October 25, 1973

UNITED STATES OF AMERICA
ATOMIC ENERGY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of METROPOLITAN EDISON COMPANY, et al. (Three Mile Island Nuclear Station, Unit 1)	)))))))	Docket No. 50-289

APPLICANTS' PREPARED TESTIMONY
RELATED TO
AS LOW AS PRACTICABLE

ALAP Regulations and Regulatory Guidelines

During the nearly ten years since Three Mile Island Nuclear Station's (TMI's) initial site studies and subsequent design and construction, the regulations and guidelines governing the release of activity in the liquid and gas effluents from a nuclear power plant have undergone considerable change. The basic regulations governing radioactivity in the liquid and gas effluents through December, 1970, were those contained in 10 CFR Part 20 which is still effective. The bulk of the design and procurement of equipment and components for the TMI-1 liquid and gas radwaste systems was completed by September, 1969. Therefore the 10 CFR Part 20 concentrations basically

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set the performance standards for these systems through the design and procurement stages for the TMI-1 radwaste system. At Met Ed's request, however, the liquid and gas systems were designed to achieve small fractions of the 10 CFR Part 20 concentration limits in the liquid and gas effluents of TMI-1. This necessarily included full flow charcoal filters in the exhaust ventilation systems of the auxiliary, fuel handling and reactor buildings.

In April of 1970, the AEC proposed a change to the regulations governing the release of radioactivity in liquid and gas effluents from nuclear power plants. Under the proposed regulation, the designer had to demonstrate that the design of a nuclear plant's radioactive liquid and gas waste treatment systems made them capable of "keeping the levels of radioactive materials in effluents to unrestricted areas as low as practicable". The proposed regulation qualitatively defined "as low as practicable" as "As low as practicably achievable taking into account the state of technology, and the economics of the improvements in relation to benefits to the public health and safety and in relation to the utilization of atomic energy in the public interest" (10 CFR Section 50.34a(a)). Thus, the qualitative standard indicated that there was an economic as well as a technical optimum to what had to be provided to achieve "as low as practicable". On December 3,

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1970, the AEC incorporated the proposed regulation on "as low as practicable" into 10 CFR Part 50 to become effective as of January 2, 1971.

Recognizing that the qualitative definition of "as low as practicable" was open to subjective interpretation and did not provide numerical guidance, the Commission, on June 9, 1971, issued a proposed Appendix I to 10 CFR Part 50, which attempts to quantify "as low as practicable". This proposed regulation has been the subject of an extensive adjudicatory rulemaking proceeding which now involves consideration of the AEC's Final Environmental Statement related to Appendix I, WASH-1258,[1/] issued in July of this year. Proposed Appendix I quantifies "as low as practicable" by specifying both allowable radioactivity concentration limits and periodic quantity limits in the liquid and gas effluents from nuclear power plants. It also allows variance from these limits provided that the designer can afford reasonable assurance that effluent concentrations and quantities different from those specified will result in less than a designated annual exposure to the whole body or any organ of an individual. The generally applicable dose limit in proposed Appendix I is 5 mrem to a hypothetical "worst case" individual. However, in the case of Iodine 131, AEC's latest guidance in Regulatory Guide 1.42

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(which is incorporated into WASH-1258 as Annex 9A) provides that the annual thyroid dose objective due to Iodine 131 exposure is 15 mrem per year.

Present ALAP Doses in Perspective

In order to put in perspective the range of doses (5 mrem whole body and 15 mrem thyroid) presently considered to be ALAP, a brief discussion of comparative doses from natural background and other radiation sources is included in this section of this testimony.

We are all exposed to radiation in varying degrees from the ground, sky, and air around us, as well as from the food we eat. The average natural radiation exposure to persons living in the United States is estimated to be about 130 mrem per year, of which 25 mrem results from internal radiation.[2/] The average exposure to persons in the Harrisburg area is closer to 112 mrem per year because terrestrial radiation levels are slightly lower than average.[3/] The source of this exposure is cosmic rays and naturally occurring radioactive elements in the earth. The exposure to cosmic radiation increases with elevation above sea level, therefore, persons living in mountain areas or who frequently fly in airplanes receive a greater annual exposure than persons at sea level. We receive radiation directly from many minerals containing uranium and thorium isotopes in the ground or in the construction materials in our homes. A

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radioisotope of potassium is the most significant radioactive substance in our food. An additional small amount of exposure is received through radioactive gases in the air.

In addition to natural radiation, we are also exposed to man-made sources such as medical X-rays, luminous dials on watches, bomb detonations in the atmosphere, and television. It is estimated that an additional exposure of 44 mrem per year may be received on the average from other than natural sources, mostly from medical sources. 1/ One measure of the extent of population exposure is to add all the radiation exposures received by each individual in a population group. This resulting quantity is referred to as man-rem. The natural background population exposure within a 50 mile radius of the TMI side is computed to be about 340,000 man-rem. The thyroid gland also receives this dose.

Application of the ALAP Standard to TMI-1

As stated earlier, the TMI-1 liquid and gas radwaste systems were designed to meet standards considerably more demanding than those set forth in 10 CFR Part 20 which, at the time of their design, were the basic criteria to be met. On the basis of calculational results presented in the TMI-1 FSAR and the TMI Environmental Report, TMI-1 can be operated with the currently installed radwaste systems such that:

1. The concentrations of radioactivity in its liquid and gas effluents are considerably lower than the limits set for them in 10 CFR Part 20;

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2. The concentrations of radioactivity in its liquid and gas effluents meet the intent of the qualitative "as low as practicable" standard in 10 CFR Section 50.34a; and

3. The maximum offsite doses to individuals due to radioactivity in TMI-1's effluents are less than the limiting values specified in the proposed Appendix I and Regulatory Guide 1.42.

Table 1 attached to this testimony shows that with the present design the annual maximum individual whole body and thyroid exposures due to gaseous effluents during routine operation at TMI-1 are 0.7 millirem per year and 5.4 millirem per year respectively. These doses are considerably below present ALAP standards. For purposes of comparison, Column (1) of Table 1 also reflects the whole body and thyroid doses of 112 millirem per year due to background radiation. If a containment kidney system employing charcoal filtration were added to TMI, the thyroid dose would be reduced to that shown in column (5) of Table 1. Similarly, if the main condenser vacuum pump discharge is charcoal filtered, the individual thyroid dose would be reduced to that given in column (7). If both of these modifications were made, the resultant thyroid dose would be that shown in column (9). The individual doses shown in Table 1 were calculated based on continuous operation with one quarter of one percent failed fuel in accordance

with current AEC guidelines. The whole body gamma and iodine inhalation doses reflected in Table 1 are those for an individual at the worst site boundary location. The iodine dose to the thyroid is that of a child who drinks milk from the cows nearest to the site boundary and was calculated using the latest meteorological diffusion and other assumptions of Regulatory Guide 1.42 for computing thyroid dose through the cow-milk pathway. Other pathways to the thyroid are also included but are small in comparison to that of the cow-milk pathway. Whole body doses were computed usin the semi-infinite plume model for gamma radiation as given in Regulatory Guide 1.4. The thyroid gland is assumed to receive the same dose as the whole body from gamma irradiation. The doses, as calculated above, represent the highest potential doses to an individual off-site although it is unlikely that any one actual individual would satisfy the conditions necessary to receive the highest doses from each pathway evaluated.

In the Final Environmental Statement related to proposed Appendix I (WASH-1256), the AEC measures the cost effectiveness of adding environmental radwaste system modifications by comparing the cost of the additional equipment in dollars to the benefit to be derived from the additional equipment in terms of reduction in population exposure. We have employed this technique to display the cost effectiveness

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of adding a charcoal filter containment kidney and/or a charcoal filter on the main condenser vacuum pump at TMI-1. Total population doses, expressed in "man-rem" are shown in Columns (2), (4), (6), (8), and (10) of Table 1.

Adding an 18,000 cfm charcoal kidney system inside containment would reduce the present total population thyroid dose of 306 man-rem to a dose of 70 man-rem; there would be no reduction in the whole body dose. The current cost of purchasing and installing this equipment in TMI-1 is estimated to be $300,000. Thus, the cost/benefit of this modification can be expressed as the ratio of $300,000 to 236 man-rem, or $1271 per thyroid man-rem.

Adding a charcoal filter system in the main condenser vacuum pump discharge would reduce the present total population thyroid dose of 306 man-rem to a dose of 282 man-rem; there would be no reduction in whole body dose. The current cost of purchasing and installing this equipment in the plant is estimated to be $100,000. Thus, the cost/benefit of this modification can be expressed as the ratio of $100,000 to 24 man-rem or $4167 per thyroid man-rem.

If, as suggested in the next section of this testimony, doses were estimated on the basis of .1% fuel failure instead of .25%, the cost to benefit ratio would be increased by a factor of two and one half. Thus, the cost/benefit ratio for the charcoal kidney system would be $3177 per thyroid man-rem, and for the charcoal filter for the vacuum pump discharge would be $10,416 per thyroid man-rem.

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A number of cost values (see WASH-1250, p. 1-28) for a whole body man-rem have been suggested by various authors, ranging from $100 to $600 per man-rem. While no values have been suggested for dose to single organs such as the thyroid (which is the only dose affected by either of the modifications considered in this testimony), the relative risk of the dose to the thyroid compared to whole body dose suggests a lower value for population thyroid dose than those referred to above for population whole body dose. This would be consistent with present Part 20 limitations which establish limits for individual organ doses at three times the level for whole body doses. Even ignoring the whole body/individual organ consideration, the cost effectiveness of the two modifications are far in excess of the range of values which have been suggested.

Failed Fuel Assumption

As stated above, in the foregoing dose calculations we used 0.25% failed fuel as a source term. This was the approach used by the AEC Staff. They averaged the percentage of maximum amount of failed fuel associated with presently operating PWRs that have Zircaloy clad fuel, and found it to be 0.23%.[4] Then 0.25% failed fuel was used to calculate the activity release from and the environmental impact of the TMI Nuclear Station. This is equivalent to saying that

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the activity release from TMI-1 will be consistent with the average maximum percent failed fuel derived from operating experience. This is conservative, since the referenced operating data reflects the relatively high fuel failure rate experienced by the early, unpressurized Zircaloy clad fuels. New, improved Zircaloy clad fuels are expected to exhibit a significantly lower failure rate. Thus, a 0.1% failed fuel was considered to be the maximum rate for the average amount of failed fuel and was used by Metropolitan Edison in evaluating the environmental impact of TMI-1 over its 40-year design life. However, since short term operation with higher amounts of failed fuel is possible, 1% failed fuel was used in Chapters 11 and 14 of the TMI-1 FSAR as a conservative basis for evaluating the consequences of accidents and for the design of the radioactive waste disposal system and the shielding of auxiliary system components.

The operating limits (Technical Specification Limits) for TMI-1 are based on the measured amount of activity in the plant systems or on the measured amount of activity actually released from the unit and are not based on the percentage of failed fuel used as the expected design value. This approach assures that the dose values used during the design phase to assess the effects of activity releases on the health and safety of the public and on the environment

will not be exceeded during the operating phase. Thus, regardless of the amount of failed fuel assumed in the design phase and regardless of the amount of failed fuel actually experienced, if TMI-1's actual activity levels become greater than the Technical Specification limits, an equipment or operating change will be made to keep the activity levels and activity releases within the accepted limits.

While power transients may affect the radioactive nuclide inventory in the reactor coolant, the radwaste system has been designed to treat radionuclides associated with up to 1% failed fuel and can accommodate such transients.

REFERENCES:

1/ Final Environmental Statement Concerning Proposed Rule Making Action: Numerical Guides for Design Objectives and Limiting Coditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, WASH-1258.

2/ Estimates of Ionizing Radiation Doses in the United States 1960-2000, USEPA, ORP/CSD 72-1, 1972.

3/ Natural Radiation Exposure in the United States, USEPA, ORP/SID 72-1, 1972.

4/ WASH-1258, Volume 2 (page B-3).

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TABLE 1 - INDIVIDUAL AND POPULATION DOSES*

	Natural Background		TMI 1 Gaseous Effluent/ Present Design		TMI 1 Gaseous Effluent/ Present Design Plus Containment Kidney Treatment		TMI 1 Gaseous Effluent/ Present Design Plus Vacuum Pump Treatment		TMI 1 Gaseous Effluent/ Present Design Plus Vacuum Pump and Containment Kidney Treatment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Organ	Individual (mrem/yr)	Population (man-rem)	Individual (mrem/yr)	Population (man-rem)	Individual (mrem/yr)	Population (man-rem)	Individual (mrem/yr)	Population (man-rem)	Individual (mrem/yr)	Population (man-rem)
Whole Body*	112	340,000	0.7	7	0.7	7	0.7	7	0.7	7
Thyroid (external gamma, inhalation, and ingestion)	112	340,000	5.4	306	1.7	70	5.0	282	1.3	46

*Plant doses are from plume gamma dose.

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