A REPORT
TO THE MET-ED COMMUNITY

Reading, Pennsylvania
June 15, 1979
Report Number Three

TABLE OF CONTENTS

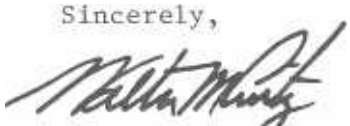
Dear Neighbor,

Here is information that will provide a perspective of the radiation exposure and health impact resulting from the accident at Three Mile Island on March 28, 1979.

What we are presenting is the summary of the complete report of the Joint Assessment Group. The full report was published by a committee composed of technical members of the Nuclear Regulatory Commission, The Environmental Protection Agency and the Department of Health, Education and Welfare. To date we consider this report to be the most reliable information available concerning radiation resulting from the accident.

We sincerely hope that this information will help build greater public understanding. Met-Ed wants to be respo..sive and we urge you to write to let us know of your special interests. We plan to continue this series of reports to the community and I can assure you that Met-Ed will make every effort to address your concerns in future communications.

Sincerely,



Walter M. Creitz
President

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

Lewis Battist	Nuclear Regulatory Commission
John Buchanan	Nuclear Regulatory Commission
Frank Congel	Nuclear Regulatory Commission
Christopher Nelson	Environmental Protection Agency
Mark Nelson	Department of Health, Education, and Welfare
Harold Peterson	Nuclear Regulatory Commission
Marvin Rosenstein	Department of Health, Education, and Welfare

May 10, 197 9

NOTE: The following pages contain the preface and the summary of the preliminary report of the Joint Assessment Group studying the radiation dosages surrounding Three Mile Island for the period March 28 through April 7 resulting from the Nuclear accident at the plant.

At the conclusion of the sumrriary, we have added a table and a map showing the average cumulative doses of radiation for radial areas up to 20 miles from T.M.I.

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 receive 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:

Nuclear Regulatory Commission -	Jeannette Kiminas Walter Pasciak Edward Branagan James Fairobent James Martin William Snell
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 (HEIR) 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 chemical 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 obtaii'd from preliminary results for Metroplitan 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.

Table of the Average Radiation Exposure at Various Distances from Three Mile Island

The table below provides a quick reference to determine the average radiation exposure at various distances from Three Mile Island. While not a specific part of the Joint Assessment Group's report, the figures were received from the Nuclear Regulatory Commission (NRC) and represent the average cumulative levels of radiation for the radial areas depicted on the table and the map on th adjoining pages for the data indicated.

DISTANCE FROM T.M.I.	AVERAGE RADIATION DOSE
0 -- 2 miles	34 millirems
2 -- 3 miles	18 millirems
3 -- 4 miles	10 millirems
4 -- 5 miles	12 millirems
5 -- 10 miles	6 millirems
10 -- 20 miles	2.4 millirems

AVERAGE ESTIMATED DOSES (MILLIREMS)
1 TO 20 MILES FROM TMI
MARCH 28 THROUGH APRIL 7, 1979
(Source NR.C.)