monitor the stack effluents and the liquid radiological waste both before and after dilution (prior to discharge to the Susquehanna River).

The licensee's monitoring program, with a quality control program conducted by NRC and Pennsylvania is adequate for routine operation with the exception that better TLD coverage of populated areas is recommended. The experience at the Three Mile Island did, however, point up difficulties and some inadequacies when dealing with the emergency situation. The delays encountered in placing additional monitoring equipment contributed to the uncertainty of the general population exposure immediately following the accident. The nature of the initial release of radioactivity (i.e., primarily noble gases) complicated the monitoring process and raised questions as to the sensitivity of the dosimeters for measuring the type of radiation to which they were exposed. In addition, effluent monitors on the stacks were pegged at full scale and were not able to provide a measurement of the intensity of the radiation being released to the atmosphere.

It would appear that any need for additional monitoring applies not to the normal operating condition, but to the emergency situation. In this respect, it is the capability to rapidly supplement the routine monitoring program which is needed.

The experience of the EPA in performing radiation monitoring for the nuclear testing program at the Nevada Test Site may offer some beneficial suggestions. For both air and milk sampling, the EPA has established a network of standby stations which operate only when needed. Arrangements are made for the placement of samplers and supplies at appropriate locations. Sampling is initiated by telephone request to the station operator. In the event that the networks are not activated for a real monitoring purpose, they are activated to test their responsiveness at least semi-annually. Around the sites of most power reactors, locations representative of population centers out to perhaps 20 miles would probably suffice for air sampling. Arrangements for additional milk sampling should be made with dairies rather than individual farms in order to rapidly screen milk which is representative of relatively large geographical areas. Positive results can then be used to indicate where sampling should occur at the individual producers. Similarly, arrangements should be made with downstream users for sampling of drinking water on demand. Additional TLDs should also be available for immediate placement following any accident.

In-plant monitors must be capable of measuring the level of radioactivity which might be released in an accident. As seen at Three Mile Island, these levels are likely to be high. While it is necessary to measure effluents in the range of permissible discharge, higher range measurements are also needed in order to assess the rate of release. In addition, it would be desirable to have the on-line monitors in the plant automatically alert the NRC and the appropriate State Agency.

At the present time no steps have been taken to implement the recommendations given here. It is anticipated that the recommendations of the NRC and the Presidential Commission, together with the results of the Hearings of this Committee will lend impetus to improving the emergency response capability.

I have been asked to discuss how to keep routine monitoring from becoming so routine that valuable information is overlooked. In my opinion, this is basically a systems analysis problem which can rely heavily on computer technology for its solution. The mass of data generated by any routine monitoring program, particularly negative data, can lead to a loss of interest in individual data points. Assuming good quality control on data generation, reporting by exception is recommended for management review. This type of system would establish limits on all types of data for normal operation and only data falling outside those limits would be reported to responsible individuals. At the same time, trend analyses should be performed on the data in order to provide early warning of changes in normal operation.

There has been great concern over the proposal by Metropolitan-Edison to discharge water from the containment building to the Susquehanna after treatment to remove radioactive contamination. The levels of radioactivity in this water will be reduced to conform to those allowed by their license to operate the plant. These allowable concentrations are designed to assure that concentrations of radionuclides in drinking water do not exceed federally prescribed standards. Although concentrations in the outfall may exceed drinking water standards, this water will be further diluted by water from the Susquehanna River. The calculation of an appropriate dilution factor is thus of prime importance and will vary depending upon the stage of the river at any given time. The low estimate for dilution, transmitted to EPA verbally by the Department of Environmental Resources of Pennsylvania, is a factor of 24. Using this dilution factor a discharge at the level of 300 pCi/l for ^{131}I (the maximum permissible discharge concentration) would result in 12 pCi/l in finished drinking water at Lancaster, Columbia or Wrightsville ignoring any removal in the treatment process. This value would exceed the drinking water standard of 3 pCi/l of ^{131}I for continuous (70 year) exposure. Federal guidance for transient intake which limits the dose to 50 m rem/year, averaged over one year, has also been provided. Again, for ^{131}I this would allow 36 pCi/l in finished water. Within this guidance for allowable concentration, discharge at a level of 300 pCi/l would not result in exceeding the proposed variance to the EPA drinking water standard. It is our understanding that clean-up of the water to approximately 10% of the allowable discharge limits has been set as the target for decontamination. The EPA would expect that the best practical technology would be employed to achieve the 10% target figure.

The one radionuclide which will not be removed from the water is tritium. It is, therefore, recommended that a tritium analysis be performed following decontamination, but prior to discharge in order to assure that concentrations are below 3×10^6 pCi/l (the mpc for tritium.)

It is further recommended that downstream users be advised of intended discharge of this water to the River.

This completes my prepared statement, I will be pleased to answer any questions.

Mr. AMBRO. Thank you very much, Mr. Bretthauer.

We will now hear from Mr. Richard Vollmer, Assistant Director for Site Analysis, Office of Nuclear Reactor Safety, NRC.

Please proceed, Mr. Vollmer.

[The prepared statement of Mr. Vollmer was read as follows:]

PREPARED STATEMENT OF RICHARD H. VOLLMER, DIRECTOR OF THREE MILE ISLAND-2 SUPPORT

Thank you, Mr. Chairman. We appreciate the opportunity to discuss with the Subcommittee the environmental and health effects of the Three Mile Island accident and the plans for cleanup and disposal of contaminated water which is currently contained in the auxiliary building and the reactor building. Because of the extensive monitoring and analysis done at Three Mile Island since the accident by the NRC, other Federal agencies, and by the Commonwealth of Pennsylvania, the releases of activity to the air and water following the accident are reasonably well understood.

Before I discuss the specifics on today's topics, let me report that the reactor core is being safely cooled by natural circulation and that several backup modes of cooling are available should they be needed. The releases of activity to the atmosphere have been low and undetectable off site for several weeks. We expect

that off-site levels will remain at natural background. The contaminated water is contained in two high integrity buildings and its processing and disposal, currently the subject of several court actions, will as a minimum, meet the NRC's strict environmental requirements as have liquid discharges since the March 28 accident.

I. ENVIRONMENTAL AND HEALTH EFFECTS OF ACCIDENT

Air Releases.—An assessment of the population dose and health impact associated with the TMI accident was prepared by an interagency group and published May 10, 1979. The interagency group consisted of individual experts in the radiological environmental field from the Nuclear Regulatory Commission, the Environmental Protection Agency, and the Department of Health, Education and Welfare. An assessment prepared by the Department of Energy is also attached to the subject report.

As stated in the introduction to the report, the interagency group has estimated the collective radiation dose received by the approximately 2 million people residing within 50 miles of the Three Mile Island Nuclear Station resulting from the accident of March 28, 1979. The estimates are for the period from March 28 through April 7, 1979, during which releases occurred that resulted in exposure to the off-site population. The principal dose estimate is based upon ground-level radiation measurements from thermoluminescent dosimeters located within 15 miles of the site. These estimates assume that the accumulated exposure recorded by the dosimeters was from gamma radiation (that is, penetrating radiation that contributes dose to the internal body organs). The data were obtained from dosimeters placed by Metropolitan Edison Company before the accident as part of their normal environmental surveillance program), from dosimeters placed by Metropolitan Edison after the accident and covering the period to April 6, and from dosimeters placed by NRC from noon of March 31 through the afternoon of April 7, 1979. These measurement programs are continuing. The results for the period beyond April 7, 1979, have not been fully examined.

The collective dose to the total population within a 50-mile radius of the plant has been estimated to be 3300 person-rem. This is an average of four separate estimates that are 1600, 2800, 3300, and 5300 person-rem. The range of the collective dose values is due to different methods of extrapolating from the limited number of dosimeter measurements. An estimate provided by the Department of Energy (200 person-rem) also falls within this range. The average dose to an individual in this population is 1.5 mrem (using the 3300 person-rem average value).

The projected number of excess fatal cancers due to the accident that could occur over the remaining lifetime of the population within 50 miles is approximately one. Had the accident not occurred, the number of fatal cancers that would be normally expected in a population of this size over its remaining lifetime is estimated to be 325,000. The projected total number of excess health effects, including all cases of cancer (fatal and non-fatal) and genetic ill health to all future generations, is approximately two.

These health effects estimates were derived from central risk estimates within the ranges presented in the 1972 report of the Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR) of the National Academy of Sciences. Preliminary information on the recently updated version of this report indicates that these estimates will not be significantly changed.

The maximum dose that an individual located off site in a populated area might receive is less than 100 mrem. This estimate is based on the cumulative dose (83 mrem) recorded by an off-site dosimeter at 0.5 mile east-northeast of the site and assumes that the individual remained outdoors at that location for the entire period from March 28 through April 7. The estimated dose applies only to individuals in the immediate vicinity of the dosimeter site. The potential risk of fatal cancer to an individual receiving a dose of 100 mrem is about 1 in 50,000. This should be compared to the normal risk to that individual of fatal cancer from all causes of about 1 in 7.

An individual was identified who had been on an island (Hill Island) 1.1 miles north-northwest of the site during a part of the period of higher exposure. The best estimate of the dose to this individual for the 10 hour period that he was on Hill Island is 37 mrem.

Water releases.—The liquid releases and resultant environmental impacts and doses to the public from March 28 through May 11, 1979, have been carefully evaluated. Consideration of the drinking water, fish ingestion and recreation

pathways for dose to individuals has shown no exposure levels that are distinguishable from existing background levels in the river. The liquid releases have been far below ($\sim 1/40$) the applicable annual design objective dose limits of 3 millirem to the whole body or 10 millirem to any organ, as required by Appendix 1 to 10 CFR Part 50, and are well within those projected in the Final Environmental Statement for the TMI Facility. Environmental samples have shown that the levels of radioactivity in the Susquehanna are indistinguishable from existing background levels at public water supply intakes from the river. This has been confirmed by independent measurements made by the NRC, EPA, and the Commonwealth of Pennsylvania.

II. PLANS FOR CLEANUP AND DISPOSAL OF CONTAMINATED WATER

The contaminated water which currently resides in the primary system, reactor building, and auxiliary building tanks is being held pending environmental assessment of methods of cleanup and methods of disposal. Of this water, about 250,000 gallons is currently stored in tanks in the auxiliary building and contains intermediate levels of activity. On May 25 the Commission issued a statement, a copy of which I can provide for the record, directing the staff to prepare an environmental assessment regarding the use of a recently completed system, EPICOR-II, to cleanup the water. Pending completion of this assessment and the opportunity for public comment, Metropolitan Edison was directed not to operate EPICOR-II in conformance with the Commission statement. Following that, the staff will prepare an assessment of the alternative methods for disposal of the water. Disposal of any water which may have been decontaminated is not permitted until this evaluation is complete.

Regarding cleanup and disposal of the contaminated water in the reactor building and primary system, Metropolitan Edison is currently formulating plans for cleanup and disposal. We have stated that such plans will receive a detailed evaluation by the NRC and made public prior to approval for implementation. Further, we will require that conditions for release of any type will remain the same as for normal reactor operation, that is conformance with appendix I to 10 CFR part 50. Our objective remains to fully assure protection of the public health and safety and the environment through our review and approval of waste management operations.

That completes my prepared testimony. I would be happy to answer any questions that the Subcommittee may have.

STATEMENT OF RICHARD VOLLMER, ASSISTANT DIRECTOR FOR SITE ANALYSIS, OFFICE OF NUCLEAR REACTOR SAFETY, NUCLEAR REGULATORY COMMISSION

Mr. VOLLMER. Thank you, Mr. Chairman.

If I may further summarize, first of all, I would like to comment that the NRC's ongoing environmental monitoring program has shown releases of activity to be quite low and detectable onsite for several weeks.

We expect the onsite levels will remain at natural background, and we see no particular threat that would raise the levels of activity, because of the systems and procedures that be put into effect since the accident.

The contaminated water that is contained, and it had been mentioned in the hearing before, is in two high integrated buildings, and its processing and disposal which is currently the subject of several court actions, will as a minimum meet the NRC's strict environmental requirements, as had the liquid discharges since the March 28 accident.

I am going on to the subject of water releases; in particular, the liquid releases and result of environmental impact and doses to the public from March 28 through May 11, 1979, which have been carefully evaluated by the NRC.

It was mentioned in the hearing that there were some samples taken by the licensee which did not detect some iodine levels, somewhat higher than might be expected by natural background.

The liquid releases according to our evaluation have been far below, about one-fortieth the applicable annual design objective dose of three millirem to the whole body or 10 millirem to any organ, as required by appendix I to 10 CFR part 50, and are well within those projected in the final environmental statement for the TMI facility.

Now, as to cleanup and disposal of the water, and I am speaking now of the contaminated water which resides in the primary system, reactor building, and the auxiliary building tanks, the water is being held pending environmental assessment of the methods of cleanup and methods of disposal.

Of this water, about 250,000 gallons is currently stored in tanks in the auxiliary building and contains intermediate levels of activity.

Now, on May 25, the Commission issued a statement, a copy of which I can provide for the record, directing the staff to prepare an environmental assessment regarding the use of a recently completed system, EPICOR-II, to clean up the water.

I would like to read that statement.

[The statement follows:]

The staff is directed to prepare an Environmental Assessment regarding proposals to decontaminate and dispose of radioactively contaminated waste water from the Three Mile Island facility. The Assessment will be divided into several portions. The first portion of the Assessment will deal with the proposed decontamination of intermediate-level waste water using the EPICOR-II system at TMI. The Assessment should include discussion of potential risks to the public health and safety, including occupational exposures and the risk of accidental releases, and a discussion of alternatives to the EPICOR-II system. Pending completion of this portion of the Assessment and opportunity for public comment, the staff should direct the licensee not to operate the EPICOR-II system. Testing of the EPICOR-II system without using contaminated waste may proceed. Except for discharge of waste water decontaminated by the existing EPICOR-I decontamination system¹ and discharge of industrial waste water² as consistent with the facility operating licenses, no discharge of waste water shall be permitted until completion of a second portion of the Assessment dealing with any such proposed discharges. This portion shall include a discussion of alternatives to discharge into the Susquehanna River.

The decontamination and disposal of high-level waste water will be the subject of a subsequent Assessment. However, the Director of the Office of Nuclear Reactor Regulation may authorize measures deemed necessary to cope with an emergency. If the Director of the Office of Nuclear Reactor Regulation believes the public health and safety requires the use of the EPICOR-II system, prior to completion of the first portion of the Assessment, he shall so report to the Commission and the Commission may then permit use of the system. The staff should inform the Commission promptly regarding its estimated schedule for completing each portion of the Assessment and for completing the entire Assessment.

SAMUEL J. CHILK,
Secretary of the Commission
(For the Commission).

Dated at Washington, D.C., this 25th day of May 1979.

That concludes the statement, and I would like to just boil it down simply as possible, we are currently preparing a draft environmental assessment which deals with the use of EPICOR-II, that is an assess-

¹ Primarily pre-accident waste water from Unit 1 which has been partially contaminated by water from Unit 2, with an activity level of less than 1 microcurie per cc. prior to treatment and with an activity level approximately 10^{-7} microcuries per cc. in the discharge canal after treatment.

² Waste water slightly contaminated (approximately 10^{-7} microcuries per cc.) due to leakage from secondary plant service support systems. The discharge of this industrial waste water is necessary to maintain TMI Unit 2 in a safe condition.

ment of the environmental impact, of simply processing the intermediate level of contaminated water with this particular system. Following that, and the opportunity for public comment, we will then prepare an assessment which will deal with the water that has been processed by EPICOR, and investigate the alternatives for the disposition of that water. And so the water can then first be cleaned up, and that can be subject to an assessment. Second, an assessment will be prepared, once it is established as to what will be done with the water, once it is cleaned up, so that it will meet our environment requirements.

Third, we will prepare a separate assessment for the cleanup of the higher level activity which is currently contained in the reactor building and the primary system.

As you may know, we have samples of activity, so we know what is in the primary system. We are not sure of what is in the reactor building, because we have not yet been able to take the water sample. We can only conclude and be bound by what we think that particular water is in terms of activity.

Pending completion of the first assessment, and the opportunity for public comment, Metropolitan Edison was directed not to operate EPICOR-II in conformance with the Commission statement.

As I said before, the staff has completed a draft of the assessment, and it has been given for review, for preliminary review to other members of the staff and the Commission staff.

Regarding plans for cleanup and disposal of the contaminated water, which we are calling the higher level contamination, and reactor building in the primary system, Metropolitan Edison is currently forming plans for cleanup and disposal.

We have stated before that such plans will receive a detailed evaluation by the NRC, and made public prior to approval for implementation.

The system to be used will also be subject to further questioning. Further we will require conditions for release of any type to remain the same as a normal reactor operation, which as you might know is much more restrictive than for the generally called MPC limits for discharge.

Our objective remains to fully assure protection of the public health and safety and the environment through our review and approval of waste management operations and are continued on site monitoring and surveillance.

That completes my prepared testimony, and we will be happy to answer your questions.

Mr. AMBRO. Just one before I ask the panel members to address their questions to you.

Mr. VOLLMER. Did you prepare, or did you reconstruct in hindsight a record of releases, both with respect to time, and radionuclides into the environment after or during the accident?

Do you have that record on paper?

Mr. VOLLMER. Yes; we do have the record on paper.

Mr. AMBRO. Could we have a copy of that for the record?

Mr. VOLLMER. We could make that available.

Mr. AMBRO. If you could, I would appreciate it.

Mr. WALKER?

Mr. WALKER. Thank you, Mr. Chairman.

If you could, I would like to start with Secretary Clusen, and pursue with you at least briefly some language I authored in the bill which left our committee recently, the authorization for the Department of Energy. That language reflects the committee's belief that there is a need for some kind of decontamination procedure to be researched, so that in the event of a nuclear accident, there would be some hope that an area so affected could be appropriately decontaminated.

I was thinking particularly of people who left the area and might never be able to return to their homes. But there also was much concern about the prime farmland in this area.

Could you outline for us briefly how you intend to use the \$21½ million if it becomes available, as it was authorized by the Science and Technology Committee?

Ms. CLUSEN. Yes, indeed, Congressman.

We see the product of such a study as a comprehensive report, which would be fully coordinated with appropriate agencies and organizations, that will include such things as the following:

We would expect to review and analyze the existing Federal and State capabilities for responding to major nuclear accidents.

We would expect to review and analyze the required radiation monitoring equipment, and the methodology which is currently in use, and have data reduction in presentation systems for estimating levels of exposure to the public and environmental contamination.

We would review the appropriate radiation protection guides and protective action guidelines which currently exist for decontamination and restoration of property.

We would review and analyze decontamination and restoration methodology, the kind of equipment which is used, plans and resource requirements which are needed for recovery from an accident situation, and restoration of land use, and we would identify further research and analytical efforts associated with the development of emergency planning.

Essentially, we would see such a study and such a plan as having three phases:

The first would be the emergency phase, which begins from the time of an accident until a facility or source of radiation has been brought under control.

The second step would involve looking at the restoration of the facility, its decontamination and its return to operating status or decommissioning.

Part three would undertake exploration of the restoration of the site area, which would involve decontamination of the site area and its restoration to use.

That is our perception of what would need to be done from the time of the incident to the period when all danger to public health or property is over.

Mr. WALKER. I thank you for the thought that has obviously gone into this effort.

If I could, I would like to follow up with a case of specifics.

Could you tell me who will be doing what on each of those studies that you mentioned, who will be doing most of the work?

Ms. CLUSEN. Congressman, if I follow the language of your amendment, which says that this shall be under the purview of the Assistant

Secretary for Environment, DOE, I would expect that involvement in the emergency operation and in monitoring health and physical environmental effects would be operated through the research and analysis capability of my office.

The office in the Department of Energy which has been given the assignment for dealing with what in effect goes on inside the nuclear facilities, or of the actual physical groundwork, what is sometimes termed "earthmoving," is the Assistant Secretary for Energy Technology, and if my office crossed over into that area, it would then become a coordinated effort.

Mr. WALKER. One of the features of what you had planned to do with this money does get into the area of monitoring. We heard much today about the need for additional monitoring as a part of the process. Can you give us some ideas as to when we might expect a final report of this type and when could we begin to get some of the data from a report that we could then begin to utilize?

Ms. CLUSEN. Well, actually, you know, the language of the amendment provides for this to begin October 1 and run 18 months, to March 30, 1981. This could, of course, be done in any order which you were to designate.

Mr. WALKER. But you feel as though it can be done within that 18-month period?

Ms. CLUSEN. I think it can, and if you were to establish a priority, that is if the committee were to make a special request, I am sure we could be selective in the way it is done.

Mr. WALKER. If we were to determine based upon these hearings, and other things that we are getting along the way, that the monitoring problem should receive first priority, that could certainly be done, and we could get an initial report on that phase of it before the end of the 18-month period?

Ms. CLUSEN. I should think so, because we would not be beginning from ground zero, so to speak. We have been involved, as are many other bodies, with the postmortem analysis of the Three Mile Island accident. We have had some experience with nuclear weapons accidents to draw on, and we have some related Department of Energy studies and experiments which could be used for background information.

Mr. WALKER. I thank you very much.

If I could, Mr. Chairman, I would like to ask Mr. Bretthauer and Mr. Vollmer a question on the water cleanup.

I appreciate both of your statements. They have shown there has been some detailed thought given to what kinds of levels we are talking about.

I submit to you, however, that part of the problem is that we are not dealing with purely technological kinds of problems. You are dealing with the psychology of the product. And after analyzing all of the various kinds of technological data, it simply gets down to the bottom line that regardless of what the levels might be, those levels become unacceptable downstream.

Are there other kinds of things that can be done with the water? We had some testimony from the utility on positive alternatives. Are you evaluating other alternatives as to the cleanup?

I am not saying there is any argument about the need to clean the water up before we do something with it.

I do not think that is the problem. I think the question is, what is the disposition of the water after it has been cleaned up? And are there things in your evaluation that can be done that would be safer than putting it into the river?

Mr. VOLLMER. The answer is that we are looking at the alternatives as part of the second portion of the environmental assessment.

There are several ways that the water could be disposed of without putting it into the Susquehanna; all of these have their drawbacks, perhaps both from an economic point of view, but even more perhaps from a social and political point of view; let me just say that one option could be to evaporate the water after it has been cleaned up, and then dispose of whatever residue is left; this may involve putting low amounts of radioactivity into the atmosphere, and dispersing them, let us say, in all directions, and again, this would be a possibility, I think the doses resulting from such a thing could be maintained at a very low level.

The second alternative would be to take the water after it is cleaned up—

Mr. WALKER. Let me interrupt you at that point.

If it is being evaporated at some site, after it had been appropriately decontaminated, during the evaporation process, would the level of radionuclides be emitted into the atmosphere ever exceed background levels?

Mr. VOLLMER. I would say I think it could be done somewhat so that it would not exceed, and likely you will get lower amounts of the volatile nuclides that may reside in the gas after decontamination, these levels of noble gases and iodine should be very low because of decay, if for no other reason, the nuclides that would likely exist of significance to the health and safety standpoint would be strontium, for example, tritium in the water, and cesium, the tritium component, again not being a really significant health and safety aspect.

The other option, of course, is to take the water after cleanup, and put it in tanks and dispose of it somewhere else, and I guess I can really not address that in much detail, except one, there are a lot of other places that you could put the water that the people in that particular area may have the same fears about the water, even though it is cleaned up, as the people downstream in the Susquehanna do, if it were, for example, taken out into a large body of water, I think the health impact there would be absolutely minimum or nonexistent.

Mr. WALKER. Some of my constituents have suggested the Potomac River as a possibility. [Laughter.]

Thank you very much, Mr. Chairman.

Mr. AMBRO. Mr. Winn?

Mr. WINN. Thank you, Mr. Chairman.

I really do not have any questions. I think this testimony has been very enlightening. Mr. Walker asked the main questions that I had in the back of my mind about what you are going to do with all of that water you have got stored over there, 6 or 7 feet of it.

Is there no way that that water can be put back in the system?

Mr. VOLLMER. Well, that is another option, that we are looking at, and that would be essentially putting the water back in and re-using it, and I think that a fraction of the water could be handled that way.

Mr. WINN. Would you have to clean it up?

Mr. VOLLMER. Yes, sir, it would be cleaned up.

Mr. WINN. What particles have to be cleaned up? What has to be taken out?

Mr. VOLLMER. I think you would probably want to clean it up to roughly the same level we would clean it up if we were to discharge it into the river.

Normally, reactor water and secondary water is kept quite clean by the existing plant cleanup system, and this is done in the normal plant for several reasons, one is to keep the occupational exposure to the minimum, and, second, to keep waste, leakage of water which usually has to be disposed of at a very low level, and so it is entirely possible that a fraction, or perhaps, I would not want to hazard a guess as to how much, but a good fraction could perhaps be reclaimed in that manner.

Mr. WINN. Do you have protection for the individuals that would be involved if you put it back into the system? Do you have coverage en masse?

Mr. VOLLMER. Yes, sir. I might add that one of the reasons that we feel that clean up of the water should proceed as expeditiously as possible, is because the water in its liquid state does—well, as it exists in the auxiliary building does pose an occupational hazard.

Further, the water and liquid state does pose the possibility of a spill, so even though all of the effluents in the auxiliary building are going through a very high grade purification system, I would personally feel much better if we were able to fix as much of the radioactivity currently existing in the water into a safe form as soon as we could.

Mr. WALKER. I wanted to make sure though that there is no need to combine the cleanup and the discharge processes, you can clean up the water without discharging it into the river?

You could go ahead with your cleanup procedure, without having to get to all of the issues whether or not it gets into the river?

Mr. VOLLMER. That is true, and that is why the environmental assessment has been split up in that way.

I think the reason for the assessment was that the city of Lancaster sued and has requested that the EPICOR system not be used as well as not have water discharged, so we have tried to address both of those questions.

It may be in the best interest of all involved to clean up the water, whether it is discharged or not.

Mr. WALKER. Thank you for yielding.

Mr. WINN. You are more than welcome.

Mr. Chairman, I do not have any further questions, but the last 2 days, I think three or four times, I have heard the statement that the contamination is probably less than what we had during the Chinese fallout following their shot in 1976.

I do not know what the devil that has got to do with it, except experience I suppose.

Thank you, Mr. Chairman.

Mr. AMBRO. Thank you, Mr. Winn.

Mr. Ertel?

Mr. ERTEL. Thank you, Mr. Chairman.

Mr. Vollmer, I notice by the outline that you are the assistant director for Site Analysis.

Mr. VOLLMER. Yes, sir.

That is an old title, not too old, but let me explain, I was the assistant director for Site Analysis through 1976, 1977, 1978, and had responsibility for the radiological aspects, health and safety, environmental in nuclear reactor regulations, and a couple of months ago, I transferred into another job, assistant director for Systems and Projects, which operated reactors, and then I was called up to Three Mile, and then recently, the NRC reorganized part of its organization to focus attention on some specific areas dealing with Three Mile, and the fallout from the Three Mile accident.

Mr. ERTEL. You have answered basically the question I wanted.

I want to turn the clock back a couple of years.

When I talk about site analysis, that means location of nuclear powerplants, is that correct?

Mr. VOLLMER. Yes.

Mr. ERTEL. And you had responsibility for radiological hazards which might ensue from the powerplant, is that correct?

Mr. VOLLMER. Yes.

Mr. ERTEL. Would that include accidents that might happen at a nuclear powerplant?

Mr. VOLLMER. Yes, sir, it does.

Mr. ERTEL. During that analysis, was there any consideration given to the fact that you are locating these nuclear powerplants in heavily populated areas?

Mr. VOLLMER. That has been for a number of years a very key part of our consideration, and it has precluded siting of plants in certain areas which even by the strict interpretation of our regulations would have normally allowed siting.

Let me cite an example of the New Bold Island proposed site.

Mr. ERTEL. Where is that?

Mr. VOLLMER. That is near Trenton and Philadelphia.

Mr. ERTEL. I am concerned about Harrisburg, Lancaster, York, Middletown, Goldboro, and Cumberland County.

I am curious how this plant was sited on Three Mile Island in the middle of a population area when electric power is easily transmitted over transmission lines. And that power was not needed in this area, but most of it was being directed into New York, or New Jersey. Why was that powerplant sited here in what I consider to be a metropolitan area?

I understand there is water, which is one of the prime requirements. But other than that, certainly it was not located close to the ultimate user, and, second, in Montour County of this State, which is a fairly small population I cannot even think of Montour County having as many people as in this one township, we have a coal-powered plant which has just been built, just come on line, and yet, it has water, because they need water for cooling too, and why did this plant get located in such a heavily populated area, we have a coal-powered plant operated in an area I consider to be rural, can you give me some explanation for that?

I have been thinking of it, and I just cannot seem to find an answer.

Mr. VOLLMER. My response may not satisfy you, but I will try.

The selection process that we do go through for a plant involves the licensee proposing a number of sites, and alternate sites, and these are looked at from a number of viewpoints, so basically we look for safety criteria, if a plant does not meet that, and I am talking about siting criteria.

Mr. ERTEL. It will not be built anyway?

Mr. VOLLMER. It will not be built anyway.

Mr. ERTEL. That has nothing to do with one site over another, but you were specifically responsible for the radiological hazards.

Mr. VOLLMER. That is correct.

Mr. ERTEL. And obviously the more people near the plant, the greater the hazard.

Mr. VOLLMER. The radiological hazards are evaluated according to the specific guidelines and in the regulations.

If the site meets that, the regulations do not require that we go to the site which may have the lowest radiological impact in the event of an accident.

Mr. ERTEL. Has anybody thought about going back and looking at the guidelines? Sometimes they may be wrong.

Mr. VOLLMER. Our siting process and guidelines have been the subject, before the TMI accident, as a matter of fact, have been the subject of a rather detailed review, and the report is due to the Commission, was due May 15.

I do not think they have it yet on that very aspect of metropolitan siting, and the existence of dense population near the reactors is certainly one consideration.

One of them is that the site meet certain minimum requirements, then they are accepted, and these do have population factors involved in them.

Mr. ERTEL. If I might turn to another subject now, Mr. Bretthauer, I noticed in your statement that you had people on site, or started deployment of EPA environmental monitoring stations on Three Mile Island on March 31, 1979, and I guess the following day, you had stations operating. Then you cite that as a pretty good example of getting people on line.

This event occurred on the 28th. Why did it take so long?

Mr. BRETTHAUER. It is the policy of the Environmental Protection Agency to offer services to a State in the times of a radiological emergency and respond if requested.

Mr. ERTEL. When were you asked to respond by the State?

Mr. BRETTHAUER. We offered our services to the State at 10 o'clock on the 29th.

Mr. ERTEL. You mean you were not contacted before the 29th when this thing took place on the 28th, and the State had notification at 8 o'clock on the 28th?

Mr. BRETTHAUER. No; we were not contacted by the State.

Mr. ERTEL. You were never asked?

Mr. BRETTHAUER. No; we offered our services at 10 o'clock on the 29th. We were requested to stay in a standby situation.

Mr. ERTEL. By whom?

Mr. BRETTHAUER. By the State.

After a discussion of the seriousness of the situation on the 30th, it was decided to send in our monitoring team.

Mr. ERTEL. Who decided that, and when were you specifically requested by the State?

Mr. BRETTHAUER. We were not not requested by the State.

Mr. ERTEL. At any time?

Mr. BRETTHAUER. To the best of my knowledge, the State never requested our assistance.

Mr. ERTEL. So typically, as far as the States are concerned, you never appeared?

Mr. BRETTHAUER. To the best of my knowledge, we were never asked.

We responded by sending in a monitoring team on the 30th. We did however do other things in the interim period. We have a network of radiological surveillance stations located in the area.

On the 28th, we activated the stations in Wilmington, Del., in Harrisburg, and in Washington, D.C.

We began collecting samples from these stations on a daily basis beginning the 28th.

On the 29th, we activated our air-monitoring station in New York City to provide for sample collection on a daily basis.

Mr. ERTEL. Now, I find that somewhat discouraging to know you were never officially requested by the State to come in and operate.

Could you have come in at the NRC request?

Mr. BRETTHAUER. Did we come in at the NRC request?

Mr. ERTEL. Are you entitled to come in? Is that one of your appropriate responses to the NRC or anybody else besides the State?

Mr. BRETTHAUER. I believe that we have the mandate that we can come in whenever we feel that monitoring is required for the protection of public health.

Mr. ERTEL. Well, then, in other words, you did not have to wait for the State to request you?

Mr. BRETTHAUER. No; I think I prefaced my earlier statement that it is the policy of the Agency to offer this assistance at the earliest possible time, and then to respond if requested.

When the situation became as serious as it was made apparent to us on the 30th, we responded.

Mr. ERTEL. You never waited for the State to come back to you after you offered your services?

Mr. BRETTHAUER. That is correct, to the best of my knowledge.

Mr. ERTEL. Let me ask you another couple of questions.

Some of these I might know, but I think the record ought to be clear.

What types of radiation do you get from an incident such as this, and what type of monitoring of the different types of radiation did you have in place at what time?

Mr. BRETTHAUER. I could go through my statement in some detail.

Mr. ERTEL. Just tell me when you were able, the types of radiation you would expect, and then when you were first able to monitor for that type of radiation?

Mr. BRETTHAUER. For the information we had available to us when we entered the area, we had two types of radiation, gamma-emitting radiation, as well as beta-emitting radiation.

Mr. ERTEL. Any others?

Mr. BRETTHAUER. To our knowledge, there were no alpha-emitting radioisotopes, although we did monitor for them.

We never detected any alpha-emitting airborne radioisotopes.

Mr. ERTEL. So when you came in, you were monitoring for all types?
 Mr. BRETTTHAUER. Yes; alpha-, gamma-, and beta-emitting radio-isotopes.

Mr. ERTEL. Was it only a specialized type of monitoring equipment here, or was it for general monitoring?

Mr. BRETTTHAUER. To my knowledge, there was no routine alpha monitoring capability.

Mr. ERTEL. Were there any others that were not routinely available?

Mr. BRETTTHAUER. I think that NRC might be in a better position to answer that.

Mr. VOLLMER. Well, the NRC monitoring began on the 28th or early on the 29th.

It was in operation when I got here, from 11 on the 29th, and the capability I am sure, they had this survey, their survey meters which were capable of entering beta and gamma radiation, they were taking environmental samples, and they had iodine measurements.

As far as alpha measurements, I do not know for sure.

Mr. ERTEL. Was there ever any alpha emission?

Mr. VOLLMER. Not that I know of. Whether it was checked for in the early days, I don't know.

Mr. ERTEL. So we have no idea if there was any alpha emission in the initial stages?

Mr. VOLLMER. The monitoring samples that we had taken would not have shown any isotopes, except for natural occurring radioactivity that would emit alphas.

Mr. ERTEL. All right.

A report has indicated the maximum dosage we could expect was 80 millirems from this incident, is that correct?

Have any of you come up with that conclusion?

Mr. VOLLMER. Let me ask Dr. Battist as one of the authors on the interagency task force.

Dr. BATTIST. That dose was actually obtained in two different manners. Initially, we started gathering all of that data, we estimated the maximum dose the individual would receive was somewhere between 75 and 80 millirems in the first 2 days, based on the TLD's we had one on the Three Mile Island itself, and one adjacent to the shore, and we made an estimate based on that, and about 11½ weeks later, we found there was a dose at the point of one of the residents in the area, which did come out to be 86 millirems, and we presented this to the Department of Energy aerial surveys, and it all came together as 80 as a very reasonable number, and we just expressed it as less than 100 millirems.

Mr. ERTEL. I have an Environmental Health letter dated January 15, 1977, and they indicated the standards set out by the EPA for the general public, the maximum annual dose equivalent of the whole body, or any internal organ except the thyroid is limited to 25 millirems; is that correct?

Mr. VOLLMER. That is the Environmental Protection Agency standard for the fuel cycle, the light-water reactor for fuel cycle that goes into effect for a reactor, sometime toward the end of this year.

December 1 of this year, that is only for the light-water reactor fuel cycle, and does not pertain to any other facilities.

Mr. ERTEL. That is normal operations?

Mr. VOLLMER. Correct.

Mr. ERTEL. So what they did, during a normal fuel cycle, and it executed normal operations in this particular incident?

Mr. VOLLMER. To that hypothetical individual, yes, or that hypothetical situation.

Mr. ERTEL. Was this hypothetical or real?

Mr. VOLLMER. We had it at the present, and I assume the person was there full time during the accident, and without any shielding, and so forth.

Mr. ERTEL. Does that have to be a naked individual?

Mr. VOLLMER. Yes; it would, as a matter of fact, because the energy of the radiation is so low——

Mr. ERTEL. I do not know anybody that takes a bath all the time, so they would not be naked the whole time, I guess.

All right. That is all I wanted to know, whether you had exceeded those levels.

I think those are all of the questions I have.

Thank you very much.

Mr. AMBRO. Thank you, Mr. Ertel.

Madam Secretary, I know you are in a hurry. I would just like to get some answers for the record, and then you can go, and maybe I will talk to Mr. Bretthauer and Mr. Vollmer.

Do you agree with the statement that there were anomalies in the high millirem readings in the north after the accident?

Ms. CLUSEN. Is this a reference that was made this morning prior to my coming.

Mr. AMBRO. Yes; it is.

Ms. CLUSEN. I cannot explicitly agree. We know that there were temporary high readings. It has been asserted they did not drop off as rapidly as expected, is that the matter to which you are referring?

Mr. AMBRO. It is a matter to which I am referring, and I might point out I think I am correct here, in saying the information was gleaned from a pilot of DOE's?

Ms. CLUSEN. Yes; and I can tell you the situation in regard to that.

There are a couple of factors involved which were not mentioned at the time.

One of them is meteorological conditions, and the other is the vertical growth of the plume which was being measured.

I understand that yesterday the scientist who works for us replied that he recalled one flight where it did not seem to fall off as rapidly as expected.

However, I understand that when our records were checked later that this was not true across the board.

In other words, it was sporadic, and this goes back to the statements made this morning about the releases coming in bursts, and at what point in time this occurred.

I would have to say after discussions with the members of my staff who are here and have been involved in the calculations and analyses, that this does not represent a significant occasion. Because there were so many flights flown and this may have been an anomaly, which was not unexpected, and was not a significant finding.

Mr. AMBRO. I remember you saying, correct me if I am wrong, that it was quite some time after the event the monitoring program began, did you say that?

Ms. CLUSEN. No; I said it was very soon after. In fact, that is what I was emphasizing in my opening remarks, that we were notified very early and responded right away.

Of course, this was because the Department of Energy has the lead on the interagency emergency response effort to radiological problems.

Mr. AMBRO. What was the time frame?

Ms. CLUSEN. Would you like to know the sequence?

A number of events occurred rather rapidly. There were some preliminary calls made to our Brookhaven Laboratory at about 7 o'clock in the morning of March 28. From about 8:45 a.m. on the people in the Office of Environment who were involved had been alerted. By 11 o'clock, we were asked by NRC, and the Commonwealth of Pennsylvania to assist them, and were up in Pennsylvania by 3:30 in the afternoon. At the same time we brought in the contractors who made it possible for us to have the helicopter aerial surveys and monitoring, and some flights were flown the same day.

Mr. AMBRO. Does all of that mean that you are satisfied with that which happened in the monitoring program?

Ms. CLUSEN. No; it means that I am satisfied that we demonstrated we could respond quickly according to the predetermined plan, and that the plan did work in that case.

Mr. ERTEL. Was your agency aware of the EPA monitoring team, and the contract by the EPA to the State offering their services?

Ms. CLUSEN. I would have to ask one of the people who was actually up here, but EPA is a party to the interagency agreement.

Mr. Deal of my staff was at the command post.

Mr. DEAL. I am Joe Deal, and I was at the command post during the accident.

We were not aware of a lot of these callups such as Eric mentioned, because some of them were made through the headquarters, and I am not sure that any of the contacts for EPA's assistance came through us, nor were we aware of the contacts through the State, but I do not recall whether our people were in that loop at all.

Mr. ERTEL. My question then is, if you are the lead agency to bring in a monitoring team, why didn't you bring in EPA? Why did it take 3 days?

Mr. DEAL. Congressman, I think that we felt at the time that we had a lot of people moving into the area. In fact, we had 18 people on March 28, 40 people on March 29, and 70 people on the 31st, who were doing most of the monitoring that we felt was needed to be done at the time. They were covering the area and taking the water, air, and vegetation samples, in support of the State and the NRC.

Mr. ERTEL. Everything I have heard today here was that there was not any adequate monitoring effort in the first few days.

Now, somebody has goofed, who?

Mr. AMBRO. While you are thinking of who goofed, let me see if I cannot try to sort it out, because I think Congressman Ertel is right.

I think while we have the EPA claiming to do a large amount of sampling, we have what is, it seems to me, a lack of coordination, and we have a variety of disjointed efforts. For example, Mr. Bretthauer, with all of the sampling, who analyzes your data when you get it?

Mr. BRETTHAUER. We had a team from Las Vegas of some 18 people to analyze the data as it became available.

We also brought with us from Las Vegas an analytical capability to actually measure the samples in the laboratory, as they were collected.

Mr. AMBRO. Who sets the criteria? Within which frame of reference do you analyze the data?

Somebody has to set the criteria, and analyze the data, within the framework of that criteria.

If he said 12 millirems is too high, and he said 25,000 millirems is just about all right, what do your people say with respect to analyzing what is all right, what are the total ranges?

Mr. BRETTHAUER. We have various criteria for various radionuclides under our safe drinking water standards, other standards can also be promulgated under specific emergency circumstances.

Never did we reach any of these levels, the levels that we reported were in basic agreement with those being reported by other agencies. The reported levels were far below any action levels.

Mr. AMBRO. When you say you reported, what did you do with the data?

Mr. BRETTHAUER. I might go back and review something that apparently has not been brought out here today.

All of the agencies, NRC, EPA, and DOE shared field command headquarters in the same building.

DOE provided a series of communications facilities to the command headquarters, interagency command center, as well as to the State. All data from those agencies were reported through those channels.

I might indicate that there was very close cooperation among the agencies. Each agency discussed what we had found that day and discussed their plans for the following day, each day at about 5 o'clock.

Many times the plans for the following day were modified depending on what other agencies were doing.

Mr. AMBRO. So you had a rather extensive network for sampling. When you got the samples, you analyzed them from a set of pre-established criteria, and then you made all of that available to the other agencies at the command post?

Mr. BRETTHAUER. That is correct.

Mr. AMBRO. At no time did the data indicate higher levels of radiation from whatever source, and then those standards that were pre-established you said were safe, is that correct?

Mr. BRETTHAUER. That is correct.

Mr. AMBRO. You heard, if you did not know this, I will say it again, there was a recommendation that monitoring be extended beyond the 13 to 15 mile radius that now exists to do monitoring out to 40 miles.

Do you see any worth or validity in that?

Mr. BRETTHAUER. Yes; in my statement I recommended expansion of the TLD monitoring network.

Mr. AMBRO. Expansion to what?

Mr. BRETTHAUER. To about a 25-mile area. I also recommended the deployment of standby air monitoring stations that could be activated when necessary.

We do this around the Nevada test site. We activate them with a phone call. They are relatively inexpensive to have. We periodically activate them for performance just to make sure they work.

Mr. AMBRO. Mr. Vollmer, do you have any objection to that?

Mr. VOLLMER. Well, I think I may comment that the environmental monitoring program that has been set up, I think has been emphasizing more the routine, in the normal operation of effluents than the accident monitoring, and without a closer investigation of what the extent of the current networks would gain you, as opposed to getting out and surveying by measuring the actual ground environmental measurements downwind, down in the plume.

I think this is likely the most effective way, in the way it was perhaps after at least the morning of March 29, I think was the most effective monitoring for the protection of the public.

Mr. AMBRO. You mean other than stationary stations?

Mr. VOLLMER. I think to keep track of what is going on, and helicopter monitoring is really the most effective.

Mr. AMBRO. What about both?

Mr. VOLLMER. And both. I think I would concur with that.

Mr. AMBRO. I would like to switch quickly to this business of the water.

I must say, I do not understand what the devil you are talking about.

We have 650,000 gallons of water which is contaminated, in one respect or another. Tritium is included in that water.

Did you say we have 150,000 gallon tanks that can take off some of that water?

Mr. VOLLMER. Let me have Mr. Collins answer that.

Mr. COLLINS. We have made a modification to the plant and installed some supplementary tankage, in what they refer to as the fuel handling building and we provided 110,000 gallons of additional storage capacity over and above that which is available in the plant.

Mr. AMBRO. Is that empty now?

Mr. COLLINS. At the present time it is empty.

Mr. AMBRO. How do you stuff 650,000 gallons in 150,000 gallon tanks?

Mr. COLLINS. That is not the only tank available. We would start removing that water from the containment building, so the water, most of it resides within the reactor building, and it is not our intent to remove that water at this present time.

Mr. AMBRO. I would like the other two panelists to listen to this question.

I think you mentioned evaporation. Now, is not tritium in the water, is it not a form of water?

If you evaporate it, in other words, would not you be packaging the problem differently, so that instead of dumping it in the Susquehanna, and having one ingest it by drinking it, you would have a fine spray get out over the cows, the meadows, the Amish, and the people, is that correct?

Mr. COLLINS. That is certainly one way to characterize it.

Instead of putting it into the water of the Susquehanna, you would vaporize it.

It would be dispersed within the environment.

Mr. AMBRO. Is that therefore a practical alternative?

Mr. COLLINS. Yes; it is a practical alternative.

Mr. AMBRO. Why?

Mr. COLLINS. Because of the quality of that which is dispersed in the environment, and the subsequent uptake would be probably a lot lower than even that which you could get from drinking the water downstream.

Mr. AMBRO. You mean the dilution would be greater?

Mr. COLLINS. Yes; the dilution would be much greater.

Mr. AMBRO. What do you think of that, Ms. Clusen?

Ms. CLUSEN. The proposal for evaporation, well, we have not really looked at the actual degree of the problem at this point.

At this point our understanding was that a clean up system was being built, but the system would not remove the tritium, and most of our information comes from NRC, with regard to that, and it is our understanding that the tritium is the largest problem that the concentration is something like 1.2 microcuries per millimeter, and that is about 400 times the concentration that can be released into the river under your regulations.

Mr. AMBRO. If we agree it was water that will vaporize, it will come out in the form of steam, and those of us who have less than effective protection, we will be affected by it, I think. Maybe we will not. What do you think?

He does not think so.

Ms. CLUSEN. I think the tritium could still be a problem, but we have not yet examined it close enough.

Mr. WALKER. Could the gentleman yield, did you say your information is the level is 1.2 microcuries per millimeter?

Ms. CLUSEN. Yes.

Mr. WALKER. We had testimony earlier today it was one-tenth of that. Now you say about 1 microcurie per millimeter, and I was told they thought concentrations were about a tenth of that.

Where is your information coming from?

Ms. CLUSEN. NRC.

Mr. WALKER. Can NRC clear up the discrepancy here?

Mr. VOLLMER. There is about 3,000 curies of tritium, and the amount of water that is there comes out to be according to our calculations about a microcurie one.

Mr. WALKER. About 1 microcurie. So my figures were right, and I indicated at that time that that would be about 300 times what the safe level would be in drinking water, does that jell with your thinking?

Mr. VOLLMER. Well, the MPC of drinking water is, yes, that would be right.

Mr. WALKER. So that the level in the water is about 300 times in excess of the standard and that is what we cannot clean up, right?

Mr. VOLLMER. That would be if cleaned up and undiluted, that would be correct.

Mr. WALKER. Thank you, Mr. Chairman.

Mr. AMBRO. Well, what is shaping up to me is you have two proposals. One would be the vaporizing of this, under the theory the dilution would be greater, and you would send it out in the atmosphere in steam, hoping the concentrations would not be sufficient to affect anyone.

The other is the other containment vessels, which will forever contain 650,000 gallons, or whatever remains of that with the high concentrations of tritium, is that the other alternative?

Mr. VOLLMER. That, or taking it and disposing of it in another body of water, where you could get high dispersion.

Mr. AMBRO. What does that mean, out in the middle of the ocean somewhere?

Mr. VOLLMER. I do not think it would take that. The small amount of dilution would get it down to the drinking water standards, and I might say we have not really evaluated yet the environmental effectiveness of any of these alternatives yet.

Mr. AMBRO. Does the disposal of this toxic waste come under the provisions of NEPA?

Mr. VOLLMER. In a sense, yes.

Mr. AMBRO. You must develop environmental impact statements with alternatives?

Mr. VOLLMER. That is correct, and I think as I indicated in my prepared statement, we would not allow the discharge of water that exceeded the amounts that we have already evaluated in the environmental statement, although we are redoing effectively the environmental impact of this water for the response to the Commission order.

Mr. AMBRO. Must you follow the NEPA process?

Mr. VOLLMER. We are considering an alternative, yes, sir.

Mr. AMBRO. I did not ask you that.

That is what you do, or feel like doing. I am asking you if you are bound by the National Environmental Policy Act to follow these procedures?

Mr. VOLLMER. Yes; we are.

Mr. AMBRO. All right.

Then you must develop an environmental impact statement with a series of alternatives.

That is what you must do, not what you want to do, correct?

Mr. VOLLMER. That is right.

Mr. AMBRO. Who reviews the EIS?

Mr. VOLLMER. The assessment, the environmental assessment is found to have negligible impact, I believe it is within the authority to issue a statement.

Mr. AMBRO. Who makes that finding?

Mr. VOLLMER. The Commission.

Mr. AMBRO. The Commission reviews its own environmental impact statements and alternatives to make determinations on whether or not you embark on one course or another?

Mr. VOLLMER. I think if it falls within the impacts already reviewed, that the environmental assessment does not have to go out for public or agency review, and although we have indicated in this case we do intend to provide an assessment for public review.

Mr. AMBRO. If it falls within what?

Mr. VOLLMER. If it falls within the environmental assessment made for the plant, as I indicated before, the intention that we would require the water be cleaned up to be within the guidelines, that was evaluated in the environmental statement.

Mr. WALKER. Will the gentleman yield?

It seems to me, recalling past work involving NEPA, is not it true that one of the things which can prevent your use of what you are talking about here, essentially a negative analysis, is that if there is substantial criticism, that you cannot go ahead with a simply negative declaration, and have to go clear through the environmental impact statement process?

Mr. VOLLMER. I am sorry. I do not really know the answer to that question.

Mr. WALKER. Thank you.

Mr. COLLINS. Could I clear up something. I think you may have the idea if you took this 600,000 gallons all at one time, with these 2,000 or 3,000, the number you had probably calculated in the order of what you came up with, but we have no intention, and there is no processing system that you could design, I guess you could, if you had enough space and room to process all 600,000 gallons at one time and discharge all 600,000 gallons at one time.

You have a very small capacity in the processing system, compared to the total volume of water to be processed.

Mr. WALKER. Yes; but the problem is you are talking about an overall amount of tritium which is 300 times the safe drinking water levels, which we are being told that you cannot process out of the body, that that is something which cannot be removed through this EPI CORE-II system.

Now, I realize you are saying you can dilute it down to certain levels, but that is, of course, where I think the public concern becomes very valid.

Mr. COLLINS. Even just releasing it over a very long period of time, which would in effect be a normal operating plant.

Mr. WALKER. But you start with a problem. It is something on the order of 300 times safe levels and over a period of time you are going to propose to feed this into the public.

The public, I think, has a reason to be concerned with that kind of process.

That comes down to the core concern here which I say is very much of a psychological problem. I think that is where a great deal of the concern legitimately rests, because you cannot do it all at once.

Mr. COLLINS. Mr. Walker, the limit you are talking about, you call a safe limit, is the fact that there is an intake limit, that you could drink water containing that a full year long, that is at that level, without any hesitation, and it is several times that concentration that is still quite safe.

Mr. WALKER. But those are the only figures we have to go on.

We do not have anything else on which to base what we decide is safe intake for the public. So while that may well be true, the base figures have been designed along the way in order to give us some standard by which to measure.

Now, if you are questioning the measurement standard, I think we will have to go back and take a look, but I do not think you can omit the measurement standard in this question.

Mr. COLLINS. But it also assumes the person drinking that water is drinking that water at the discharge of the Susquehanna River, without any further dilution downstream through a water distribution system.

Mr. WALKER. I understand your point on that as well, except that we know that the Susquehanna is made up of some rather interesting currents from time to time. And there could be a possibility that a stream of that could be carried right down to the water supply intake fairly quickly, and I was just thinking that what we are dealing with here is a very legitimate public fear based upon the kinds of figures we have talked about today.

Thank you, Mr. Chairman.

Mr. AMBRO. Is there such a thing as a discharge for iodine rated at MPC's?

Mr. VOLLMER. Yes.

Mr. BRETHAUER. 300.

Mr. AMBRO. Is that the same as the drinking water standard?

Mr. VOLLMER. No.

Mr. AMBRO. What is the difference?

Mr. VOLLMER. MPC would be the part 20 for continuous intake by an individual, and our environmental requirement, it is more than a factor of a hundred below that, and this is the level at which we are intending to impose on discharges.

That is where the normal plant has to abide by, and we said that these releases from TMI as a result of the cleanup process will also have to abide by these, and then there is the EPA safe drinking water standard, which may be further definable, I think it is 4 millirems per year for an individual at the point of discharge, at the point in which the water leaves the cleanup process.

Mr. AMBRO. Is there any comparable discharge level for the tritium?

Mr. VOLLMER. Part 20, that is what Mr. Walker had described before, the dose resulting from tritium is quite low, and I do not know if there is any EPA drinking water standard on that.

Mr. BRETHAUER. If you will permit me, the 10 CFR 20 for tritium is 3 million. The drinking water standards, EPA drinking water standards, it is 20,000.

That is in the same units. Now, for transient doses, the alert levels are 240,000. The dilution factor is something like, the low dosage factor in the river from the TMI plant at Lancaster is something like 24.

Mr. AMBRO. Now, all scientists of course agreed that dilution is uniform both in terms of combining with water, and evaporation, is that correct?

Mr. BRETHAUER. Only for tritium.

Mr. AMBRO. Well, that is a very significant point, I think, and I am getting much too esoteric, because I am beginning not to understand myself. But it seems to me that if I get out of these hearings, by thanking you, and telling you, we would like to hold the record open for written questions for all witnesses, and just say this, that the kinds of questions that are raised here by the representatives of those people who live in this area, are the kinds of questions that would be raised by all 435 of us in the House, if we were under the umbrella of this kind of a nuclear accident in our district.

It seems to me that unless we have answers which are understood and credible to all people, then the nuclear option will not be available to those who believe in it, because the people will come together and bring down the hammers of hell on everyone. I really think that

without being overly immodest that these hearings go a long way toward mitigating some fears but in some cases, of course, raising others. It evolves on a variety of people to develop credible answers to these kinds of concerns, and I must tell you, I am not overwhelmed by the testimony today. I think these hearings have to be ongoing, and I suggest too that we will be holding them in concert with the McCormick subcommittee, and jointly with others on low-level ionizing radiation next week. I am sure you will all be delighted to be there and tell us what you know about that, and what you do not know, and we do not know. But the whole question, the only reason I make light of it, is because it is so heavy really. We have to be able to provide answers to a public which is becoming increasingly susceptible to a valid emotional concern about these things. I, myself, live within the shadow of a nuclear plant on a major aquifer.

I was going to get into what would happen in the case of a meltdown, even though our scientist friends say there could never be a meltdown, and what would happen in the case of a hydrogen block, even though our friends tell us there could never be a hydrogen explosion. So we see the paradox of the contradictions we all live with. So I must tell you, while some answers have been cleared up, others have been raised. And having said that, I leave this area happy to have seen it.

Mr. WALKER. Thank you.

Mr. AMBRO. We stand adjourned.

[Whereupon, the subcommittee was adjourned at 2:25 p.m.]





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