TMI-Hearing

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SECRETARIAT RECORD COPY

JUN 19 1979

MEMORANDUM FOR: Commissioner Ahearne

(Signed) T. A. Rehm

THRU: Executive Director for Operations

FROM: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

SUBJECT: QUESTIONS FOLLOWING UDALL HEARINGS OF JUNE 4, 1979

Your memorandum of June 7, 1979 to the Executive Director for Operations raised several questions related to the June 4, 1979 Udall Hearings. Answers to each of your questions are provided below.

QUESTION (1)(a): Regarding containment isolation:
(a) What plants (operating and in construction) have only single signal isolation?

ANSWER:

The following plants have only a single isolation demand signal. In all cases the signal is containment pressure.

Combustion Engineering	Westinghouse	Babcock & Wilcox
Maine Yankee	Yankee Rowe	Oconee 1,2 & 3
Arkansas 2	San Onofre 1	Arkansas 1
Calvert Cliffs 1 & 2	Connecticut Yankee	TMI-1
San Onofre 2 & 3	Surry 1 & 2	Crystal River 3
Waterford 3		TMI-2

QUESTION (1)(b): How difficult would it be to add triggers for radiation and positive pressure?

ANSWER:

The traditional signal used for containment isolation by the industry is containment high pressure (2-5 psig), and all light water power reactors utilize this signal.

6/1/1/

The most readily available diverse signal which could be used for containment isolation is the safety injection signal. The signal is already available and is generated by the reactor protection system. Hence it is a safety grade signal. It could be incorporated as a diverse actuating signal for containment isolation quite readily. The incorporation of radiation level could not be accomplished as easily. In many plants the current radiation monitors in the containment are not safety grade and in some cases not redundant. Incorporation of radiation as a diverse containment isolation signal would in most cases require acquisition of new equipment and design and installation of the monitoring system and controls. In most cases incorporation of radiation level as a diverse safety grade signal would entail design, procurement and installation activities which might take 6 months to a year to complete as opposed to relatively rapid capability to incorporate safety injection as a diverse containment isolation signal. The backfit of diverse containment isolation signals will be recommended by the Lessons Learned Task Force to the RRRC on June 22 and to the Commission on June 26. The backfit review for operating plants will be managed by the Bulletins and Orders Task Force.

QUESTION (2): Congressman Weaver referred to a paper by Dr. Weinberg regarding radioactive wear and tear on structural parts; written about 1977. Can you identify the paper and obtain a copy?

ANSWER:

We have not been able to identify the paper.

Mr. Mark Rice from Congressman Weaver's office indicated that a newspaper article supposedly quoted passages from an article by Alvin M. Weinberg (ORNL) regarding radiation effects on material properties. Mr. Rice could not identify the newspaper which printed the article.

We contacted Dr. Weinberg and he has said that he was not the author of a paper in this technical area.

QUESTION (3): Have we analyzed the weather conditions existing during the TMI accident to determine whether a significant plume could have missed the monitors?

ANSWER:

Yes. This question has been separately evaluated by the NRC and DOE. Both evaluations are described in NUREG-0558, "Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station", issued May 1979 (copy enclosed). The methods used to calculate plume dose as a function of plume-detector position are detailed in NUREG-0558. No significant plume escaped inclusion in the dose calculations reported. Amplification of the NRC methodology is given in "Detailed Calculations of Population Dose Estimates at Three Mile Island During the Period of March 28, 1979, 4 A.M. through March 31, 1979, 4 A.M." (copy enclosed).

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosures:
1. NUREG-0558, "Population Dose and Health Impact of the Accident at Three Mile Island Nuclear Station", issued May 1979
2. Detailed Calculations of Population Dose Estimates at Three Mile Island During the Period of March 28, 1979, 4 A.M. through March 31, 1979, 4 A.M.

cc: Chairman Hendrie
Commissioner Gilinsky
Commissioner Kennedy
Commissioner Bradford
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DETAILED CALCULATIONS OF POPULATION DOSE ESTIMATES AT THREE MILE ISLAND DURING THE PERIOD OF MARCH 28, 1979, 4 A.M. THROUGH MARCH 31, 1979, 4 A.M.

RADIOLOGICAL ASSESSMENT BRANCH/NRR
U.S. NUCLEAR REGULATORY COMMISSION
WASH., D.C.

MAY 6, 1979

On May 10, 1979, the Ad Hoc Population Dose Assessment Group completed a report which described the population dose and potential health consequences that occurred as a result of the accident at the Three Mile Island Nuclear Station, Unit 2. The Ad Hoc Group was made up of individuals from the Environmental Protection Agency, the Department of Health, Education and Welfare, and the Nuclear Regulatory Commission. Several different methods were used to estimate the population dose presented in the report. The method utilizing meteorological dispersion factors is described below.

As the description on p. 42 of the report indicates the dose, H, delivered to an individual is equal to

$$H = (X/Q)\,K \qquad (1)$$

where

- H = dose received over the time interval, Δt (mrem)
- Q = source (Ci/sec)
- (X/Q) = meteorological dispersion factor (sec/m^3)*
- DF = dose factor (mrem - m^3/Ci-sec)
- Δt = length of time interval (sec)
- K = $Q(DF)\,\Delta t$.†

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* The meteorological dispersion factor at some point downwind of the source is equal to the concentration at that point, X, divided by the rate of release of material from the source, Q, and is a measure of the rate at which material disperses. The X/Q values in Tables 1 and 2 were calculated by summing the spatial averages of the central and two adjacent sectors at ground level and averaging them over the time period.

† Note that K is independent of location for any specific time interval.

The total 50-mile population dose, D, is determined by taking the sum of the product of the dose, H, and the population, P_i, in each sector segment within the 50-mile radius:

$$D = \sum_{\substack{\text{all sector}\\ \text{segments}}} H_i P_i = K \sum_{\substack{\text{all sector}\\ \text{segments}}} (X/Q)_i P_i \qquad (2)$$

Table 1 lists the X/Q values for each sector segment for the first time period (3/28; 4 a.m. to 3/29; 8 a.m.), and Table 2 lists these values for the second time period (3/29; 8 a.m. to 3/31; 4 a.m.). Tables 3 and 4 list the products of the X/Q values times the population values for each sector segment for the first and second time periods, respectively. The entry in the lower right hand corner of these tables is the sum of this product for each time period: $\sum(X/Q)_i P_i$. Tables 5 and 6 list the net dose values for each Met. Ed. sampling location along with the respective station X/Q values interpolated from the data of Tables 1 and 2. The average values of K was computed by averaging the individual K values, excluding stations located 9 miles or greater from the plant. These stations were excluded because they appear not be a part of the K distribution. Multiplying the $\sum(X/Q)_i P_i$ value of 0.13 of Table 3 by the $\overline{K}$ value of $1.4 \times 10^{+7}$ of Table 5 results in D = 1900 person-rem for the first time period; multiplying the $\sum(X/Q)_i P_i$ value of 0.36 of Table 4 by the $\overline{K}$ value of 1.9×10^{6} of Table 6 results in D = 680 person-rems for the second time period. These values of D appear in Figure 3.6 and on p. 43 of the Ad Hoc Committee Report.

Average Downwind X/Q Values for Mar. 28 (4 AM) to Mar. 29 (8 AM) (Sec/M³)

	0.5	1.0	2.0	3.0	4.0	5.0	10.0	20.0	30.0	50.0 Mi.
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-8
NNE	5.1E-6	1.4E-6	4.3E-7	2.2E-7	1.4E-7	9.7E-8	3.5E-8	1.4E-8	8.3E-9	4.4E-9
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-10
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-10
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-10
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-10
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-9
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-9
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-9
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-9
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-8
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-8
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-8
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-8
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-8

* No wind in this sector for the period.

Table 2

Average Downwind χ/Q Values for Mar. 29 (8 AM) to Mar. 31 (4 AM) (Sec/m^3)

	0.5	1.0	2.0	3.0	4.0	5.0	10.0	20.0	30.0	50.0 Mi.
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	3.2E-6	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	6.5E-6	2.3E-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-7	3.3E-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

$\chi/Q \times P$

Product of χ/Q and population for each Sector Segment
Mar. 28 (4AM) to Mar. 29. (8AM)

	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-50	
N	2.6E-4	8.6E-4	5.1E-3	2.6E-3	1.8E-4	3.9E-3	1.5E-3	4.1E-4	1.5E-3	
NNE	2.8E-4	1.0E-4	7.2E-5	1.0E-4	5.2E-5	1.0E-3	6.3E-4	9.5E-5	4.9E-4	
NE	1.1E-5	5.4E-6	5.6E-6	5.9E-6	1.8E-6	1.8E-5	1.6E-4	8.1E-5	1.0E-4	
ENE	1.7E-5	2.5E-6	4.2E-6	6.9E-6	2.8E-6	1.4E-5	4.6E-5	3.3E-5	3.3E-4	
E	1.3E-5	2.7E-6	8.9E-7	2.0E-6	6.0E-6	9.4E-5	8.6E-5	1.4E-4	1.2E-4	
ESE	9.6E-7	8.6E-7	1.7E-6	1.7E-6	1.4E-6	1.3E-5	8.2E-5	1.4E-4	5.7E-5	
SE	0	0	0	0	0	0	0	0	0	
SSE	1.7E-4	1.2E-4	2.3E-5	8.5E-6	3.0E-6	1.9E-4	8.3E-4	7.8E-5	3.4E-4	
S	0	0	2.7E-5	8.9E-5	9.4E-5	6.3E-4	2.1E-3	1.0E-4	3.7E-4	
SSW	3.2E-4	1.1E-4	2.3E-4	4.7E-5	1.0E-4	6.8E-4	1.2E-3	6.1E-4	4.5E-4	
SW	2.6E-4	9.6E-5	5.6E-5	8.9E-5	2.4E-5	3.2E-4	3.1E-4	1.9E-4	2.4E-4	
WSW	5.2E-4	1.4E-3	2.1E-4	7.7E-4	1.4E-4	1.3E-3	9.9E-4	5.0E-4	1.1E-3	
W	7.5E-4	2.3E-3	7.9E-5	3.9E-4	4.3E-4	3.9E-3	4.3E-3	2.6E-3	1.3E-3	
WNW	5.2E-4	7.7E-4	6.0E-4	2.5E-4	2.0E-4	7.3E-3	1.6E-2	1.2E-3	4.4E-4	
NW	7.0E-4	5.8E-4	1.1E-4	4.1E-5	7.6E-4	1.3E-2	1.6E-2	6.1E-4	7.8E-4	
NNW	8.1E-4	5.0E-4	2.1E-3	8.4E-4	1.1E-3	6.9E-3	3.9E-3	6.2E-4	6.8E-4	
SUMS	4.6E-3	6.8E-3	8.5E-3	5.2E-3	3.0E-3	3.9E-2	4.8E-2	7.4E-3	8.2E-3	1.3E-1

SUM OF ALL ENTRIES →

$\chi/Q \times P$: Product of χ/Q and Population for each Sector Segment
Mar. 29 (8AM) to Mar. 31 (4 AM)

	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-50	
N	3.4E-4	1.1E-3	7.5E-3	3.7E-3	2.7E-4	5.4E-3	2.4E-3	6.7E-4	2.4E-3	
NNE	1.4E-3	5.9E-4	4.5E-4	7.2E-4	3.7E-4	8.1E-3	5.2E-3	8.1E-4	4.1E-3	
NE	8.8E-4	8.4E-4	5.6E-4	5.1E-4	1.4E-4	1.3E-3	8.7E-3	3.5E-3	3.8E-3	
ENE	9.2E-4	2.6E-4	3.1E-4	4.2E-4	1.5E-4	6.8E-4	1.7E-3	1.0E-3	9.1E-3	
E	4.6E-4	1.9E-4	4.2E-5	8.2E-5	1.0E-4	3.0E-3	2.0E-3	2.8E-3	2.1E-3	
ESE	9.0E-5	1.5E-4	2.2E-4	1.7E-4	1.2E-4	1.1E-3	5.4E-3	7.8E-3	2.6E-3	
SE	1.2E-4	5.9E-4	1.7E-4	2.4E-4	3.2E-4	1.2E-3	4.8E-3	9.9E-4	2.2E-3	
SSE	1.9E-3	1.2E-3	2.6E-4	1.0E-4	3.6E-5	2.3E-3	1.1E-2	1.0E-3	4.9E-3	
S	0	0	4.0E-4	1.3E-3	1.4E-3	1.0E-2	3.7E-2	2.0E-3	7.2E-3	
SSW	2.1E-3	7.7E-4	1.5E-3	3.2E-4	7.5E-4	5.0E-3	9.2E-3	5.2E-3	3.8E-3	
SW	2.1E-3	7.6E-4	4.5E-4	7.8E-4	2.0E-4	2.8E-3	3.0E-3	1.9E-3	2.6E-3	
WSW	7.8E-4	2.1E-3	3.1E-4	1.1E-5	2.3E-4	2.1E-3	1.5E-3	8.7E-4	2.0E-3	
W	9.7E-4	2.9E-3	9.7E-5	4.9E-4	5.6E-4	5.2E-3	6.0E-3	3.8E-3	2.0E-3	
WNW	5.9E-4	8.4E-4	6.8E-4	2.9E-4	2.3E-4	8.5E-3	1.9E-2	1.5E-3	5.6E-4	
NW	5.8E-4	4.6E-4	9.6E-5	3.2E-5	6.1E-4	1.0E-2	1.4E-2	5.1E-4	7.2E-4	
NNW	7.6E-4	4.8E-4	1.9E-3	8.3E-4	1.1E-3	7.1E-3	4.2E-3	6.9E-4	7.8E-4	
	1.4E-2	1.3E-2	1.4E-2	9.9E-3	6.5E-3	7.3E-2	1.4E-1	3.5E-2	5.0E-2	3.6E-1

SUM OF ALL ENTRIES →

Table 5

3/28 (4AM) to 3/29 (8AM)

$\overline{K} = 1.4$ E+7

Station	Dose mR	(χ/Q)	K
1S2	83.9	3.0E-5	2.8 E+6
1C1	7.8	8.6E-7	9.1E+6
2S2	31.5	2.5E-6	1.3E+7
4S2	21.1	1.6E-6	1.3E+7
4A1	6.4	3.0E-7	2.1E+7
4G1	1.3	4.5E-9	2.9E+8
5S2	17.6	3.0E-6	5.9E+6
5A1	4.7	6.0E-7	7.8E+6
7F1	4.4	0.	—
7G1	4.2	0.	—
8C1	2.5	1.6E-7	1.6E+7
9S2	11.0	3.0E-6	3.5E+6
9G1	4.5	9.0E-9	5.0E+8
10B1	24.8	1.1E-6	2.3E+7
10B1	28.8	1.1E-6	2.6E+7
11S1	201.	2.0E-5	1.0 E+7
12B1	51.6	2.6E-6	2.2E+6
14S2	118.	3.0E-5	3.9E+6
14S2	135.	3.0E-5	4.5E+6
15G1	3.0	7.0E-6	4.3E+5
16S1	1020.	4.0E-5	2.6E+7
16A1	441.	2.0E-5	2.2E+7
16A1	896.	2.0E-5	4.5E+7

Table 6

3/29 (8AM) to 3/31 (4AM)

$\overline{K} = 1.9E+6$

Station	Dose mR	(χ/Q)	K
1S2	19.7	2.0E-5	9.8E+5
1C1	2.9	1.2E-6	2.4E+6
2S2	32.2	1.7E-5	1.9E+6
4S2	124.	2.9E-5	4.3E+6
4A1	34.0	1.6E-5	2.1E+6
4G1	0.9	1.7E-7	5.3E+6
5S2	49.0	4.6E-5	1.1E+6
5A1	8.0	1.7E-5	4.7E+5
7F1	7.5	1.7E-5	4.4E+5
7G1	7.1	1.7E-5	4.2E+5
8C1	0.7	2.9E-7	2.4E+6
9S2	0.7	1.7E-7	4.1E+6
9G1	10.5	1.9E-6	5.5E+6
10B1	25.0	3.6E-5	1.6E+6
10B1	1.0	2.4E-7	4.2E+6
11S1	14.8	6.5E-6	2.3E+6
12B1	107.	1.2E-4	8.9E+5
14S2	9.2	3.6E-6	2.6E+6
14S2	48.7	4.0E-5	1.2E+6
15G1	1.6	6.0E-8	2.7E+7
16S1	83.3	4.8E-5	1.7E+6
16A1	45.0	1.9E-5	2.4E+6
16A1	—	—	—