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

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POPULATION DOSE ESTIMATES

DIRECTION	DISTANCE (MILES) 0–0.4	0.4–1	1–2	2–3	3–4	4–5	5–10	10–20	20–30	30–40	40–50	50–
北	1S2			1C1								
北北東		2S2										
北東												
東北東	4S2	4A1					4G1					
東	5S2	5A1										
東南東												
南東							7F1	7G1				
南南東				8C1								
南	9S2							9G1				
南南西			10B1									
南西	11S1											
西南西			12B1									
西												
西北西	14S1											
北西								15G1				
北北西	16S1	15A1										

Table 1

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

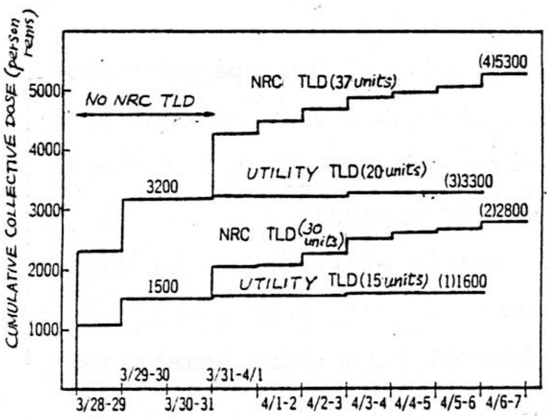

Figure 1

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

Here, four different sets of cumulative doses are shown:

(1) 1,600 person rems based on 15 TLDs deployed within the 8 mile-radius by the utility; 5

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

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

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

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

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

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

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

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

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

And as the 20 utility TLDs are concerned, it is

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

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

$$770 / 0.05 \approx 15,400 \text{ person rems}$$

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

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

NOBLE GAS RELEASES

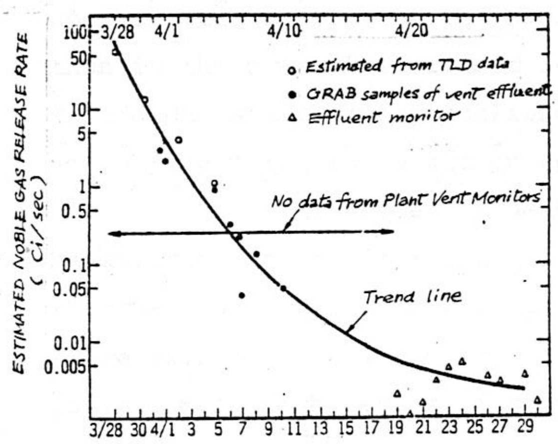

Figure 2

Estimated noble gas release rate by the utility.[4] The earliest two values based on data from the TLDs are underestimated as to be less than one fourth the actual level.

Evaluating the released amount of radioactive noble gases solely on the bases of this uncorrected TLD data, combined with the available meteorological information, cannot but result in an underestimation of the released levels. The final conclusion by NRC (NUREG-0600)[5] adopts their own preliminary estimation made in their July report[6] of 1.0 X 10E7 Ci for the total amount of the noble gas releases. This July report presents a sequence of the noble gas releases (see Figure 2) tabulated after a detailed calculation with a computor system. However, such detailed and precise calculations cannot correct an extensive loss of actual, basic data.

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

$$3,500 / 16,200 = 0.22$$

should be adopted to correct the final estimation made by NRC of the amount of noble gas releases. Thus, instead of 1.0 × 10E7 Ci (or 9 × 10E7 Ci in terms of Xe-133) should be the estimate for the amount of noble gases released.

IODINE RELEASES

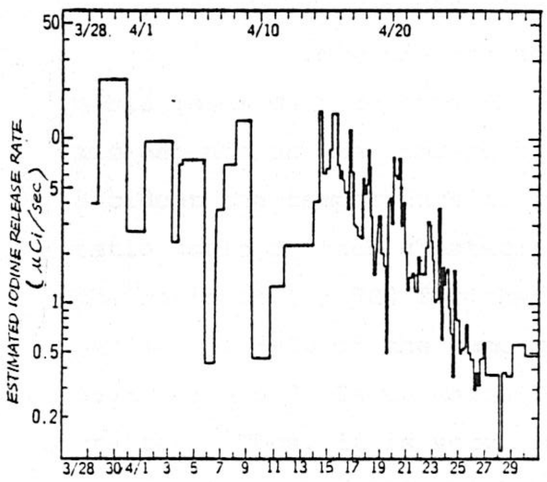

Figure 3

Radioactive iodine release rate based on TMI-2 vent monitors (charcoal cartridges).[8]

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

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

The Japanese Atomic Energy Commission's second report on the TMI-2 accident states that this sudden rising of the monitored iodine release is due to the filter changings done between April 12 and April 20.[9] If this were the case, however, the effects of the replacement of filters would appear in peaks rather than in the overall increased level as shown in Figure 3. Moreover, according to the NRC staff report published in June, those cartridge changings were done not during April 12-20 but on April 20, 24-25, and May 23-24.[10]

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

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

1 / 3,400.

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

1 / 8,800

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

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

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

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

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

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

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

1) Ad Hoc Population Dose Assessment Group (L. Battist *et al.*), "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), May 10 (1979)

2) Ibid.

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

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

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

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

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

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

9) 原子力委員会，米国原子力発電所事故調査特別委員会，「米国原子力発電所事故調査報告書—第2次—」，9月13日 (1979)

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

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

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

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

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