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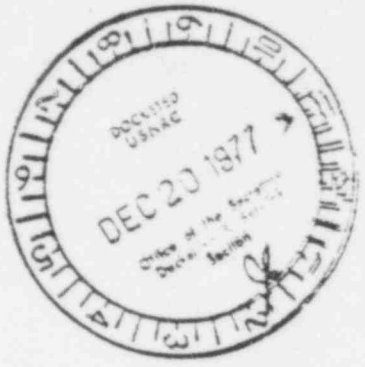
UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Edward Luton, Chairman
Ernest O. Salo, Member
Gustave A. Linenberger, Member

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| In the Matter of<br><br>METROPOLITAN EDISON COMPANY,<br>JERSEY CENTRAL POWER & LIGHT COMPANY,<br>and<br>PENNSYLVANIA ELECTRIC COMPANY<br><br>(Three Mile Island Nuclear Station,<br>Unit No. 2) | Docket No. 50-320 |

SERVED DEC 20 1977

December 19, 1977

INITIAL DECISION

Appearances

Chauncey R. Kepford, for Joint Intervenors York Committee for a Safe Environment and Citizens for a Safe Environment

Karin W. Carter, Esq., for the Commonwealth of Pennsylvania

George W. Trowbridge, Esq., and Ernest L. Blake, Esq., Shaw, Pittman, Potts and Trowbridge, for the Applicants

Henry J. McGurren, Esq. and Gregory H. Fess, Esq., for the NRC Regulatory Staff

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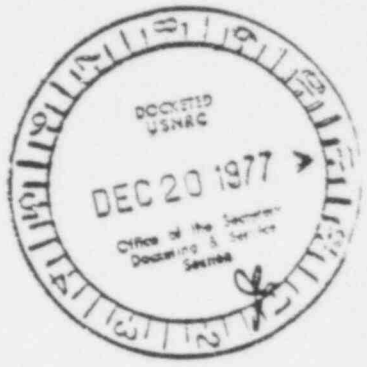


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INITIAL DECISION

I. Introduction

1. This is a proceeding on the application of Metropolitan Edison Company, the Jersey Central Power and Light Company, and the Pennsylvania Electric Company ("Applicants") for licenses to construct and operate the Three Mile Island Nuclear Station, Unit No. 2 ("TMI-2"). The plant is located adjacent to a similar unit (Three Mile Island Nuclear Station, Unit No. 1) on Three Mile Island in the Susquehanna River in Londonderry Township, Dauphin County, Pennsylvania.

2. Construction of TMI-2 was authorized on November 4, 1969. By application dated April 4, 1974, Applicants requested authorization,

pursuant to Section 104.b of the Atomic Energy Act of 1954, as amended, to possess, use and operate TMI-2, a pressurized water nuclear reactor, at a steady state power level of 2772 megawatts thermal. On May 20, 1977, the Commission issued a notice which provided that any person whose interest might be affected by the proceeding could file a request for a public hearing in the form of a petition to intervene in accordance with the Commission's regulations contained at 10 CFR §2.714. Petitions to intervene were received from the Citizens for a Safe Environment and the York Committee for a Safe Environment (as "joint petitioners"), and from Mrs. Barbara Pradel of Greencastle, Pennsylvania. Additionally, the Commonwealth of Pennsylvania requested leave to participate as an interested State pursuant to 10 CFR §2.715(c). On July 24, 1974, the Atomic Safety and Licensing Board designated to rule on intervention requests granted the joint petitioners' request to intervene, granted the Commonwealth's request to participate, and denied the intervention petition of Mrs. Barabara Pradel.[1/]

3. This Atomic Safety and Licensing Board ("Board") has conducted a public evidentiary hearing to consider (1) issuance or denial of a full-term operating license for TMI-2 or its appropriate conditioning to protect environmental values, and (2) because TMI-2 is subject to the provisions of Section C of Appendix D of 10 CFR Part 50, whether considering those matters covered by Appendix D, the provisional construction permit for TMI-2 should be continued, modified, terminated, or appropriately conditioned

1/ On August 15, 1974, a petition to intervene was filed by Gertrude and Frederick Hellrich, et al.. Intervention was granted by the Board but thereafter, on August 20, 1976, these intervenors withdrew from the proceeding.

to protect environmental values. With respect to its consideration under Appendix D of the TMI-2 construction permit, the Board has conducted a full NEPA review covering both contested and uncontested environmental matters. With respect to the operating license the Board has, in accordance with §2.760a of the Commission's Rules of Practice, confined its findings to the matters in controversy.[2/]

4. The Board has considered the entire record of this proceeding and all of the proposed findings of fact and conclusions of law submitted by the parties. All proposed findings and conclusions submitted by the parties which are not incorporated directly or inferentially in this initial decision are rejected as being unsupported in law or in fact, or as being unnecessary to the rendering of this decision.

2/ At the evidentiary hearing in this matter, the Applicants and the Commission's Regulatory Staff made their responses to a number of questions asked by the Licensing Board. The matters raised by the Board concerning the issues in controversy among the parties, or the environmental review, are discussed in this decision. Additional matters raised by the Board are not discussed herein for the reason that examination of them has revealed no "extraordinary" circumstances warranting further concern (10 CFR §2.760a).

## II. Findings of Fact

### A. Matters in Controversy

Contention 1

> Applicants have failed to consider the environmental impact on the atmosphere and weather of the combined thermal releases of the generation facilities on the lower Susquehanna River. These releases will add a significant amount of energy to the local area to be dissipated by radiation and convection with possible alterations in the local climate. No operating license should be granted until such effects are discussed.

5. Witnesses presented by Applicants and the NRC Staff provided bases for concluding that there will be no significant impact on the local weather due to operation of TMI-2. The evidence indicates that, in reaching the conclusion that the impact of operation of TMI-2 on the weather will be negligible, consideration was given to the effects of TMI-2 operation on the air temperature, local air circulation patterns and the ambient wind fields convective cloud development, enhancement of fog, and the possibility of triggering convective vortices such as dust devils, water spouts and tornadoes. The only potentially noticeable effects on local conditions expected from operation of the cooling towers would be some increase in local fogging (Prepared testimony of Applicants' witness C. L. Hosler on Contention 1, following Tr. 284; prepared testimony of Staff's witnesses L. Andrews, E. H. Markee, R. L. Drake on Contention 1, following Tr. 304; Tr. 300, 301, 333-34; FSFES, Appendix B, §V.A.3.b., at pp. B-38, 39). Snowfall attributed to a cooling tower plume has been observed. However, the record indicates that such snow would not create a significant environmental problem, since the snowfall would be extremely localized.

Further, evidence indicates that plume meander lessens the potential for accumulation of snow and that snowfall attributable to the plume would only occur during the time of the year when snowfall would normally be expected. For snowfall to occur from the plume, the centerline of the cooling tower plume must fall below 10°F (-12°C) and the atmospheric conditions must be stable. TMI's size, considering both units, is significantly less than the 8,000-10,000 MW size which appears to be the threshold for a concentrated energy source to cause detectable effects on the climate. (Andrews, Markee, Drake, as cited above; Tr. 298, 314)

6. The Applicants and the Staff provided witnesses who addressed the concern raised in the contention that TMI's cooling tower releases in combination with releases from other power plants located along the Susquehanna could impact weather in the area. The Board, after considering the full record on this matter, concludes that this concern can be dismissed for the following reasons. The distribution of generating plants along the Susquehanna is such that they act independently on weather conditions; the impact of each on the atmosphere is diffused and lost before it can combine with impacts due to other plant releases under any conceivable combination of winds in the Susquehanna River Basin. If all the generating capacity which releases heat to the air along a 100-mile stretch of the Susquehanna were combined in one concentrated complex, one might expect local weather effects; spread over 100 miles, however, it is insignificant when compared to the naturally released energy in the same area.

(Witnesses Hosler; Andrews, Markee, Drake, as previously cited)

7. The Board finds that the environmental impact on the atmosphere and weather due to operation of TMI's cooling towers singly and in combination with releases of other generation facilities on the lower Susquehanna has been adequately evaluated and that any such impacts will be insignificant and within naturally occurring variations in the area.

Contention 2

The biological survey performed by the Applicants' consultant (as amended by Supplement II of the Environmental Report) is inadequate, in that it consists of little more than a listing of species which may be in the area. A more thorough survey is necessary, including population estimates on a year-round basis, to positively assess any possible impact of Unit 2 on the environment. No operating license should be granted until such a study is made.

8. Aquatic surveys, on specific aspects of the aquatic environment, have been initiated by the Applicant at varying times, some of which have been continuous on an annual basis. Some surveys have been overlapping in time and on species emphasis and although the purposes for the surveys may have differed (some served as background and operational monitoring for TMI-1), they have all contributed, with varying success, to the accumulation of usable data.

9. The evidence shows that an annual survey on the macroinvertebrate fauna was begun in 1967. In 1970, two aquatic biology programs were initiated to meet requirements imposed on the York Haven Power Project by the Federal Power Commission. Personnel from Millersville State College were engaged to conduct fish and macroinvertebrate studies of the Susquehanna River in the vicinity of Three Mile Island and the York Haven Hydroelectric Station. The fish study for Three Mile Island Nuclear Station, Unit 1, began in July 1970 and continued through October 1973 (Four summer seasons). The second aquatic study conducted during the TMI-1 preoperational period was a study of macroinvertebrates in the vicinity of the plant. The aquatic biological programs were increased in scope in 1974. Early in 1974 Metropolitan Edison Company's consultant, Ichthyological Associates, Inc., initiated an aquatic biological surveillance program to meet certain environmental technical specifications for [illegible]. These studies are being continued, although no NRC environmental technical specification requirements for TMI-1 are in effect at the present time. The history of these is summarized in Applicants' Exhibits 4, 5, 6, 7 and 8.

10. At the present time, the Applicant is continuing studies of impingement, entrainment of ichthyoplankton, benthic macroinvertebrates, fisheries, thermal plume mapping, ambient water quality and some supplemental studies. These include ichthyoplankton sampling in the reservoir, estimation of fish populations, and surveys (census), fish movements

and food habits (Tr. 956).

11. The impingement in 1974 was extrapolated to be 21,243 fish weighing 33.5 kilograms (73.7 lbs.). This is an extrapolation of 21, 24-hour surveys. The Applicants attempt to do two surveys per month. The intakes (three each for Units 1 and 2) have a three-eighths inch mesh with an intake velocity of 0.2 feet per second (Tr. 958-59). An estimated 82.7 lbs. were impinged in 1975. This was an extrapolation from 23 surveys in 1975.

12. The ichthyoplankton surveys consisted of taking six 10-minute samples (at four-hour intervals) in a 24-hour period, semi-monthly from April through October 1974 (Applicants' Answer to Board Questions, p. 7). The fourteen samples (April through October contained a total of 390 fish eggs and 167 larval of 18 taxa. In 1975, 67 larval fish, six juvenile fish, and zero fish eggs were collected. No extrapolations were attempted, as no reasonable confidence limits could be attached (Tr. 962).

13. Entrainment surveys for phytoplankton and zooplankton were done on a similar schedule, i.e. semi-monthly at four-hour intervals over a 24-hour period, (Applicants' Answer to Board's Questions, pp. 7-8; Tr. 962), and the Applicants' experts believed that the numbers entrained, directly associated with the volume of water pumped, were so small compared to the total biomass in the (so-called) reservoir that the biomass entrained was insignificant (Tr. 963).

14. Samples of zooplankton were taken at four-hour intervals during semi-monthly studies April through October 1974. A total of 85 taxa [30 through early September (Applicants' Answers to Board's Questions, pp. 8-9)] of zooplankton and other invertebrates was identified. Samples were taken at the intake and discharge and the mean values of percent zooplankton mortality ranged from 1.2% to 3.7% through September and 3.2 to 8.8% through October (Applicants' Answers to Board's Questions, p. 9). In 1975, 85 taxa of zooplankton and other invertebrates were identified and the mortality rates ranged from 0.6 to 9.6%.

15. Fishes were sampled at two-week intervals by seine and trapnet from April through October 1974. A total of 108 trapnet samples caught 1,970 specimens of 22 species. The channel catfish was the most common single species while the sunfish family accounted for approximately 50% of the trapnet catch. (Applicants' Answers to Board's Questions, p. 11). The seine collections caught 8,587 specimens of 30 species. The spottail and spotfin shiners were the most common. (Applicants' Answers to Board's Questions, p. 11). The effort and catches of trapnet fishing and seining were of the same orders of magnitude in 1975, while in 1976, 90 seine collections yielded 10,478 fish of 35 species. Significant differences in species rank at one upstream and one downstream station were observed between 1975 and 1976. The variations in fish abundance are attributed, by the Applicants' consultants, to year-class fluctuations. The fact that the macroinvertebrate communities have been sampled by three separate programs has lead to some confusion and difficulties in analyses. Since

1967, Dr. Wurtz has sampled annually, in the first week of August, at ten stations (Testimony of James E. Mudge, following Tr. 980). Starting in 1970, personnel from Millersville State College sampled eight stations at monthly intervals from May through November. Early in 1974, the Applicants' consultant, Ichthyological Associates, included macroinvertebrates in its sample program. Ichthyological Associates collected semi-monthly, April through October, at five stations. (Ibid.) The trend indicated by Dr. Wurtz' sampling was questioned by the Joint Intervenors (para. 33 of Joint Intervenors' Findings of Fact). There was a drop in numbers of species from 145 in 1967 to 79 in 1969 (mean per station varied from 48 in 1977 to 24 in 1969). The recovery (119, 118, and 106 in 1972, 1973 and 1974, respectively) has not been complete but is within the sampling error (means of 32, 29 and 30 per station). On the other hand, TMI-1 started operation in 1973 and it is doubtful that construction activities were the cause of the decline in 1968 and 1969. Dr. Wurtz attributes the decline to upriver perturbations. (FSES §II-13, B-18) This is illustrated by Station 8 which is well beyond the influence of TMI-1 and 2. The Board agrees that these declines were caused by influences other than construction and operation of TMI-1 and 2.

16. Selected water quality parameters were studied semi-monthly April through October 1974. The pattern of monthly distribution of the parameters, with some exceptions, was similar. (Applicants' Answers to

Board's Questions, p. 15). The parameters studied included total dissolved oxygen, total alkalinity, nitrate-nitrogen, nitrite-nitrogen, chlorides, and total suspended solids. The pattern of monthly distribution of the parameters with some exceptions was similar. Mean values were high in September and low in April and May.

17. The TMI-1 discharge plume was mapped semi-monthly May through December 1974, with additional mappings done during high and low ambient river temperature conditions. The discharge temperatures ranged from 5.6°C (10.1°F) to 3.9°C (7.0°F) above ambient river temperatures. Plume characteristics usually were distinguishable less than 20 meters into the river and downstream 50 meters. In 1975, 28 plume maps were made during various river flow conditions and station operation levels. In 1976, 33 plume surveys were conducted at various river flow conditions and station operation levels.

18. Larval fishes were sampled in 1974 by towed 0.5-meter nets during semi-monthly 24-hour studies and during weekly daytime surveys May through September as reported in the 1974 Supplemental Report. A total of 467 larvae was taken during the 24-hour studies. Cyprinids were the most common; Catostomids, Percids, and Ictalurids, and Centrarchids were also taken. Three stations in York Haven Pond were sampled for fishes by fyke net in October and November 1974 (1974 Supplemental Report). Ten collections caught 59 specimens of eight species. Some 137 specimens of

12 species were taken in 21 trapnet collections during June and July. Sunfish were the most common. The sampling was repeated in 1975 (1975 Supplemental Report). Trawl collections were taken in the center and east channels of the Susquehanna River in 1974 (in the vicinity of TMINS). A boat-mounted electrofisher was used in the York Haven Pond during July through November 1974 when 2,903 fish of 24 species was captured. The redbreast sunfish, pumpkinseed, rockbass and smallmouths comprised 77.5% of the catch. Population estimates of the larger fishes were attempted in 1974 and in 1975 by the conventional methods of capture, tagging, and then recapture using a tag-to-untag ratio to determine the estimates.

19. A creel census was conducted by interviewing over 2,000 anglers in 35 surveys from May through December 1974. The creel census was repeated in 1975. The catch per unit of effort 1974 was 0.93, in 1975 it was 0.92 and in 1976 it was 0.93, i.e. a fisherman could expect to catch approximately one fish per hour. The fishery is considered to be a good smallmouth bass and sunfish fishery. The fishery consists of approximately 11,000 angler days.

20. The study of diseases in natural (wild) populations of fishes is difficult. The best that can be done is to superficially examine representative samples up- and down river from the plant, for external parasites, tumors and any other abnormalities. During periods of high temperatures, monitoring for bacteria (particularly Aeromonas) is worthwhile; however, any causal implications with respect to the operation of

the plant would be speculative. The best indicator at TMI has been the catch per unit of effort in the sampling year and in the recreational catch. The Board has not seen any undue causes for concern.

21. There was extensive cross-examination of both the Applicants' (Tr. 1992-2039) and Staff's (Tr. 2041-2073) panels of witnesses presented to address aquatic impacts, particularly with respect to the capability of aquatic monitoring programs to detect adverse impacts caused by station operation. Intervenors p sed numerous questions with respect to how large a change in species composition would have to be in order to conclude that a significant effect had occurred, and how a determination would be made that the nuclear facility had caused the effect. (Tr. 2011-30; 2043-2055; 2057-63; 2066-73). The testimony of both the Applicants' and Staff's witnesses was in agreement that no specific percent or number could be placed on the magnitude of impact which an aquatic species must experience in order to classify the impact as significant. The witnesses consistently testified that numerous parameters had to be measured in order to determine the significance of the aquatic impact and its source. Included among these parameters would be measurements from sampling stations outside the plant's impact area, (Tr. 2015, 2024-25, 2027, 2052-53) the time of year (Tr. 2017) previous catastrophic events (Tr. 2099-2100, 2019, 2058-59), turbidity, pollution load, river level, temperature changes (Tr. 2028), changes in species dominance, and movement of fishes.

22. The Board finds that entrainment can be expected to kill all organisms that enter the cooling system, but the volume of water used in relation to the flow of the river cannot be expected to produce a significant impact upon fishes of concern. The net water use of 9,250 GPM is 0.1% of the Susquehanna flow fifty percent of the time and up to 1% of the river flow less than one percent of the time (Applicants' Answers to Board's Questions, p. 2, Tr. 935). The size and composition of the populations existing in the river at the present time are such that they are able to compensate for any losses of larvae due to entrainment.

23. The changes in species ranking that occurred between 1974 and 1975 in the trapnet catches can be accounted for by natural fluctuations (a catch of a large number of channel catfish) rather than to station operation. The same can be said for any changes in the indices of affinity or diversity in the macroinvertebrate populations.

24. The thermal plume studies have been adequate enough to determine that no significant impact either through mortalities or undue avoidance are to be expected.

25. The losses due to impingement are within the range that might be expected from an increase in fishing effort equivalent to two or three fishermen on a single day below or near York Haven Dam.

26. The macroinvertebrate communities appear to be more affected by natural conditions such as ice and high river flow than by the influence of the operation of the plant.

27. There appears to be no adverse impact upon any of the food organisms utilized by the resident fishes.

28. Although the Applicants' consultant obtained point estimates for the numbers in the populations of the principal species, the variances were such that perhaps a mortality of 50% might be detected. However, lower mortality rates may or may not be detectable.

29. The creel census indicated catch-per-unit-of-effort, in this case the catch-per-hour. Although this was not correlated with the population estimates, (the creel census encompassed the entire reservoir while the population estimates were for specific areas) the catch-per-unit-of-effort indicates that a fairly healthy fishery has been maintained.

30. Although the populatior estimates are not refined enough to determine small changes in the population--that are either instantaneous or continuous--and although the creel census is not tied in directly with the populaton estimates, the impact of the operation of TMI-1 and TMI-2 is expected to be so insignificant that increases in scope and refinement of the biological studies to a level that would measure slight changes are unwarranted.

Contention 3

> The design for the cooling towers is inadequate to withstand the earthquake or tornado that the rest of the plant is built to withstand. As a result, if this earthquake or tornado does occur and the main plant does withstand it, it is highly probable that the cooling towers will not. Then, either the plant will shut down for two or three years while the towers are rebuilt or repaired, or the plant will continue to operate without cooling towers using once-through cooling. In this latter event, it is highly likely that state water quality criteria would be violated and severe environmental impacts would ensue. Therefore, no operating license should be granted until the entire plant is rendered capable of withstanding the maximum anticipated earthquake or tornado or until an adequate cost-benefit analysis pursuant to NEPA is conducted taking into account the impact of possible loss of the cooling towers.

31. Testimony with respect to Contention 3 was presented by witnesses for both the Applicants and the Staff. This testimony supports the Joint Intervenors' assertion that the cooling towers are not designed to withstand the maximum anticipated earthquake or tornado that certain safety related structures, systems and components of the plant are built to withstand. The record corrects a possible misinterpretation that might derive from the first sentence of the Contention; namely, that all but the cooling towers is built to withstand the maximum anticipated earthquake and tornado. The towers have been designed to conventional standards which are common for similar structures and equipment in an area of fairly low seismic activity and low tornado probability. (SER, Chapter 2) This resulted in the present design which permits the structures to withstand

one hundred mile per hour winds thirty feet above the ground, and approximately one hundred forty mile per hour winds at the top of the towers. No consideration was given to seismic activity, although some resistance to seismic shock is expected. (Prepared testimony of Applicants' witness R. W. Heward, Jr., following Tr. 1114; prepared testimony of Staff witnesses Jan Norris, Harley Silver, and Robert Samworth, following Tr. 1123.)

32. The Applicants and the Staff maintain that since the cooling towers are non-safety-related structures, that is, the loss of the cooling towers would not inhibit the safe shutdown of the plant, NRC regulations do not require such stringent design. In its review, the Staff did determine that failure of the cooling towers would not affect any safety-related structure, component or system of the plant. (Ibid.) Answers to Board questions vertified that safe plant shutdown can be achieved and maintained irrespective of loss of cooling tower and loss of cooling tower catch basin integrity. (Tr. 1120, 1128)

33. Testimony was presented to show that, from considerations of cost-benefit and of alternatives, there is no need to upgrade the design of the cooling towers to the same criteria established for safety grade equipment. It was noted by both Applicants and Staff that should a natural event occur at the site that had the capability of disrupting the operation of the cooling towers, other operationally important but non-safety-related structures might be disrupted also. Thus, the upgrading

of the towers to withstand the maximum anticipated earthquake or seismic event would not assure the ability of the overall plant to maintain operation. It was the expert opinion of witness Heward that the cost of upgrading all appropriate portions of the plant to meet safety-grade standards for natural phenomena would be substantial. Mr. Heward further testified that it is implicit in industry practice that very large capital costs are not justified on an economic basis to avoid plant outages due to such improbable events. Furthermore, a consideration of alternatives indicates that the cost of upgrading a fossil plant to the same criteria in order similarly to increase reliability would require a substantial redesign and would cost even more than to perform such a task at a nuclear plant, where portions of the plant are already so qualified. (Ibid.; Tr. 1119)

34. The concern of Contention 3 that the TMI-2 plant would be operated with once-through cooling if the cooling towers were lost is now addressed. It is noted that since TMI-2 is designed and built to operate with closed-cycle cooling, in order to operate it in a once-through-cooling mode would require substantial design and construction modifications, which would necessitate a further environmental impact review, request for license modification, and possibly a public hearing. Since an event that damaged the towers would likely damage other structures and components designed to similar standards, it is unlikely that such modification of the cooling system alone would allow the plant to remain in operation or would even

pace the schedule of repairs needed to reactivate the plant. Finally, the present operating limitations placed on the Applicants by the NRC (e.g., via technical specifications), the Environmental Protection Agency, and the Commonwealth of Pennsylvania would not allow discharges into the Susquehanna River from once-through operation of TMI-2. (Testimony of witnesses Heward, Norris and Silver, and Samworth as previously cited; Tr. 1117-1119)

35. Based upon the foregoing, the Board finds as follows:

(a) Although the TMI-2 cooling towers, per the allegation of Contention 3, are not designed to safety Category I standards and criteria, they are designed in accordance with the general practices of industry;

(b) There is no justification, technically, for requiring that the cooling towers be upgraded to meet safety Category I standards, and no economic justification that the entire plant be so upgraded; and,

(c) There is no basis for the Joint Intervenors' concern that loss of the cooling towers will lead to an unauthorized and environmentally unacceptable once-through-cooling mode of operation, in view of the various constraints

that will militate against such operation; hence this concern likewise cannot justify the application of safety Category I criteria to the cooling towers and the balance of plant components. The Joint Intervenors have elicited nothing through cross-examination nor through the production of direct evidence which successfully contradicts the foregoing.

Contention 4

The cost-benefit figures used by the Applicants are fallacious. In particular, the assumption that the unit will operate over its lifetime at a capacity factor of 0.8 is totally unjustified in the operating history of U. S. nuclear reactors. Through 1973, no U. S. nuclear reactor had a lifetime average capacity factor for all licensed reactors in 1973 was 0.55. No operating license should be granted until the Applicants can justify in a factual manner their capacity factor assumptions.

36. The Applicants and the Staff both presented prepared testimony and proposed findings on this Contention (Applicants' Witness S. J. Zuckernick, following Tr. 1141; Staff's Witness R. G. Easterling, following Tr. 1919). The Joint Intervenors presented no evidence in this regard.

37. The Board makes the following findings. Neither the Applicants nor the Staff holds that a capacity factor of 0.8 is currently the appropriate value to use for the TMI-2 plant. Both parties, however, have

shown to the satisfaction of the Board, and without meaningful contradiction by the Joint Intervenors, that commensurately compared with an existing coal-fired plant at the same site, operation of the TMI-2 facility is the economical choice down to a capacity factor range of 35% (FES, Fig. 8.2) to 46% (Zuckernick testimony). By comparison the Applicants currently project a value of 65% (Zuckernick testimony); and the Staff, by a rather rigorous statistical analysis, calculated a 10-year, size-independent capacity factor of 62 ± 21%. For the size related calculation (an assumption of questioned validity on the Staff's part), the prediction is 54 ± 22%. Thus, the Board finds that there is a sufficiently adequate margin between predictions of capacity factor and break-even generation costs such that a coal-fired plant is not a viable economic alternative. In other words, the proscriptive aspect of Contention 4 has been satisfied.

Contention 5

> The containment structure and other buildings designed to withstand certain aircraft impact events are of inadequate strength to withstand the impact of airplanes which can reasonably be expected to frequent Harrisburg International Airport. Both the Boeing 747 and the Lockheed C-5A are reasonably expected to frequent Harrisburg International Airport and greatly exceed the Kinetic energy set for the design consideration.

38. The Board views this Contention as, in effect, comprising the following two allegations:

(a) A first allegation that claims that critical (safety Category I) structures are not capable

of withstanding the impact of the Boeing 747 and the Lockheed C-5A aircrafts; and

(b) A second and follow-on allegation that these two types of aircraft will potentially use the Harrisburg International Airport with sufficient frequency to generate more than a de minimus concern for the health and safety of the public.

39. The Applicants and the Staff both presented prepared testimony and proposed findings on this Contention (Testimony of Applicants' Witness J. M. Vallance, following Tr. 511; testimony of Staff's Witness J. B. J. Read, following Tr. 617; supplemental testimony of Read, following Tr. 1297). The Joint Intervenors relied on cross-examination of the Applicants' and Staff's witnesses, and upon argument presented in their proposed findings.

40. The evidence is that the TMI-2 facility is not capable of withstanding the impact of an aircraft weighing in excess of 200,000 pounds. In addition, the Boeing 747 and the Lockheed C-5A, in flight at 200 knots or greater velocity, each has a kinetic energy that exceeds the impact resistance for which the TMI-2 structures (particularly the containment) are designed to withstand (Vallance, cited above). The Board thus finds that Item a) is a correct statement of fact.

41. The follow-on allegation, Item (b) above, reflects the remaining substantive issue within this Contention. The nature of the direct testimony and the scope of the Joint Intervenors' cross-examination prompts the Board to, in effect, subdivide Item (b) into three sub-issues:

i) Has the computation of the probability of an aircraft impact been properly carried out?

ii) If so, is the result adequate to justify a negligible concern for the health and safety of the public, absent an analysis of the consequences of such an impact?

iii) Are the current and anticipated frequencies of heavy aircraft operations at the Harrisburg Airport properly taken into account?

The Board considers it appropriate to resolve Item (b) via these sub-issues.

42. The probability computation (Item (b)(i) above) is addressed first. The Applicants have calculated a probability of about $3 \times 10^{-9}$ events per year, per unit, for aircraft larger than 200 thousand pounds, based upon Harrisburg International Airport data that yielded an estimate for 1976 of approximately 511 operations (take-offs or landings) of such planes, using those runways that could require a flight pattern imposing a potential threat to TMI-2. This result includes all strikes upon any structure, irrespective of whether there is disabling damage leading to shutdown; it disregards the angle of strike; and, further it disregards

any protective shielding effect from the cooling towers and other non-critical structures. Finally, the Applicants' analytical approach incorporates an angular correlation consideration that results in a decrease of strike probability for planes whose approaches lie along lines displaced at increasing angles from the extended runway centerline (Vallance, loc. cit.).

43. According to the testimony of Vallance, the Staff assumed for the sake of conservatism that the TMI Station lies within (although it is slightly outside of) a 60° sector centered on the runway centerline, and that all strike locations are equally probable within that sector. Using otherwise similar geometry and flight frequency assumptions, the Staff, per Vallance's testimony, has obtained a probability of $10^{-7}$ events per year, per unit (Vallance, loc. cit.). The Staff's witness stated the Staff's conclusions as follows:

> "The staff (sic) has concluded that, with respect to the TMI-2 site, the risk from aircraft is acceptably low if fewer than 2400 operations per year at Harrisburg International Airport are flown by aircraft larger than the design basis aircraft. The basis for this conclusion is that the expectation of aircraft larger than the Boeing 720 striking the plant would then be less 10-7 per year (estimated by the algorithm contained in Standard Review Plan Section 3.5.1.6, NUREG-75/087 (September 1975). At present, about 600 four-engine jets per year use the airport, which is considerably within our criterion of 2400." (Testimony of J. B. J. Read, following Tr. 617)

44. The Board here interprets the above quoted airport usage of "600 four-engine jets per year" to be consistent with the Applicants' value of 511 operations per year. The two different probability results are judged by the Board to be compatible in the sense that the difference between them is plausible, based upon the cited assumptions regarding conservatism. The Board finds that the probability assessments have been properly carried out.

45. The Joint Intervenors, as the result of cross-examination, have submitted proposed findings that challenge the validity of the computational model used by the Applicants and by the Staff, criticize the lack of "peer review" given to the model, and question the applicability of the results. After a careful weighing of the cross-examination and the results of our own examination of the witnesses, the Board finds that, while certain of the Intervenors' proposed findings are literally true, none of them represents a significant flaw in the adequacy and applicability of the strike probability results. Nor were the competence and judgments of the two witnesses impugned to any significant extent. We find to be acceptable and conservative the result that the probability of an impact of any nature on some portion of the TMI-2 facility by a heavier-than-200 thousand-pound aircraft is currently less than $10^{-7}$ per year, under the various qualifying conditions imposed.

46. Item (b)(ii) is addressed next. Regarding the health and safety of the public, neither the Applicants nor the Staff refuted the concern

of the Joint Intervenors that the impact of a plane weighing more than 200 thousand pounds into a safety Category I structure might give rise to radiological consequences greater than the exposure guidelines of 10 CFR Part 100. This concern, in turn, prompted the Intervenors to file a motion to compel the appearance of a witness to discuss the consequences of such an event (nature and disposition of this motion discussed below).

47. Applicants' witness and counsel for the Staff appealed to the guideline probability values set forth in NUREG-75/087 (in particular, §3.5.1.6, AIRCRAFT HAZARDS), whereby an analysis of consequences is not required if, as here, the probability assessment yields a value of less than $10^{-7}$ per year. The Staff's witness, in response to Board questions, indicated that in his professional judgment consequences are not entirely ignored by the $10^{-7}$ probability guideline. If, for example, the consequences were so severe as to threaten a monumental loss of life or property, a different approach would be taken before deciding whether to permit plant operation (Tr. 673-675).

48. Irrespective of the foregoing, the Joint Intervenors at various times during the course of the hearing requested that the Applicants and the Staff provide witnesses to discuss the consequences of an accident caused by a larger than 200 thousand pound aircraft colliding with the facility (Tr. 590-600, 615-616, 621, 632-650, 713). By written motion dated April 15, 1977, Joint Intervenors sought to have this Board compel the Applicants to produce witnesses on such consequences. We denied that

motion orally at the evidentiary hearing on May 18, 1977 (Tr. 1549). On August 8, 1977, we set out in writing the basis for that denial. We there took the position that under the Commission's scheme of regulation, Applicants need not be concerned with the consequences of extremely improbable accident events (less than $10^{-7}$ per year) such as we find here. We adhere to that view for the reasons stated in our Order of August 8.

49. We turn now to the frequency of heavy aircraft operations (Item (b)(iii) above). As noted above, the Applicants have established that for 1976 about 511 heavy (200 thousand pounds or greater) aircraft used the Harrisburg International Airport in those flight patterns that could potentially pose a threat to the TMI-2 facility. This corresponds to one to two operations per day for 1976, compared with five to six per day at the time of the Staff's review of Unit 1. At that time, the Staff concluded that about 2400 operations per year represented no undue risks to the health and safety of the public. The Unit 1 technical specifications require that the Applicants monitor and report to NRC the number and size of craft using the field. Only a substantial increase in the usage rate would warrant the Staff's reconsideration of its position (Supplemental Testimony of J. B. J. Read, following Tr. 1297). The Board's questions concerning the options that the Staff might then exercise resulted in supplemental Staff testimony to the effect that Department of Transportation information projects a 50% to 100% increase in airport operations

during the period 1975 to 1990; conservatism in the crash probability analyses are consistent with the Staff's judgment that a significant increase in the frequency of operations is needed to justify a re-evaluation of the risk to the public of larger than design basis aircraft; corrective measures such as restrictions of airspace in the site vicinity or hardening of plant structures could potentially be undertaken; alternatively, plant shutdown may be required if the crash probability becomes unacceptably large.

50. We find that proper account has been taken of the current and anticipated airport traffic. Indeed, we find that there will be an adequate opportunity to anticipate an increase in heavy aircraft traffic well in advance of any increase potentially posing an unacceptable risk. We find that such an increase is unlikely and that should it nevertheless occur, acceptable corrective measures can be taken to make the risks acceptable.

Contention 6

> The environmental radioactivity monitoring program of the Applicants is inadequate to accurately measure the dose delivered to the public during normal and accident conditions. Only active, real-time detectors can determine what the actual dose rate is. Furthermore, an array of off-site detectors could greatly aid in possible evacuation plans. No operating license should be granted until the Applicants provide a network of active radiation monitors.

51. The Board views this Contention as comprising two allegations:

(a) the actual radiation dose received by the public during normal and accident conditions can be properly measured only if off-site, real-time detectors are deployed; and

(b) the implementation of evacuation plans could be greatly aided by the deployment of such detectors.

52. Based upon a review of Applicants' present capabilities to monitor and assess radioactive releases from TMI-2, as well as upon the advantages and disadvantages of employing active real-time detectors, the Applicants and the NRC Staff are in agreement that the current monitoring capabilities of Applicants are adequate. They also agree that installation of the type of real-time detectors currently commercially available would provide no meaningful improvement over the existing system; indeed, certain disadvantages were noted. For normal releases, the Applicants sample and analyze the release at its source prior to discharge, monitor the release at the time of discharge, and variously take continuous composite samples and grab samples of releases. Through a wide variety of types of samples, of types of detectors and of locations, including thermoluminiscent dosimeters, sampling of surface water, drinking water and rain water, collection of particulates and iodines, and collection and analysis of vegetation, soil and agricultural products in the TMI site environs, radiation levels and radioactivity around the plant site are measured to

assist the Applicants in assessing the impact of releases, and to provide confirmation of the effluent monitoring results done at the points of release.

53. With respect to off-normal conditions that might justify the evacuation of members of the public within the low population zone, testimony was offered to the effect that the environmental monitoring program is not intended for use in formulating nor in implementing evacuation plans. With respect to the ability of active, real-time detectors to aid in evacuation plans, such detectors would again be of little or no value. Instrumentation used to determine the severity of an accident, and the need for any off-site emergency action, is located on site and is monitored from the reactor control room. This instrumentation monitors area conditions and process variables such as the reactor coolant temperature and pressure and any abnormal release of radioactivity. In the event that accident conditions arose for which evacuation would be an effective protective measure, necessary measurements and corrective actions to mitigate the consequences, including notification of offsite emergency personnel, would be performed quickly, within 10-15 minutes of the incident. It would, therefore, be unlikely that any offsite active detectors would register any abnormal reading since no release from the containment would as yet have occurred. Only after some period of time (to allow the release and transport of radiation emitters) would the detectors be of any use, and even then they would add nothing to the

information that the previously dispatched offsite survey teams would not already have gathered.

54. In summary of this matter, the Board finds that the radiological effluent and environmental monitoring programs as proposed by the Applicants and approved by the Staff are adequate to measure and evaluate normal radioactive effluent releases and to measure radioactivity in the plant environs; and that active, real-time detectors would add nothing to the present capability. We further find that the response or effectiveness of both in-plant instrumentation and off-site personnel in the event of an accident would not be aided or improved by such detectors. (Testimony of Porter, following Tr. 1011; testimony of Osloond and Stoddart, following Tr. 1060; testimony of Van Niel, following Tr. 1060; testimony of Wayne Britz).

Contention 7

> The flood protection system for Unit 2 is inadequate. This is because the flood data presented and the floods designed against are based on historical data which do not include the intentional efforts of man to effect weather modification. Such efforts at weather modification render the historical data of questionable value. No operating license should be granted until the effects of human efforts at weather modification are understood.

55. The Applicants' witness Hosler is an expert in the field of meteorology and weather modification (see biographical sketch and publications of C. L. Hosler, following Tr. 284). His testimony establishes

that no weather modification efforts of man can conceivably be expected to increase the precipitation rate during a hurricane or heavy storm episode, nor to increase the flood threat to the TMI site. "The water is either there or coming into the region or it isn't and nothing man can do is going to change this." (Hosler testimony, following Tr. 481).

56. The Staff's witnesses concurred in the above conclusion. They further explained the various elements of conservatism not only used to estimate the probable maximum precipitation that might initiate a flood, but also used to estimate the probable maximum flood that could result therefrom. The estimation methodology, a portion of which had been previously developed for TMI-1, was tested during the 1972 hurricane "Agnes" flood and was found to overpredict the river stages that actually occurred. In addition to this conservatism, four feet of freeboard protection has been provided at TMI-2 to eliminate wave effects produced during a probable maximum flood by up to 40 mph winds blowing from the least desirable direction. Examination by the Board established that the reason the TMI site was flooded during the occurrence of Hurricane Agnes was because certain protective levees had not been completed (Tr. 509).

57. From a review of the available evidence, we find that weather modification does not represent a material threat with respect to the adequacy of the flood protection design at the TMI-2 facility, which

design we find to be acceptable and conservative. (Testimony of Hosler, following Tr. 481; testimony of Johnson and Bivins, following Tr. 508).

Contention 8

> The warning and evacuation plans of the Applicants and the Commonwealth of Pennsylvania are inadequate and unworkable. The plans assume that all local and state officials involved are on 24-hour notice and can be contacted immediately. They further assume that all people notified will promptly react and know how to respond and are trained in what to do. They also assume that the public which has been assured that accidents are "highly unlikely" or "highly improbable", will respond and allow themselves to be evacuated. No operating and evacuation plans are shown to be workable through live tests.

58. The Applicants' prepared testimony described the plans and procedures which govern their actions in accident situations; described the equipment relied upon both for accident detection and evaluation and for assured communications with offsite authorities; and described pertinent portions of their training program, including emergency drills. The Joint Intervenors presented no pre-filed testimony, but conducted extensive cross-examination and submitted proposed findings on this contention. This was the only contention for which the Commonwealth presented prepared testimony and submitted proposed findings, adopting as its own the Applicants' proposed findings numbered 43 through 56.

59. The witnesses for the Commonwealth of Pennsylvania were from the state and local civil defense organization. Their testimony described

the civil defense organizational structure; the action plans that would be followed in the event of an emergency, including a nuclear power incident; and described their experience in evacuation involving non-nuclear events. (Testimony of J. G. Herbein, G. P. Miller, and R. W. Dubiel, following Tr. 757; following Tr. 1556; testimony of Thomas Potter).

60. The Staff's testimony described the results of its review of the Applicants' emergency response plans, including the ability to provide early warning to the public, to arrange for public evacuation (Testimony of K. J. Molloy and C. A. Williamson, following Tr. 801), and to interface appropriately with the State. (Testimony of C. R. Van Niel, following Tr. 1701; Testimony of Charles Gallina and Phil Stohr).

61. We see no need to recite here--as do the proposed findings of the Applicants, the Commonwealth and the Staff--those uncontradicted, descriptive characteristics of the Applicants' state of preparedness, nor that of the cooperating state and local agencies upon whom the success of the emergency plans depend. We find these to be adequate. We do address those assumptions deemed by the Intervenors to be necessary for the success of the emergency plans, and hence challenged by this contention, namely,

a) that appropriate state and local officials are available to be contacted any time they are needed;

b) that such personnel, upon being notified, will know the right th[illegible] and will do it promptly because they have been so trained; and

c) that any members of the public that should be evacuated will respond appropriately and will permit themselves to be evacuated despite there having been no live drills or tests of the public response.

Underlying all of those is the need for the existence of dependable, prompt, and intelligible modes of communication amongst the emergency plan participants and with the public. The referenced testimony is replete with evidence confirming this. Examination by the Intervenors and the Board cast no doubt upon the adequacy of the communications equipment and the various modes of communication. The Board finds these matters to be satisfactory.

62. We turn now to Item (a) above. In the event of an accident, TMI-2 personnel initially contact the State Council of Civil Defense Duty Officer and the Dauphin County Civil Defense Headquarters. Calls also would be made by Applicants directly to Pennsylvania State Police, Hershey Medical Center, and the Brookhaven Assistance Group, as necessary. The State's Civil Defense (CD) Duty Officer is available twenty-four hours a day, seven days a week; the County Civil Defense Headquarters, which serves as the constant communications center for all emergencies

in the county, is always manned. Similarly, Pennsylvania's Bureau of Radiological Health (BRH), which is the Commonwealth's expert radiological advisor and whose personnel are notified immediately by the state civil defense duty officer, maintains a number of contact points where BRH representatives can be reached by the CD duty officer. Upon receipt of the call from the CD duty officer, the BRH representative then contacts TMI on one of its multiple phone lines to confirm the validity of the initial notice to CD and to receive details of the event. In the event that BRH cannot be contacted (considered remote in view of BRH's multiple contact points and successful drills in the past), civil defense could proceed based on Applicants' expert recommendations as to the need for protective action.

63. The Dauphin County CD unit claims to have responded effectively to several disasters over the past several years involving evacuation of the public and the handling of physical injuries. These claims were not disputed. The Board finds that a randomly required initiation of the appropriate emergency response plans will not fail due to any inability to contact state and local officials.

64. Regarding Item (b) as noted above, prior successful disaster responses (albeit to non-radiological events) also support the conclusion that state and local officials are knowledgeable about their jobs. Joint Intervenors and the Board were particularly interested in the effect on

the emergency response plans if the state's lead radiological assessment agency, i.e., the Bureau of Radiological Health, should suffer a reduced capability. This possibility was suggested by a press release from the Department of Environmental Resources, within which BRH operates, indicating that the state budget may reduce funds for radiological monitoring (Board Exhibit 1). NRC Staff witnesses, when presented with information in the press release, generally observed that the NRC requires an adequate emergency plan, and that should that plan become insufficient for some reason, the Applicants would be required to fill the gap (Tr. 1075-1090). In fulfilling the Board's request to specifically address the question of responsibilities (Tr. 1097-1099), the Staff determined that it would, in fact, have several options available to it, including having the Applicants fill the void, looking to other groups within the state, or perhaps filling the void at the federal level (Tr. 1745-1749). Furthermore, the Staff's witness observed that the Applicants' monitoring capability outside the LPZ would be more than adequate until such time as subsequent or supplemental monitoring teams would be available to the Commonwealth. Indeed, the NRC regional office itself could provide up to 20 additional inspectors, in addition to other teams from Brookhaven Laboratory and radiological teams from western Pennsylvania (Tr. 1806-1809).

65. The testimony stresses the drills and training that various emergency response groups undergo. The Commonwealth's civil defense witnesses saw no compromise of their own effectiveness of response

because of their not having technical knowledge and training concerning radiological matters. Staff witnesses testified that the Commonwealth's BRH possessed the requisite radiological know-how needed to assist with protection of the public health and safety. The Board finds that the evidence adequately supports the conclusion that the effectiveness of state and local officials is based upon an adequate knowledge of their job. These officials will not be hampered by not having had technical training in radiological matters.

66. Finally, we address Item (c), regarding the necessity of the public's being subjected to live tests or drills in order to insure that it will respond appropriately. All witnesses agreed that members of the public need not be drilled to assure their proper response to emergency evacuation instructions. Witnesses for the Commonwealth's CD organization explicitly offered the opinion that such drills might be counter-productive, citing a Stanford Research Institute study to support this opinion, and pointed to the actual behavior of the public during disasters in their own recent experience as being satisfactory and supportive of the lack of need for drills. The Staff similarly cited an EPA evacuation study. Examination by the Intervenors elicited the information that conclusions regarding the lack of need for public drills were without the benefit of experience with radiological events requiring evacuation. Nevertheless, the Board's examination revealed that such a diversity of non-radiological

events had been successfully dealt with to provide confidence that drills are not necessary. Furthermore, the Board additionally determined that the civil defense emergency preparedness literature that has been disseminated to the public is being revised to include radiological awareness and response information. The ability of the County's CD organization to adequately cope with the management of public vehicular traffic during an evacuation was also examined by the Board. (Tr. 1731-1735; Tr. 1840-1841; Tr. 2528-2541).

67. The Board thus finds that Item (c) states an assumption supported by a preponderance of the evidence. More broadly, we find that the record supports the conclusion that Contention 8, in its entirety, is without merit and that the Staff has properly assessed the adequacy and workability of the emergency response. We also find the emergency and evacuation plans to be both adequate and workable.

Contention 9

> The releases of gaseous radioactivity exceed the "as low as practicable" guidelines of Appendix I to 10 CFR Part 50. Systems exist for significantly reducing the emissions from Unit 2. In a plant of similar design (Rancho Seco), equipment is being utilized to reduce by a factor of 10 the release of radioactive iodine from that expected to be released from Three Mile Island, Unit 2. Also, at the San Onofre, Unit 1 plant a cryogenic system is used to reduce the release of radioactive noble gases. These practicable and workable systems are available at modest cost to reduce by approximately a factor of 10 the emission of gaseous radioactive fission products from Three Mile Island, Unit 2. No operating license should be granted for Unit 2 until such systems, or comparable ones, are installed.

68. The Applicants and the Staff each put on a direct case (for the Applicants, the testimony of W. A. Rodger, dated March 25, 1977, following Tr. 1858; and, for the Staff, the testimony of P. G. Stoddard, following Tr. 1869). The Applicants' witness answered several questions posed by the Board (Tr. 1859-1867). These answers, along with the direct testimony, have been fully reviewed and found to be dispositive of this contention.

69. At the time this contention first was advanced by the Joint Intervenors, the Appendix I "as low as practicable" rulemaking hearing (RM-50-2) was underway and there existed only a qualitative standard in this regard. In April 1975, the rulemaking hearing was completed and Appendix I was promulgated, establishing quantitative standards. ("Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents", CLI-75-5, 1 NRC 277 (1975)). Since Appendix I was adopted, Applicants have performed a detailed cost-benefit analysis of the radwaste systems at TMI-2, which demonstrated for gaseous effluents that there is compliance with the design objectives in Sections II.B and II.C of Appendix I. The analysis also demonstrated that there are no cost-effective ways of augmenting the TMI-2 gas handling system pursuant to Section II.D of Appendix I.

70. TMI-2's present gaseous radwaste treatment systems have been compared with Rancho Seco's equipment. Testimony produced by the NRC

Staff indicates that the treatment systems for radioiodines at Rancho Seco and at TMI are essentially the same and that the releases from these plants are expected to be similar, rather than different by a factor of 10 as the contention asserts. The Applicants' witness noted that the Rancho Seco treatment system is atypical in that its liquid wastes are discharged as vapor to the air; if a similar technique were employed at TMI-2, the resultant doses to the offsite population would be increased rather than decreased.

71. As for the assertion that TMI-2's radwaste equipment should be augmented with a cryogenic system such as that used at San Onofre, Unit 1, Staff testimony indicates that the basic principle employed to reduce offgas releases at both San Onofre, Unit 1, and Three Mile Island, Unit 2, is radioactive decay during collection and storage, and that the available collection and storage times are approximately equal. Thus, neither off-gas system has an inherent advantage over the other with respect to reduction of radioactive effluents. The Staff and the Applicants both presented testimony indicating that such a modification would be far from cost-beneficial, using the Appendix I (10 CFR Part 50) basis of $1000 per one man-rem reduction of whole-body exposure to the population within a 50-mile radius. The Staff estimated that the total annual cost of operating a cryogenically-cooled offgas system is $120,000; this compares with the cost estimate by the Applicants' of $500,000. Both estimates,

coupled with their respective calculated exposure reductions, yielded costs per man-rem of exposure reduction considerably in excess of $1000.

72. The Board finds that, in the context of this contention, TMI-2's gaseous radioactive releases do not exceed the design objectives of Appendix I to 10 CFR Part 50. We further find that there are no modifications--including Rancho Seco-type equipment or a cyrogenic system--that can be made to TMI-2's gaseous radwaste system that would be cost-beneficial with respect to the above mentioned basis of comparison. (Testimony of W. A. Rodger, following Tr. 1858; testimony of P. G. Stoddard, following Tr. 1869).

Contention 10

The discharge of chlorine from Three Mile Island, Unit 2 will have an adverse effect on water quality and this has not been adequately considered in the NEPA cost/benefit analysis.

73. TMI-2 will employ chlorine gas as a biocide in the circulating water system (4,000-6,000 ppd) and the service water system (150 ppd) for control of fouling. The chlorine will be introduced in three 15-20 minute periods per day. The Applicants calculate that chlorination of the circulating water system will result in no more than 1.0mg/l total residual chlorine in the natural draft cooling tower blowdown, resulting in no detectable total residual chlorine at the plant discharge to the Susquehanna River.

74. The operation of the circulating water chlorination system will be on an alternating and intermittent basis with that of the service water system, so that the two systems will not be chlorinated simultaneously. In addition, no chlorine will be discharged from Unit 1 and Unit 2 at the same time. Tests at Unit 1 indicated virtually no detectable residual chlorine in the station effluent; however, the Applicants might need to increase the use of chlorine in the circulating water system since algae growth had not been controlled in the cooling tower distribution trays. (Testimony of Robert B. Samworth, following Tr. 2077)

75. The effluent limitations on TMI-2 imposed by the NPDES permit include a limitation of 0.5mg/l for free available chlorine, but do not include a limitation for total residual chlorine. If chlorination occurs at the maximum allowable rate, total residual chlorine at the discharge could be as high as 1.5mg/l, which is toxic to aquatic biota. However, even if chlorination occurred at the maximum allowable rate, the Staff concluded, based on the experience at Unit 1 and the quick dilution in the river water, that the introduction of chlorine at toxic levels would not constitute a significant adverse impact, since the maximum rate would rarely occur, would be of short duration, and the affected area would be small. Experience at Unit 1 shows that the discharge concentration has rarely approached the potential toxic level of 0.2 mg/l total residual chlorine and that when such levels did occur, the Applicants took steps to reduce the concentration.

76. The discharge is not located in an important aquatic habitat. The Staff also noted that with two units in operation, additional dilution will occur which will lower chlorine concentrations even further and the Applicants' consulting biologisit predicts that no adverse impact will occur to aquatic biota. (Testimony of James A. Fava, following Tr. 1889).

77. The Board finds that no expected significant impact on aquatic biota is to be expected from the proposed chlorination program for TMI-2. The Board also finds that should the Applicant chlorinate at the maximum rate allowed under the NPDES permit, the impact on aquatic biota will continue to be insignificant.

Contention 11

> In its dose calculations the Applicant has ignored the effect of the cooling towers. Interaction between the gaseous release of radioactivity (in particular, radioactive iodine isotopes) and the cooling tower plumes can increase the thyroid dose by the cow-milk pathway by up to a factor of 10. Such a possible increase in the dose would exceed that allowed by the "as low as practicable" guidelines of Appendix I of 10 CFR Part 50. No operating license should be granted until the Applicant considers the effect of the cooling towers on the gaseous iodine and reduces the releases as necessary.

78. The treatment of this contention proceeded upon the direct, prefiled testimony of witnesses for the Applicant and the Staff, followed by examinations of these witnesses by the Joint Intervenors and the Board. The Joint Intervenors did not offer direct testimony, nor did they file

proposed findings hereon. In response to questions from the Board, the Staff also provided a witness who discussed certain aspects of proposed Regulatory Guide 1.109. The witnesses were as follows:

- for the Applicants, the prepared testimony of C. L. Hosler, dated March 25, 1977, following Tr. 360;
- for the Staff, the prepared testimony of L. Andrews, E. H. Markee, Jr., J. Osloond, following Tr. 380; and
- witnesses K. F. Eckerman re Regulatory Guide 1. 109 (no prepared testimony) following Tr. 2552.

79. Cross-examination by the Joint Intervenors was helpful to the Board's understanding of the treatment of this contention. However, their examination in no way successfully contradicted the testimony of the Applicants and the Staff, nor compromised the validity of the proposed findings, which we make use of below.

80. The Applicants explicitly testified, in agreement with the first sentence of the contention, that the dose calculations did indeed ignore any interaction of the radioactive gaseous effluent releases

(primarily iodine) with the cooling towers and their vapor plumes. To take account of the various possible types of interactions would either reduce offsite doses or minimally increase them to well within acceptable levels. Interaction of the radioiodine releases in the gaseous effluent with the cooling tower effluent can be postulated to occur in several ways--by entrainment of the gaseous effluent with the tower plume; by intersection of the two plumes at or above the release point of the cooling towers; or by washout of the radioactive plume due to drift droplets from the cooling towers. Each of these possibilities was addressed by witnesses for the NRC Staff and the Applicants, and the impact of them on the Appendix I evaluation of radioiodines were found not to be significant, even if they were to occur.

81. Intersection of the two plumes or entrainment of the gaseous plume in the towers with some portion contained in the existing plume can be considered together. In either case, because the effect would be to elevate the gaseous plume to at least 1500 feet, the deposition rates within a few miles of the plant (including the critical dairy receptor which for TMI-2 is located about 1.2 miles from the unit), would be decreased. Dr. Hosler conservatively calculated that the downwind concentrations of radioiodines would be reduced to 4/100ths of the concentration calculated based on no interaction. This would be so even if the radioactive gases were assumed to be absorbed onto or dissolved in drift droplets exiting the tower, since such droplets evaporate before

reaching the ground, leaving the radioactive residue to disperse in the atmosphere but from an elevation greater than the level used in the Appendix I calculation. The Staff testified that the resultant deposition estimate due to entrainment of the radioactive gases into the cooling tower plume is about a factor of ten less than the dry deposition estimates calculated by the Staff in its 10 CFR Part 50 Appendix I evaluation.

82. In response to a Board question concerning the entrainment of gaseous plume from the plant and the effect of drift eliminators and ultimate release in the cooling tower blowdown, the Applicants conservatively estimated an increase of less than one mrem per year whole-body or thyroid dose would result to the maximum exposed individual, a dose still well within the limits of 10 CFR Part 50, Appendix I. (Tr. 1864-1865)

83. The possibility of drift droplets from the cooling towers falling through the gaseous plume and washing the radionuclides to the ground was examined. The Applicants' witnesses testified that this mechanism is of extremely minor significance, amounting to something less than 1/4000ths of the washout effect due to natural rainfall in the area. (Tr. 477-478) The washout effect of rain was not included in the NRC Staff Appendix I calculation, due to the insignificant effect of rain on deposition rate at TMI-2. (Tr. 468-471) Using a conservative equation in response to this contention, the Staff calculated that drift droplet washout could increase the deposition rate used in the Appendix I analysis

by a little less than a factor of 1.5, thereby increasing the critical cow-milk pathway dose from 1.6 to 2.4 millirem per year, which is still well below the Appendix I value of 15 millirem per year. (Tr. 470-471) The Board also asked questions of the Staff concerning the use of proposed Regulatory Guide 1.109 that were later answered by its witness Dr. Eckerman. The Board is satisfied that the Guide, based in part upon experimental data, has been properly interpreted and applied.

84. Upon careful consideration of all of the evidence in this matter, the Board finds that the various plausible mechanisms for interaction between the gaseous radioactive plume from TMI-2 and the cooling tower plumes--when evaluated--do not overturn our prior determination, made with regard to Contention 9, that TMI-2 complies with 10 CFR Part 50 Appendix I. Contention 11 of the Joint Intervenors is without merit.

## B. Compliance with the National Environmental Policy Act of 1969 (NEPA) and Appendix D to 10 CFR Part 50

### 1. General Description

85. The TMI-2 construction permit was issued on November 4, 1969. On September 9, 1971, the Commission revised 10 CFR Part 50, Appendix A, in such a way as to require an environmental review of the facility. Pursuant to Appendix D, the Board has conducted a full NEPA review of TMI-2. The results of that review are described below.

86. In accordance with Appendix D, the Applicants submitted an environmental report in October 1970 and, following revision of the Appendix D regulations, a revised environmental report in December 1971. Based on the environmental information thus supplied, the Staff made an assessment of the considerations specified in Section 102(2)(C) of NEPA and Appendix D to 10 CFR Part 50. The results of the Staff's assessment were published in a Draft Environmental Statement (DES) which was issued in June 1922. Following receipt of comments by interested members of the public and by appropriate governmental agencies, the Staff published its Final Environmental Statement (FES) in December 1972.

87. On April 4, 1974, Applicants made application for an operating license for TMI-2. In support of that application, they filed a document entitled "Supplement II to Environmental Report, Operating License Stage, Unit 2, Three Mile Island Nuclear Station, Units 1 and 2". This filing updated the discussion of the environmental considerations related to the operation of TMI-2. Thereafter, the Staff determined that its original environmental review should be supplemented. This resulted in the issuance by the Staff of a draft supplement to the FES in July 1976. Interested members of the public and appropriate governmental agencies were invited to comment on this document. Following receipt of such comments, a Final Supplement to the Final Environmental Statement (FSFES) was published in December 1976. The FSFES contains a detailed description of the site and the plant, and contains a discussion of the status of compliance of the

facility with applicable Federal, State, regional and local environmental requirements. The FSFES includes an evaluation of the probable environmental impacts of continued plant construction and plant operation. It contains an assessment of Applicants' effluent and environmental measurement and monitoring programs, and an assessment of the environmental effects of postulated accidents. In the FSFES, the Staff analyzed the need for the power to be generated by the facility and assessed alternatives to the plant, its site and its design. In addition, the FSFES includes an evaluation of the adverse environmental effects which cannot be avoided, and the irreversible and irretrievable commitment of resources. Finally, the FSFES contains a cost-benefit analysis which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects. The Staff's conclusion in the FSFES is that the action called for under NEPA and Appendix D of 10 CFR Part 50 is the continuation of the construction permit and issuance of an operating license for TMI-2, subject to certain conditions for the protection of the environment.

a. Impacts of Construction

(1) Impacts on Land Use

88. Construction of TMI-2 is substantially complete at the present time (FSFES §4.1 and Table 4.1). Site preparation and construction for both units has affected 472 acres on Three Mile Island and a small area

totaling ten acres on the river's east bank. The major portion of the disturbed land was previously farmland, although about 28 acres of woodland were also disturbed. Most of the forest land on the island, about 172 acres, remains untouched (FES §IV.B.1; FSFES §4.2). Approximately 190 acres of land have been removed for the duration of the plant life from use for agriculture or as wildlife habitat (FSFES §4.4.1).

89. A major impact of construction has been the removal of 70 recreational cabins and a small picnic area from the island. This impact has been reduced, however, by the relocation of all but two of these cabins to nearby islands (FES §IV.B.1).

90. The proximity of human activity has decreased the attractiveness of the uncleared areas for wildlife. This is an unavoidable but acceptable cost.

91. The construction of the transmission system is substantially completed at this time. The right-of-way for the 67.3 mile 500 KV TMI-2 to Bechtelsville line occupies about 1620 acres. An additional 7.36 mile transmission line from Bechtelsville to Hosensack has been constructed parallel to an existing 230 KV corridor, requiring an additional 175 feet of right-of-way for the new line. Approximately 254 acres of forest or woodlands have been cleared and one home in the right-of-way purchased. Clearing was carried out consistent with U. S. Departments of Agriculture and Interior guidelines. The predominant land use through which the

right-of-way passes is agricultural. Easements have been obtained which permit the owners of the right-of-way to use the land for growing crops, grazing cattle, or growing trees to a limited height (FES §V.A.2; FSFES 4.4.1). The Board finds that the effects of construction and maintenance of the transmission corridor is an acceptable environmental cost.

(2) Impacts on the Aquatic Environment

92. The effects on shoreline aquatic environs were due primarily to the construction of the intake channel and pumphouse. This resulted in some temporary silting of the river and changes in the topography of the shoreline and near-shore river bottom. These impacts were kept to a minimum and although some of localized changes are permanent, the adverse impacts are reversible.

(3) Summary of Construction Impacts

93. The Board finds that the adverse impacts on the site area from construction of TMI-2 have been described reasonably correctly and that the Applicants' attempts to limit these impacts have been appropriate. The Board considers the unavoidable impacts of construction on the terrestrial and aquatic environment to be acceptable costs. Considering the completion and operation of TMI-1 and near completion of TMI-2, completion of construction will not result in any additional significant adverse impacts.

b. Impacts of Operation

(1) Impacts on Land Use

94. The facility is located on an island wholly owned by the Applicants. In addition, the Applicants own all the land within the exclusion radius. Thus, station operation will not deny access to any locations that would otherwise have been accessible (FES §V.A.1; FSFES §5.2.1). The Staff has reviewed possible operational effects which may be attributable to the transmission system, including electrostatic induction and ozone production. The Staff concluded that no adverse impacts due to ozone production will occur, and that the Applicants' grounding of all transmission towers and ground fences where electrostatic induction hazards exist will remedy any potential inconvenience or nuisance from electrostatic induction (FES §V.A.2; FSFES §5.2.2).

(2) Impacts on Water Use

95. In response to a Board question (Tr. 144-145), the Staff provided up-to-date data on expected water use, with particular reference to operating experience at Unit 1 (Samworth Testimony, following Tr. 988). The net maximum consumption of water from the Susquehanna River by both units operating at full power will be 20,800 gpm. This amounts to 2.7% of the minimum river flow of 1700 cfs, 0.23% of the median river flow of 20,000 cfs, and 0.14% of the mean river flow of 34,000 cfs (FSFES §5.3.1).

Experience with Unit 1 operation confirms these projections (Samworth, supra). The Applicants' calculations indicate that the monthly average consumption at TMI-1 during 1976 was 0.045%, based on actual river flow and consumption observed (Applicants' Environmental Responses, following Tr. 935). The Board finds that removal of water at these rates will not have a significant effect on either the physical balance or biological systems in the Susquehanna River.

96. The TMI nuclear station represents about one-fourth of the total installed and currently planned capacity for steam electric power production for the Susquehanna River Basin. Although there is no evidence that the availability of water will be of concern at TMI, additional demands for water may be cause for concern near the end of the useful life of the TMI station. The Staff's review indicates that the Susquehanna River Basin Commission intends to review the impact on river flow due to consumptive withdrawals, and that the need for water required for power generation is being adequately recognized (FSFES §5.3.1).

(3) Aquatic Impacts

97. The effects of both impingement and entrainment were considered by the Staff in its FSFES, and by the Applicants in the ER (FES §V.C.2; FSFES §§5.5.2.1 and 5.5.2.2; ER §§5.5.1.5 and 5.5.1.7). In addition, in response to a Board question, (Tr. 144-145), the Staff and the Applicant both provided analyses of impingement and entrainment potential from station operation. The analyses were supported by the Unit 1 operational

history (Hickey Testimony, following Tr. 988; Applicants' Environmental Responses, supra). The design velocity at the intake structure is approximately 0.2 fps. Consequently, most of the fish impinged during Unit 1 operation were juveniles (FSFES §5.5.2.1; Applicants' Environmental Responses, loc. cit.). Most of the fish impinged were forage fish, with few game or food fish impacted (Ibid.; Hickey, supra). Phytoplankton, zooplankton, fish eggs and larvae small enough to pass through the 3/8 inch mesh traveling screens will be entrained in the cooling system and killed by the combination of mechanical, thermal and biocidal effects. It is not expected that any adverse effects on local planktonic populations will occur due to entrainment because of the small cooling water requirements of the station. The numbers of larval fish entrained at TMI-1 were minimal so that no significant extrapolation can be made as to total mortality.

98. A major water quality influence of station operation will occur through the concentration of naturally occurring substances in the evaporative cooling system, through the addition of sulfuric acid to the cooling system to control scaling, and through the chemical regeneration of high purity water treatment systems (FES §V.B.3; FSFES §3.3, Table 3.5). The concentration of sodium, sulfate, and chloride ions in the discharge is predicted to be noticeably higher than the concentration at the intake. However, the predicted discharge concentrations of these substances are below their toxic levels (FSFES §5.5.2.2; Samworth, supra). The Staff's

and the Applicants' analyses indicate that the discharge of chemicals from the station will not cause any adverse effect on river biota (Ibid., ER §5.3.1). The Board has reviewed these analyses and agrees with the assessment that no adverse impact will occur.

99. In addition to evaluating the thermal discharge effects on the Susquehanna River pursuant to the standard environmental review (FES §§V.B.2, V.C.2; FSFES §5.5.2.3; ER §5.1), both the Staff and the Applicants provided additional analyses of thermal effects (Hickey, supra; Applicants' Environmental Responses, supra) in response to a Board question (Tr. 144-145). During 1974, the discharge temperature at Unit 1 ranged from 5.6°C above ambient on December 3. The relatively small size of the plume along with its diffuse character will allow fish to avoid it. The temperature differential is not of a magnitude that will either cause mortalities or serve as a significant attraction.

100. In response to a Board question (Tr. 145), both the Staff and the Applicants provided further analyses of reported fish kills in the Susquehanna River near the TMI-1 facility in the spring of 1974 and 1975 (Hickey, supra; Applicants' Environmental Responses, supra). The Staff concluded that since initial criticality was not achieved for the unit until June 5, 1974, the spring 1974 fish kill, reported to be about 200, could not have resulted from Unit 1 operation. In addition, the Staff reviewed the ambient river conditions and the operating history of Unit 1

for the spring of 1975 and compared these data with the temperature tolerances of the fish species observed in the kills. The Staff's analysis indicated that the species involved are capable of withstanding the potential thermal stresses which may have been imposed on them. Data compiled by the Staff shows that numerous fish kills occur in the Susquehanna River and its tributaries. Their causes, including the 1974 and 1975 kills, could be linked to several causative agents (Hickey, supra). The Board finds that the investigations of the reported fish kills performed by the Staff and the Applicants have been thorough and comprehensive, and agrees that the available evidence on the reported fish kills does not indicate that they were the result of Unit 1 operation.

101. In response to a Board question (Tr. 145), clarification was requested with respect to the term "complete mixing zone" as it appeared in the FSFES §11.1.5.9. The responses (Samworth supra; Applicants' Environmental Responses, supra) by the Staff and the Applicants have provided detailed explanations of the expected mixing zone, Unit 1 operational experience, and Pennsylvania requirements in this regard. The Board finds that those responses satisfy our concerns with respect to the mixing zone.

(4) Terrestrial Impacts

102. The only potential source of significant environmental damage to the terrestrial environment from the operation of Unit 2 is the drift

from the natural draft cooling towers (FSFES §5.5.1). Although no impacts from the operation of Unit 1 have been reported, since Unit 2 will approximately double the salt load from drift, the Staff recommends that the Applicants implement a low altitude true and false color aerial photographic monitoring program with a continuation of the current monitoring program (Ibid.). Although the Board finds that there has been no evidence of adverse terrestrial impact from Unit 1 operation, to assure that operation of both units will not impact surrounding vegetation, the Board requires that the Staff's recommendation with respect to monitoring be adopted by the Applicants.

103. The Staff's analysis of bird impactions at the TMI site (FSFES Table 5.13 - 5.14) indicates that neither the total numbers nor the species involved represent an unacceptable impact. The Staff recommends that the current bird impaction monitoring program be terminated. We find that bird impaction does not presently constitute a significant adverse effect; however, the matter ought not be entirely ignored. To that end, the license to be issued hereunder shall be appropriately conditioned to require the reporting of significant bird impactions to the Regulatory Staff.

(5) Atmospheric Impacts

104. Two large natural draft cooling towers will be used to dissipate most of the condenser heat from the station. In addition, a three-celled wet mechanical draft cooling tower will be used to cool the combined

service water effluent and the blowdown from the natural draft towers. At full load, 5.75 x $10^9$ BTU/hr will be discharged to the atmosphere. A maximum of 10,000 gpm of water will be evaporated and discharged to the atmosphere (FES §V.A.3). Under the worst meteorological conditions, the Applicants predict that there may exist some potential for ground fogging; however, the effects would be slight, and the Staff considers the Applicants' estimates conservative, since experience at operational cooling towers shows that plumes rarely, if ever, reach the surface (FES §§V.A.3-4; ER §5.1). It is not expected that ground fogging will have any effect on Harrisburg International Airport, three miles away from the station. Similarly, no increase in humidity, precipitation, or icing is expected to occur (Ibid.). The Board finds that atmospheric effects of station operation will be insignificant.

(6) Radiological Effects

105. The radiological releases from TMI-2 have been calculated to assure that the Commission's regulations contained in Appendix I to 10 CFR Part 50 are met. Appendix I requires that levels of radioactive materials released to unrestricted areas are "as low as is reasonably achievable." The Staff independently reviewed and evaluated the Applicants' Appendix I analysis. The Staff's evaluation considered releases of radioactive materials in liquid and gaseous effluents for normal operation and anticipated operational occurrences based on expected radwaste inputs

over the 30-year operating life of the plant. Both the Applicants' analysis and the Staff's independent calculations demonstrate that the proposed liquid and gaseous radwaste treatment systems are capable of reducing releases of radioactive materials in liquid and gaseous effluents to "as low as is reasonably achievable" levels in conformance with 10 CFR §50.34a and Sections II.A, B, C and D of Appendix I to 10 CFR Part 50 (FSFES §3.2.1.2; SER Supp. 1 §11.7). In addition, the Staff considered the potential effectiveness of augmenting the proposed liquid and gaseous radwaste systems in order to reduce the dose to the population reasonably expected within 50 miles of the reactor at a cost of $1000 or less per man-thyroid rem. The Staff's cost-benefit analysis concluded that there is no reasonably available equipment embracing demonstrated technology that, when added to the system, can effect dose reductions to the population (on the above cost basis) within 50 miles (FSFES §3.2.1.2). The Board finds that the releases of radioactivity will meet the requirements of 10 CFR Part 50, Appendix I.

106. Radioactive effluents released to the atmosphere and hydrosphere from the facility during normal operation will result in small radiation doses to individuals and populations (FSFES §§5.4.1.2, 5.4.1.3). Using pathways to maximize the amount of radiation received (FSFES §5.4.1.1), the Staff calculated the maximum doses which could be received by an individual and the U. S. population in the year 2010 (FSFES §5.4.1). The maximum annual individual dose commitment resulting from routine operation

of the plant is a small fraction of the dose limits specified in 10 CFR Part 20 and within the Appendix I design objectives. The maximum individual dose is 5.9 mrem/yr calculated for the dose to any organ from all pathways. The Appendix I design objective is 15 mrem/yr (FSFES §5.4.1.6; FSFES Table 5.10). The annual population dose commitment is a small fraction of the dose from natural environmental radioactivity. The calculated dose to the general public within fifty miles of the facility is 11 man-rem, which compares with a natural background level of 310,000 man-rem (FSFES §5.4.1.6; FSFES Table 5.7); the annual dose commitment to the U. S. population for the year 2010 is calculated to be 33 man-rem as the result of TMI-2 operation, which compares with a dose from natural background of 28 million man-rem.

107. The Applicants have agreed to design features and operating practices that will assure that individual and total plant population doses will be as low as is reasonably achievable. Based upon its review of exposure experience at operating light water cooled nuclear reactors, the Staff estimates the projected occupational radiation exposure impact of TMI-2 to be 500 man-rem per year (FSFES §5.4.1.4).

108. The radiological effects of the transportation of cold fuel to the reactor, of irradiated fuel from the reactor, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the NRC report entitled "Environmental Survey of Transportation of

Radioactive Materials to and from Nuclear Power Plants". These effects are adequately described in the Staff's FSFES Table 5.8.

109. On March 14, 1977, the Commission promulgated in the Federal Register (42 F. R. 13803) an interim rule regarding the environmental considerations of the uranium fuel cycle. As a result of the Appeal Board's June 1, 1977 ruling in ALAB-407, this Board was instructed to consider the revised values presented in the interim Table S-3 rule. During the hearing, the Staff presented its evaluation of the revised environmental impacts associated with the uranium fuel cycle (Testimony of Jan Norris, following Tr. 2620). The effects are not significantly different from those which the Staff had considered pursuant to its earlier review and which appeared in the FSFES §5.4.3 now superceded by the Norris testimony (Tr. 2620, 2647-2648). The environmental effects from the uranium fuel cycle, as presented by the Staff, are sufficiently small in their contribution to environmental costs that the overall environmental impact assessment is not significantly affected.

110. The Board finds that the radiological impacts associated with the operation of TMI-2, including those resulting from the uranium fuel cycle, have been adequately described and evaluated, that radiological releases will meet the requirements of applicable Commission regulations, and that there will be no unacceptable radiological impact on man from the routine operation of the plant.

(7) Community Impacts

111. The impacts on the local community due to the influx of construction workers to construct Unit 2 are substantially over, since construction is essentially complete. Due to the small plant operating force moving into the area, i.e. 165 people, no significant impacts are expected on the community (FSFES §5.6).

(8) Summary of Operational Impacts

112. The Board finds that the impacts on the site area from construction and operation of the facility have been adequately described and evaluated, and they are acceptable. The Board further finds that the operation of the TMI-2 plant will not have a significant impact on the terrestrial and aquatic biota on or near the site, and that the radiological effects will be small. Further, the influx of operating personnel will constitute a minimal impact on the surrounding communities. The Board notes that the site is sufficiently remote and rural so that its visual impact is limited to relatively small numbers of people.

c. Environmental Monitoring

113. The Applicants' aquatic and terrestrial monitoring programs have already been discussed in connection with the Board's resolution of Contention 2, above. The Applicants have conducted a hydrological monitoring program in the Susquehanna River that includes measurements of

temperature, conductivity, pH dissolved oxygen, turbidity, color, odor, and other chemical parameters. (FSFES §6.2)

114. The on-site meteorological monitoring program was begin in May 1967 with the installation of a 100 foot-high instrumented mast to measure wind speed and direction. In October 1970, a 150-foot high meteorological tower became operational on site, measuring wind speed and direction, ambient air temperature, relative humidity, vertical temperature differences, and horizontal and vertical wind fluctuations. The Applicants provided combined frequency distributions of wind speed and direction for two one-year periods, with a joint recovery rate of 79%. Meteorological data collection is continuing onsite. The Staff will require that the Applicants submit a year of onsite data with 90% recovery rate to confirm its radiological impact assessment. The meteorological data collection will continue throughout the entire period of plant operation. (FSFES §6.3.2)

115. Radiological environmental monitoring programs have been established to provide data on measurable levels of radiation and radioactive materials in the site environs. (FSFES §6.6; FSFES Table 6.1) Monitoring programs are conducted to verify the proper operation of in-plant controls used for controlling the releases of radioactive materials and to assure that undetected radioactivity will not build up in the environment. (FSFES §6.6) The preoperational phase provides for

the measurement of background levels and their variations along the anticipated important pathways. The radiological monitoring proposed by the Applicants has been reviewed by the Staff and found to be generally acceptable (FSFES §6.6.1); but the Staff has recommended certain additions to improve the effectiveness of the program. The Board, upon its own review of the evidence, agrees that the radiological monitoring program is acceptable, subject to the changes recommended by the Staff in the FSFES at paragraph 6.6.1, pages 6-9, which changes the Board hereby adopts.

116. In response to a Board question (Tr. 145), both the Staff and the Applicants discussed FSFES §11.1.6.2 dealing with the monitoring of radioactive releases entering the river. The Board has determined that the operational radiological environmental monitoring program for Unit 2 will include a composite water sampler capable of collecting hourly aliquot samples from the Susquehanna River one mile downstream of the plant discharge. Composited water samples will be analyzed monthly for gamma isotopic content and analyzed for Sr-89, Sr-90, and tritium, all on a quarterly basis. (Testimony of Joseph Osloond, following Tr. 1062; Applicants' Environmental Responses). The Board finds that the Staff and the Applicants have sufficiently clarified the meaning of FSFES §11.1.6.2, and that the sampling program provides a means for confirming that concentrations of radioactivity between the plant release point and the sampling location are low.

117. The Board finds that the various preoperational and operational monitoring programs performed or proposed by the Applicants, when revised to include the Board's modifications and additions, are adequate to provide the required information with which to assess the environmental impacts which may result from the operation of TMI-2.

d. Environmental Effects of Postulated Accidents

118. The environmental effects of postulated accidents have been assessed by the Applicants (ER §7). The Staff has reviewed the Applicants' assessment, has made independent calculations, and has concluded that the environmental risks are extremely small (FES §VI; FSFES Chapter 7). The radiological effects of accidents on the environment have been assessed using the standard accident assumptions and guidance issued as a proposed annex to Appendix D to 10 CFR Part 50 on December 1, 1971 (36 F. R. 22851). The annual potential radiation exposure of the population from all postulated radiological accidents is assessed to be a very small fraction of the exposure from natural background. The Board thus finds that the environmental impact due to postulated radiological accidents is acceptably small.

e. Need for Power

119. TMI-2 is to be a base loaded plant, which will contribute to meeting the energy demand placed on the General Public Utilities (GPU)

System. The General Public Utilities Corporation, with its subsidiaries, the Metropolitan Edison Company, the Pennsylvania Electric Company, and the Jersey Central Power and Light Company (Applicants), supplies electricity to an area of about 24,000 square miles, in parts of Pennsylvania and New Jersey, having a population of about 4 million. The Metropolitan Edison Company operates in an area of 3,274 square miles in eastern Pennsylvania. Pennsylvania Electric Company supplies an area of 17,600 square miles in western, northern, and south central Pennsylvania, with the Jersey Central Power and Light Company operating in an area of 3,256 square miles in north central, east central, northwestern and western New Jersey (FSFES §8.2.1).

120. The GPU system service area is included in the Federal Power Commission (FPC) Northeast Power Survey Region. The GPU system is a member of the Pennsylvania-New Jersey-Maryland (PJM) Interconnections, which is a formal power pool that serves three-quarters of Pennsylvania, most of New Jersey, more than half of Maryland, a small part of Virginia, and all of the District of Columbia, and Delaware. In addition to coordination of planning, the companies in the PJM Interconnection share in any load curtailment or voltage reduction if conditions warrant it (FSFES §8.2.2).

121. TMI-2 is scheduled for fuel loading in late 1977, with commercial operation anticipated for the spring of 1978 (See FSFES Table 8.1)

With the addition of TMI-2, in 1976, the GPU System reserves will meet the criterion of 20 percent over summer peak load that both GPU and the Pennsylvania-New Jersey-Maryland (PJM) Interconnection have set as the standard for their reserves margin, based on reliability standards of the Mid-Atlantic Area Council (MAAC). Should TMI-2 be delayed a year, the GPU Systems reserves would stand at 13.8 percent, i.e., considerably below the standard (FSFES §§8.2.2, 8.3.1). The Board has reviewed the 5.9 percent (for 1976-1980) compound annual growth rate of energy requirements developed by GPU for its system and finds it to be reasonable. This is below the 6.9 percent annual growth rate computed by the Staff using FEA provided regional forecasts for the time period 1974-1985 (FSFES §8.3.1). Energy conservation alternatives were considered by the Staff, including load shedding, load staggering, interruptible load contracts and pricing alternatives (peak load pricing, flat rates, and increasing block rates). The Staff determined that none of these measures would be a viable alternative to a base load facility such as TMI-2 and, therefore, concluded that construction of TMI-2 should continue (FSFES §8.3.2). The Board, upon its own review of the evidence, agrees. The Staff further concluded that, because TMI-2 would be one of the lowest cost sources of baseload power in the GPU system, operation of TMI-2 can be justified even if there is no load or energy requirement growth (FSFES §§8.3.1, 8.3.3). The Board has reviewed this conclusion and finds that there is a need for the operation of the TMI-2 plant on its current schedule.

f. Alternatives

122. Alternative energy sources, sites and designs to TMI-2 have been evaluated. As alternates to TMI-2, hydroelectric potential, fossil-fired generating plants (including oil, natural gas and coal-fired) and the purchase of power from other companies, as well as substitution of MHD, solar heat, fuel cells, wind or tidal power, and conservation of energy have been considered. In the December 1976, FSFES, these alternatives were dismissed as (a) neither feasible nor viable, or (b) viable but less desirable from the standpoint of economic and environmental impacts. ((a) included MHD, solar, fuel cells - FSFES, Appendix B, XI.A.2.6, and purchased power - FSFES, Appendix B, XI.A.2.a; (b) included gas-fired, oil-fired, and coal-fired plants - FSFES, §9.2, Appendix B, XI.A.6, XI.B.). As for alternate sites, a number of sites were evaluated including a site on the coast of New Jersey where this unit was originally sited until 1968; no other site is obviously superior to the Three Mile Island site selected. (FSFES, Appendix B, XI.A.3). Alternative cooling systems and methods of operation for the cooling system installed at TMI-2 have been evaluated, but none is judged overall to have advantages that would suggest its use in lieu of the present system. (FSFES §9.3.1, Appendix B, XI.A.5)

123. Pursuant to a decision by the Atomic Safety and Licensing Appeal Board in the Hartsville case, (ALAB-367, 5 NRC 92, at 103 fn. 52 (1977)), that consideration of alternatives in certain cases should

include a discussion of the comparative incremental health effects associated with viable alternatives, the NRC Staff and the Joint Intervenors offered witnesses on the comparative health effects associated with the nuclear and coal fuel cycle. This consideration is relevant here since this proceeding falls within Section C of Appendix D of 10 CFR Part 50. The Staff presented as its witness Dr. R. L. Gotchy, a senior radiologist with the NRC. (Gotchy testimony, following Tr. 1883) Joint Intervenors' representative in the proceeding, Dr. Chauncey Kepford, also submitted prepared testimony and presented himself as Joint Intervenors' witness on the subject. (Following Tr. 2835). Both witnesses were examined extensively by the Board and the parties.

124. The Applicants and the Staff objected to the admission into evidence of Dr. Kepford's testimony on the basis that it constitutes a challenge to the Commission's Table S-3, relating to effects of offsite portions of the uranium fuel cycle activities necessary to support a typical nuclear plant, and on the basis that Dr. Kepford's professional credentials do not qualify him to testify on this subject matter. The Board ultimately admitted the entire testimony for whatever weight is deemed appropriate (Tr. 2801-2803, 2806, 2828, 2931). Dr. Kepford's testimony alleges that Table S-3 errs by not considering that the Rn-222 that emanates from a uranium mill tailings pile does so for an indefinite time (billions of years) into the future, thus

increasing the dose commitment to future generations, and thus modifying the nuclear assessment of Dr. Gotchy's analyses. We note, parenthetically, that this Board has received a letter from the Staff dated November 30, 1977, transmitting a letter from Dr. W. Jordan to Chairman Yore of the ASLB Panel, in which Dr. Jordan alleges that an error exists in Table S-3. We see this as being analogous to Dr. Kepford's allegation. The Staff notes that Dr. Gotchy's testimony may be affected by this Jordan claim, and commits itself to a later assessment of the matter.

125. We need not address the questions of whether this aspect of Dr. Kepford's testimony poses a permissible challenge to Table S-3, nor whether Dr. Gotchy's conclusions are affected by the Jordan allegation, for our decision does not require a resolution of these matters. Dr. Kepford--under cross-examination--testified that even with the significantly larger releases of Rn-222 that he alleges should have been used by Dr. Gotchy, one is still dealing with releases that are small compared with the natural background (Tr. 2864-2866). The corresponding TMI-2 related health effect would amount to an increased mortality rate of one additional death per billion deaths from other causes over the time span of several billion years required (by Dr. Kepford's reckoning) to account for the decay of the parents of Rn-222. (Tr. 2867-2875) Hence, granting for the sake of argument the correctness of Dr. Kepford's analysis, we find the relative impact of the Rn-222 consideration to be of negligible materiality.

126. The results of Dr. Gotchy's analyses, summarized in Table 1 and 2 attached to his written testimony, indicate that there are more severe health effects associated with a coal fuel cycle than with a nuclear fuel cycle, by factors ranging from 3 to 250, depending upon various assumptions and uncertainties. However, Dr. Gotchy characterizes either fuel cycle as contributing a very small or minute increase in the risk of health effects to which the public is exposed already. Without belaboring the details, we find these results plausible, of little materiality, but technically in need of considerable refinement because of the numerous unknowns that Dr. Gotchy indicates have not been quantitatively considered. Dr. Gotchy indicated that a soon-to-be published National Research Council Report may assist in reducing much of the uncertainty in his analyses.

127. The Board finds that despite the uncertainties of the Gotchy testimony and the possibly improper treatment of the impact of Rn-222 alleged by Dr. Kepford, the nuclear fuel cycle is environmentally an acceptable alternative to coal and an economically more desirable alternative than coal, consistent with the Staff's conclusions in the Final Supplement to the FES.

2. Cost-Benefit Balance

128. The Board finds from the evidence in this proceeding that a systematic, interdisciplinary approach has been employed in the environmental review of TMI-2, that environmental factors have been given appropriate consideration in decision-making, along with technical and other considerations, and that an appropriate evaluation of alternatives to minimize environmental impacts and suitable cost-benefit analyses, as required by NEPA and Appendix D to 10 CFR Part 50, has been conducted. The primary benefit of continuing construction and operating TMI-2 will be the generation of 906 MWe (880 MW summer rating) net generating capacity (FSFES §10).

129. The Board, on the basis of the entire record, finds that the principal costs of TMI-2 may be summarized as follows:

(a) Removal from use for agricultural or wildlife habitats of approximately 190 acres of land for the unit's facilities for the duration of the plant's life.

(b) Use of land for approximately 75 miles of transmission line right-of-way.

(c) Some temporary disturbance of land onsite and of adjacent waters, which has occurred during construction.

(d) Consumptive use of 10,000 gpm of Susquehanna River Water.

(e) Possibility of some increased local fogging from operation of cooling towers.

(f) Some visual impact from the cooling towers, their plumes and the transmission lines.

(g) Discharge to the river of about 1800 gpm of water with small amounts of chemicals and heat. Average effluent temperatures will be less than 3°F above river ambient.

(h) Some small and localized destruction of minute aquatic organisms by entrainment and of small fishes by impingement.

(i) Annual release of about 550 curies of radionuclides (0.24 Ci/yr excluding tritium) in liquid effluents and about 6,700 Ci/yr of noble gases, 0.01 Ci/yr of iodine 131, 560 Ci/yr of tritium, 25 Ci/yr of argon-41 and 0.06 Ci/yr of particulates in gaseous effluents.

(j) A very low likelihood of accidental radiation exposure to nearby residents.

(k) Minimal environmental effects associated with the uranium fuel cycle and transportation of

fuel and waste to and from the facility.

(l) Consumptive use of uranium fuel resources.

(m) The capital and operating costs of the plant.

130. The Board finds that the benefits of construction and operation of TMI-2 outweigh the environmental, economic, and other costs, and, therefore, that the balancing of these factors favors continuation of the TMI-2 provisional construction permit.

3. Compliance with the Federal Water Pollution Control Act Amendments of 1972

131. On June 22, 1977, the Commonwealth of Pennsylvania, through its Department of Environmental Resources, certified, pursuant to §401(a)(1) of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA) that any discharge from the construction and operation of TMI-2 will comply with the applicable provisions of §§301, 302, 306, and 307 of the FWPCA and will not violate the applicable water quality standards of the Commonwealth of Pennsylvania as approved by the United States Environmental Protection Agency (Applicants' Exhibit 9). On November 9, 1977, the Commonwealth of Pennsylvania revised the 401 Certification previously issued on June 22, 1977. The revised sections pertain to thermal effluent limitations (Affidavit of Clarence R. Hickey, Jr., dated December 6, 1977, with attached copy of the revised 401 Certification, dated November 9, 1977, both of which are hereby received in evidence). The Board finds

that this certification satisfies the requirement of Section 401 of the FWPCA. Pursuant to §401(d) of the FWPCA, this Commission is required to include in any NRC license or permit such conditions or effluent limitations as are set forth in the §401 Certification. The §401 Certification issued by the Commonwealth of Pennsylvania for this station includes the following conditions and/or limitations:

a. That the Applicants comply with Pennsylvania's Clean Streams Law.

b. That the Applicants comply with Industrial Waste Permits 2270204 and 2272202, and Sewerage Permit 2275419 issued by the Department of Environmental Resources.

c. The following effluent limitations should be imposed

1. Discharge 101 - Effluent of sewage treatment facilities. Total phosphorous shall not exceed 2 mg/l on an average basis, nor 4 mg/l at any time.

2. Discharge 001 - Combined Mechanical Draft Cooling Tower Blowdown.

a. The Applicants shall at all times maintain in good working order and operate the Mechanical Draft Cooling Towers (MDCT's) as efficiently as possible so as to mini-

mize temperature differential between ambient river temperature and the temperature of the discharge; provided, however, the MDCT's may be shut down when in the judgment of the responsible TMINS personnel a combination of atmospheric conditions and river temperature may exist which causes the waste water to be heated as it passes through the MDCT's or ice formation is observed to occur within the MDCT's.

b. The temperature of the discharge shall never exceed a maximum of 87°F, except when the ambient river temperature exceeds 87°F, in which case, the discharge temperature shall not exceed the ambient river temperature; the temperature of the discharge shall not change by more than 5°F during any one hour period.

Ambient river temperature is the temperature of the river upstream of the heated waste discharge. The ambient temperature sampling point should be unaffected by any sources of waste heat. The temperature of the intake

water will be considered as ambient river temperature so long as the intake water is unaffected by TMI's or any other nearby heated water discharge.

c. The following temperature limitations shall never be exceeded:

1. During the period November 1 through April 30, the temperature of the discharge shall not exceed 12°F above ambient river temperature.

2. During the period May 1 through October 31, the temperature of the discharge shall not exceed 7°F above ambient river temperature.

3. During plant cooldown operations the temperature of the discharge shall not exceed 12°F above ambient river. temperature.

d. At no time shall the discharge exceed the rate of 150 million gallons per day.

e. The Chief of the Operations Section of the Harrisburg Regional Office of the Bureau of Water Quality Management shall be advised by telephone within 24 hours when the MDCT's

are shut down for reasons other than those specified in condition 2(a) above and again when tower operation is resumed; shall be notified within 24 hours when the discharge limitations specified in paragraph 2(c) above are exceeded and again when the discharge is in compliance with such limitations; and shall be notified, at least thirty (30) days in advance, whenever possible, of all scheduled plant cooldown operations.

f. Within two years after both nuclear reactor units are in commercial operation, the Metropolitan-Edison Company will collect and submit to the Department of Environmental Resources stream data which accurately defines the thermal plume or zone of impact from the TMINS heated waste discharge. As a minimum, thermal plume mapping data collected to meet the Nuclear Regulatory Commission's re re-ments shall be submitted to Pennsylvania Department of Environmental Resources.

g. That the Applicants submit to the Pennsylvania Department of Environmental Resources within ninety (90) days of issuance of Amendment No. 1 to the NPDES permit, an application for a new Pennsylvania Water Quality Management permit for the facilities associated with the thermal component of discharge 001.

## III. Conclusions of Law and License Conditions

132. In accordance with the Atomic Energy Act and the Commission's Regulations, and on the basis of the record in this proceeding, the Board concludes as follows:

a. The environmental review conducted by the NRC Staff pursuant to the requirements of Section 102 (2) (A), (C) and (E) of the National Environmental Policy Act of 1969 and Appendix D to 10 CFR Part 50 has been adequate;

b. The requirements of Section 102(A), (C) and (E) of the National Environmental Policy Act and Appendix D of 10 CFR Part 50 has been adequate;

c. Having considered and decided all matters in controversy among the parties related to construction, and having independently considered the final balance among conflicting factors contained in the record with a view to determining the appropriate action to be taken, and after weighing the environmental, economic, technical, and other benefits against environmental costs, and considering the available alternatives, the construction permit for Three Mile Island Nuclear Station, Unit No. 2, should be continued;

d. Having considered and decided all matters in controversy among the parties related to operation, the Director of Nuclear Reactor Regulation should be authorized to make such additional findings on uncontested issues as may be necessary to issuance of a full-term operating license for Three Mile Island Nuclear Station, Unit No. 2, subject, however, to the following conditions:

(1) Before engaging in additional construction or operational activities which may result in an environmental impact which has not been evaluated by the Commission, the licensee shall prepare and record an environmental evaluation of such activity. If the evaluation indicates that such activity may result in a significant adverse environmental impact which has not been evaluated, or an impact which is significantly greater than that which has been evaluated, the licensee shall provide a written evaluation of such activities to the Director, Office of Nuclear Reactor Regulation, and shall obtain the approval of that office prior to proceeding with the proposed activity;

(2) Since Unit 2 will approximately double the salt load from drift, after startup of Unit 2 the Applicants shall implement a low altitude true and false color aerial photographic monitoring program in this regard, with a continuation of the current monitoring program, both of which shall

continue for at least a period of two years, the programs to be terminated only upon approval of the Regulatory Staff;

(3) The current bird impaction monitoring program may now be terminated; however, if the Applicants should become aware of any case of excessive bird impaction (i.e., greater than 100 in any one day), they shall analyze the occurrence and report the matter to the Regulatory Staff within 30 days thereafter;

(4) The changes in the radiological monitoring program recommended by the Staff in its FSPES at paragraph 6.6.1, page 6-9, shall constitute conditions upon the license to be issued hereunder;

(5) The Applicants shall develop an environmental monitoring program for inclusion in the environmental technical specifications that uses as a baseline a consolidation of the data (particularly that relating to macroinvertebrates) gathered

by the Applicants' consultants, i.e., Dr. Wurtz, Millersville State College, and Ichthyological Associates, Inc.). The Regulatory Staff, paying particular attention to the macroinvertebrates and to the population estimates of fishes in specific areas, shall assure that the monitoring program thus developed utilizes the collected information in an efficient and meaningful manner. The program shall also include a sampling of fishes by various methods, if meaningful statistics in the form of catch-per-unit-of-effort can be obtained. Additionally, creel census shall continue to be performed and if a significant deviation from preoperational conditions is discovered, the reasons for the deviation shall be determined.

The monitoring program described in this paragraph shall continue for a period of at least three (3) years following the beginning of plant operation. At the expiration of the three year period, it

shall be evaluated by the Staff for its continued usefulness. The monitoring program shall be terminated only upon a Staff determination that its further continuation would serve no significantly useful purpose.

## IV. Order

133. On the basis of the foregoing findings and conclusions, and pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's regulations, IT IS ORDERED that the Director of Nuclear Reactor Regulation is authorized to continue in effect the construction permit of Metropolitan Edison Company, Jersey Central Power and Light Company, and Pennsylvania Electric Company for Three Mile Island Nuclear Station, Unit No. 2, and to make such additional findings on uncontested issues as may be necessary to the issuance of a full-term operating license for that Unit, consistent with the terms of this Initial Decision.

134. IT IS ORDERED, in accordance with 10 CFR Sections 2.760, 2.762, 2.764, 2.785 and 2.786 that this Initial Decision shall be effective immediately and shall constitute the final action of the Commission 45 days after the date of issuance hereof, subject to any review pursuant to the above cited rules. Exceptions to this Initial Decision must be filed

within seven (7) days after service of this decision. A brief in support of the exceptions must be filed within 15 days thereafter (20 days in the case of the NRC Staff). Within 15 days of the filing and service of the brief by the appellant (20 days in the case of the NRC Staff), any other party may file a brief in support of, or in opposition to, the exceptions.

THE ATOMIC SAFETY AND
LICENSING BOARD

Ernest O. Salo, Member

Gustave A. Linenberger, Member

Edward Luton, Chairman

Dated at Bethesda, Maryland
this 19th day of December 1977.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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| In the Matter of | ) | |
| | ) | |
| METROPOLITAN EDISON COMPANY, ET AL. | ) | Docket No.(s) 50-320 |
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| (Three Mile Island Unit No. 2) | ) | |
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CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document(s) upon each person designated on the official service list compiled by the Office of the Secretary of the Commission in this proceeding in accordance with the requirements of Section 2.712 of 10 CFR Part 2 - Rules of Practice, of the Nuclear Regulatory Commission's Rules and Regulations.

Dated at Washington, D.C. this
20th day of Dec 1977.

Peggy T Downing
Office of the Secretary of the Commission

60-088

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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| In the Matter of | ) | |
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| METROPOLITAN EDISON COMPANY, ET AL. | ) | Docket No. 50-320 -OL |
| | ) | |
| (Three Mile Island Unit No. 2) | ) | |

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