ENCLOSURE 3

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# A METHOD FOR CALCULATING DOSES TO THE POPULATION FROM $^{133}$Xe RELEASES DURING THE THREE MILE ISLAND ACCIDENT

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ABSTRACT On March 28, 1979, a series of events occurred at Three Mile Island, Unit 2, which resulted in a significant release of primary circulating system cooling water onto the containment building floor. Some of this water reached the auxiliary building floor via pathways that are not yet known. The xenon activity in the water entered the atmosphere of the auxiliary building and over a period of a few days passed through the building air filters to the atmosphere. The resulting offsite radiation levels were much greater than during routine operation.

Doses received by the population were mainly due to $^{133}$Xe. The health and safety consequences of these releases were analyzed and found to be minimal in an ad hoc interagency report published by NRC, HEW, and EPA in May 1979. In that report, the dose to the general population is estimated by two different methods, both of which rely on offsite TLD measurements. This article describes in detail one of the calculational methods that was used in the report. This method utilizes the topological time averaged meteorological dispersion factors derived from meteorological data obtained during the accident as well as TLD data from the site environs.

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The dose to the population residing within 50 miles of the accident was estimated to be about 2600 person-rems by this method.

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# INTRODUCTION

In the ad hoc interagency report (Ad79) by NRC, HEW and EPA, the health and safety consequences of the atmospheric releases made as a result of the first ten days of the accident at Three Mile Island (TMI) were evaluated and found to be minimal. Most of the dose received by the population was a result of $^{133}$Xe emissions. In the report, several estimates of the dose from these emissions were made. Most of the estimates were based on a method which interpolated data from thermoluminescent dosimeters (TLD) located at numerous locations around the site. This was done by dividing the area around the site into 16 equal compass sectors with their center located between the two reactors. Each sector was divided into sections delimited by distances from the center of 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 10.0, 20.0, 30.0, and 50.0 miles. For each sector in which two TLD's were located, a straight line was drawn through the two data points on log-log paper. This line was used to estimate the dose in the sector out to the furthest dosimeter. Similar interpolations were adopted for sectors with only one or no TLD's by utilizing data in adjacent or nearby sectors. For distances beyond the farthest data points, the dose was assumed to decrease as distance to the 1.5 power. In this manner, the dose was estimated for all individuals residing in a 50-mile radius of the site. Several approaches based on different combinations of the TLD data were taken with this method to estimate the dose to the general population.

Another method was used in the report to verify the overall results of the interpolative method. This alternative method employed the use of calculated meteorological dispersion factors which were based on meteorological data

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collected over the course of the releases, as well as on the TLD readings. The purpose of this paper is to describe this method and the results obtained.

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## BACKGROUND

In reactor licensing, NRC estimates doses (H) to an individual from noble gas releases in the following manner. It is assumed that an individual is immersed in a semi-infinite cloud of the noble gas (e.g., $^{133}$Xe). The dose to the individual immersed in the semi-infinite cloud is determined by taking the product of the concentration of the $^{133}$Xe in the cloud ($\chi$) and a dose factor (DF) integrated over the time the individual is exposed to the cloud ($\Delta\tau$). The dose factor incorporates the absorption of radioactive decay particles and photons in air, the absorption and scattering of them as they pass through the body, and translates the energy deposited as a result of the absorption or scattering by the body into dose to each organ. Since $\chi$ is the only variable that is time dependent under the integrand, the dose can be expressed in terms of the time averaged value of the concentration ($\bar{\chi}$) as is done in Equation (1).

$$H = \bar{\chi}\ \Delta\tau\ DF \qquad (1)$$

USNRC Regulatory Guide 1.109 (Nu77a) describes the calculational method for releases containing a spectrum of radioactive isotopes. Basically, a summation over all radionuclides is involved. The equations that follow are for a single nuclide release, but they can be easily generalized to a release spectrum.

To more readily incorporate the results of meteorological dispersion models, the right side of Equation (1) is usually multiplied and divided by the time averaged rate of nuclide release source term ($\bar{Q}'$), resulting in Equation (2).

$$H = (\bar{\chi}/\bar{Q}')\ \Delta\tau\ DF\ \bar{Q}' \qquad (2)$$

Note that $\chi/Q'$ is a purely meteorological parameter, independent of the magnitude of the source term. The output of meteorological dispersion models is in the form of time and space dependent $\chi/Q'$ values. These models are described in Slade (Sl68) and the use of site specific data in them is described in Gifford (Gi61). To use this information in Equation (2), the time average values, $\overline{\chi/Q'}$, are computed from the meteorological model results. These time averages are not expected to be exactly equal to the quotient of the time averages of $\chi$ and $Q'$ appearing in Equation (2) from the mathematical standpoint alone. In practice, however, they are expected to be close because the time functional form of $\chi$ in the downwind sector is expected to closely resemble that of $Q'$ provided the time rate of change of the release rate is not too great in comparison to the transit time from the emission point to the reception point. In consideration of the mechanism by which xenon passed from the water of the auxiliary building to the atmosphere outside the building, it is expected that the releases were varying fairly slowly, and thus, $(\bar{\chi}/\bar{Q}') = (\overline{\chi/Q'})$.

The most reliable estimates of H are obtained when estimates of $\chi/Q'$ are based upon meteorological variables measured at the site during the releases, and when $Q'$ is measured simultaneously at the effluent source. The time averaged values of these two parameters are then used in Equation (2), along with the dose factor from Regulatory Guide 1.109, to calculate doses. In routine licensing of nuclear power plants, NRC estimates doses by using annually averaged $\chi/Q'$ values as described in USNRC Regulatory Guide 1.111 (Nu77b).

The source terms for the average annual release are estimated by models described in USNRC reports (Nu76) for pressurized water reactors and (Ca79) for boiling water reactors. The method described below is different from that used in the typical NRC licensing case because it does not rely on direct measurement or estimates of the source term. Instead, it relies on TLD field measurements of dose, and as discussed earlier, on meteorology measurements made over the course of the releases.

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## CALCULATIONAL METHODS AND RESULTS

Since TLDs were located only in 20 or so locations around the plant, it was necessary to use this information to characterize the system in a way that would allow calculation of doses in all 160 sector sections. This was done by use of the ratio, K, which is equal to the dosimeter reading (background subtracted out) divided by the $\bar{\chi}/\bar{Q}'$ value at each dosimeter location, which has the same value, at least in theory, at each TLD location. The basis for expecting K to be the same in all sector sections can be shown mathematically as follows. The only terms of Equation (2) which are spatially dependent are H and $\bar{\chi}/\bar{Q}'$, thus, the equation can be arranged so that all the spatial dependence is on one side as follows:

$$\frac{H}{(\bar{\chi}/\bar{Q}')} = \Delta\tau \; DF \; \bar{Q}' \qquad (3)$$

Since, for any given release period, $\Delta\tau$, the three terms on the right of Equation (3) are independent of space and time, hence, $H/(\bar{\chi}/\bar{Q}')$ can be equated to a constant:

$$\frac{H}{(\bar{\chi}/\bar{Q}')} = K \qquad (4)$$

The K value of Equation (4) is computed for two release periods during the accident. The first period was 28 hours long (3/28; 4 a.m. to 3/29; 8 a.m.) and the second period was 44 hours long (3/29; 8 a.m. to 3/31; 4 a.m.). These time periods correspond to the durations the TLDs were exposed in the field.

Figure (1) depicts the locations of TLDs in the field. The TLDs at these 20 locations were placed by Metropolitan Edison Company and are described in detail in the Ad Hoc Interagency Report (Ad79). Table (1) lists the dose from these TLDs (background subtracted out) for the two time periods. The $\bar{\chi}/\bar{Q}'$ values at each TLD location and for each time period for use in determining K values were based on actual meteorological data, as mentioned above. Hourly calculations were made of the $\chi/Q'$ value throughout each of the two periods. To determine the average value for each period at the 160 sector locations, the sum of the value at the location in question and the values of its two adjacent locations in the azimuthal direction, summed over each hour was taken and divided by the total number of hours. This summation results in a conservative estimate of $\bar{\chi}/\bar{Q}'$, by as much as a factor of 3, as more contribution than actually occurs is figured in for the adjacent sector locations. Tables (2) and (3) list the $\bar{\chi}/\bar{Q}'$ values for the 160 sector sections for the first and second time period, respectively. The $\bar{\chi}/\bar{Q}'$ values at each TLD location were obtained by interpolation of the data in Tables (2) and (3) and are listed in Table (1) for both time periods.

Using H and $\bar{\chi}/\bar{Q}'$ values obtained in this manner, values of K were determined by Equation (4) and are listed in the fourth and seventh columns of Table (1). The average K value for the first time period is 48.7 x $10^3$ R-m$^3$/sec and for the second time period is 3.42 x $10^3$ R-m$^3$/sec. Using the t-distribution from small sampling statistical theory, at the 95% comfidence level the value of $\bar{K}$ for the first time period is expected to be below 94.9 x $10^3$ R-m$^3$/sec and for the second time period is expected to be below 5.47 x $10^3$ R-m$^3$/sec. It is appropriate that the upper limit of $\bar{K}$ is quantified here because, as shown below, both the individual dose and the population dose, as well as the estimated activity released, are proportional to the estimate of $\bar{K}$.

The K values of locations far from the plant should not be considered as reliable as those close in. Figure (1) shows that 5 stations (Stations 4G1, 7F1, 7G1, 9G1, and 15G1) are nine miles or more from the plant. The K values for these five stations are not considered as reliable as those for the other stations for three reasons. First, the uncertainty in the $\bar{\chi}/\bar{Q}'$ increases with distance from the plant since site meteorological measurements are less likely to represent local conditions. Second, the dose recorded by a TLD decreases as distance from the plant increases; hence, natural variations due to background, and other measurement uncertainties, have a greater effect. Third, since $\bar{\chi}/\bar{Q}'$ decreases as distance from the plant increases, and it appears in the denominator of Equation (4), equivalent absolute errors in $\bar{\chi}/\bar{Q}'$ have a larger effect on far out stations than for close in stations. On this basis, these five stations are excluded from the data for the purpose of the dose and source term calculations presented below. With these exclusions, $\bar{K}$ for the first period becomes $14.1 \times 10^3$ R-m$^3$/sec and for the second time period it becomes $2.15 \times 10^3$ R-m$^3$/sec. Applying the t-distribution here as was done above, at the 95% confidence level the value of $\bar{K}$ for the first time period is expected to be below $18.8 \times 10^3$ R-m$^3$/sec and its value for the second time period is expected to be below $2.65 \times 10^3$ R-m$^3$/sec

Table (4) lists the dose for the inner boundary of the central 96 sector sections (out to five miles) for both time periods calculated with the expression $H = \bar{K}(\bar{\chi}/\bar{Q}')$. The $\bar{K}$ values used are those determined above after exclusion of the data from the 5 stations furthest out and the $\bar{\chi}/\bar{Q}'$ values are from Tables

(2) and (3). Figures (2) and (3) depict these data drawn as isopleths on maps of the site vicinity for the first and second time period respectively. As Figure (2) indicates, general meteorological conditions were favorable for minimizing the individual dose which occurred during the first period as the released activity was blown out over the river and dispersed significantly before it reached inhabited areas. It should be remembered that the doses presented in Table (4) and in Figures (2) and (3) represent an estimate of the dose that would be received by an individual if the individual was outdoors during the entire course of the passage of the noble gas cloud. In actual fact, it is known that a significant portion of the population residing near the plant avoided going outdoors or left the area completely.

The total dose received by the population residing within 50 miles of the plant was determined by multiplying the number of people living in each sector section by the dose for that section and summing this over all 160 sector sections. Doses were based on the projected 1980 population. The population data was obtained from the Ad Hoc Interagency Report (Ad79), and the dose data was determined as was done with Table (4). For each sector section, the dose for the inner boundary was used; hence, this method overestimates the actual dose since the dose within a sector section is always highest at the inner boundary. For the first time period, the dose was calculated to be 1900 person-rem and for the second time period it was 790 person-rem.

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Gi61 Gifford, F. A., Jr., 1961, "Use of Routine Meteorological Observations for Estimating Atmospheric Dispersion," Nucl. Safety 2, 47.

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Nu77b U.S. Nuclear Regulatory Commission, July 1977, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Cooled Reactors," Regulatory Guide 1.111, Rev. 1, Office of Standards Development, Washington, D.C.

Sl68 Slade, D. H., (Ed.), 1968, "Meteorology and Atomic Energy," Report TID-24190, U.S. Department of Commerce, Springfield, VA.

Table 1. Proportionality constant "K" derived from dosimetry and meteorological data for two release times.

| Station | First time period 3/28 (4 a.m.) to 3/29 (8 a.m.) | | | Second time period 3/29 (8 a.m.) to 3/31 (4 a.m.) | | |
|---|---|---|---|---|---|---|
| | Dose,* mR | Meteorological dispersion,** sec/m³ | K† 10³R-m³/sec | Dose,* mR | Meteorological dispersion,** sec/m³ | K† 10³R-m³/sec |
| 1S2 | 83.0 | 3.0E-5 | 2.8 | 19.7 | 2.0E-5 | 0.98 |
| 1C1 | 7.8 | 8.6E-7 | 9.1 | 2.9 | 1.2E-6 | 2.4 |
| 2S2 | 31.5 | 2.5E-6 | 13. | 32.2 | 1.7E-5 | 1.9 |
| 4S2 | 21.1 | 1.6E-6 | 13. | 124. | 2.9E-5 | 4.3 |
| 4A1 | 6.4 | 3.0E-7 | 21. | 34.0 | 1.6E-5 | 2.1 |
| 4G1 | 1.3 | 4.5E-9 | 290. | 0.9 | 1.7E-7 | 5.3 |
| 5S2 | 17.6 | 3.0E-6 | 5.9 | 49.0 | 4.6E-5 | 1.1 |
| 5A1 | 4.7 | 6.0E-7 | 7.8 | 8.0 | 1.7E-5 | 0.47 |
| 7F1 | 4.4 | 0. | -- | 7.5 | 1.7E-5 | 0.44 |
| 7G1 | 4.2 | 0. 1.6E-7 | -- | 7.1 | 1.7E-5 | 0.42 |
| 8C1 | 2.5 ~~11.0~~ | ~~3.0E-6~~ | 16. | 0.7 | 2.9E-7 | 2.4 |
| 9S2 | 11.0 ~~4.5~~ | 3.0E-6 ~~9.0E-9~~ | ~~500.~~ 3.50 | 0.7 | 1.7E-7 | 4.1 |
| 9G1 | 4.5 | 9.0E-9 | 500. | 10.5 | 1.9E-6 | 5.5 |
| 10E1 | 24.8 | 1.1E-6 | 23. | 25.0 | 3.6E-5 | 1.6 |
| 10B1 | 28.8 | 1.1E-6 | 26. | 1.0 | 2.4E-7 | 4.2 |
| 11S1 | 201.0 | 2.0E-5 | 10. | 14.8 | 6.5E-6 | 2.3 |
| 12B1 | 5.6 | 2.6E-6 | 2.2 | 107.0 | 1.2E-4 | 0.89 |
| 14S2 | 116.0 | 3.0E-5 | 3.9 | 9.2 | 3.6E-6 | 2.6 |
| 14S2 | 135. | 3.0E-5 | 4.5 | 48.7 | 4.0E-5 | 1.2 |
| 15G1 | 3.0 | 7.0E-6 | 0.43 | 1.6 | 6.0E-8 | 27. |
| 16S1 | 1020.0 | 4.0E-5 | 26. | 83.3 | 4.8E-5 | 1.7 |
| 16A1 | 441. | 2.0E-5 | 22. | 45.0 | 1.9E-5 | 2.4 |
| 16A1 | [illegible] | 2.0E-5 | ~~54.~~ 45. | -- | -- | -- |

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*Doses are based on TLD readings for the indicated station. Doses have been correcte for background radiation.

**Meteorological dispersion valves (i.e., $\overline{X}/\overline{Q}'$) are based on real time meteorological averaged over the indicated time period. The meteorological data was obtained by ______________.

†The proportionality constant "K" is obtained by dividing the dose at a particular st the appropriate time period by the corresponding meteorological dispersion factor (i

Table 2. Average downwind meteorological dispersion values ($\overline{X/Q^T}$) for different locations for first time period (Mar. 28 (4. a.m.) to Mar. 29 (8 a.m.)), sec/m$^3$

| Downwind direction | Distance, miles.† 0.5 | 1.0 | 2.0 | 5.0 | 4.0 | 5.0 | 10.0 | 20.0 | 30.0 | 50.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| N | 1.4E-5 | 4.1E-6 | 1.3E-6 | 7.0E-7 | 4.5E-7 | 3.3E-7 | 1.2E-7 | 4.6E-8 | 2.7E-8 | 1.3E- |
| NNE | [illegible] | [illegible] | [illegible] | 2.2E-7 | 1.4E-7 | 9.7E-8 | 3.5E-8 | 1.4E-8 | 8.3E-9 | 4.4E- |
| NE | 2.8E-7 | 4.1E-8 | 2.1E-8 | 1.4E-8 | 1.0E-8 | 8.2E-9 | 4.1E-9 | 2.1E-9 | 1.4E-9 | 8.2E- |
| ENE | 3.1E-7 | 4.6E-8 | 2.3E-8 | 1.5E-8 | 1.1E-8 | 9.1E-9 | 4.6E-9 | 2.3E-9 | 1.5E-9 | 9.1E- |
| E | 3.1E-7 | 4.6E-8 | 2.3E-8 | 1.5E-8 | 1.1E-8 | 9.1E-9 | 4.6E-9 | 2.3E-9 | 1.5E-9 | 9.1E |
| ESE | 1.6E-7 | 2.4E-8 | 1.2E-8 | 8.1E-9 | 6.1E-9 | 4.9E-9 | 2.4E-9 | 1.2E-9 | 8.1E-10 | 4.9E |
| SE* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SSE | 2.0E-6 | 6.1E-7 | 2.0E-7 | 1.1E-7 | 7.2E-8 | 5.2E-8 | 1.9E-8 | 7.3E-9 | 4.2E-9 | 2.1E |
| S | 2.0E-6 | 6.1E-7 | 2.0E-7 | 1.1E-7 | 7.2E-8 | 5.2E-8 | 1.9E-8 | 7.3E-9 | 4.2E-9 | 2.1E |
| SSW | 3.9E-6 | 1.2E-6 | 4.0E-7 | 2.2E-7 | 1.4E-7 | 1.0E-7 | 3.8E-8 | 1.4E-8 | 8.1E-9 | 4.0E |
| SW | 3.1E-6 | 9.3E-7 | 3.1E-7 | 1.6E-7 | 1.1E-7 | 7.6E-8 | 2.7E-8 | 1.0E-8 | 5.6E-9 | 2.7E |
| WSW | 1.8E-5 | 5.4E-6 | 1.8E-6 | 9.7E-7 | 6.3E-7 | 4.6E-7 | 1.7E-7 | 6.3E-8 | 3.6E-8 | 1.8E |
| W | 2.1E-5 | 6.5E-6 | 2.2E-6 | 1.2E-6 | 7.7E-7 | 5.5E-7 | 2.0E-7 | 7.7E-8 | 4.4E-8 | 2.2E |
| WNW | 2.4E-5 | 7.3E-6 | 2.4E-6 | 1.3E-6 | 8.6E-7 | 6.2E-7 | 2.3E-7 | 8.8E-8 | 5.0E-8 | 2.5E |
| NW | 1.8E-5 | 5.5E-6 | 1.8E-6 | 1.0E-6 | 6.5E-7 | 4.7E-7 | 1.7E-7 | 6.6E-8 | 3.8E-8 | 1.9E |
| NNW | 1.7E-5 | 5.2E-6 | 1.7E-6 | 9.0E-7 | 5.8E-7 | 4.2E-7 | 1.5E-7 | 5.9E-8 | 3.4E-8 | 1.7E |

*No wind in this sector for the period.

†Distances are measured from a point midway between the reactor buildings

Table 3. Average downwind meteorological dispersion values ($\overline{X/Q^T}$) for different locations for second time period (Mar. 28 (8 a.m.) to Mar. 29 (4 a.m.)), sec/m$^3$

| Downwind direction | 0.5 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 10.0 | 20.0 | 30.0 | 50.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Distance, miles* | | | | | | | | | |
| N | 1.8E-5 | 5.5E-6 | 1.9E-6 | 1.0E-6 | 6.7E-7 | 4.9E-7 | 1.9E-7 | 7.5E-8 | 4.4E-8 | 2.3E-8 |
| NNE | 2.6E-5 | 7.9E-6 | 2.7E-6 | 1.5E-6 | 1.0E-6 | 7.3E-7 | 2.9E-7 | 1.2E-7 | 6.9E-8 | 3.6E-8 |
| NE | 2.1E-5 | 6.3E-6 | 2.1E-6 | 1.2E-6 | 7.9E-7 | 5.8E-7 | 2.2E-7 | 9.0E-8 | 5.3E-8 | 2.8E-8 |
| ENE | 1.6E-5 | 4.9E-6 | 1.7E-6 | 9.2E-7 | 6.1E-7 | 4.4E-7 | 1.7E-7 | 6.9E-8 | 4.1E-8 | 2.1E-8 |
| E | 1.1E-5 | [illegible] | 1.1E-6 | 6.0E-7 | 4.0E-7 | 2.9E-7 | 1.1E-7 | 4.6E-8 | 2.7E-8 | 1.4E-8 |
| ESE | 1.5E-5 | 4.4E-6 | 1.5E-6 | 8.3E-7 | 5.5E-7 | 4.0E-7 | 1.6E-7 | 6.3E-8 | 3.8E-8 | 2.0E-8 |
| SE | 2.1E-5 | 6.3E-6 | 2.2E-6 | 1.2E-6 | 8.2E-7 | 6.0E-7 | 2.4E-7 | 9.9E-8 | 5.9E-8 | 3.1E-8 |
| SSE | 2.2E-5 | [illegible] | 2.2E-6 | 1.3E-6 | 8.5E-7 | 6.2E-7 | 2.5E-7 | 1.0E-7 | 6.1E-8 | 3.2E-8 |
| S | 2.9E-5 | 8.7E-6 | 3.0E-6 | 1.7E-6 | 1.1E-6 | 8.3E-6 | 8.3E-7 | 1.4E-7 | 8.1E-8 | 4.3E-8 |
| SSW | 2.6E-5 | 7.9E-6 | 2.7E-6 | 1.5E-6 | 1.0E-6 | 7.4E-7 | 2.9E-7 | 1.2E-7 | 6.9E-8 | 3.6E-8 |
| SW | 2.5E-5 | 7.4E-6 | 2.5E-6 | 1.4E-6 | 9.2E-7 | 6.7E-7 | 2.6E-7 | 1.0E-7 | 6.0E-8 | 3.1E-8 |
| WSW | 2.7E-5 | 8.0E-6 | 2.7E-6 | 1.5E-6 | 9.8E-7 | 7.2E-7 | 2.7E-7 | 1.1E-7 | 6.3E-8 | 3.3E-8 |
| W | 2.7E-5 | 8.1E-6 | 2.7E-6 | 1.5E-6 | 9.9E-7 | 7.3E-7 | 2.8E-7 | 1.1E-7 | 6.5E-8 | 3.3E-8 |
| WNW | 2.7E-5 | 8.0E-6 | 2.7E-6 | 1.5E-6 | 9.8E-7 | 7.2E-7 | 2.7E-7 | 1.1E-7 | 6.3E-8 | 3.3E-8 |
| NW | 1.5E-5 | 4.4E-6 | 1.5E-6 | 7.9E-7 | 5.2E-7 | 3.7E-7 | 1.4E-7 | 5.5E-8 | 3.2E-8 | 1.7E-8 |
| NNW | 1.6E-5 | 4.9E-6 | 1.6E-6 | 8.9E-7 | 5.9E-7 | 4.3E-7 | 1.6E-7 | 6.6E-8 | 3.9E-8 | 2.1E-8 |

*Distances are measured from a point midway between the reactor buildings

Table 4. External exposure from $^{133}$Xe releases for close-in locations, mrem*

| Downwind direction | First Time Period | | | | | | Second Time period | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Distance, miles | | | | | | Distance, miles | | | | | |
| | 0.5* | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 0.5 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 |
| N | 200. | 57.0 | 18.0 | 9.8 | 6.3 | 4.6 | 39.0 | 12.0 | 4.2 | 2.2 | 1.3 | 1.1 |
| NNE | 71. | 20. | 6. | 3.1 | 2.0 | 1.3 | 57. | 17. | 5.9 | 3.3 | 2.2 | 1.6 |
| NE | 3.9 | .6 | .3 | .2 | .1 | .1 | 46. | 14. | 4.6 | 2.6 | 1.7 | 1.3 |
| ENE | 4.3 | .6 | .3 | .2 | .1 | .1 | 35. | 11. | 3.7 | 2.0 | 1.3 | .9 |
| E | 4.3 | .6 | .3 | .2 | .1 | .1 | 24. | 7.0 | 2.4 | 1.3 | .8 | .6 |
| ESE | 2.2 | .3 | .2 | .1 | .1 | 0 | 33. | 9.7 | 3.3 | 1.8 | 1.2 | .9 |
| SE | 0 | 0 | 0 | 0 | 0 | 0 | 46. | 14. | 4.8 | 2.6 | 1.8 | 1.3 |
| SSE | 28. | 8.5 | 2.8 | 1.5 | 1.0 | .7 | 48. | 14. | 5.1 | 2.9 | 1.9 | 1.4 |
| S | 28. | 8.5 | 2.8 | 1.5 | 1.0 | .7 | 64. | 19. | 6.6 | 3.7 | 2.4 | 1.8 |
| SSW | 55. | 17. | 5.6 | 3.1 | 2.0 | 1.4 | 57. | 17. | 5.9 | 3.3 | 2.2 | 1.6 |
| SW | 43. | 13. | 4.3 | 2.2 | 1.5 | 1.1 | 55. | 16. | 5.5 | 3.1 | 2.0 | 1.5 |
| WSW | 250. | 76. | 25. | 14. | 8.8 | 6.4 | 59. | 18. | 5.9 | 3.3 | 2.2 | 1.6 |
| W | 290. | 91. | 31. | 17. | 11. | 7.7 | 59. | 18. | 5.9 | 3.3 | 2.2 | 1.6 |
| WNW | 340. | 100. | 34. | 18. | 12. | 8.7 | 59. | 18. | 5.9 | 3.3 | 2.2 | 1.6 |
| NW | 250. | 77. | 25. | 14. | 9.1 | 6.6 | 33. | 9.7 | 3.3 | 1.7 | 1.1 | .8 |
| NN | 240. | 73. | 24. | 13. | 8.1 | 5.9 | 35. | 11. | 3.5 | 2.0 | 1.3 | .9 |

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*Water locations are indicated by lined-out values. Individuals were not expected to be in water locations

FIG. 1. Location of Metropolitan Edison dosimetry sites for the time period March 28 (4 a.m.) to March 31 (4 a.m.)

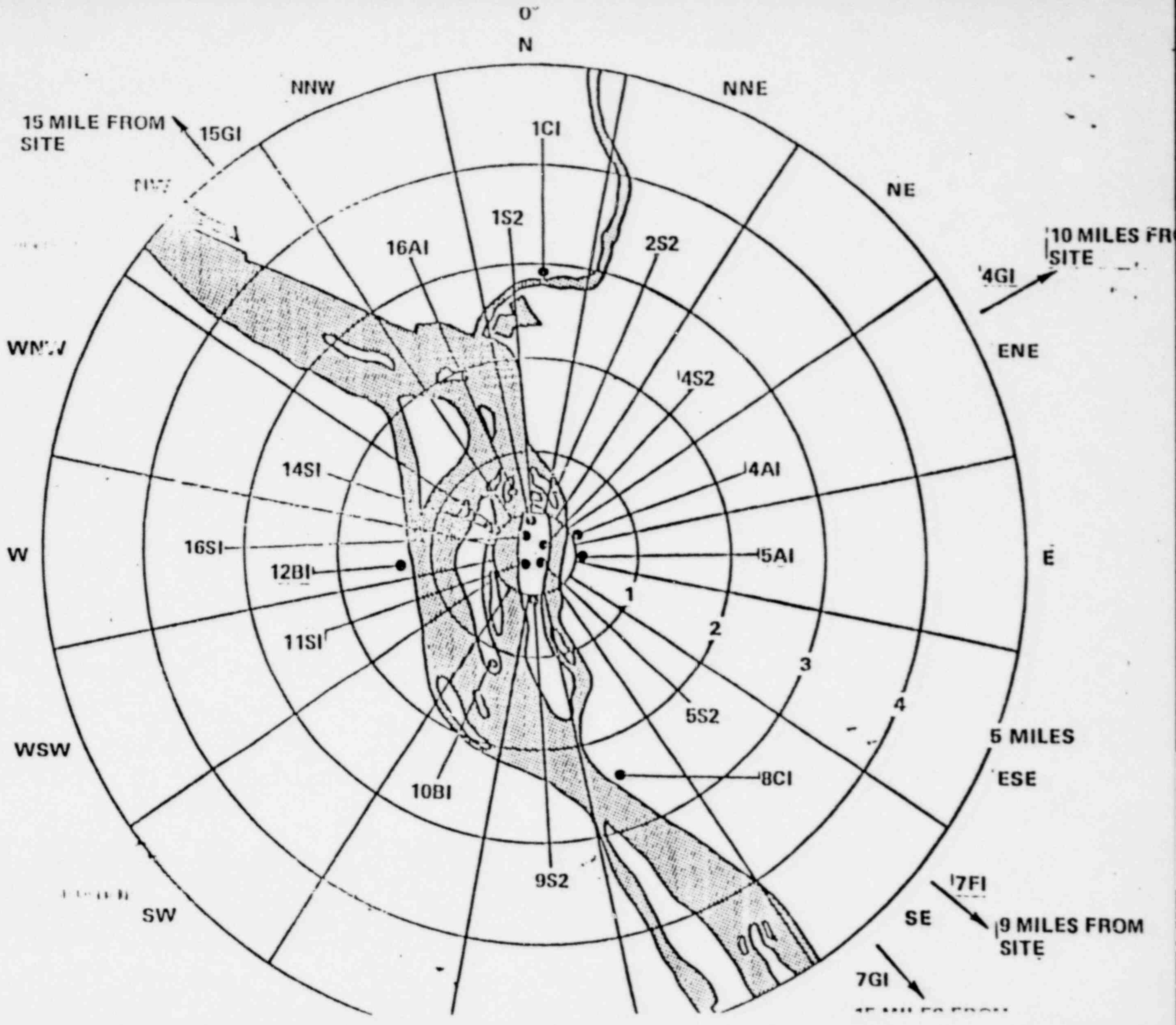
0°
N
NNW
NNE
15 MILE FROM SITE
15GI
1CI
NE
NW
1S2
16AI
2S2
10 MILES FR SITE
4GI
WNW
ENE
4S2
14SI
4AI
W
16SI
12BI
5AI
E
1
2
11SI
3
4
5S2
WSW
5 MILES
10BI
8CI
ESE
9S2
7FI
SE
9 MILES FROM SITE
SW
7GI

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FIG. 2. Dose isopleths out to five miles for the first time period (i.e., Mar. 28 (4 a.m.) to Mar. 29 (8 a.m.)). The innermost circle represents the exclusion boundary. Non-occupational exposure was not expected within it.

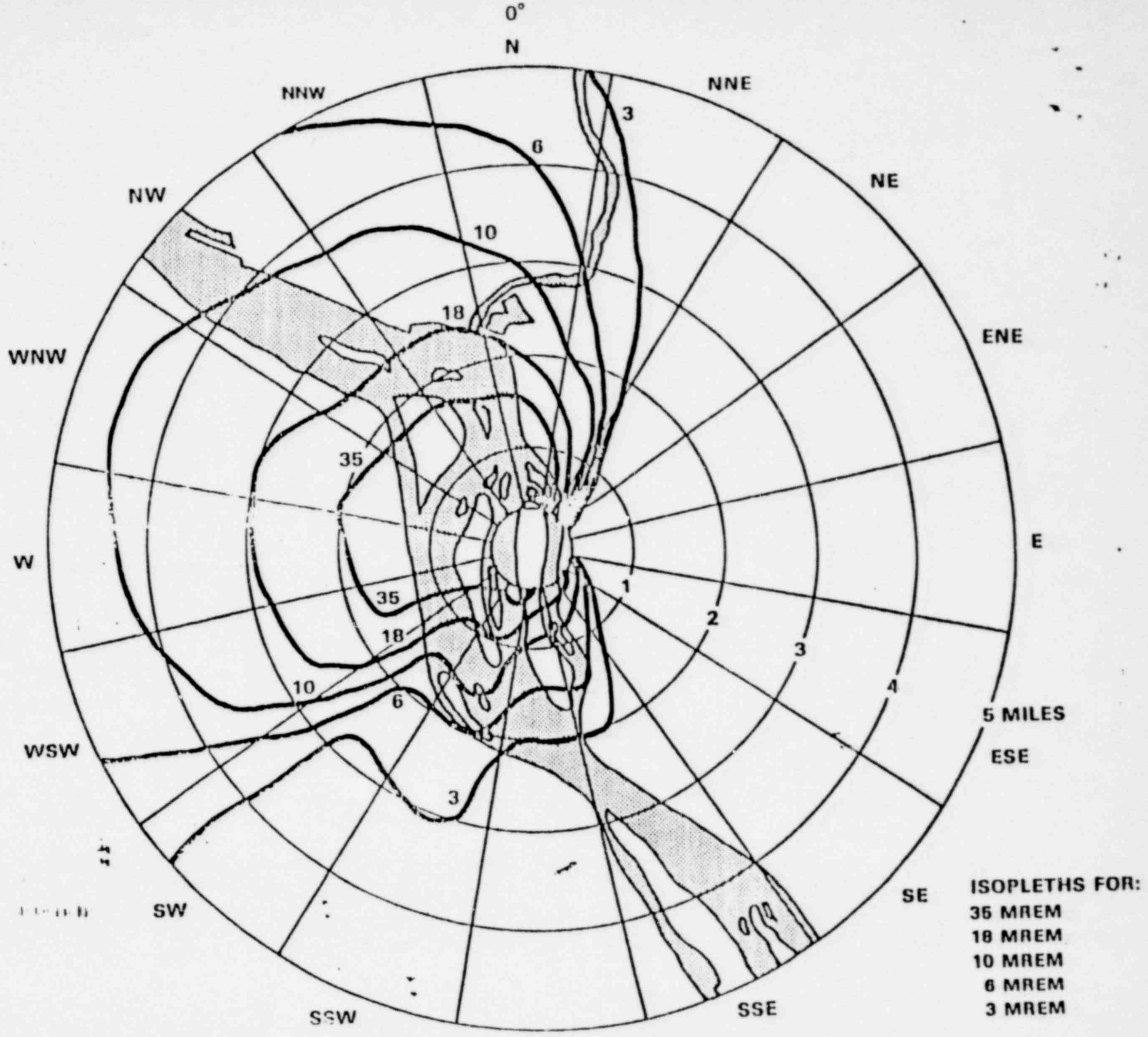
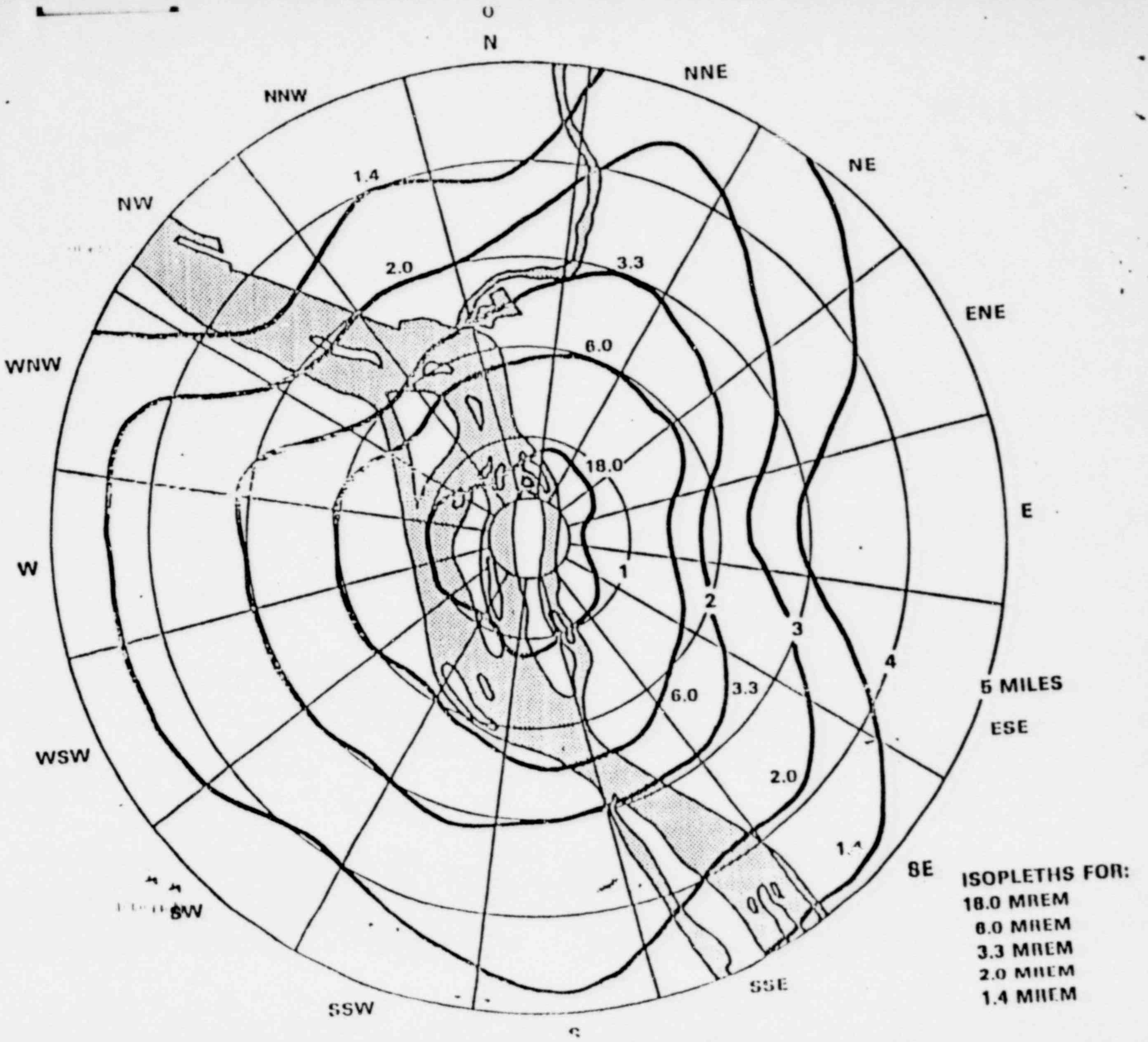

0°
N
NNE
NE
ENE
E
ESE
SE
SSE
SSW
SW
WSW
W
WNW
NW
NNW
1
2
3
4
5 MILES
3
6
10
18
35
35
18
10
6
3
ISOPLETHS FOR:
35 MREM
18 MREM
10 MREM
6 MREM
3 MREM

FIG. 3. Dose isopleths out to five miles for the second time period (i.e., Mar. 29 (8 a.m.) to Mar. 31 (4 a.m.)). The innermost circle represents the exclusion boundary. Non-occupational exposure was not expected within it.


N
NNE
NE
ENE
E
5 MILES
ESE
SE
SSE
SSW
SW
WSW
W
WNW
NW
NNW
1
2
3
4
18.0
6.0
3.3
2.0
1.4
ISOPLETHS FOR:
18.0 MREM
6.0 MREM
3.3 MREM
2.0 MREM
1.4 MREM

1546 260

## REFERENCES

(1) During the period from March 28, 1979 until May 28, 1979 (except for 8 hours on April 28) the TMI Technical Specifications for instantaneous discharges were not satisfied. On May 2, 1979, the station was once again in full compliance with the TMI-TS for instantaneous discharges of I-131.

(2) Data obtained from GeLi analysis of charcoal cartridge from Unit 2 Station Vent (HPR-219) for a sampling period of 1.73E+5sec (1900, 3/28/79 to 1900, 3/29/79). This was the highest measured release rate during the period.

(3) Data obtained from GeLi analysis of charcoal cartridge from Unit 2 Station Vent (HPR-219) for a sampling period of 3.6E+3sec (1300, 4/14/79 to 1400, 4/14/79). This was the highest measured release rate during the period.

(4) From Table 4.4, Pickard, Lowe and Garrick, Draft Assessment of Offsite Radiation Doses Following the TMI Unit 2 Accident (TDR-TMI-116). The instantaneous release rate was extrapolated from TLD measurements made during the period (0700, 3/28/79 to 1600, 3/29/79) 1.19E+5sec. The activity of the noble gases released during this period was estimated to be 6.6E+6 curies.