UNITED STATES OF AMERICA
ATOMIC ENERGY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CONSUMERS POWER COMPANY	)	Docket Nos. 50-329 and 50-330
	)	
(Midland Plant, Units 1 and 2)	)	

APPLICANT'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW IN THE FORM OF AN INITIAL DECISION

INTRODUCTION

1. This proceeding has been commenced pursuant to the Atomic Energy Act of 1954, as amended, 42 U.S.C. §2011 et seq., (hereinafter the "Act") for the purpose of considering issuance of a construction permit for a nuclear plant. The Act provides for a two-step licensing procedure involving issuance of a construction permit prior to construction of a plant and issuance of an operating license following completion of construction (42 U.S.C. §2235). An application for a construction permit presents the technical and financial information regarding an applicant and sets forth preliminary design criteria and analyses (42 U.S.C. §2235; 10 CFR §50.34). It is furnished to local governmental officials and made available to the public (10 CFR §2.101). The application is reviewed by the Atomic Energy Commission's (AEC) Regulatory Staff ("Staff") and by the Advisory Committee on Reactor Safeguards ("ACRS"), a body of independent experts (42 U.S.C. §2232b). In such review, the Staff visits the proposed site and ensures the

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completeness of the information furnished by the applicant and the Staff and the ACRS review the material to ensure that the proposed plant can be constructed and operated without undue risk to the health and safety of the public.

2. Prior to the effective date (January 1, 1970) of the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. §4321 et seq.), AEC jurisdiction was limited to those issues, primarily matters of radiological health and safety, prescribed in the Act and the AEC's regulations. NEPA, however, requires the AEC to make an environmental evaluation of its major actions having a significant effect on the environment. The AEC promulgated regulations designed to implement the requirements of NEPA (35 F.R. 5463; 35 F.R. 18469). However, on July 23, 1971, the United States Court of Appeals for the District of Columbia found such regulations to be in noncompliance with the requirements of NEPA (Calvert Cliffs Coordinating Committee, Inc. v AEC, 449 F2d 1109, (D.C. Cir 1971)). Subsequent to that decision the AEC promulgated its presently effective regulations implementing NEPA (10 CFR §50 App. D). Under the effective regulations, an applicant files an environmental report, which is made available to the public, detailing the environmental impacts of the proposed action and alternatives available and makes a cost-benefit analysis of the project and alternatives; the Staff reviews the information furnished, makes independent investigation and issues a draft environmental statement which is made available to the public and Federal, state and local agencies for comment; and on receipt of comments the Staff

evaluates them and issues a final environmental statement which details the impact and alternatives and presents a cost-benefit analysis (10 CFR Part 50, Appendix D).

3. Following favorable Staff review of the application and the environmental aspects of the plant, a mandatory hearing is held before an Atomic Safety and Licensing Board (42 U.S.C. §2239; 42 U.S.C. §2241). Public notice of the hearing is given and interventions are permitted by interested persons. The hearing board does not conduct a de novo review of the application in uncontested proceedings, but determines whether the application and record of the proceeding contain sufficient information on radiological health and safety, whether the Staff review has been adequate and whether the requirements of NEPA and 10 CFR Part 50, Appendix D, have been complied with, and makes an independent final environmental balancing among any conflicting factors in the record. In a contested proceeding the hearing board additionally makes a de novo determination of any matters in controversy between the parties. Upon conclusion of the hearing, the hearing board issues its initial decision which, if favorable, empowers the Staff to issue a construction permit and which modifies the final environmental statement to the extent its conclusions differ with those of the final statement.

4. Following receipt of a construction permit, an applicant must apply for an operating license setting forth final design and analyses and identifying any differences from the construction permit. Additionally, the applicant must file an environmental report discussing only those matters that differ from the construction permit stage report.

Review by the Staff and ACRS is conducted and new environmental statements are prepared and circulated on matters contained in the operating license stage environmental report and other matters that the Staff believes should be included. However, a public hearing is not required on the operating license application unless a person whose interest may be affected requests one. If, following notice of intent to issue a license, no intervention is received, the AEC can proceed to issue a license after it has satisfied itself that the plant as designed and constructed can be operated so as not to create an undue risk to the health and safety of the public and that environmental factors have been adequately considered. If, however, an intervention is received, a hearing will be held before an Atomic Safety and Licensing Board to determine the matters in controversy. Following a favorable decision, the operating license will be issued.

PRELIMINARY STATEMENT

5. On January 13, 1969, Consumers Power Company ("Applicant") filed with the Atomic Energy Commission ("AEC" or "Commission") an application for a license to construct and operate a dual purpose pressurized water nuclear power plant ("application" or "PSAR"). The proposed plant, designated the Midland Nuclear Plant, Units 1 and 2 ("Plant"), would produce approximately 1300 megawatts of electricity and 4,050,000 pounds of process steam for use by the Dow Chemical Company. It is to be located on Applicant's approximately 1200-acre site on the south shore of the Tittabawassee River in Midland County, Michigan.

6. The application has undergone an extensive and continuous review by the Commission's Regulatory Staff ("Staff") since its filing.

Even prior to the filing of the application, the Staff commenced the regulatory review with a number of informal site discussions. The Staff met with the Applicant on numerous occasions to discuss the application and made a number of requests for additional information. The application was amended twenty-one times to provide such additional information and to update previously supplied information. Copies of the application and each amendment were served on the Mayor of the City of Midland, the Township Supervisor of Midland Township and the Chairman of the County Board of Supervisors by the Applicant as they were filed. Additionally, copies of the application and amendments were transmitted by the AEC to the Governor of the State of Michigan and were placed in the AEC's Public Document Room in Washington, D. C. as they were received.

7. In its review of the application, the Staff consulted with numerous independent experts on specialized subject matters, e.g., climate and meteorology (Air Resources Environmental Laboratory, National Oceanic and Atmospheric Administration, Department of Commerce); seismicity (U. S. Coast and Geodetic Survey, Environmental Science Services Administration, Department of Commerce and John A. Blume & Associates, Engineers); fish and wildlife (U. S. Fish and Wildlife Service, Department of the Interior), and geology and hydrology (U. S. Geological Survey, Department of the Interior) (Staff Safety Evaluation, p. 2, and Appendices C, D, E, F and G, following Tr. 1674). The Advisory Committee on Reactor Safeguards ("ACRS") also reviewed the application and held six sub-committee meetings including a site visit and four full committee meetings regarding the

application (Applicant's Ex. 4 and Ex. 5). After identifying a number of items to be resolved during construction of the Plant, the ACRS in its reports, dated June 18, 1970 and September 23, 1970, reached a favorable decision and concluded that the Plant, Units 1 and 2, "can be constructed with reasonable assurance that they can be operated without undue risk to the health and safety of the public." (Applicant's Ex. 4 and Ex. 5) After almost two years of review, the Staff in its Staff Safety Evaluation ("SSE"), dated November 24, 1970, concluded, among other things, that ". . ., the proposed facility can be constructed and operated at the proposed location without undue risk to the health and safety of the public;" (SSE, p. 87, following Tr 1674). By Amendments Nos. 20 and 21, dated April 2, 1971 and July 6, 1971, respectively, Applicant modified its liquid radwaste system to reduce releases to very low levels and to update financial and corporate information. On November 3, 1971, Applicant incorporated as part of its application Babcock & Wilcox Company Topical Reports BAW-10015; BAW-10015, Supplement 1; and BAW-10034 to demonstrate compliance of the Plant's proposed emergency core cooling system with the AEC's Interim Acceptance Criteria for Emergency Core Cooling Systems For Light-Water-Cooled Nuclear Power Reactors. By letter, dated January 6, 1972, Applicant incorporated in its application Revision 1 to BAW-10034. Following review of these various filings, the Staff issued a supplement, dated January 14, 1972, to its Safety Evaluation, dated November 12, 1970. The Supplemental Safety Evaluation concluded that "the conclusions reached in our Safety Evaluation . . . are still valid and that

the proposed facility can be constructed and operated at the proposed location without undue risk to the health and safety of the public." (Staff Ex. 8)

8. By letter dated July 30, 1970 from the Director, Division of Reactor Licensing, Applicant was granted an exemption authorizing it to perform certain below grade construction activities at the site. In November, 1970, because of the prolonged hearing that appeared to be inevitable, Applicant suspended all site activity except for necessary material preservation and material receiving. Such suspension has continued in effect to the present time. As of the present, the following site activities which were performed pursuant to the previously effective 10 CFR §50.10(b)(1) and (3) and the exemption are at the following stages of completion:

> Clearing and preparation of site (80% complete); site excavation, preliminary construction activities for nuclear facilities and construction work on non-nuclear facilities (5% complete); concrete placement for substructure of auxiliary building (75% complete), for tendon galleries (65% complete), and for reactor building foundations (20% complete) (Applicant's letter, dated April 18, 1972).

Pursuant to 10 CFR §50.12(b), Applicant by letter dated April 18, 1972 requested the Commission to consider granting an exemption authorizing Applicant to engage in certain activities previously allowed by its regulations but prohibited by 10 CFR §50.10(c) [adopted effective March 11, 1972], and to allow Applicant to retain the construction exemption dated July 30, 1970. In Applicant's letter of April 18, 1972, Applicant stated that it had no intention to resume work at that time and therefore requested that the Commission hold in abeyance any authorization to resume construction pursuant to §50.12(a) until such

time as the approximate date of receipt of a construction permit might be predictable and Applicant might make a supplemental filing specifying the desired date for the authorization.

9. At the time the application was filed the jurisdiction of the AEC was regarded by AEC as limited to matters of financial and techincal competence and protection of the health and safety of the public against radiological hazards (State of New Hampshire v Atomic Energy Commission, 395 U.S. 962, 406 F2d 170 (1 Cir 1969) cert. denied). However, with the enactment of the National Environmental Policy Act of 1969 (42 U.S.C. §4321 et seq.) ("NEPA"), effective January 1, 1970, all Federal agencies were required to make an environmental evaluation of major actions having a significant effect on the environment. The AEC, on April 2, 1970, was the first agency to promulgate a regulation designed to provide for environmental review pursuant to NEPA (35 F.R. 5463). This regulation provided for circulation of the application to Federal agencies for comment and for preparation of an environmental statement by the AEC following receipt of such comments. On June 3, 1970, the AEC proposed revised environmental regulations to reflect recently issued guidance of the Council on Environmental Quality and enactment of the Water Quality Improvement Act of 1970 (33 U.S.C. §1171; 35 F.R. 8594). The proposed regulation provided for submission of environmental reports by applicants, circulation of such reports to Federal agencies and noticing availability of such reports to the public and state and local agencies, preparation of a detailed statement by the agency following receipt of comments and treating certificates

of compliance with the Water Quality Improvement Act of 1970 as satisfying concerns as to environmental effects on water quality.

10. On request of the AEC, Applicant filed an environmental report, dated July 24, 1970, in compliance with the proposed regulations. The environmental report was circulated to Federal agencies for comments and the public and state and local agencies were given notice of its availability and requested to comment on it (35 F.R. 12795, August 12, 1970). Comments were received from the U. S. Departments of Defense, Housing and Urban Development, Interior and Agriculture, the Federal Power Commission and the Michigan Department of Natural Resources (Draft Environmental Statement, Appendices A-G, February 5, 1971). Applicant filed its responses to the comments received and requested the AEC to circulate its draft environmental statement for comment in compliance with the then in effect guidelines of the Council on Environmental Quality.

11. On December 4, 1970, the AEC issued effective revised environmental regulations (35 F.R. 18469, December 4, 1970). The revised regulations provided for submission by applicants of environmental reports presenting the applicants' assessment of environmental impact and possible alternatives to alter the impact, preparation and circulation of a draft environmental statement by the Staff, and preparation of a final environmental statement by the Staff following receipt and consideration of comments received. The revised regulations also provided, among other things, that environmental factors need not be considered by

Atomic Safety and Licensing Boards at hearings unless affirmatively raised by parties or the Staff, prohibited the raising of nonradiological environmental matters in hearings noticed prior to March 4, 1971, and provided that no independent evaluation need be made of environmental factors that had been certified by other Federal agencies as complying with their standards. Applicant furnished additional environmental information on January 19, 1971 in response to a request from the Staff and the Staff on February 5, 1971 issued its Draft Detailed Environmental Statement for circulation to Federal agencies and state and local agencies and the public were given notice of its availability and an opportunity to comment (36 F.R. 3080, February 17, 1971). Comments were received from the U. S. Departments of Interior, Transportation (U. S. Coast Guard), Health, Education and Welfare (Bureau of Radiological Health and Food and Drug Administration) and Commerce, the Environmental Protection Agency and the Environmental Defense Fund. On May 20, 1971 and June 21, 1971, Applicant filed responses to the comments received.

12. On July 23, 1971, the United States Court of Appeals for the District of Columbia Circuit required the AEC, inter alia, to revise its regulations to require consideration of environmental matters at all hearings before Atomic Safety and Licensing Boards and to perform an independent evaluation of environmental factors even where other Federal agencies had certified their compliance with applicable standards (Calvert Cliffs Coordinating Committee, Inc. v. AEC, 449 F2d 1109 (D.C. Cir 1971)). The AEC, on September 9, 1971, revised its regulations to reflect the decision of the Court (36 F.R. 18071) and this, with several subsequent amendments, constitutes the present AEC regulations, 10 CFR Part 50, Appendix D.

13. Following issuance of the new regulations, Applicant filed its Supplemental Environmental Report, dated October 19, 1971, with amendments in response to questions from the Staff, dated December 10, 1971, December 24, 1971 and January 7, 1972 (Applicant's Exhibits 38F-1, 38F-2, 38F-3, 38G, 38H and 38I, hereinafter collectively "ASER" or "Supplemental Environmental Report"). The availability of the ASER was noticed in the Federal Register for January 5, 1972 (37 F.R. 104). The AEC employed the expert services of personnel at Argonne National Laboratory to aid them in their environmental evaluation. Staff and Argonne personnel visited the site and its environs and contacted many of the local and state agencies in their evaluation (Final Environmental Statement, Appendix A; Tr. 7618-7624). The AEC circulated for comment and noticed the availability of a new Draft Environmental Statement, dated January 7, 1972 (36 F.R. 410, January 11, 1972). Comments were received from the Department of Transportation (United States Coast Guard); Department of Commerce (Bureau of Domestic Commerce, the National Bureau of Standards and the National Oceanic and Atmospheric Administration); Department of Health, Education and Welfare; Federal Power Commission; United States Department of the Interior; Department of Agriculture (Soil Conservation Service and Forest Service); Department of Housing and Urban Development; Environmental Protection Agency; Midland Township Supervisor; Midland Public Schools; East Central Michigan Economic Development District; Greater Midland Area Chamber of Commerce; Midland United Conservation Clubs; and the utility boards of the Cities of Grand Haven, Holland, Coldwater, Traverse City and Zeeland, Michigan and the Northern Michigan and Wolverine Electric Cooperative (Staff Ex. 6, Appendix E).

14. Following evaluation and review by the Staff of the numerous, generally favorable comments received from various agencies and the public and of responses by Applicant to such comments, the Staff in March 1972 issued its Final Environmental Statement (FES) which concluded "that the benefits to be derived from operation of the Midland Plant Units 1 and 2 outweigh the adverse effects identified in this statement." (Staff Ex. 6) The Final Environmental Statement, the availability of which was noticed in the Federal Register on April 7, 1972 (37 CFR 7012), further concluded that if certain additional actions were taken by Applicant, "from the standpoint of environmental effects the action called for is the issuance of a construction permit . . . ."

15. Under AEC regulations, including 10 CFR Parts 2 and 50, and the notice of hearing in this proceeding, the responsibilities of this Board with respect to radiological safety differ depending on whether this is a contested or uncontested proceeding. If this is a contested proceeding, the Board is charged with the responsibility to adjudicate all contested nuclear safety issues. "As to matters not in controversy", the Board is "neither required nor expected to duplicate the review already performed by the Commission's regulatory staff and the ACRS; the Board is authorized to rely upon the testimony of the regulatory staff and the applicant, and the conclusions of the ACRS, which are not controverted by any party." (10 CFR 2, App. A, §VI(b)(4)). The Board has found that certain issues were contested and has so conducted this proceeding. By various orders and requests to the opposing intervenors, the Board attempted to obtain from them

prior to the oral hearing a reasonable specification of the matters they controverted and a description of the evidence upon which they relied. The efforts of the Board were unsuccessful.

16. Insofar as radiological safety matters were concerned, Saginaw and Mapleton Intervenors made or filed only general statements of contention without the specification or description of supporting facts. The issues they raised at the hearing itself seemed to bear only a coincidental relationship to the statements of contention previously made. At the hearing, Saginaw Intervenors presented no affirmative case other than a single witness, a police official from East Lansing, who testified in connection with the matter of Applicant's emergency procedures. Mapleton Intervenors presented no witnesses other than two individuals on meteorological matters. Except with respect to the testimony of those three witnesses, opposition intervenors attempted to contest the adequacy of the application solely by cross-examination of the Applicant and Staff. Thousands of pages of testimony and weeks of hearings in 1971 on radiological matters were thus occupied by cross-examination of Applicant and Staff, which, in the opinion of the Board, was primarily in the nature of discovery and was largely unproductive. The cross-examination of Staff and Applicant by Saginaw and Mapleton Intervenors was addressed principally to the following subjects:

(1) Meteorology and the adequacy of related dose calculations.

(2) Quality assurance.

(3) Emergency procedures.

(4) Sodium thiosulfate iodine spray removal.

Since much time was devoted to cross-examination on these subjects, and intervenors presented witnesses as to two of them, the matters have been

treated by the Board in these findings as contested although, in a strict sense, it is questionable whether (except as to meteorology) sufficient evidence was adduced by intervenors to create any substantial issues. Consequently, the Board, as to each of these subjects, in addition to deciding the "contested" issues, has considered the adequacy of the record and of the Regulatory Staff review.

17. With respect to these matters, therefore, the members of the Board frequently asked questions of the Applicant and Staff in an attempt to develop a full record and to determine whether there was a basis for intervenors' concern. By asking such questions, the Board sought also to establish with regard to these matters whether there was sufficient information in the record and whether or not the Staff had performed an adequate regulatory review.

18. Under the AEC regulations, including 10 CFR Parts 2 and 50, Appendix D, and the Supplemental Notice of Hearing in this proceeding, dated November 29, 1971 (36 F.R. 23169), the Board's responsibilities with respect to environmental matters also differ depending upon whether the proceeding with respect to such matters is contested. As in the case of nuclear safety matters, the Board found certain issues to be contested and has so conducted this proceeding. Under the Supplemental Notice and 10 CFR Parts 2 and 50, it is the responsibility of the Board to decide all contested matters and whether the permits should be issued as proposed. In addition, it is the responsibility of the Board, regardless of whether the proceeding is contested, to "determine whether the requirements of Sections 102(2)(C) and (D) of NEPA and Appendix D . . . have been complied with"; to "independently consider the final balance

among conflicting factors contained in the proceeding with a view toward determining the appropriate action to be taken"; and to "determine whether the construction permits should be granted, denied or appropriately conditioned to protect environmental values" (Supplemental Notice, Par. No. 3; 10 CFR 2, Appendix A, §VI(c); 10 CFR 50, Appendix D). From this statement it is evident that the Board has responsibilities under the Supplemental Notice and Commission regulations which impose upon it responsibilities "independently to consider the balance among conflicting [environmental] factors".

19. The Board has been impressed by the work done both by Applicant and Staff since the Court of Appeals decision in the Calvert Cliffs case in July 1971. Comprehensive information was included in the ASER and in the amendments thereto in which Applicant responded to requests from the Staff for additional information. The comments filed by other agencies (FES Appendix E, Staff Ex. 6) show that the Staff's Draft Detailed Environmental Statement (Staff Ex. 5) was given extensive consideration by many agencies of government. It is clear from Applicant's responses (Applicant's Exhibits 38K and 38L) to those comments and from the FES that the agency comments received extensive consideration by both Applicant and Staff.

20. The Board is also impressed by the scope and depth of the AEC Regulatory Staff review. Expert consultants from the Argonne National Laboratory and elsewhere were retained to assist the Staff in their review, in the preparation of Draft Detailed Environmental Statement and the FES and in the furnishing of information to the Board at the hearing.

It is clear to the Board from its review of the Staff request to Applicant for additional information, from the Board's review of agency comments and the FES, and from the testimony of the Staff and its consultants at the hearing, that the Staff and its consultants carried out a conscientious and competent review of environmental matters under NEPA and Appendix D, 10 CFR 50.

21. Intervenors' participation in the environmental aspects of the proceeding since the Calvert Cliffs decision was not characterized by the same earnestness and effort to frame issues and furnish information for the record. In particular:

A. Saginaw and Mapleton Intervenors failed to pursue their rights of discovery and deposition. (Paragraphs 143, 150, 151 and 154);

B. For the most part, Saginaw and Mapleton Intervenors failed repeatedly to identify in good faith the nature and basis for their contentions. (Paragraphs 143, 148, 149, 150, 153 and 154);

C. Neither Saginaw nor Mapleton Intervenors filed comments on the Draft Environmental Statement.

D. On April 28, 1972, Mapleton Intervenors stated they had no direct testimony or witnesses and then produced seven witnesses at the hearing on matters as to which all significant information had been available to them for many months.

E. Testimony of Mapleton Intervenors' witnesses and cross-examination by counsel for Mapleton Intervenors may generally be characterized as not reflecting careful preparation. Their testimony for the most part was either of little probative value or bore only remote relevance to significant issues in the case.

As in the hearings in 1971, the members of the Board frequently asked questions of the Applicant and the Staff in an attempt to develop a full record and to determine whether there was a basis for intervenors' contentions. By asking such questions, the Board also sought to carry out its responsibilities under the Supplemental Notice of Hearing and 10 CFR Part 2, Appendix A, §VI(c).

PARTIES

22. By publication in the Federal Register, 35 F.R. 16749, October 29, 1970, the Commission announced that a public hearing would be held before this Atomic Safety and Licensing Board (hereinafter "Board") to consider whether a construction permit should be granted to Applicant. The notice of hearing established the time and place of hearing and the time and place of a prehearing conference. It also explained how interested persons could petition for leave to intervene in the proceedings as parties and how persons wishing to express their views at the hearing could do so without becoming intervening parties.

The Applicant and Staff made timely notices of appearance in this proceeding. Applicant was represented by Lowenstein, Newman & Reis (primarily Robert Lowenstein, Esq.), Smith & Brooker, P.C. (primarily Richard G. Smith, Esq.) and John K. Restrick, Esq.; and the Staff was represented primarily by David E. Kartalia, Esq. and Thomas F. Engelhardt, Esq. Within the time permitted for intervention by the notice of hearing, petitions to intervene in the proceeding were filed by the Environmental Defense Fund ("EDF") represented by the firm of Berlin, Roisman and Kessler (primarily by Anthony Z. Roisman, Esq. and Gladys Kessler, Esq.), by the Dow Chemical Company ("Dow") represented by the firm of Kaye, Scholer, Fierman, Hayes and Handler (primarily by Milton R. Wessel, Esq.) and James N. O'Connor, Esq. and by the Midland Nuclear Power Committee represented by the firm of Kendall and Curris (James A. Kendall, Esq.) and a joint petition to intervene was filed by the Saginaw Valley Nuclear Study Group, Citizens Committee for Environmental Protection of Michigan, Sierra Club, United Auto Workers of America, Trout Unlimited, West Michigan Environmental Action Council and University of Michigan Environmental Law Society ("Saginaw Intervenors") all represented by Myron M. Cherry, Esq. These petitions were granted by the Board in its Order dated November 24, 1970. Trout Unlimited subsequently withdrew from the proceeding (Tr. 5685-86). A late petition to intervene, filed by six residents of the community of Mapleton ("Mapleton Intervenors") represented by William J. Ginster, Esq. (subsequently with Irving Like, Esq. as co-counsel), was permitted by the Board's Order of December 8, 1970.

23. The State of Kansas filed a petition to intervene, dated September 13, 1971, on environmental matters, particularly ultimate disposal of high level wastes from reprocessing of spent fuel from the nuclear plant. Over objection from the Applicant, the State of Kansas was permitted to intervene initially only on the legal issue of whether the environmental effects of such waste disposal was a proper issue in the proceeding. By publication in the Federal Register (December 4, 1971, 36 F.R. 23169), the AEC issued a Supplemental Notice of Hearing on Application for Construction Permits to reflect revised regulations, 10 CFR 50, Appendix D, in implementation of NEPA. Mr. Steve Gadler filed a petition to intervene pursuant to the Supplemental Notice. The petition to intervene was opposed by the Applicant and the Staff and the Board in its Order, dated February 9, 1972, concluded that there was doubt that he satisfied the minimal requirements of standing and that the public interest which he claimed to represent was adequately represented by the three groups of intervenors participating in the proceeding. The Atomic Safety and Licensing Appeal Board, in its Order of March 31, 1972, denied Mr. Gadler's petition to review the Board's Order of February 9, 1972.

RADIOLOGICAL HEALTH AND SAFETY PREHEARING PROCEDURES

24. Prehearing conferences were held on November 17, 1970, December 1, 1970, January 21, 1971, April 2 and 3, 1971, May 1, 1971, and June 7, 1971. The Board attempted to use the prehearing conferences as a means of developing an orderly discovery process and defining the matters in controversy between the parties. However, the

Board was continually frustrated in its attempts by the repeated delays of the Saginaw and Mapleton Intervenors in commencing discovery, and by their repeated failures to comply with Board orders and Commission regulations or to make any effort to convert their general unsupported contentions into any meaningfully specific contentions that would apprise the Board and other parties as to their position on various issues or their basis for challenging the proposed construction permit.

25. The Board, in its Order of December 8, 1970, ordered Mapleton Intervenors to file a statement of their legal issues by December 11, 1970 and a preliminary list of witnesses and scope of their testimony by December 15, 1970. Mapleton Intervenors defaulted on both of these obligations and continued to default on the Board's repeated orders to them to provide specific contentions (TR 546, 1218-10, Order of March 3, 1971). Mapleton Intervenors did finally furnish a statement of contentions on June 8, 1971 in response to the Board's Order of May 18, 1971 requiring such filing by June 7, 1971. Applicant by motion, dated June 19, 1971, moved the Board for an order striking the contentions of Mapleton Intervenors, revoking their intervention and dismissing their petition to intervene. This motion was denied by the Board (Tr. 1519-20) which at the June 24, 1971 hearing informed Mapleton Intervenors that their contentions were insufficiently specific and ordered further specification (Tr. 2295-2298). At the hearing of July 7, 1971, the Board again found it necessary to inquire of Mapleton Intervenors when they would specify their contentions (Tr. 2690). On July 8, 1971, following a further filing of Mapleton Intervenors, the Board indicated that it did not find the further filing

much of an improvement over previous filings (Tr. 2951). Following this, the Mapleton Intervenors did in fact present two witnesses on meteorology. Mapleton Intervenors did not actively participate in the radiological health and safety prehearing processes and made their presence known primarily through a series of defaults ani lame excuses.

26. The Midland Nuclear Power Committee intervened in favor of the Plant and did not participate actively in the prehearing procedures or at the hearing. The Environmental Defense Fund raised no radiological health and safety questions, conducted no discovery on such matters, and did not appear at the radiological health and safety hearing.

27. All of the remaining parties: The Applicant, the Staff, Dow and Saginaw Intervenors, participated in the prehearing procedures. The major portion of the Board's and the parties' efforts between the first prehearing, November 17, 1970, and the commencement of the evidentiary hearing, June 21, 1971, was devoted to attempting to secure from Saginaw Intervenors some meaningful specification of their contentions and to attempting to get them to conduct discovery. Saginaw Intervenors refused to specify their contentions on the ground that they did not have enough information (Tr. 98) and yet refused to review documents which Applicant voluntarily made available to them on December 1, 1970 (Tr. 122, 389, 443, 612) until April 5, 1971 and failed to file any interrogatories until March 22, 1971 in spite of a Board Order, dated November 24, 1970, requiring such filing by January 7, 1971 and in spite of a "good faith" obligation to "serve a substantial batch of interrogatories" by February 11, 1971 (Tr. 600,

606-607). Saginaw Intervenors' reason for not filing any interrogatories by the February 11, 1971 "good faith" date was that the application relied on documents, including proprietary documents, not readily available. (See letter dated February 12, 1971.) Yet all of these documents had been made available to Saginaw Intervenors two months earlier on December 1, 1970 and they had refused to look at them. (See letter of Applicant dated February 23, 1971.) The Board in its Order of March 3, 1971 stated:

> ". . . it is cause for concern that although the petitions for intervention were granted on November 17, 1970, and interrogatories originally required by January 7, nothing has been produced to date by intervenors except briefs on questions of law -- most of which are frivolous or clearly controlled by previous court or Atomic Energy Commission decision." p. 1

On March 22, 1971, Saginaw Intervenors served lengthy interrogatories on Applicant, the Staff, Dow and the Midland Nuclear Power Committee. A large number of those filed on the latter three were duplicates of those filed on Applicant. Applicant promptly answered most of the interrogatories, Dow answered a few and objected to the remainder and the Midland Nuclear Power Committee and the Staff objected to all as being unreasonable and burdensome. The Board in its Order of May 13, 1971 sustained most of Applicant's and Dow's objections and found that because of the Midland Nuclear Power Committee's limited role in the proceedings the interrogatories directed to it seemed "intended more to harass than enlighten." In its Order of June 1, 1971, the Board, after extensive briefing by all concerned parties, determined that, apart from those interrogatories that it had specifically ordered the Staff to answer, it needn't answer most of the interrogatories directed to it. Those that did not need to be answered included all of those

that were duplicative of those asked of Applicant. The basis of the Board's decision was that the interrogatories were burdensome, both as a result of their number and of the type of information they sought to elicit. The interrogatories did not seek facts but sought instead to explore the thought processes of the Staff over the previous two years. As stated in the Order of May 13, 1972:

> "It is perhaps not an exaggeration to say that complete answers to these interrogatories would require the staff to prepare a justification, intelligible to laymen, of the whole history of the development of pressurized water reactors, without, in the Board's view making a significant contribution to safety." p. 3

28. At the conclusion of the radiological health and safety prehearing procedure, Saginaw Intervenors, the only active opposition intervenors, had received at least the following documentation and information:

1. Four-volume application - Available beginning January 13, 1969 with amendments thereto available as filed.

2. Applicant's files from which Saginaw Intervenors had received copies of in excess of 8,000 pages of documents, viewed over double that number of pages and had available to them an even greater quantity of material - Available to intervenors beginning December 1, 1970, but not viewed until early April 1971.

3. Applicant's two-volume set of answers to approximately 210 interrogatories filed on April 13, 1971 in response to interrogatories filed March 22, 1971 (originally ordered by Board on November 25, 1970 to be filed by January 7, 1971 but deadline extended on request of Saginaw Intervenors to March 22, 1971).

4. All documents on file in the AEC Public Document Room - Available at all times.

5. The Staff Safety Evaluation - Available beginning November 12, 1970.

6. A list of 159 documents upon which the Staff relied in preparation of the Staff Safety Evaluation, all but eight of which were publicly available (the eight being available in the documents Applicant made available December 1, 1970) - List furnished to intervenors in early December 1970.

7. Collection of 136 documents furnished by AEC to intervenors in April of 1971.

8. List of 51 documents in the possession of Dow Chemical Company - List furnished December 3, 1970 but no motion for production supported by good cause made.

9. Answers by Dow Chemical Company, filed March 30, 1971, to 25 interrogatories received March 22, 1971 (originally ordered by Board on November 25, 1970 to be filed by January 7, 1971 but deadline extended on request of Saginaw Intervenors to March 22, 1971).

Although Saginaw Intervenors had stated at the beginning of the prehearing procedure that they could not make contentions in the absence of the various documents underlying the application (Tr. 69), they still refused to furnish the Board with any meaningful contentions beyond a brief, self-styled non-exclusive listing of areas of cross-examination, dated June 10, 1971. They primarily based their refusal on the refusal of the Staff to produce certain internal documents and memoranda that the Board had ordered them to produce in its Order of May 19, 1971 and on the delay by the Staff in answering those interrogatories that the Board had ruled should be answered.* The Board had permitted all interventions although

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*The Atomic Safety and Licensing Appeals Board in its Order, dated September 3, 1971, upheld the Board's ruling that certain Staff documents could be withheld and reversed the ruling of the Board ordering certain documents produced on the basis that such documents were privileged under 10 CFR §2.744 and such disclosure would be contrary to the public interest. Additionally, the Staff did file answers to the required interrogatories during the course of the hearing, which filings resulted in no additional areas of concern from Saginaw Intervenors.

one was untimely and the demonstration of interest in all of them was not very clear. However, the Board viewed the granting of the intervention not as the end, but only the beginning of the process of defining the proper role of intervenors in a proceeding of this kind. The Board in its Order of March 3, 1971 informed the intervenors that they would be given a fair opportunity to make their case but that the primary function of intervenors is to assist the Board in making its safety evaluation. As a corollary of the Board's view that at the time of intervention intervenors had not had time to adequately prepare, the Board is of the opinion that with adequate time for preparation the intervenors should have availed themselves of the opportunity to secure a technical evaluation of the documents publicly available and made available to them by the parties. In light of the amount of material available to them, Saginaw Intervenors' refusal to specify their contentions and the bases of such contentions could only be viewed as indicating a lack of any substantive contentions, an unwillingness to put in the effort necessary to formulate contentions or an attempt to delay the proceeding or create a confused record. Although Saginaw Intervenors had refused to specify their contentions or file any affirmative evidence in compliance with the Board's Order of March 3, 1971, the Board denied Applicant's motion to dismiss the intervention (Tr. 1519-20) and in the interest of maintaining public participation in the proceeding permitted them to participate in the hearing by way of cross-examination of Applicant, Dow and Staff witnesses. However, the Board made it clear that there would have to be some specification by Saginaw Intervenors why a particular kind of inquiry ought to be made before it would be allowed (Tr. 1383) and if, after preliminary inquiry in an area, the Board felt that further inquiry would not be fruitful, it would require that Saginaw Intervenors justify continuance of cross-examination (Tr. 1524-25).

29. In addition to the matters of specification of contentions, discovery and determination of the handling of environmental matters related to the radiological health and safety hearing, numerous other legal issues were brought to the Board's attention from time to time. The AEC regulations, 10 CFR §2.743(g), provide that the application, Staff Safety Evaluation and other official filings shall be offered as evidence at the hearing. Saginaw Intervenors "objected" that offer does not mean "received" and that their rights would be adversely affected if they were denied the right to cross-examine witnesses on these documents. The Board in its Order of March 3, 1971 ruled that the application and certain other documents in the docket of this proceeding would be received in evidence on the understanding that all parties would be permitted to cross-examine witnesses in support of the documents to the extent deemed fruitful by the Board.

30. At the December 1, 1970 hearing, Saginaw Intervenors filed eight motions requesting that the hearing be adjourned on the bases, inter alia, that (1) there had been failure to comply with the Atomic Energy Act in that the Plant was being licensed as a research and development reactor rather than a commercial reactor, (2) that there was no final design for the reactor, (3) that the notice of hearing failed to set forth the issues required by the National Environmental Policy Act, (4) that the standard of operation without undue risk was contrary to the Atomic Energy Act, (5) that the Atomic Safety and Licensing Board should be disqualified because of prejudice, because one of its members is an employee of the AEC, because its members are inherently biased toward nuclear power and because the technical members are not technically qualified in all environmental areas, (6) that the AEC regulations were obsolete due to passage of the National Environmental Policy Act,

(7) that the Commission's regulations under the National Environmental Policy Act were illegal, (8) that the Commission failed to comply with the Water Quality Improvement Act, (9) that the Commission's standards for protection against radiation were illegal, and (10) that the siting of the Plant was in violation of the siting guideline 10 CFR Part 100 and TID 14844. It was agreed that argument on the motions relating to environmental aspects be postponed until the Final Environmental Statement was issued (Tr. 409).

31. The issuance of the Calvert Cliffs decision prior to issuance of a Final Environmental Statement mooted the necessity for further consideration of the environmental portions of the Saginaw Intervenors' motion. The Board at the January 21, 1971 prehearing after considering the briefs of all parties denied Saginaw Intervenors' nonenvironmental motions as being contrary to established precedent and legislative history as set forth in the briefs of Applicant, the Staff and Dow (Tr. 508-537). Saginaw Intervenors voluntarily withdrew their last motion which related to the Commission's siting guideline 10 CFR Part 100 and TID 14844 (Tr. 537). While the Board denied Saginaw Intervenors' motion challenging the radiation standards prescribed in 10 CFR Part 20, it left open the opportunity for them to make an offer of proof as to the invalidity of that regulation in accordance with the standards provided in the Commission's memorandum decision In the Matter of Baltimore Gas & Electric Company (Calvert Cliffs Nuclear Power Plant), 2 CCH Atomic Energy L. R. Par. 11,578, August 8, 1969 (Tr. 517).

LIMITED APPEARANCES

32. Limited appearances were heard by the Board at the hearing held on December 1, 1970. Limited appearances in favor of the Plant

were made by the following individuals and organizations: Harold Krefft for Federal Power Commission (Tr. 197); William G. Turney for Michigan Water Resources Commission (Tr. 206); Donald E. VanFarowe for Michigan State Air Pollution Control Commission (Tr. 229); James Woodruff for Michigan Public Service Commission (Tr. 236); John A. Rapa[illegible] (Tr. 241); Franklin E. Braman for Board of Directors of Downtown Bay City, Inc. (Tr. 246); Hon. Julius Blasy, Mayor, City of Midland (Tr. 248); Frank Olds, Chairman, Board of Commissioners, Midland County (Tr. 253); Robert B. Chatterton, Supervisor Midland Township, Midland County (Tr. 256); Dr. Sidney Smock for Midland Hospital Association (Tr. 258); Fred L. Yockey, City Manager, City of Midland (Tr. 261); Dr. Edward L. Kern, President, High Performance Technology, Inc. (Tr. 265); Clifford Mapes, Vice Chairman, Midland County Road Commission (Tr. 269); Ned Arbury, President, Arbury & Sons Insurance (Tr. 271); Milton Getzendaner, President, Midland Nature Club (Tr. 276); H. C. Allison, Vice President, Alden B. Dow Associates, Inc. (Tr. 279); Fred Minzer for Minzer Realty (Tr. 283); J. R. Buckley, Vice President, Mutual Savings and Loan Association (Tr. 285); Roy Lanham, President, Brown Lumber, Inc. (Tr. 289); John A. Miller (Tr. 291); Alan Ott, Vice President and Director, Chemical Bank and Trust Company (Tr. 294); Rev. Theodore M. Greenhoe for Memorial Presbyterian Church (Tr. 296); Robert Ferries, President, Ferries and Maxwell Insurance Agency, Inc. (Tr. 297); James G. Bandeen, President, Bandeen Chevrolet (Tr. 299); Arthur E. Maass, Superintendent, Wastewater Department, City of Midland (Tr. 301); Miss Lyn DeVries for Midland Business and Professional Womens Club (Tr. 303); Robert Parker, Executive Vice President, Midland Area Chamber of Commerce (Tr. 306); William H.

Meier, President, Meier Studio and Camera Shop (Tr. 307); Robert Kingsley, Director of Elementary Education, Midland Public Schools (Tr. 308); Mrs. George B. Ulmer (Tr. 309); Robert Copeland, Chairman, Midland Section, American Institute of Chemical Engineers (Tr. 311); Lewis Warren, Executive Vice President, Greater Saginaw Chamber of Commerce (Tr. 317); William Demers, President, Lumber Dealers Association (Tr. 320); Robert R. Denison, Airport Manager, Tri-City Airport Commission (Tr. 322); Bruce R. Benway, Vice President, First National Bank (Tr. 333); Larry Reed, Executive Vice President, Bay Area Chamber of Commerce (Tr. 335); George Elleson, Bay County Industrial Development Corp. (Tr. 340); and James L. Collison, Executive Director, East Central Michigan Economic Development District (Tr. 342).

33. Limited appearances opposing issuance of the construction permit were made by the following individuals: Mrs. Georgena Goff (Tr. 342) and Wendell Marshall (Tr. 345).

34. Limited appearances expressing interest in procedural or safety matters related to the Plant but not opposing issuance of a construction permit were made by the following: Thomas Doyle for Michigan Department of Natural Resources (Tr. 233); Mrs. Judith Boli for Saginaw YWCA (Tr. 245); William Foster (Tr. 326); and Frederick L. Brown, President, Michigan United Conservation Clubs (Tr. 347).

RADIOLOGICAL HEALTH AND SAFETY HEARINGS AND FINDINGS

35. The Board held 18 days of public hearings on the radiological health and safety questions relating to the Plant. These hearings were held on December 1, 1970; June 21, 22, 23, 24 and 25, 1971;

July 7, 8, 9, 12, 13, 14, 15, 16, 19, 20, 21 and 23, 1971. These hearings dealt with all issues relating to the Plant except environmental issues, for the reasons explained above, and those issues relating to performance of the Plant's emergency core cooling system (ECCS), which subject is discussed subsequently in this decision. Although a number of matters were left open following adjournment of the hearing on July 23, 1971, these matters were settled by subsequent filings or defaults over the next several months and the Board in an Order dated March 10, 1972 closed the record on radiological issues, except for ECCS and iodine spray removal which were subsequently concluded.

Technical Qualifications

36. The Applicant is one of the nation's largest electric power generating and marketing investor-owned utilities. It has competently built and operated an integrated bulk power system consisting primarily of fossil and nuclear fueled thermal generating facilities. It has built and operated the Big Rock Point and Palisades Nuclear Plants. The Applicant has a staff of experienced and qualified personnel which will oversee engineering, construction and operation of the Midland Plant. In addition to the experience gained in constructing and operating two light water nuclear generating plants, Applicant has gained experience in nuclear technology through its participation in the Power Reactor Development Company (PSAR Applicant's Ex. 1-D, Appendix E). Plant operation will be the responsibility of the Plant Superintendent who oversees the Plant operating, technical and maintenance staffs. Key members of the Plant staff will have received extensive experience in Applicant's Palisades and Big Rock Point Plants

in addition to other specific training conducted by Applicant and Babcock & Wilcox. An experienced General Office technical staff will conduct independent off-site review of Plant operation and maintenance (PSAR Applicant's Ex. 1-B, §12).

37. Bechtel Corporation, one of the world's largest engineer-constructors for industrial facilities and for development of natural resources, and its affiliate, Bechtel Company, as engineer, have direct responsibility for the design and/or procurement of equipment, systems and structures not furnished by the Babcock & Wilcox Company and will perform the on-site construction of the entire Plant. Technical advice and consultation will be provided Bechtel by the Babcock & Wilcox Company for the installation of the nuclear steam supply system (NSS) (PSAR Applicant's Ex. 1-A, §1.7). Bechtel has been actively engaged in the study, design and construction of nuclear installations over the past 20 years and has a broad experience in providing engineering and construction services for over 166 power generating units. Some of the most recent installations in which Bechtel has had major responsibility include the following nuclear power plants: San Onofre, Point Beach, Monticello, Turkey Point, Russellville, Rancho Seco, Peach Bottom, Davis-Besse, and Palisades (PSAR Applicant's Ex. 1-D, Appendix D).

38. The Babcock & Wilcox Company (B&W) will supply the nuclear steam supply system. B&W's participation in the development of nuclear power dates from the Manhattan Project. B&W's nuclear activities are broad and include applied research to develop fundamental data, design and manufacture of nuclear systems components, and design and

manufacture of complete nuclear steam generating systems. B&W carries on its nuclear activities through several divisions and subsidiaries. B&W nuclear steam supply systems will be used in the following installations: Oconee Nuclear Station, Three Mile Island Nuclear Station, Crystal River Station, Russellville Nuclear Unit and Rancho Seco (PSAR Applicant's Ex. 1-D, Appendix C).

39. The Staff in its review concluded that the Applicant and its contractors, B&W and Bechtel, are technically qualified to design and construct the Midland Plant (SSE, §13.1). The Board finds that Applicant has furnished sufficient information, that the Staff review has been adequate and that Applicant and its contractors, Babcock & Wilcox and Bechtel, are technically qualified to design and construct the Plant.

Site

40. Site Location - The Plant site is located on the south shore of the Tittabawassee River in Midland County, Michigan. The site consists of approximately 1200 acres of which a relatively few acres along the river will be utilized for Plant buildings and about 880 acres to the south of the area occupied by the Plant itself will be used for a cooling pond. The site is bounded on the north and east by the Tittabawassee River, on the south by Gordonville Road and on the west by farmland and scattered residences (PSAR Applicant's Ex. 1-A, §2 and Figure 2-1). When the Application was filed and during most of the period of review and hearings the Plant site was located in Midland Township with the Tittabawassee River serving as the boundary with the City of Midland (PSAR Applicant's Ex. 1-A, §2). However, the Board

takes official notice that the Michigan State Boundary Commission has recently ruled that Midland Township shall be annexed to and become a part of the City of Midland (Orders of State Boundary Commission, Dkt. Nos. 71-AT-7 and 71-AR-11, June 27, 1972), that this matter is presently in litigation and that the effectiveness of the order has been temporarily restrained. (Ingham County Circuit Court, File No. 14598C, July 21, 1972) Thus, the City of Midland's boundaries may shortly be extended to include all of the Plant site.

41. Population and Use Characteristics - AEC Regulations contain Reactor Site Criteria, 10 CFR Part 100, which describe criteria to be used in evaluating the suitability of a given site. One set of criteria in evaluating sites relates to consideration of population density and use characteristics of the site environs, including the exclusion area, low population zone and population center distance (10 CFR §100.10(b)). Applicant has described the population density and use characteristics in the site environs (PSAR Applicant's Ex. 1-A, §§2.2.5 and 2.2.6). The areas directly across the river from the Plant to the north and east are occupied primarily by the industrial complexes of the Dow Chemical Company and the Dow Corning Company for a mile to 1-1/2 miles. The area beyond these industrial complexes to the north is occupied by the commercial and residential areas of the City of Midland and the area to the east is a sparsely populated residential area containing many forested areas and scattered farms. The area to the south of the Plant is occupied by the cooling pond and other portions of the site for about one mile, is primarily forested for an additional two miles and primarily farming for another two miles.

The first mile to the east of the Plant is industrial property owned by Applicant and Dow, the next mile is mostly residential and light farming and the next three miles are sparsely populated and primarily agricultural. The area 5 - 50 miles from the site is primarily used for farming, where not forested, except for the industrial communities of Bay City, Saginaw and Flint (PSAR Applicant's Ex. 1-A, §2.2.6). Projections of population growth have been made by Applicant for Midland County and surrounding counties based on material supplied by the Michigan Department of Commerce (PSAR Applicant's Ex. 1-A, §2.2.5).

42. Exclusion Area and Low Population Zone - The AEC Reactor Site Criteria require that an applicant have an area around its reactor in which the applicant has the authority to determine all activities, including exclusion or removal of personnel and property from the area (10 CFR §100.3(a)). This area is called the "exclusion area" and it must be of sufficient size so that the calculated radiation dose to an individual at the boundary of the exclusion area in the event of a hypothesized fission product release from the reactor will be within certain defined limits using extremely conservative assumptions (10 CFR §100.11(a)(1)). Additionally, a low population zone, an area immediately surrounding the exclusion area which contains residents, the total number and density of which make it resonably probable that protective measures can be taken on their behalf in the event of the hypothesized fission release from the reactor, must also be determined (10 CFR §100.3(b)). The low population zone is also determined on the basis that the calculated radiation dose to an individual remaining at its outer boundary during the course of the hypothetical fission release will be within defined limits using extremely conservative assumptions

(10 CRF §100.11(a)(2 Applicant and the Staff have calculated the size of the exclusion area and low population zone for this site on the basis of radiation do d the Board in the safety analysis section of this decision has determined that such calculations were properly performed.

43. Exclusion Area - The required exclusion area for the Plant has a radius of 0.31 miles (500 meters). The land within this area will be owned by Applicant except for a small portion which consists of a fenced-in waste treatment area owned by Dow. However, Dow employees visit this site only occasionally and Dow has agreed that Applicant may exercise the right to remove persons from this property when required (PSAR Applicant's Ex. 1-A, §2.2.4; Response to Staff Question 2.8, PSAR Applicant's Ex. 1-C, p. 2.8-1). The Staff reviewed and concurred in the Applicant's evaluation (SSE p. 8). The Board concludes that Applicant has the authority to determine all activities in the calculated exclusion area as required by 10 CFR Part 100. Of additional interest is the fact that the actual exclusion distance around the reactor will, in several directions, be significantly larger than the required exclusion area, e.g., the exclusion distance to the south is in fact 1800 meters rather than the required 500 meters, and that the total exclusion area will be 1200 acres (Applicant's Ex. 13; PSAR Applicant's Ex. 1-A, §2.2.4). The Applicant has presented sufficient information and the Staff has adequately reviewed the Applicant's determinations with respect to the exclusion area.

44. Low Population Zone - The low population zone proposed by Applicant has a radius of approximately one mile (1600 meters) from the reactors. The area encompasses property owned and controlled by

Applicant south of the reactors, a part of the Dow and Dow Corning Company complexes to the north and east and a few residences in the southwest (PSAR Applicant's Ex. 1-A, §2.2.5.5). The residential population within this zone is approximately 38 and the transient industrial or business population, primarily employees of Dow and Dow Corning, is about 2145 (PSAR Applicant's Ex. 1-A, §2.2.4; Tr. 3103, 3119, 3295). The Staff reviewed the Applicant's submissions and determined that the low population zone was acceptable because of the small residential population and the well-structured evacuation plans of Dow and Dow Corning which would cover the business population (SSE p. 8, Tr. 3294-95). The Board finds that sufficient information has been furnished by Applicant and that the Staff has adequately reviewed this material.

45. Population Center Distance - A third population distribution factor to be evaluated pursuant to 10 CFR 100 is the population center distance. The regulation provides that the distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents should be at least one and one-third times the distance from the reactor to the outer boundary of the low population zone. In applying this guide due consideration shall be given to the population distribution within the population center (10 CFR Part 100.11(a)(3)). Evaluation of the Plant siting by the Staff and Applicant was made while the site was in Midland Township and bordered on the City of Midland, the nearest population center over 25,000. This evaluation showed the distance to the nearest corporate boundary of the City of Midland to be 0.21 miles and one and one-third times the low population zone distance to be 1-1/3 miles. However, on

consideration of the population distribution in the City of Midland, primarily that the population within 1-1/3 miles was largely limited to a transient population which is more mobile than would be a resident population, and that populous areas of Midland were sufficiently removed from the site vicinity, it was determined that the reduced population distance was acceptable (SSE, p. 9; Tr. 2135-39, 2145, 2165). The recently ordered annexation of Midland Township by the City of Midland would place the Plant site within the corporate boundary of the population center. The Board has reviewed this occurrence, in light of the guidance of 10 CFR Part 100 and the evidence presented in this proceeding. It is the conclusion of the Board that the important consideration for health and safety evaluation is still the population distribution within the population center. The annexation does not affect this and the site will be as acceptable subsequent to annexation as it was prior thereto. Of particular interest is the fact that the population distribution at this site is more favorable than that of at least two larger reactor complexes (Indian Point and Zion) which have received con-construction permits (Applicant's Ex. 13). It is the Board's opinion that population distribution surrounding this site is acceptable (particularly considering the relatively large actual exclusion area).

46. Surface Water Hydrology - The Plant site lies in the Tittabawassee River Basin which includes ten counties which are drained by the Tittabawassee River and five principal tributaries (PSAR Applicant's Ex. 1-A, §2.4 and Appendix 2B). The Tittabawassee River is not a known source of domestic or irrigation water supply downstream

of the Plant (PSAR Applicant's Ex. 38E, p 11.8-12; ASER Applicant's Ex. 38H, p 4.2-4; FES Staff Ex. 8, p V-27). Several municipalities and water districts obtain their water supplies from a portion of Saginaw Bay which is within 50 miles of the Plant site (PSAR Applicant's Ex. 1-A, pp 2-10).

47. The Midland Plant is designed to withstand the probable maximum flood (PMF), which is the largest flood conceivable for the river based upon extreme rainfall plus melting snow plus the unlikely effect of breaching of the four upstream dams on the Tittabawassee River. It is unlikely that a fifth upstream dam which is on the Chippewa River would be breached coincident with breaches of the Tittabawassee dams. However, Applicant did consider the effect of such a breach and it was found to be negligible (PSAR Applicant's Ex. 1-A, §2.4.4 and Appendix 2B, pp. 2B-3 and 2B-4; PSAR Applicant's Ex. 1-C, p. 2.4-2; Staff Ex. 4, p. 4, Para. 2 referencing Staff Response to Saginaw Intervenors' Interrogatory 250).

50. The PMF was computed according to calculational techniques utilized by the Applicant and approved by the Staff (Staff Ex. 4, p. 4, Para. 2, referencing Staff Response to Saginaw Intervenors' Interrogatory 250). The Staff is satisfied with the Applicant's calculational techniques (Tr. 2458) and agrees that the PMF flood evaluation is accurate to within 1 or 2 feet which would not affect siting of the Plant (Tr. 2459). All equipment required to protect public health and safety or for safe shutdown will be designed to withstand and be operable during the PMF (PSAR Applicant's Ex. 1-C, p 2.3-1). The Board finds that

the Applicant presented sufficient information, and that the Staff adequately reviewed the surface water hydrology, including consideration of the PMF.

49. Ground Water Hydrology - The ground water hydrology for the Plant is set forth in detail in the PSAR (Applicant's Ex. 1-A, §2.6). There are two ground water-bearing zones underlying the site area. These are a shallow sandy zone which has a perched water table and a deeper zone of sand and gravel which is an artesian aquifer. These two zones are separated by an impermeable clay aquiclude ranging in thickness from 124 to 187 feet (PSAR Applicant's Ex. 1-A, p. 2-18; PSAR Applicant's Ex. 1-C, p. 2.12-1). The quantity of water in the surface sands is limited and therefore they are not a source of domestic supply in the site area. Small domestic supplies are obtained from the underlying confined aquifer. If accidental discharge of contaminated water occurred at the site, it would flow through the surface sands at a rate of about five feet per year down gradient toward the river because of the natural hydraulic gradient toward the river. Accidental contamination of the surface sand would have no effect on the artesian aquifier below the thick, impermeable clay layer because this layer acts as a confining medium preventing the upward flow of the artesian water and the downward percolation of surface water from the site area. Because domestic wells in the area are up-gradient from the site and obtain their water from the underlying artesian zone, they will be unaffected by any accidental discharge. All exploration holes and water wells located within the cooling pond area have been sealed as a preliminary phase of the dike construction program. This sealing will ensure that cooling pond water does not seep into the domestic supply and that no artesian ground water leaks

into the cooling pond water (PSAR Applicant's Ex. 1-A, p. 2-19; PSAR Applicant's Ex. 1-C, pp. 2.2-2 and 2.2-3 and pp. 2.12-1 through 2.12-8). A system of monitoring wells will be installed to maintain a surveillance of both the upper and lower ground water horizons in the vicinity of the Plant (ASER Applicant's Ex. 38F-1, p. 6-18-1). The Staff reviewed the record regarding hydrology and found the information to be acceptable for issuance of a construction permit (SSE §3.4 and Appendix D). The Board concludes that sufficient information was supplied regarding hydrology, that the Staff review was adequate, and that the site hydrology is acceptable for location of a nuclear plant at this site.

50. Geology - The Plant will be located on a glacial lake plain having a ground elevation varying from 600 to 625 feet above mean sea level (PSAR Applicant's Ex. 1-A, p. 2-14). Plesitocene glacial deposits about 350 feet thick overlie bedrock of the Saginaw formation of lower Pennsylvanian age. The bedrock at the site consists of closely interbedded shale, sandstone and siltstone of continental origin (PSAR Applicant's Ex. 1-A, p. 2-16). Salt horizons occur in the Silurian and Devonian rocks of Michigan, and brine is extracted from the Devonian strata at depths of from 4100 to 4300 feet by the Dow Chemical Company's plant near the site (PSAR Applicant's Ex. 1-B, p. 2.17-1). Careful analysis was made of the possibility of subsidence due to salt extraction, and the effect it might have on the Plant. Separate analyses were made by independent consultants Woodward-Clyde & Associates and General Analytics, Inc. (PSAR Applicant's Ex. 1-B,

p. 2.17-6). In addition to these analyses, ground surface observations by Dow in the area of the salt extractions show no change in ground elevation, within the accuracy limits of the survey, since 1958 (PSAR Applicant's Ex. 1-C, General Analytics Report p. 27). The subsidence analyses as well as actual field surveys indicate that no surface displacement will occur as a result of negligible settlements, if any, from the existing cavities (PSAR Applicant's Ex. 1-B, p. 2.17-7). No future salt cavities will be mined within 0.5 miles of the Plant (PSAR Applicant's Ex. 1-C, pp. 2.17-10a), and Applicant has agreed prior to operation of the Plant to establish an extensive surveillance program to monitor for potential subsidence (Staff Safety Evaluation, p. 12). Applicant furnished sufficient information as to site geology. The Staff adequately reviewed the site geology and confirmed that the potential for subsidence would be very low (Staff Safety Evaluation, pp. 11-12). The Board concludes that the geology of the site is satisfactory.

51. Soils and Plant Foundations - The soils at the Plant site overlie bedrock of glacial origin and consist of glacial tills, glacial outwash, and glacial lake deposits (PSAR Applicant's Ex. 1-A, p. 2-16). Applicant's soil consultant expert for the foundation investigation made an investigation of the site and concluded that the site is suitable for the support of the proposed structures under both static and seismic loading (Dames & Moore Letter to Bechtel Corporation, dated June 28, 1968; Dames & Moore Report, dated June 28, 1968. and Supplement to Report, dated March 15, 1969, PSAR Applicant's Ex. 1-B). The AEC Consultant, U. S. Department of Interior, Geological Survey,

confirmed that the geological conditions pertinent to the safety evaluation of the site had been adequately assessed by the Applicant (SSE, Appendix D, p. 109). Accordingly, the Board finds that the soils and Plant foundations at the site have been properly described, investigated and reviewed and that there is adequate soil support for the proposed structures.

52. Seismology - The Plant site is in a quiet seismic region for which there is no known geologic correlation between earthquake distribution and known faults. No faults have been detected in the surficial deposits of the southern peninsula of Michigan, although there is a remote possibility of an inactive fault zone 55 miles south of the site. Although earthquakes generally occurring in other regions have been experienced in this region of the United States, their intensity in the Midland area has been extremely low (PSAR Applicant's Ex. 1-A, pp. 2-21 through 2-25). The maximum intensity assumed to have been experienced at the site is V (Modified Mercali) which occurred as a result of the February 6, 1872 earthquake (PSAR Applicant's Ex. 1-A, p. 2-25). Intensity V corresponds to a surface acceleration of 0.03g on Hershberger's (1956) curve. Plant equipment necessary to permit continued operation is designed to remain functional during surface accelerations of 0.06g ("operating basis earthquake") (OBE) and equipment required to protect the health and safety of the public or for safe shutdown is designed for surface accelerations of 0.12g ("design basis earthquake") (DBE) (PSAR Applicant's Ex. 1-A, p. 2-25; SSE, p. 13). The Staff and the United States Coast and Geodetic Survey (USC&GS) agree that seismic

design accelerations for the site of 0.06g and 0.12g are appropriate for the OBE and DBE earthquakes, respectively, and Applicant has agreed to design to these accelerations (SSE pp.12-13). Sufficient information has been supplied by the Applicant and the Staff has performed an adequate review with respect to seismology. The Board finds that the seismic design accelerations are sufficiently conservative in light of the seismic history of the area.

Meteorology

53. The AEC requires that data as to site meteorology be included in the PSAR for a construction permit, or in the PSAR for an operating license. This information is used by AEC at the construction permit stage in evaluating the adequacy of plant site and design and at the operating stage in evaluating the adequacy of plant operating procedures and technical specifications. At both the construction permit and the operating license stage, the meteorological information provides data to be used in calculating the dose which might be received over any given period of time by a person at the site boundary from normal operating or accidental airborne releases. Typically, at the construction permit stage extensive on-site meteorological data is not available and is therefore not included in the PSAR. In the absence of such information, the AEC will make very conservative assumptions as a basis for evaluating the adequacy of the site and of the reactor design as long as sufficient other information is provided in the PSAR to demonstrate that the assumptions as applied to the particular site and design are highly conservative. In other words, in the absence of on-site meteorological

measurements AEC will assume poor diffusion characteristics and low wind speed, provided that information furnished in the PSAR demonstrates a high probability that when on-site meteorological data has been collected, the actual site diffusion characteristics will be more favorable than the given assumptions. The assumptions to be made for this purpose are set forth in Safety Guide No. 4. Safety Guide No. 4 provides (1) calculational methods; and (2) assumptions to be made in absence of on-site meteorological information. In the present case, no issue is presented as to the adequacy of the data for plant design purposes. Intervenors did raise questions as to the adequacy of the meteorological data with respect to the evaluation of the adequacy of the site under 10 CFR Part 100 and the balance of our meteorological findings consider this subject from that standpoint.

54. Pursuant to AEC requirements, Applicant extensively investigated site meteorology for the Midland Plant and presented a summary of its investigation as a part of its PSAR (PSAR Applicant's Ex. 1-A, Appendix 2A). The scope of Applicant's meteorological investigation included: (a) a description of general weather conditions, (b) an analysis of diffusion climatology of the site based on available data from nearby sources, (c) development of two-hour, one-day, 30-day and annual diffusion models for the purpose of calculating off-site radiation doses for these periods, (d) discussion of storms and tornadoes (PSAR Applicant's Ex. 1-A, Appendix 2A). Two main sources of data were used by Applicant in its report. The first was from the Dow Plant, nearby, which had recorded weather records for over ten years. The other source of data was the Saginaw (Tri-City) Airport, about eight miles southeast of the site.

A third source of some upper air data is U. S. Weather Bureau information from Flint, Michigan, which is about 50 miles southeast of Midland (PSAR Applicant's Ex. 1-A, pp. 2A-3 to 2A-4).

55. There were two types of weather data available from Dow. In 1925, the local Weather Bureau Station recording precipitation and temperature for Midland was moved to Dow. Currently, a weighing rain gauge with a seven-day recorder, a seven-day thermograph, maximum and minimum thermometer, a U. S. Weather Bureau rain gauge of the dipstick type and a seven-day dew-point recorder are on Dow property. This station is within the Dow plant complex. In the past ten years Dow has also maintained two Bendix-Friez Aerovane wind systems (PSAR Applicant's Ex. 1-A, pp. 2A-3 to 2A-4). Weather records began in Saginaw in 1896, the same starting date as Midland, and since 1947 have been taken by FAA personnel at Tri-City Airport. Besides the usual climatological data on precipitation and temperature, there are also hourly airway observations of sky condition, visibility, weather and winds. At Saginaw, wind sensors are located on a 20-foot mast well away from any obstructions and on very flat grass-covered land. Temperature and dew point are measured at the same location, but precipitation is measured with a standard dipstick type of rain gauge on top of the flight service building (PSAR Applicant's Ex. 1-A, p. 2A-4). The Applicant in its PSAR acknowledged that, although the Dow climatological data are the closest to the proposed nuclear site, the Saginaw data was also used to provide general site climatology since it was more adaptable for analysis (PSAR Applicant's Ex. 1-A, p. 2A-4).

56. The Midland site is on the flat land of the Lower Peninsula of Michigan. While it is too far from Lake Huron and Saginaw Bay to be significantly affected by land-sea breezes, it is close enough to the Great Lakes to have a higher than average amount of cloudiness in the late fall and early winter. About 30 inches of precipitation fall per year. Some of this is from an average annual snowfall of 33 inches. Mean monthly temperatures range from 25 F in January and February to 72°F in July. The highest and lowest recorded temperatures are 106°F and -30°F, respectively. Cloudiness is the greatest in the late fall and early winter, a condition accentuated in Michigan's Lower Peninsula by the presence of Lake Michigan on the west and, to some extent, Lake Huron on the east. Prevailing wind direction in the area is southwest and average hourly velocity is greatest in the early spring and lowest in late summer and early fall (PSAR Applicant's Ex. 1-A, Appendix 2A, p. 2A-5).

57. Diffusion characteristics for a site are analyzed for various time periods. The results of applying the diffusion models are called "relative concentrations" or simply X/Q, and are applicable at certain distances, usually the site boundary, downwind from the Plant. When the X/Q is multiplied by the amount of the radioactive release and properly adjusted for breathing rate, isotopic half-life, etc., the dose to an individual at the site boundary can be calculated. In developing diffusion models, the Applicant in its PSAR relied primarily on the data from Tri-City Airport located only eight miles away (PSAR Applicant's Ex. 1-A, p. 2A-32). The diffusion models created were conservative in that no credit was taken (a) for wind direction

changes (in the two-hour model), (b) for the greater dilution which would occur due to the Dow buildings, or (c) for the thermally induced turbulence due to about 1-1/3 square miles of warm cooling pond water around the reactor site (PSAR Applicant's Ex. 1-A, p. 2A-23 and 2A-32). Therefore, the PSAR contained data and models which Applicant believed to provide a sound basis for the design of the reactor facility. In creating a two-hour diffusion model, five years of hourly wind data at Midland were analyzed and nine months were identified from Dow data as having the greatest air pollution potential.* (PSAR Applicant's Ex. 1-A, pp. 2A-28 to 2A-32) Hourly data from the Tri-City (Saginaw) Airport for these nine months were placed into Pasquill stability categories (PSAR Applicant's Ex. 1-A, p. 2A-36). The Dow data were not amenable to this method of treatment. Each night of these nine months was examined to find the two consecutive hours having the highest stability category (poorest diffusion). From these data, the occurrence of the worst first and second hour diffusion conditions were determined. The stability applicable to the two worst hours was primarily that of Category F, the most stable (PSAR Applicant's Ex. 1-A, p. 2A-36). The average winds associated with each category were used to calculate relative concentrations, X/Q, as a function of distance. The relative concentration for each category was then weighted by its frequency of occurrence

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*Dow data were found by Applicant and the NOAA witness not to be useful in calculating diffusion models for the site because they included no cloud cover or cloud ceiling data, had incomplete "gustiness" detail, and were too incomplete (PSAR Applicant's Ex. 1-A, p. 2A-32; SSE p. 10). The data were useful, however, in selecting the nine-month period of greatest air pollution potential (PSAR Applicant's Ex. 1-A, p. 2A-28 and 2A-36).

and divided by a dilution factor of 4.2, due to the cavity dilution effect of the building, to give an average hour X/Q of 1.9 x 10^{-4} sec/m^3 at the exclusion boundary (500 meters) (PSAR Applicant's Ex. 1-A, pp. 2A-36 to 2A-37). From the same nine months, 18 days were selected from which to develop the 24-hour model (PSAR Applicant's Ex. 1-A, pp. 2A-37f to 2A-38). Selection was based on those days having the highest frequency of Pasquill Category F and the highest frequency of calms. This was to establish conservative worst-day conditions. Pasquill categories and winds for these days were averaged for each direction. That direction with the highest stability category (poorest diffusion) and the lowest wind speed (lowest dilution) was chosen. The X/Q for that wind direction was calculated, multiplied by the ratio of the average number of hours of continuous wind in one direction, from 18-day sample, to 24 hours (7.5/24) and divided by the cavity dilution factor of 4.2 at the exclusion boundary of 600 meters to give an average hourly X/Q of 3.1 x 10^{-5} sec/m^3 (PSAR Applicant's Ex. 1-A, pp. 2A-37f to 2A-38). The nine months of data were also used to obtain an average stability category and wind speed for each direction for the thirty-day model; this is similar to the 24-hour model (PSAR Applicant's Ex. 1-A, p. 2A-40). That direction with the highest stability category and the lowest wind speed was chosen to calculate relative concentration, X/Q. From five years of monthly wind data at Saginaw, the highest monthly frequency of any one wind direction was 19 percent. Thus, the calculated relative concentration was multiplied by 0.19 and divided by a cavity dilution factor of 2.6 (for stability

Category D) at the exclusion boundary (500 meters) to give an average hourly X/Q of 1.1×10^{-5} sec/m^3 (PSAR Applicant's Ex. 1-A, p. 2A-40). An annual model also was devised for purposes of scheduled normal releases, but this model is not required in safety analyses (PSAR Applicant's Ex. 1-A, p. 2A-42). The 2-hour, 24-hour and 30-day models evaluated provided the Applicant a basis for estimating the effects of exposure from a postulated accident. However, because of the absence of on-site data, the Applicant in the PSAR indicated that it would conduct a meteorology program with a continuous recording of meteorological data (wind direction, velocity and temperature lapse rate) until at least a year's history was obtained. The data would be used to further evaluate and, if necessary, upgrade the meteorological data used in the diffusion models previously presented (PSAR Applicant's Ex. 1-C, p. 1.00-1).

58. The Staff analyzed the meteorological analysis presented by Applicant (SSE pp. 9-11 and Appendix C). In this regard, the Staff relied upon reports prepared by the National Oceanic and Atmospheric Administration (NOAA) formerly the Environmental Science Service Administration (ESSA) and others (SSE pp. 9-11 and Appendix C). The Staff stated that available data indicated the Midland site to be situated in a flat terrain where atmospheric flow is largely governed by large-scale continental pressure patterns, and where, in winter, frequent storm tracks pass through the area resulting in a high ventilation rate and relatively good atmospheric diffusion (SSE p. 9). The Staff, however, questioned Applicant's technique for characterization of available weather data. The Staff reported in its Safety Evaluation that the technique used by Applicant resulted in data in

the form of gross frequency distributions rather than joint frequency distributions between stability, wind speed and direction (SSE p. 9). This objection was raised by NOAA in Appendix C of the Safety Evaluation where NOAA stated that without joint frequency data between gustiness and wind speed, it is not possible to quantatively assess the probability of specific diffusion rates. Secondly, NOAA agreed with the Applicant that insufficient on-site data was available to accurately analyze the diffusion climatology of the site (SSE p. 102). However, rather than using the Tri-City Airport data as an alternative to the actual on-site data, the Staff analyzed the diffusion based upon the meteorological model which the Staff normally uses to determine the two-hour and longer term diffusion characteristics where adequate on-site data is unavailable (SSE p. 10). As indicated previously, the standard model utilized by the Staff incorporates extremely conservative assumptions of weather data. That model is the NOAA standard meteorological model (Safety Guide No. 4 model) and like the Applicant's models based on Tri-City Airport data, uses the Pasquill Category F but with a 1 meter per second wind speed (SSE p. 102). As part of that model the Staff assumed the following meteorological conditions.

(1) For the first eight hours: Pasquill Type F stability, a one meter per second wind speed, nonvarying wind direction, and a volumetric building wake correction factor of one-half used with the cross-sectional area of the containment structure to determine the building wake reduction factor, with a maximum building wake dilution factor of three.

(2) From eight hours to twenty-four hours: Pasquill Type F stability, one meter per second wind speed with meander in a 22-1/2° sector.

(3) From one to four days: Pasquill Type F stability and a two meter per second wind speed with a frequency of 60%, and Pasquill Type D stability and a three meter per second wind speed with a frequency of 40%, with meander in the same 22-1/2° sector.

(4) From four days to 30 days: Pasquill Type C, D, and F stability each occurring 33-1/3% of the time with wind speeds of three meters per second, three meters per second, and two meters per second, respectively, and with meander in the same 22-1/2° sector, 33-1/3% of the time. (Safety Guide No. 4)

61. The Staff noted that the Applicant agreed to conduct an on-site meteorological measurements program to obtain a minimum of one year's data including (1) continuous time-history measurements of wind velocity and direction at an elevation of 100 feet above the general terrain and (2) differential temperature measurements made at the 10-foot and 90-foot levels (SSE p. 10). Based on the Staff's evaluation of the proposed program, the Staff and its meteorological consultant, NOAA, concluded that the measurements proposed will be adequate to determine the diffusion characteristics of the site prior to issuance of an operating permit (SSE p. 10). Applicant in calculating site boundary doses for purposes of determining whether the site meets the requirements of 10 CFR Part 100 used different assumptions and calculations than the Staff and calculated lower doses at the site boundary

than did the Staff. Since the Staff calculations are however within Part 100 and Safety Guide No. 4 and the Staff properly concluded that the requirements of Part 100 are met, we do not need to choose between the approach of the Staff and that of Applicant and hence we do not need to consider the validity of the Applicant's dose calculations to the extent they might differ from those of the Staff.

60. The Mapleton Intervenors' witnesses, Mr. Watson and Dr. Epstein, consulting meteorologists, contended that Applicant's meteorological analysis of the proposed site in evidence was inadequate (Mapleton Ex. 23, Tr. 3432-36). However, it is clear to the Board that both opinions were based on the erroneous assumption that Applicant had used Dow data directly in determining diffusion models for the Midland site. It was clear that Mr. Watson had no concept of the manner in which the Dow data had been used (Tr. 3569-74). Although Dr. Epstein, in his appearance on the stand following Mr. Watson, indicated that he was at that time aware of the use made of the Dow data, it is clear from reading his previously filed affidavit that he had not understood such use at the time he signed it (Tr. 3638-39). The Board is particularly puzzled by the fact that all of the major objections to Applicant's analysis were to items which Applicant explicitly hadn't utilized in its meteorological model or taken any credit for. The Staff's NOAA consultant, Dr. Van Der Hoven, testified, however, that he considered the Saginaw (Tri-City) Airport data provided in the Applicant's PSAR to be the best data available (Tr. 3698). The PSAR with respect to meteorology was prepared under the supervision of the Applicant's consulting meteorologist, Dr. T. V. Crawford, an experienced, qualified and competent meteorologist,

well versed in diffusion meteorology. Dr. Crawford, a meteorologist with the U. S. Air Force for four years, also taught at the University of California at Davis for seven years. In addition he has consulted on five power plant meteorological site reports (Tr. 6206). The Board has considered the testimony and finds that the contention was not well supported and is without merit.

61. The Saginaw and Mapleton Intervenors argued that the Applicant's and the Staff's analyses should have assumed that the radioactive release from the accident would be depleted by a rainstorm or fog from the cooling pond, deposited on the ground and then resuspended rather than assuming that all of the releases were available to be inhaled by a given individual (Tr. 3791-97). In pursuing this contention they found it necessary to use a number of quotations out of context (Tr. 3785-87). The Staff's meteorological consultant, Dr. Van Der Hoven, testified that from deposition of radioactivity any subsequent inhaled dose could not be larger than the original NOAA diffusion model without deposition and that only a portion of deposited material is ever resuspended in the atmosphere and that at a very slow rate (Tr. 3799-3800, 3807). The Board has considered the testimony, agrees with Dr. Van Der Hoven and finds that the Staff Safety Guide No. 4 assumption represents the most conservative credible meteorological mechanism for calculating dose to an individual at the site boundary.

62. In direct testimony, the Mapleton Intervenors' meteorologist consultant, Mr. Bruce Watson, argued that the Dow wind data was erroneous and should not be used (Tr. 3435). Applicant had previously stated that the Dow wind data was not considered suitable to use in

the diffusion analysis (PSAR Applicant's Ex. 1-A, Appendix 2A, p. 32). The Staff NOAA witness also testified that he had problems with the Dow wind data and did not use it (Tr. 3593-95). The Board has considered this subject and finds that the usefulness of the Dow data is not an issue in these findings.

63. The Mapleton Intervenors' witness testified that Pasquill atmospheric stability categories are not accurate (Tr. 3465). The Staff's meteorological consultant, Dr. James C. Carson of Argonne National Laboratory, testified that Pasquill Categories are the best available for diffusion analyses (Tr. 7702). The Board finds that Pasquill Categories are the best stability categories available. The Board takes official notice that the Pasquill Categories are generally recognized by scientists in the field as providing reliable categories for atmospheric stability characteristics. They are also used by the AEC in Safety Guide No. 4.

64. The Mapleton Intervenors contended that no reliable data was presented in the meteorological study (Tr. 3447). Applicant's PSAR shows that the data are reliable since Tri-City (FAA) Airport data were used and are obtained from hourly recording by trained Federal Aviation Agency observers (PSAR Applicant's Ex. 1-A, Appendix 2A, p. 32). Furthermore, the Staff's consultant, NOAA, considered the Tri-City Airport data to be the best available (Tr. 3698). The Board finds the Mapleton Intervenors' contention to be unsupported.

65. The Mapleton Intervenors contended that the warm cooling pond created an element of unpredictability of climatological effects (Tr. 3465). The Applicant previously had stated that no credit is

taken in the diffusion analysis for the considerable enhancement of turbulence due to the warm cooling pond (PSAR Applicant's Ex. 1-A, Appendix 2A, p. 23). Likewise, the Staff's NOAA consultant did not assume any credit for the hot pond, the Dow Chemical complex and the heated buildings of the City of Midland but stated that these could only enhance the diffusion (Tr. 3701-02). The Board finds that the Applicant's and Staff's analyses are conservative with regard to the effects of the warm cooling pond, the Dow complex and the City of Midland on diffusion.

66. The Mapleton Intervenors contended that the site meteorological conditions assumed by the Staff from Safety Guide No. 4 may not be sufficiently conservative based on actual Midland site data (Tr. 3532-33), and that the Midland site meteorology may be more adverse about 2 or 3 percent of the time (Tr. 3541). The Mapleton Intervenors' witness, however, characterized the site as "being rather good from the point of view of diffusion by and large." (Tr. 3659) The Applicant's PSAR shows that the worst 2-hour data (mainly Category F with mean wind speed of 2.5 meters/sec) is considerably better from a diffusion viewpoint than Safety Guide No. 4 (Category F and 1 meter/sec wind speed) (PSAR Applicant's Ex. 1-A, Appendix 2A, p. 36c). Nevertheless, the Staff's NOAA witness stated that conditions could be worse than Safety Guide No. 4 approximately 5 percent of the time (Tr. 3704). He also stated that data of the type compiled at the Tri-City Airport has been used in the past with very good success when later on-site data was presented, and that he saw no evidence which would lead to a conclusion that more restrictive meteorological assumptions should be used than those presented in Safety Guide No. 4 (Tr.

3699-3700). Even the Mapleton Intervenors conceded that the NOAA-Safety Guide No. 4 models were good in the absence of on-site data (Tr. 3684). The Board finds that the use of Safety Guide No. 4, without the application of special restrictive conditions, is sufficiently conservative when applied to the Midland Plant site, in view of the explicit conservatisms in the Safety Guide No. 4 method, the well ventilated atmospheric characteristics of the site as implied by the analysis of the Tri-City Airport data, the favorable experience with this type of analysis at other sites and the absence of any unusual site-sensitive topographical or meteorological problems which would impede diffusion.

67. The Board also notes that the acceptability of the prop. 1.00-1) was generally confirmed by the Mapleton Intervenors' witnesses, Mr. Watson (Tr. 3471) and Dr. Epstein (Tr. 3646), with minor reservations regarding whether the tower used for meteorological measurements would be operated with the cooling pond in place, the proper height of the tower, whether multiple towers were desirable and whether a wind tunnel model should be built. With regard to one of these reservations, the NOAA witness concluded that a wind tunnel model of the Plant and cooling pond as proposed by Dr. Epstein would not produce useful results (Tr. 3723). Since the conclusion of the hearing, the AEC has promulgated Safety Guide No. 23, Onsite Meteorology Programs. This guide describes the requirements of an acceptable onsite meteorological program. Such a program is considerably more extensive than that proposed by Applicant in the PSAR. The Board concludes that the Staff should require Applicant to conduct a meteorological program of the scope described

in Safety Guide No. 23. Such a meteorological program shall be sufficient to validate the conservatism of the meteorological assumptions made and can be developed and executed during the construction phase.

Plant Description

68. Reactor and Reactor Coolant Systems Description - The reactors for the Plant are of the pressurized water type. They have an initial core rating of 2452 MWt and will have an ultimate power level of 2552 MWt each and together will produce approximately 21 x 10^6 lb/hr steam for production of electricity and use as process steam (PSAR Applicant's Ex. 1-A, pp. 1-1 and 4-32). The nominal operating pressure for the reactor is 2185 psig, with an average core outlet temperature of 604°F (PSAR Applicant's Ex. 1-A, p. 3-7). The reactor coolant system is designed for a pressure of 2500 psig at a nominal temperature of 650°F (PSAR Applicant's Ex. 1-A, p. 4-13). The Board takes official notice that these reactors and reactor coolant systems are similar to nine other Babcock & Wilcox units which have previously received construction permits (Docket Nos. 50-269, 50-270 and 50-287, Oconee Plant Units Nos. 1, 2 and 3; Docket No. 50-289, Three Mile Island Unit No. 1; Docket No. 50-320, Three Mile Island Unit No. 2; Docket No. 50-312, Rancho Seco Unit No. 1; Docket No. 50-313, Arkansas Nuclear One Unit No. 1; Docket No. 50-346, Davis Besse Unit No. 1; and Docket No. 50-302, Crystal River Unit No. 3). The fuel for the reactor is sintered pellets of low enriched uranium dioxide clad in Zircaloy-4 tubing. (PSAR Applicant's Ex. 1-A, p. 3-71) Each complete core has 177 fuel assemblies which are arranged on a square lattice to approximate the shape of a

cylinder. The basic fuel assembly has 208 fuel rods, 16 control rod guide tubes, one instrumentation tube, eight spacer grids and two end fittings (PSAR Applicant's Ex. 1-A, p. 3-71). The assemblies are designed to operate safely during steady state and transient conditions under the combined effects of flow induced vibration, cladding strain caused by reactor pressure, fission gas pressure, fuel growth and differential thermal expansion (PSAR Applicant's Ex. 1-A, §3.1.2.4.2, §3.2.4.2, §3.3). The thermal and hydraulic design limits of the the core are conservative, and are consistent with those of other pressurized water reactors currently in operation or under construction (PSAR Applicant's Ex. 1-A, p. 1-9, §3.2.3). The Staff has concluded that the Midland Plant design is acceptable with regard to core physics, core thermal and hydraulic design, and core mechanical design (SSE, p. 18). Core reactivity is controlled by a combination of 49 movable control rod assemblies, a neutron absorber dissolved in the coolant, and burnable absorber rod assemblies. Upon trip, all control rod assemblies required for shutdown fall into the core by gravity causing immediate reactor shutdown (PSAR Applicant's Ex. 1-A, §3.2.2, pp. 3-5 and 3-9). Eight-part length axial power shaping rod assemblies are provided to minimize axial power shifts resulting from a redistribution of xenon (PSAR Applicant's Ex. 1-A, §3.2.2, p. 3-9).

69. The core is contained within a cylindrical reactor vessel having internal dimensions of 14 feet 3 inches in diameter and 37 feet 4 inches in height (PSAR Applicant's Ex. 1-A, §4.2.2.1, p. 4-31).

The reactor vessel is manufactured under close quality control, and several types of nondestructive tests are performed during fabrication. These tests include radiography of welds, ultrasonic testing, magnetic particle examination, and dye penetrant testing (PSAR Applicant's Ex. 1-A, §§4.5.1 and 4.5.2). Surveillance specimens consisting of excess material from the reactor vessel will be inserted in the reactor vessels to confirm the predicted value of neutron induced material nil-ductility transition temperature shift (PSAR Applicant's Ex. 1-A, §4.2.5.2). The two coolant loops are connected to the reactor vessel by nozzles located near the top of the vessel. Each loop contains one steam generator, two motor-driven coolant pumps, and the interconnecting piping (PSAR Applicant's Ex. 1-A, Figures 4-2 and 4-3). The steam generator is a vertical straight tube-and-shell heat exchanger which produces superheated steam at constant pressure over the power range. Reactor coolant flows downward through the tubes and steam is generated on the shell side (PSAR Applicant's Ex. 1-A, p. 4-7). The operating pressure of the system is maintained by the pressurizer which is a surge tank partially filled with steam connected to the reactor coolant system. Self-actuated safety relief valves connected to the pressurizer prevent overpressurization of the reactor coolant system (PSAR Applicant's Ex. 1-A, p. 4-6).

70. Reactor and Reactor Coolant Systems Criteria - The reactor vessel, steam generator, and pressurizer will be designed, manufactured and tested in accordance with Section III of the ASME Code.

The reactor coolant piping will conform to the nuclear power piping code, USASI B31.7, and the reactor coolant pump casings will be manufactured in accordance with Section III of the ASME Code, where applicable (PSAR Applicant's Ex. 1-A, §4.5). All system components will be designed to withstand normal loads of mechanical, hydraulic and thermal origin plus the forces that would result from the blowdown of the reactor coolant system as a result of a design basis loss-of-coolant accident, concurrent with the design basis earthquake loads (PSAR Applicant's Ex. 1-A, Appendix 5A). The proposed codes and standards for reactor coolant system components and piping comply with 10 CFR §50.55a (SSE p. 20 and Applicant's Ex. 25). The Staff has reviewed the codes, the plans for design and fabrication, and the quality specified for the reactor vessels and coolant piping and concluded that the reactor vessels and coolant piping as planned are acceptable (SSE p. 20). In addition, the quality assurance program calls for verification by the Applicant of the analytical and empirical methods used by the vendor to certify that this equipment meets the specifications developed on the above bases (Applicant's Ex. 1-C, QA Program Plan p. 5g; SSE p. 22). The Staff and their consultants have reviewed and found the seismic design methods acceptable (SSE p. 22; SSE Appendix G). Major core and core support components will be designed to provide assurance that they are not vulnerable to vibratory excitation (PSAR Applicant's Ex. 1-B, p. 4.3-1). Confirmatory vibration testing will be conducted as part of the preoperational start-up program (PSAR Applicant's Ex. 1-C, p. 5.00-1). The Staff has found the Applicant's plans and methods for limiting internals vibration acceptable (SSE p. 23). The Board

finds that Applicant has adequately described the reactor and reactor coolant system and that the Staff conducted an adequate review.

71. Leak Detection - Applicant will provide redundant and diverse leak detection systems within the reactor building to provide timely alarm of significant leakage from the reactor coolant system (PSAR Applicant's Ex. 1-A, §4.2.7; PSAR Applicant's Ex. 1-B, p. 4.13-1; SSE §5.6). The Staff in their review has concluded that these systems are acceptable and that limits on permissible leakage rates from the reactor coolant system will be established at the operating license stage (SSE §5.6). The Board finds that the Applicant has furnished sufficient information on the leak detection systems and the Staff has conducted a proper review. Furthermore, the Board finds that limits on permissible leakage rates is a matter which can reasonably be left for later consideration in the preparation of technical specifications at the operating license stage in accordance with 10 CFR 50.35 and customary AEC practice.

72. Seismic Design Methods - The Applicant has defined Class I structures, systems and equipment as those whose failure could cause a release of radioactivity that would result in calculated concentrations at the site boundary in excess of 10 CFR 20 limits, and those necessary for safe shutdown of the facility. Class I structures, systems and equipment must be designed so as not to fail in the event of the design basis earthquake. Class II structures, systems and equipment are those whose failure would not result in a release of radioactivity which would exceed 10 CFR 20 levels at the site boundary and those not necessary for safe shutdown (PSAR Appendix 1-A, Appendix 5A). The Staff has reviewed the Applicant's categorization of

Plant structures and components and considers the categorization proper (SSE pp. 26-27). Applicant supplied satisfactory detail of its proposed seismic design methodology, including seismic acceleration criteria and site response spectra (PSAR Applicant's Ex. 1-A, p. 2-25 and Appendix 5A; PSAR Applicant's Ex. 1-C, pp. 9.00-3 and 9.00-4). The Staff's consultants reviewed the seismic acceleration criteria and the site response spectra which the Applicant proposes to use and considers the criteria to be satisfactory (SSE pp. 29, 125). The Board finds that the seismic design methods utilized have been properly reviewed and approved by the Staff.

73. Reactor Buildings - The reactor buildings provide containment for the reactors and reactor coolant systems. Applicant has described the reactor buildings as fully continuous reinforced concrete structures in the shape of right cylinders with shallow-domed roofs and flat foundation slabs. The cylindrical portions are post-tensioned in two directions and the domes are post-tensioned with three-way systems (PSAR Applicant's Ex. 1-A, p. 5-1). The proposed prestressing system is essentially the same as that which the Staff reviewed for the Arkansas Nuclear One-unit 1 and found acceptable (SSE p. 29). The foundation slabs are conventionally reinforced with high-strength reinforcing steel. The inside faces of the concrete shells are steel-lined to insure a high degree of leak tightness (PSAR Applicant's Ex. 1-A, §5.1.1.1). The Staff found that the materials proposed to be incorporated into the reactor buildings are consistent with current design practice and are acceptable (SSE p. 29). Each reactor building is designed to safely contain or withstand internal and external loadings which may occur during the life of the Plant or which could result from postulated accidents to the reactor's primary coolant system

(PSAR Applicant's Ex. 1-A, §5.1.1.2). The proposed design loads and load combinations considered include normal operation loads, accident conditions and extreme environmental conditions due to earthquakes, tornadoes and probable maximum flood. The Staff adequately evaluated the proposed design loads and load combinations, acceptance limits and design techniques for the Plant and found that the proposed design is acceptable (SSE pp. 29-30). The Applicant will design the reactor buildings for a pressure of 67 psig, which exceeds the peak calculated pressure due to a loss-of-coolant accident by more than 10% (PSAR Applicant's Ex. 1-A, p. 1C-24; SSE p. 28). Analysis of reactor building pressure time history during and after a loss-of-coolant accident was calculated using the Bechtel computer code COPATTA utilizing conservative input assumptions (PSAR Applicant's Ex. 1-B, §14.2.2.3.5). In analyzing the spectrum of break sizes in the reactor coolant system, the Applicant found that a loss-of-coolant accident involving a five square foot break imposed the most stringent requirements on the reactor building (Tr. 2384; PSAR Applicant's Ex. 1-B, §14.2.2.3.5, 14.2.2.3.6). The Staff adequately reviewed the design of the reactor buildings and performed an independent calculation using the Idaho Nuclear Corporation's CONTEMPT code. The Staff confirmed by independent calculations the Applicant's choice of the reactor building design basis accident and its resultant calculated peak containment pressure (SSE p. 28).

74. As a part of the containment design, piping lines which penetrate the reactor building are to be equipped with double isolation barriers such that no single failure or component malfunction will

result in leakage from the reactor building to the atmosphere. These barriers consist of closed piping systems and isolation valves where applicable (PSAR Applicant's Ex. 1-A, §5.1.5; PSAR Applicant's Ex. 1-B, pp. 5.4.1-1 and 5.4.1-2; SSE p. 27).

75. The Applicant will also install two accident mitigating systems. The first is an isolation valve seal water system which provides additional assurance of the effectiveness of the containment isolation valves located in lines connected to the reactor coolant system or which could be exposed to the containment atmosphere (PSAR Applicant's Ex. 1-A §5.1.5.3). The second system is a containment penetration and leak chase channel pressurization system which provides for continuously pressurizing the positive pressure zones incorporated into the containment penetrations and the channels over the welds in the steel liner. Although no credit is taken for the operation of these systems in calculating off-site accident doses, they do provide assurance that the containment leak rate would be lower than that assumed in the safety analysis (PSAR Applicant's Ex. 1-A, §5.1.5.3; PSAR Applicant's Ex. 1-B, p. 5.1.19-1; Tr. 2488). Further, the Applicant will conduct a pre-operational structural integrity test of the reactor buildings (PSAR Applicant's Ex. 1-B, pp. 5B-1 and 5H-1), pre-operational and periodic integrated leak rate tests on the reactor buildings (PSAR Applicant's Ex. 1-B, p. 5-53), and periodic structural surveillance tests of the post-tensioning systems (SSE p. 30; PSAR Applicant's Ex. 1-B, p. 5-52). The Staff has evaluated the Applicant's pre-operational testing program and has concluded that it is acceptable and contains adequate

provisions for conducting acceptable post-operational testing so as to assure safe operation (SSE p. 30).

76. The Board finds that the Applicant has submitted sufficient information and the Staff has conducted an adequate review as to Applicant's plans for the design, construction and testing of the reactor buildings.

77. Auxiliary Building - The auxiliary building is located adjacent to the reactor buildings. It contains the following systems and facilities related to Plant safety: (1) New and spent fuel handling storage facilities, (2) Control room and related facilities, (3) Radioactive waste decontamination facilities, (4) Radioactive waste, and the reactor plant chemical and volume control facilities, (5) Access control, (6) Engineered safeguards systems, and (7) Reactor building penetration areas. The building is designed for normal external and internal loads, accident loads, and extreme environmental conditions, such as earthquake, tornado, and probable maximum flood (PSAR Applicant's Ex. 1-A, §5.2.1). The Board concludes that Applicant has furnished sufficient information and the Staff has performed an adequate review with respect to the design of the auxiliary building.

78. Service Water Pump Structure and Diesel Generator Building - The Service water pump structure is designed to house the service water and fire water pumps. The diesel generator building houses the two emergency diesel generators. These structures are designed for normal operating loads, accident loads, and to protect their contents against extreme environmental conditions, such as tornadoes, earthquakes, and probable maximum flood (PSAR Applicant's Ex. 1-A, p. 5-64;

PSAR Applicant's Ex. 1-A, p. 5-65). The Board concludes that the Applicant has furnished sufficient information and the Staff has performed an adequate review with respect to the service water pump structure and diesel generator building.

79. Missile Protection - Applicant will protect the primary system and all engineered safety features from damage that might be caused by missiles generated as a result of equipment failures within the containment structure or by external missiles generated by tornadoes. Protection against missiles and pipe whip will be provided by physical separation, restraints and missile shields, such as the containment structure, the auxiliary buildings, external walls and internal separation walls (PSAR Applicant's Ex. 1-A, p. 5-5; PSAR Applicant's Ex. 1-B, §5.1.1.4.10; PSAR Applicant's Ex. 1-B, pp. 4.11-1 through 4.11-3 and 4.14-1). The Staff found the Applicant's design criteria for protection against missiles and pipe whip consistent with AEC criteria and acceptable (SSE p. 23-24). The Board finds that sufficient information has been furnished and the Staff's review has been adequate to provide for sufficient protection against missiles and pipe whip.

80. Radiation Shielding - The Applicant will design the Plant to include shielding throughout, primarily in the form of heavy concrete walls, so as to ensure that radiation exposures to the general public and to operating personnel are within applicable radiation limits as prescribed in 10 CFR 20 and as required by the proposed Appendix I to 10 CFR 50 when in effect and as applicable to the Plant (PSAR Applicant's Ex. 1-A, §5.4.2.1; Applicant's Ex. 38-M). No objections to Applicant's proposed shielding design were raised. The Board concludes

that sufficient information has been presented by Applicant and an adequate review has been conducted by Staff with respect to radiation shielding.

81. Instrumentation and Control - Redundant networks of instrumentation and controls will be provided to ensure the safe operation of the Plant. The reactor protection system and the engineered safeguards actuation system are being designed, as required by 10 CFR §50.55a, to meet the requirements of the "Standard for Nuclear Power Plant Protection Systems," IEEE-279, in effect twelve months prior to issuance of the construction permit (Applicant's Ex. 25). The engineered safety features actuation system monitors Plant conditions and automatically initiates operation of the engineered safety features systems, if required (PSAR Applicant's Ex. 1-B, §7.1). In the event of a loss-of-coolant accident reactor trip will be initiated by low reactor coolant pressure. The Staff will require Applicant to provide initiation of reactor trip from high containment pressure or other suitably diverse signal in addition to the low reactor coolant pressure trip (SSE pp. 40-41). The Staff reviewed the reactor protection instrumentation and control systems, and the instrumentation systems which initiate and control the engineered safety features (SSE p. 39) and concluded that these systems provide added redundancy compared to previously licensed plants and are acceptable (SSE p. 40).

82. Common Mode Failure - The Applicant is performing studies of means of preventing common mode failures in the reactor protection system from negating reactor trip. Studies are also being performed of the consequences of failure to trip in the event of anticipated

transients. The Applicant has stated that it will maintain flexibility in the engineering design in order to tolerate the consequences of a failure to trip during anticipated transients. The Staff will, if necessary, require modifications to the Plant to make tolerable the consequences of failure to trip during these transients (SSE pp. 47-48). The Board concludes that this is an item that can be satisfactorily resolved during construction.

83. Radiation Monitoring and Control Room - Radiation monitoring systems are provided to monitor all systems which could release radioactivity to the environment, to record a continuous indication of the gamma radiation levels in selected Plant areas and to provide protection to operating personnel from exposure to radiation levels or radioactive concentrations in excess of the maximum permissible limits of 10 CFR 20 (PSAR Applicant's Ex. 1-B, §7.5.1). The Applicant states that it will use radiological monitoring of personnel and radiological contamination control procedures similar to those it has developed and used successfully in its Big Rock Point Plant and have been adapted for its Palisades Plant (PSAR Applicant's Ex. 1-B, §7.5.5). A centrally located control room for both units is provided which contains all of the control stations, switches, controllers, and indicators necessary to start up, operate and shut down the nuclear units. Additionally, the capability is provided for taking the Plant to, and maintaining the Plant in, a safe shutdown condition from other locations in the Plant should occupancy of the control room be temporarily denied (PSAR Applicant's Ex. 1-B, pp. 7.16-1 and 7.19-1).

84. Instrumentation and Control Adequacy - The Applicant's design of instrumentation and control systems (including radiation monitoring systems and the control room) was not contested. The Staff adequately reviewed the Application and record regarding instrumentation and control systems, and this Board finds that with the addition of a diverse reactor trip signal and further analysis of common mode failure the described instrumentation and control systems are adequate for safe operation of the Midland Plant. Applicant's commitment to add such a signal and to analyze common mode failures is sufficient for the construction permit stage and can be satisfactorily resolved during construction. The Board concludes that Applicant has presented sufficient information and the Staff has performed an adequate review with respect to instrumentation and controls.

85. Electrical Systems Descriptions - Electric power generated by the Plant is to be fed through separate connections to a main transformer for each unit. There, it is stepped up to 345 kV and delivered to a switchyard on separate overhead lines. The units and associated switchyard will be part of the Applicant's integrated electric system. The Plant electrical output also feeds the Plant station power transformers. The five 345 kV transmission lines which terminate at the Midland switchyard will provide start-up and standby power from the system through a step-down substation (to change the voltage from 345 kV to 138 kV) and a plant start-up transformer. A second Plant start-up transformer will provide an alternate off-site power source via another 138 kV substation (PSAR Applicant's Ex. 1-B, §8.2.1; PSAR Applicant's Ex. 1-B, p. 8.2-2; SSE p. 41-42). The Plant has an auxiliary power distribution system which

is a two-bus system for each unit. The engineered safeguards system bus sections are electrically separate and redundant and will be located in separate rooms of the auxiliary building to provide physical isolation. The redundant safeguard bus sections will have access to (a) the Plant electrical output through the station power transformers, (b) the Applicant's off-site area transmission network, and (c) the on-site emergency diesel generators. Operation of either of the two redundant bus sections will supply the minimum engineered safeguards load requirements. Distribution equipment and wiring for redundant channels of the engineered safeguards system will be installed to protect against the loss of redundant counterparts from any single event, such as fire or mechanical failure (PSAR Applicant's Ex. 1-B, §8.2.2; PSAR Applicant's Ex. 1-C, p. 8.2-3 - 8.3-1; SSE p. 42-43). There is also a standby alternating-current power supply consisting of two redundant emergency diesel generators which are electrically and physically independent. Each diesel generator will have sufficient capacity to start and supply the minimum engineered safeguards load in one unit and the minimum safe shutdown load in the other unit. Automatic and manual controls will be provided for starting and loading the diesel generators (PSAR Applicant's Ex. 1-B, §8.2.3; SSE p. 43). The Plant's direct current power supply for safeguards systems consists of two 125-volt batteries located in separate rooms. Two separate 125-volt d-c power distribution buses will be provided to supply redundant safety related loads in each unit. These batteries will have the capacity to provide a safe and orderly hot shutdown in the event that

all a-c power is lost. Separate 250-volt batteries will supply non-safety related loads on site (SSE, p. 44-45). The independence between redundant standby power sources and their distribution systems complies with AEC Safety Guide No. 6 (Staff Ex. 4).

86. Electric Systems Adequacy - The Saginaw Intervenors questioned whether there was sufficient redundancy and electrical independence in order to assure that electrical power would always be available to operate required safeguards equipment. In this regard, testimony indicated that the design criteria for the two-unit Plant is satisfied by the two shared diesel generators and that their ability to perform their safety functions is not significantly impaired by such sharing. The Staff concurred in this conclusion (Tr. 2330-2340, 2497; PSAR Applicant's Ex. 1-B, pp. 8.4-1 and 8.5-1). The Board asked Applicant to indicate the experience of other industries with emergency generation and their redundancy requirements (Tr. 2920-21). Applicant informed the Board that no industry, except the nuclear industry, requires redundant emergency power sources although some airports have redundant systems. The absence of such a requirement appears to be based on the satisfactory performance of emergency power systems over the past twenty years (Testimony of Mr. Castleberry, filed August 16, 1971).

87. The Board questioned the adequacy of the installation criteria for circuit and component protection. (Written Questions, June 1971) Testimony indicated that circuit installation will be different than at the Applicant's previously built Palisades Plant due to both a

all a-c power is lost. Separate 250-volt batteries will supply non-safety related loads on site (SSE, p. 44-45). The independence between redundant standby power sources and their distribution systems complies with AEC Safety Guide No. 6 (Staff Ex. 4).

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87. The Board questioned the adequacy of the installation criteria for circuit and component protection. (Written Questions, June 1971) Testimony indicated that circuit installation will be different than at the Applicant's previously built Palisades Plant due to both a

different equipment configuration and new industry criteria (Tr. 2351-52). The reactor protection systems will be designed to satisfy the requirements of the IEEE criteria for Nuclear Power Plant Protective Systems (PSAR Applicant's Ex. 1-B, §7.1.1.2; PSAR Applicant's Ex. -B, pp. 7.1-1 - 7.13-1; Applicant's Ex. 25).

88. Cable installation design criteria were presented during the Staff review (PSAR Applicant's Ex. 1-C, p. 8.6-1) and this was supplemented by specific quantitative design guide rules (Applicant's Ex. 37, pp. 3-5). The Board concludes that Applicant has presented sufficient information and the Staff has conducted an adequate review with regard to electrical systems.

89. Auxiliary Systems - Auxiliary systems are provided to supply reactor coolant makeup and pump seal water, to cool the reactor during shutdown, to cool components, to ventilate station spaces, to handle fuel, to cool spent fuel, to adjust the concentration of various chemicals in the reactor coolant and to provide for fire protection. The systems include (1) the reactor coolant makeup and purification system, (2) the chemical addition system, (3) the decay heat removal system, (4) the fuel pool cooling system, (5) the shield cooling system, (6) the component cooling system, (7) the service water system, (8) the auxiliary feedwater system, (9) the fuel handling system, (10) the sampling system, (11) the instrument and service air system, (12) the heating, ventilating and air-conditioning systems, and (13) the fire protection system (PSAR Applicant's Ex. 1-B, §§ 9). The Staff reviewed the design bases, mechanical design and redundancy requirements of those systems, found the design bases to be similar to those

on other pressurized water reactor plants approved for construction and found the systems adequate to perform their intended functions (SSE §10.0). The Board concludes that sufficient information has been supplied on these systems and that they were properly evaluated by the Staff.

90. Turbine and Process Steam System - The steam and power conversion system is designed to accept steam from the reactors which produce approximately 21 x 10^6 lb/hr of steam (PSAR Applicant's Ex. 1-A, Table 4-5). Part of this steam (approximately 75 percent) is then converted to electrical energy by turbine-generators. A second part is used in the process steam reboilers (also termed tertiary heat exchangers (THX)) to generate process steam for Dow Chemical (PSAR Applicant's Ex. 1-C, pp. 11.00-1 to 11.00-5). The balance is rejected by the turbine condensers and dissipated to the closed-cycle cooling system (PSAR Applicant's Ex. 1-B, pp. 10-2 and 10-4). The steam produced in the secondary side of the steam generators is routed through main steam headers to two 1800 rpm, tandem-compound indoor turbines (PSAR Applicant's Ex. 1-B, p. 10-2). Normally, the process steam will originate in Unit 1. On Unit 1, a portion of the steam produced, 400,000 lb/hr, is routed directly from a point upstream of the #1 turbine stop valves to the high pressure (HP) reboilers in which the high pressure process steam for Dow is generated. After expansion in the high pressure turbine and subsequent passage through the moisture separator reheaters between the high and low pressure stages of the turbine, approximately 3,650,000 lb/hr of low pressure (LP) steam is extracted to the LP process steam reboilers. The remainder of steam produced in the Unit 1 steam generators is further expanded through one double-flow

low pressure turbine which exhausts to the main condenser (PSAR Applicant's Ex. 1-A, p. 1-5; PSAR Applicant's Ex. 1-B, p. 10-2; PSAR Applicant's Ex. 1-C, pp. 11.00-1 and 11.00-2). The steam produced in the Unit 2 steam generators is entirely routed through a double-flow high pressure turbine and through moisture separator reheaters to two double-flow low pressure turbines which exhaust to the two main condensers. High pressure steam is removed directly upstream of the two turbine stop valves by cross-connection lines and through reducing valves to the extent necessary to supply the heating steam to the HP and LP reboilers during the periods when the Unit 1 turbine may be shut down for maintenance purposes. Additionally, when the Unit 1 nuclear steam system is shut down for annual refueling, cross-connections are provided between the main-steam headers, such that steam from Unit 2 can directly supply the HP reboilers and the Unit 1 turbine. This provision allows for the more efficient use of steam produced and requires shutdown of the Unit 2 turbine (PSAR Applicant's Ex. 1-B, p. 10-1). Process steam produced on the secondary side of the reboilers is transported to the Dow complex via a single 675 psia steam header and two 197 psia headers (PSAR Applicant's Ex. 1-B, p. 10-1). The condensate produced by the process steam after use in the Dow processes, plus makeup as necessary to provide for system losses, is returned to the Plant as feedwater for the reboilers. The design of the turbine and process steam system has been analyzed and evaluated by the Applicant and the Staff (SSE p. 57). The Board finds that the Applicant presented sufficient

information and the Staff performed an adequate review as to the proposed turbine and process steam system.

91. Process Steam Monitoring - The process steam will be monitored for radioactivity with an on-line gross gamma monitoring system and with grab samples for gross beta. Within the detection limits and turn-around time required to achieve the detection level, the tertiary steam to Dow will be compared with and will not contain more radioactivity than the Lake Huron makeup water supplied to the tertiary heat exchangers (PSAR Applicant's Ex. 1-C, p. 11.00-2). The Board questioned the Applicant as to its ability to monitor the process steam at the low levels required to insure radioactivity levels comparable to Lake Huron background (Tr. 2478-2481). The Applicant described this in more detail and showed that it was capable of monitoring at these low levels with equipment commercially available (Applicant's Ex. 36). All Dow products which come in contact with contaminated process steam will be monitored and in the event the radioactivity in the product exceeds the inherent natural background radioactivity, the product will be decontaminated or disposed of as necessary. (Applicant's Ex. 38C, Response to Comment of Department of Health Education and Welfare) The Staff analyzed the monitoring system and concluded that it would adequately ensure levels of radioactivity essentially equivalent to natural background (SSE pp. 57-58). The Board finds that the system provides adequate assurance that leakage of radioactivity into the process steam will be an extremely remote possibility and that the radioactivity of the process steam will be essentially at natural background levels and is acceptable. The Board further finds that Applicant has submitted sufficient information and Staff has performed an adequate review with respect to process steam monitoring.

92. Cooling System - Cooling of the two turbine generator condensers is provided by circulating water from the closed cycle 880-acre cooling pond which has been sized to satisfy Plant cooling needs during a 100-day drought. Service water, which is water used to remove waste heat from both nuclear and turbine auxiliary systems during normal, shutdown or emergency conditions, is cooled by circulation through the cooling pond and, when necessary, by circulation through a service water cooling tower. A depressed area will be created in the cooling pond to provide for storage of a sufficient supply of water for reactor decay heat removal in the unlikely event of a failure of the pond dike (PSAR Applicant's Ex. 1-B, §9.7 and pp. 2.2-1 through 2.2-3). The Staff has reviewed the design of the cooling pond and service water systems and has concluded that they are adequate to protect the public health and safety (SSE pp. 54-56). The Board finds that Applicant has furnished sufficient information and the Staff review has been adequate in regard to the health and safety aspects of the cooling facilities.

93. Engineered Safeguards - Engineered safeguards in each nuclear unit are provided to protect the fuel cladding, maintain reactor building integrity, reduce the driving force for reactor building leakage and reduce iodine in the reactor building atmosphere in the event of a loss-of-coolant accident (PSAR Applicant's Ex. 1-A, §6). All active engineered safeguards are redundant and independent systems with redundant power sources (Tr. 2390-91). The major engineered safeguards are described in the following paragraphs.

94. Emergency Core Cooling System Description - The emergency core cooling system (ECCS) is comprised of the high pressure injection system, the low pressure injection system, and the core flooding system. The emergency core cooling system is provided to prevent fuel clad melting for the entire spectrum of postulated reactor coolant system breaks from the smallest leak to the complete severance of the largest pipe (PSAR Applicant's Ex. 1-B, §6.1). The high and low pressure injection systems are subdivided such that there are two separate and independent strings, each including high and low pressure injection and each string capable of providing 100 percent of the required core injection in conjunction with the core flooding tanks. If a postulated break in the reactor coolant system piping occurs, the high pressure injection system will be actuated if the reactor coolant system pressure decreases to 1500 psig or the reactor building pressure exceeds a preset limit. The two core flooding tanks inject water directly into the reactor vessel when the pressure has decreased to 600 psig. This injection does not require any electrical power, automatic switching or operator action. The low pressure injection system is the emergency mode of operation of the normal decay heat removal system and is actuated when the reactor coolant system pressure decreases to 200 psig or the reactor building pressure exceeds a preset limit. The borated water storage tank supplies water to the low pressure injection system until a tank low level signal is received, at which time the pump suctions will be switched to the reactor building sump and the system will operate in the recirculation mode with the decay heat coolers cooling the recirculation flow. The decay heat coolers have a heat transfer capability in excess of the heat

generation rate of the core in the recirculation phase (PSAR Applicant's Ex. 1-A, §6.1.2; Tr. 2371-81). Decay heat removal pumps and reactor building spray pumps are located and the piping sized such that adequate pump net positive suction head is assured in accordance with AEC Safety Guide 1 (PSAR Applicant's Ex. 1-B, pp. 6.2-1; Staff Ex. 4, Response No. 1). Capacity is provided in the borated water storage tank to provide a sufficient source of water for emergency injection for a postulated LOCA in one unit even when the tank level has been reduced by an amount necessary to fill the reactor building refueling canal of the other unit during refueling of the other unit (PSAR Applicant's Ex. 1-B, p. 6.6-1). Because of the complex history of the analysis of the ECCS system in this proceeding, the subject is treated separately in Paragraphs 123 through 128.

95. Reactor Building Air Recirculation & Cooling System - The reactor building air recirculation and cooling system which consists of four separate cooling units, is designed to remove heat and vapor from the reactor building atmosphere during normal operation and, in the event of a loss-of-coolant accident, this system by itself can limit reactor building pressure rise in order that the containment pressure and temperature will not exceed the design values of 67 psig and 297°F. Each unit consists of a roughing filter, fin tube cooling coils and two direct driven fans. One fan motor per unit is rated for post-accident conditions. The reactor building air recirculation system is redundant to the reactor building spray system for purposes of heat and vapor removal as discussed below under the reactor building spray system (PSAR Applicant's Ex. 1-A, p. 1C-24; PSAR Applicant's Ex.

1-A, §6.3.1). The Staff reviewed this system and found it acceptable (SSE pp. 36-37). Applicant has presented sufficient information and the Staff has performed an adequate review concerning the reactor building air recirculation and cooling system.

96. Reactor Building Spray System - The reactor building spray system is provided to remove heat and fission products from the reactor building atmosphere following a loss-of-coolant accident in order to limit the reactor building pressure to the design value and to reduce the post-accident level of fission products in the reactor building atmosphere. Chemicals are added to the water coming from the borated water storage tank after a loss-of-coolant accident to establish a basic pH by addition of sodium hydroxide and to provide for iodine retention by addition of sodium thiosulfate.(PSAR Applicant's Ex. 1-A, §6.2). Each reactor unit has a spray system consisting of two independent reactor building spray headers, one sodium thiosulfate tank, and one sodium hydroxide tank. Each header contains one spray pump, one thiosulfate injection pump, one hydroxide injection pump and the necessary piping, instrumentation, and controls (PSAR Applicant's Ex. 1-A, p. 6-10; Applicant's Ex. 23). Interlocks will be provided to insure that, in the event of malfunction of any chemical injection pump or other active component, the solutions entering the building are of an alkaline pH (PSAR Applicant's Ex. 1-A, §6.2.2; Tr. 2855-63; Applicant's Ex. 23). Operation with only one spray header is sufficient to control fission product releases as discussed in the safety analysis section. Applicant has demonstrated the effectiveness of the spray system in removing fission products and the stability of the solution (PSAR Applicant's

Ex. 1-B, §14, Appendix 14A; Applicant's Ex. 10; Tr. 1624-28, 2033-38, 2836-52). For heat removal the system provides the cooling capacity necessary to limit the reactor building pressure below the design value, and together with the reactor building air recirculating and cooling system provide the required redundancy and diversity as any of the following combinations is capable of providing the cooling capacity required: (1) two reactor building spray headers, (2) four air cooling units, and (3) one spray header and two cooling units. The Staff evaluated the reactor building spray system and, in view of the research and development effort being conducted on the long-term stability of sodium thiosulfate and the fact that using the Staff's extremely conservative assumptions the system would perform its function (See paragraphs 112-114, infra), the Staff concluded that the system was acceptable (SSE pp. 35-37). Applicant's testimony at the hearing demonstrated that its research and development program had been completed and had confirmed the long-term stability of sodium thiosulfate solutions (Tr. 2836-55). The Board concludes that Applicant presented sufficient information and the Staff has conducted an adequate review with respect to the reactor building spray system, including the Applicant's system for removal of iodine from the containment atmosphere after a LOCA.

97. Hydrogen Control System - Applicant's proposed hydrogen purge system would operate to limit the reactor building hydrogen concentration below 3.5 percent by volume, thereby precluding hydrogen ignition as an energy source subsequent to a loss-of-coolant accident and assuring that reactor building integrity will be maintained. This is a conservative limit because the lower flammability limit of hydrogen is considered to be 4.1 percent by volume (PSAR Applicant's Ex. 1-B,

§9.12.2.1 and p. 14-63d; PSAR Applicant's Ex. 1-B, Enclosure B, Item No. 8). The Staff concluded that, while hydrogen purging should not be the primary means of limiting hydrogen buildup, the purge system should be a backup to a positive hydrogen control system (SSE p. 38). Applicant is presently funding a research and development program investigating various types of hydrogen recombiner systems (PSAR Applicant's Ex. 1-B, Enclosure B, Item No. 8). Applicant will be required to install a redundant (2-unit) catalytic recombiner system or other adequate system, as required by AEC Safety Guide 7, as a means of preventing the hydrogen concentration in the reactor building from reaching 3.5 percent by volume in the event of a loss-of-coolant accident. The Staff will review the plans for this system as a part of their operating license review of the Plant and will require that an acceptable hydrogen control system be provided prior to issuance of an operating license (SSE p. 38; Staff Ex. 4). The Board has found that the Applicant has presented sufficient information and the Staff has conducted an adequate review of Applicant's hydrogen purge system and program for development and installation of a hydrogen catalytic recombiner system.

98. Liquid Radioactive Waste Treatment System - The liquid waste treatment system is designed to collect, process and reuse or dispose off-site all liquid wastes, except for laundry waste, containing radionuclides generated during normal operation of the Plant (PSAR Applicant's Exhibit 1-B, §11; ASER Applicant's Ex. 38-F, §4.2). The clean liquid wastes (liquids which are relatively low in chemical impurities and suspended solids) will normally be processed through a degassifier to remove radioactive gases and through filters and demineralizers to remove suspended or dissolved radionuclides. At this

point low boron wastes are processed through an additional demineralizer for reuse and high boron wastes are separated by evaporators into two reusable constituents: demineralized water and concentrated boric acid. These constituents can be further decontaminated by ion exchange if necessary (PSAR Applicant's Ex. 1-B, pp 11-6 and 11-7 and Figure 11-1). The dirty liquid wastes (liquids containing rather high concentrations of chemical impurities) are passed through a filter and an evaporator or two demineralizers in series, the purified water is reused and the concentrated wastes, depending on their quality, are either reused or disposed of off-site (PSAR Applicant's Ex. 1-B, p. 11-7 and Figure 11-2). The laundry waste of about 120 gallons per day will be the only waste containing radionuclides from the Plant that will be released to the Tittabawassee River during normal operation (PSAR Applicant's Ex. 1-B, Table 11-1; PSAR Applicant's Ex. 38-E, p. 11.1-1). The Applicant conservatively estimates that the gross activity in the dilution stream from the laundry waste based on operation with 1% failed fuel for a full year shall not exceed 25 pico curies per liter on an annual average. This is equivalent to about two curies per year (PSAR Applicant's Ex. 38-E, p. 11.1-1). Using this upper limit concentration, the Applicant calculates a potential dose to a hypothetical individual who consumes 2200 cc's per day of water from the river and eats 37 lb of fish per year from the river to be about 0.8 mrem/year, using standard factors for reconcentration of radionuclides in fish (PSAR Applicant's Ex. 38-E, p. 11.8-11). This calculation yields a very conservative value because the nearest municipal water supply is 40 or 50 miles from the discharge (SSE p. 51) and it is very unlikely that either unit will experience 1% failed

fuel for a full year (Tr. 7590, 7599). The liquid radioactive waste system is located in Class I structures and outside water tanks through which the recycled tritium will pass are designed to seismic Class I standards (Applicant's Ex. 38-E, p. 11.3-1). The Staff reviewed Applicant's liquid radioactive waste system including its proposed recycle of tritium. The Staff found that the liquid radioactive effluent system would permit effluent releases to be held at a small fraction of 10 CFR Part 20 limits and within the numerical guidelines of proposed Appendix I to 10 CFR Part 50. The Board finds that Applicant has supplied sufficient information regarding its radioactive waste treatment system, the Staff review was adequate, and that liquid discharges from the Plant will be a small fraction of 10 CFR Part 20 limits and well within the guidelines in 10 CFR Part 50, proposed Appendix I, published in the Federal Register June 9, 1971. Although the application was filed prior to January 1, 1971, the Board has concluded that the Applicant has adequately identified the design objectives and the means to be employed for keeping levels of radioactive materials in effluents to unrestricted areas "as low as practicable" in accordance with 10 CFR §50.34a.

99. Gaseous Radioactive Waste Treatment System - Potentially high activity waste gas is routed to the waste gas surge tank where its activity is monitored. Usually the activity in such gas is low enough so that it can be released to the atmosphere through high efficiency filters. However, in the event of high levels of radioactivity the waste gas is routed to waste gas decay tanks where such gases can be stored for up to sixty days to permit decay of all of the radioactive gases, other than Krypton-85, to essentially zero (PSAR Applicant's Ex. 1-B, p. 11-7; ASER Applicant's Ex. 38-F-1, p. 4.2-4A).

Applicant estimated that using its previous design which allowed for 30-day holdup, the Plant would release about 63,500 curies of Krypton-85, 48 curies of xenon-133m and 26,000 curies of xenon-133 in the event both units operated for a full year with 1% failed fuel and the gases were stored 30 days prior to release (PSAR Applicant's Ex. 38-E, p. 11.1-1). Subsequently, Applicant upgraded the radwaste system to allow for 60 days' holdup of gases instead of 30 days (ASER Applicant's Ex. 38-F-1, p. 4.2-1). Based on the extended holdup and more exacting calculation of Kr-85 generation, the Applicant estimated that in the event both units operate for a full year with 0.1% failed fuel, the quantity of Kr-85 and Xe-133 released through the radwaste treatment system will be about 1224 curies and 50 curies, respectively (ASER Applicant's Ex. 38-F-1, §4.2; ASER Applicant's Ex. 38-G, p. 6.7-1). The Applicant further calculated the dose to an individual continuously present at the site boundary for a full year to be about 0.46 mrem/year (ASER Applicant's Ex. 38-F-1, §4.2). A conservative calculation of the dose using 60 days' holdup and the extremely conservative 1% failed fuel would be approximately 4.6 mrem/yr. This dose is a small fraction of 10 CFR Part 20 and is less than the dose specified in the proposed Appendix I to 10 CFR Part 50. The Staff evaluated the proposed 30 days' holdup assuming 0.25% failed fuel and concluded that the gas release will be well within 10 CFR Part 20 and the proposed Appendix I to 10 CFR Part 50 (Staff Ex. 8, p. 10). The Board finds that sufficient information has been furnished and the Staff has adequately reviewed the information. The Board concludes that the releases from a system which allows for 60 days' holdup will be only a small fraction of 10 CFR Part 20, and within the guidelines in the proposed Appendix I to

10 CFR Part 50. Although the application was filed prior to January 1, 1971, the Board has concluded that the Applicant has adequately identified the design objectives and the means to be employed for keeping levels of radioactive materials in effluents to unrestricted areas "as low as practicable" in accordance with 10 CFR §50.34a.

100. Solid Radioactive Waste System - The solid waste treatment system consists of tankage and facilities for collecting and packaging spent demineralizer resins and evaporator bottoms and for packaging contaminated items such as spent filter elements, rags, clothing, etc. All radioactive material from the solid waste system will be shipped off-site for storage by AEC licensed contractors (PSAR Applicant's Ex. 1-B, p. 11-8). No radioactivity will be released to the environment. The Staff reviewed the Applicant's solid waste design information and concluded it was adequate (SSE p. 53). The Board concludes that sufficient information has been furnished and that the Staff review has been adequate.

101. Radioactive Release Regulations - There was no challenge made to the conformity of the Plant releases with applicable regulations governing release of radioactive materials and resultant doses to the public. However, Saginaw and Mapleton Intervenors repeatedly raised the issue of whether the calculated doses, although substantially within the limits of the AEC Standards for Protection Against Radiation, 10 CFR Part 20, constituted an undue risk to the public and whether the radionuclide releases in combination with chemical releases from Dow might result in biological effects greater than one would expect from the addition of the biological effects of the radiation and the biological effects of the chemicals. The AEC has previously ruled in regard to a challenge

to its radiation standards in an individual licensing proceeding that,

> ". . . the Commission's licensing regulations establish the standards for reactor construction permit determinations; and . . . the findings in proceedings such as the instant one must be made in accordance with those regulations. Further, it should be clear that our licensing regulations - which are general in their application and which are adopted in public rulemaking proceedings wherein the Commission can draw on the views of all interested persons - are not subject to amendment by boards in individual adjudicatory proceedings." In the Matter of Baltimore Gas & Electric Company; Memorandum, Docket Nos. 50-317, 50-318, August 8, 1969.

However, the AEC did provide in that memorandum that challenges to the validity of the radiation protection standards could be permitted in individual licensing proceedings on the limited grounds of (1) whether the regulation was within the Commission's authority, (2) whether it was promulgated in accordance with applicable procedural requirements, and (3) whether the standards are a reasonable exercise of the AEC's broad discretion. The AEC in its Memorandum further indicated that if intervenors did raise a substantial question as to the validity of a regulation, it should be certified to the Commission for guidance.

102. On the basis of that decision, the Board determined that compliance with the effective provisions of 10 CFR Part 20 sufficiently demonstrated that radionuclide releases during normal operation would not create an undue risk to the public health and safety in the absence of a showing by intervenors of the type permitted under the AEC memorandum decision (Tr. 517, 1074-75). The Board, however, on numerous occasions extended to both Saginaw and Mapleton Intervenors an opportunity to make a showing of any serious question as to the validity of the AEC's regulations (Tr. 517, 1074-75).

103. Following completion of the radiological health and safety portion of the hearing, the Board in its Order of August 26, 1971 provided that Saginaw and Mapleton Intervenors should file their written evidence with respect to the validity of Part 20 on or before September 15, 1971. Saginaw filed only a letter, dated September 30, 1971, objecting to the Board's ruling. Mapleton Intervenors filed a letter, dated September 14, 1971, objecting to the September 15, 1971 due date and on September 28, 1971 an affidavit by Dr. Charles Huver, dated September 14, 1971 which purported to discuss the effects of radiation from the Plant. Subsequently, Mapleton Intervenors filed affidavits by Dr. Orie Loucks (dated October 22, 1971, filed December 13, 1971), Dr. Ernest Sternglass and Dr. Richard Meierotto (both dated December 17, 1971, filed December 22, 1971). The Board reviewed the various affidavits in order to determine if they raised any substantial question as to the validity of the AEC's radiation standards. The affidavit of Dr. Huver appeared to deal with a different plant than that of Applicant's and discussed levels of radiation releases unrelated to those projected to be released by the Plant. Dr. Meierotto's affidavit was a general statement of concern unsupported by any evidence. Dr. Louck's affidavit expressed concern over concentration of radionuclides in living organisms. His basic premise appeared to be that more knowledge is needed regarding concentration of certain unspecified radionuclides. His affidavit revealed unfamiliarity with much of the Plant's design, particularly in his statements that radionuclides were to be released to the cooling pond, contrary to the undisputed filings of Applicant (Applicant's Exhibits 1-B p. 2.10-1, and

38-E) and that relatively large quantities of radioactive material were to be released from the Plant. The Board is well aware that the releases from this Plant relative to the present generation of reactors will be small and that the dose to the public from the releases will be very small in relation to the normal background dose. (ASER Applicant's Ex. 38-F-1, pp. 4.2-4 and 4.2-7) Of particular interest is the fact that the article appended to Dr. Louck's affidavit upon which he placed great reliance clearly states:

> ". . ., controlled releases of radioactive materials into the general environment up to the present time have been restricted to such low levels that the health and safety of the public apparently are adequately protected." Reichle, Dunaway and Nelson "Turnover and Concentration of Radionuclides in Food Chains" Nuclear Safety Vol. 11, No. 1, Jan-Feb. 1970.

104. Dr. Sternglass' affidavit, to which was attached a paper on the general subject of radiation effects,* merely stated that he did not believe that a construction permit should be issued until a calculation of the environmental radiation and its corresponding effect on human health had been included in a cost-benefit analysis of the Plant. The Board is of the opinion that the general statistical study presented by Dr. Sternglass is not sufficient to indicate that releases of the small quantity of radioactive materials permitted under 10 CFR Part 20 and 10 CFR, §50.34a can be expected to result in any adverse effect on the public. The Board notes that the sole scientific basis cited by Dr. Sternglass that low level radiation can cause injury is the work of Dr. Alice Stewart. Since her work is not before the Board, it takes official notice that Dr. Stewart at the

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* "Environmental Radiation and Human Health" Ernest J. Sternglass.

Shoreham Plant proceeding repudiated Dr. Sternglass' use of her data, stating that his "approach is null and void." (Long Island Lighting Company (Shoreham Plant) Dkt. No. 50-322, Tr. 7483-84). He postulates no credible connection between the releases of radioactive material and his claimed consequences. He does not correlate release levels, wind directions, water consumption and other important factors with the supposed consequences of the releases in most instances. Being devoid of any basis in scientific research or credible connection between releases and consequences, his papers and conclusions must stand on his statistical methodology. However, the Board takes official notice that in other statistical studies by Dr. Sternglass, he has been found to use "statistical methodology and selective sampling techniques [which] are not scientifically credible and, indeed, raise serious questions as to whether his presentation is consistent with even a moderate degree of scientific responsibility." (In the Matter of Columbia University, Memorandum and Order, Dkt. No. 50-308, May 18, 1972) Dr. Sternglass' testimony at the environmental portion of this hearing confirmed the Board's opinion that his paper cannot be accepted as proof of effect of low level releases. The very paper which was attached to Dr. Sternglass' affidavit has been entered into the record of the AEC's Effluents from Light Water Reactors rulemaking proceeding (Dkt. No. RM-50-2) by the Consolidated Intervenors through which group Mapleton Intervenors are participating in that rulemaking. Thus whatever merit Dr. Sternglass' views may have will be fully evaluated in a rulemaking proceeding in which all persons interested in the controversial subject of the

effects of radiation will have had their full say. The Board on the basis of what Mapleton Intervenors have filed does not consider it fruitful to further pursue that issue in a duplicative proceeding here. None of these four affidavits indicated in any way that the AEC had abused its discretion in promulgating its standards for protection against radiation. The Board in a March 10, 1972 Order found:

> "The evidence submitted by Mapleton Intervenors . . . is not sufficient to raise a substantial challenge to the validity of Part 20 of the AEC regulations within the meaning of the Calvert Cliffs opinion and, therefore, the Board will not refer the question to the Commission."

The releases having been found to be small fractions of 10 CFR Part 20 limits and well within the guidelines of proposed Appendix I to 10 CFR Part 50 are clearly acceptable.

Safety Analysis

105. In order to assure that the Plant can be constructed and operated without undue risk to the health and safety of the public, the Applicant and Staff made detailed safety evaluations and analyses, which were reviewed by the ACRS, of a variety of postulated accidents and equipment failures. Two categories of incidents were analyzed: (1) Those abnormalities and accidents in which the integrity of fuel rods and the reactor coolant system pressure boundary is maintained and (2) those accidents in which one or more of the barriers to fission product release are not effective and operation of engineered safeguards systems is required. The results of these analyses demonstrate that the radiation doses to the public resulting from all such credible accidents and from a maximum hypothesized accident are well within the

guideline values established by the AEC (10 CFR Part 100; PSAR Applicant's Ex. 1-B, §§14.1 and 14.2; SSE §12.0).

106. The first category analyzes those abnormalities and accidents that are either inherently terminated or require operation of a normal protection system in order to maintain the integrity of the fuel rods and/or the reactor coolant system. These include: (a) Uncompensated reactivity changes resulting from fuel depletion and changes in fission product poison concentrations; (b) Control rod withdrawal during startup and at power; (c) Dilution of the boron concentration in the reactor coolant; (d) Startup of an inactive coolant loop (cold-water accident); (e) Loss of coolant flow; (f) Malpositioning of a control rod; (g) Loss of AC electric power; (h) Loss of electrical load; (i) Steam line failure and (j) Steam generator tube failures. The analyses indicate that no fuel damage will occur and that there will be no exposures to the public that would exceed very small fractions of the guideline limits of 10 CFR Part 100 (PSAR Applicant's Ex. 1-B, §14.1). The Staff concluded, based on their analysis of Applicant's information and evaluation of other pressurized water reactor ("PWR") designs during operating license review, that transients (a)-(h) can be terminated by the Plant protection and control system design without damage to the core and reactor coolant boundary and with no significant off-site radiological consequences (SSE, pp. 59-60). These transients will be analyzed again prior to issuance of an operating license to verify their accuracy in light of final design information (SSE, pp 59-60). The Staff's evaluation of accidents (i) and (j), steam line failure and steam generator tube

failure, on the basis of their experience with analysis of those accidents for PWR's of similar design, resulted in a conclusion that the consequences of these accidents can best be controlled by limiting the primary and secondary coolant system radioactivity concentrations. The Staff stated that they would include technical specification limits on radioactivity concentrations in reactor coolant to limit the potential 2-hour dose from these incidents to well within 10 CFR Part 100 guidelines as has been recently done in several operating PWR's (SSE, pp. 60-61). These analyses were not contested. The Board concludes that Applicant has furnished sufficient information and the Staff has adequately reviewed such information so as to provide reasonable assurance that the occurrence of any of the first category abnormalities and accidents will not create any undue risk to the health and safety of the public.

107. The second category accidents analyzed were those in which one or more of the normal protection systems were not effective and therefore operation of engineered safeguards systems is required (PSAR Applicant's Exhibit 1-B, §14.2). The accidents analyzed consisted of serious but extremely unlikely accidents (loss-of-coolant accident, failure of a gaseous waste decay tank, fuel handling accident resulting in damage to a fuel assembly during refueling and a control rod ejection accident) and an extremely serious but not credible maximum hypothetical accident. Of these accidents evaluated, it was determined that of the credible accidents the loss-of-coolant accident yielded the most severe consequences. The analysis of all of these accidents indicated that even when using extremely conservative assumptions, the consequences to the public were well within the guideline values of 10 CFR Part 100 (PSAR Applicant's Ex. 1-B, §14.2).

108. Because the primary purpose of engineered safeguards systems is to limit the consequences of accidents, the accidents assumed for the purpose of analysis establish the functional requirements for such systems and are commonly referred to as "design basis accidents." The most severe accident analyzed and designed for is the postulated loss-of-coolant accident (LOCA) resulting from the rupture of a pipe in the reactor coolant system. This accident has been analyzed assuming various sized ruptures up to and including a hypothetical double-ended rupture of the largest reactor coolant pipe. These analyses show that of the spectrum of possible break sizes in the reactor coolant system a 5.0 sq. ft. hot leg break (Tr. 2382, 2384, PSAR Applicant's Ex. 1-B, §14.2.2.3.6) and an 8.55 sq. ft. split in the cold leg (B&W Topical Report BAW-10034, p. 2-1) result in imposing the most stringent requirements on the reactor building and the emergency core cooling system, respectively. Hence, the 5.0 square foot break has been defined as the "Design Basis Accident" for the reactor building (Tr. 2320) and the 8.55 square foot break has been defined as the "Design Basis Accident" for assessing the effectiveness of the emergency core cooling system (Tr. 2382; BAW-10034, §2).

109. Applicant has analyzed LOCAs for the complete spectrum on breaks and has discussed the sequence of occurrences in the Plant following a LOCA (PSAR Applicant's Ex. 1-B, §14.2.2.3 and pp. 13.7.1.3-1 through 13.7.3.7-2; Tr. 2311-2400). Following the pipe break, the emergency core cooling systems, consisting of the core flooding system and two independent strings of equipment, each capable of providing sufficient high-pressure and low-pressure coolant injection, are activated in order to prevent significant chemical reactions and excessive

core temperatures. Operation of the reactor building spray system commences to remove heat and fission products from the containment atmosphere. The air recirculation system is also activated to remove heat from the reactor atmosphere. Release of heat to the reactor building containment results in an increase in reactor building pressure. Operation of either the reactor building spray system or the air recirculation and handling system is sufficient to reduce the reactor building pressure to less than one-half of its peak value in one hour and to near atmospheric pressure within approximately 24 hours (PSAR Applicant's Ex. 1-B, pp 14-34, 13.7.3.4-1 and 13.7.3.4-2, Figure 14-54). In calculating the resultant dose from this accident, Applicant incorporated conservatisms regarding activity release from the core to the reactor containment atmosphere, removal of radioactive iodine from the containment atmosphere by plate-out on surfaces within the reactor building and operation of the chemical sprays, containment leakage rate, meteorological assumptions and the recipient. Since similar or greater conservatisms were utilized in the calculation of dose from the maximum hypothetical accident, it is unnecessary to discuss the conservatisms used in the Applicant's LOCA dose analysis. The Applicant's analysis does, however, demonstrate that the dose to the public from a LOCA, the largest credible accident, will be an insignificant fraction of the 10 CFR Part 100 guideline doses.

110. In order to demonstrate that the operation of a nuclear plant at a proposed site does not present a hazard to the general public, 10 CFR Part 100 requires that a major hypothetical accident be assumed and analyzed. The resultant dose calculated from this analysis should be such that an individual on the boundary of the exclusion area for two

hours would not receive a total radiation dose to the whole body exceeding 25 rem or a total radiation dose in excess of 300 rem to the thyroid from iodine exposure (10 CFR §100.11(1)). Additionally, the analysis should show a resultant dose not in excess of the same limits to an individual on the boundary of the low population zone exposed to radioactive releases from the accident (10 CFR §100.11(2)). The regulation provides that the evaluation should be conducted by assuming a fission product release rate from the core based on:

> "a major accident, hypothesized for purposes of site analysis or postulated from consideration of possible accidental events that would result in potential hazards not exceeded by those from any accident considered credible. Such accidents have generally been assumed to result in substantial melt-down of the core with subsequent release of appreciable quantities of fission products." (10 CFR §100.11(a) fn. 1)

The regulation provides in a note at the end that the calculational method used in AEC Technical Information Document 14844 ("TID 14844") may be used as a point of departure for making such analyses (10 CFR Part 100) and this document was in fact utilized as a starting point (Tr. 1809-10). The Applicant and Staff assumed as their maximum hypothetical accident ("MHA") (the Staff calls it the design basis accident (DBA) but to avoid confusion with Applicant's DBA we will herein refer to it as an MHA) a LOCA which released to the reactor building the amount of fission products utilized in the TID 14844 assumptions: 100% of the noble gases, 50% of the halogens (e.g., iodine) and one percent of the fission product inventory (PSAR Applicant's Ex. 1-B, p. 14-63c; SSE pp 63-64; Tr. 1594-95). Saginaw Intervenors argued that some greater accident equivalent to a complete meltdown of the core should be utilized in the analysis rather than that recommended

in TID 14844 (Tr. 1737). However, the Staff made it clear that it considered an accident resulting in a release of the magnitude of the TID 14844 release to be incredible (Tr. 1946-50) and a Staff witness testified that, although the Staff analysis did not postulate a mechanism causing the release, e.g., meltdown, in his opinion the TID 14844 fission product releases were a fairly realistic approximation of the releases that might be expected from a complete meltdown of the core (Tr. 1867-68). The Board, after permitting extensive cross-examination which proved unfruitful, terminated cross-examination and requested Saginaw Intervenors to present some affirmative case as to why the technical judgments of the Staff as evidenced by the witnesses, the AEC regulations, TID 14844, and AEC Safety Guide No. 4 were not an adequate basis for concluding that the fission product release utilized was representative of a major accident not exceeded by any accident considered credible (Tr. 1890-93). This they failed to do. It is the conclusion of the Board that the fission product release utilized for the MHA analysis is in fact a release representative of a major accident which exceeds any accident considered credible. While other incredible accidents may perhaps be hypothesized which would result in greater releases, releases of the type hypothesized here are clearly of the magnitude contemplated by the regulation for conservative evaluation of a site.

111. Applicant and Staff, in making their analyses of the MHA, assumed for added conservatism that concurrently with the LOCA, the Plant lost all off-site power and one of the two emergency generators failed to perform. This assumption results in half of all the active engineered safeguards in the Plant being unavailable to limit the consequences of the accident (Tr. 2320). Both the Applicant and

the Staff analyzed the MHA utilizing the method of analysis prescribed in TID 14844 with variations based on development of technology since TID 14844 was authored and based on different meteorological assumptions (Tr. 1828, 1829, 1838-1840). The Staff analysis was done by the method prescribed in Safety Guide No. 4 and the variations from TID 14844 utilized, were those prescribed therein (Tr. 1714-1722). Following release of the fission products from the core, TID 14844 assumes that 50% of the iodine in the release instantaneously plates out on the surfaces of the reactor and that the remainder becomes part of the reactor building atmosphere where it becomes available for leakage from the reactor building (PSAR Applicant's Ex. 1-B, p. 14-63c; SSE p. 64; Tr. 1595). The Staff pointed out that this is a non-mechanistic assumption which when compared to actual data is conservative. Actual data of course does not support the instantaneous nature of the assumption, but does indicate plate-out removal on the order of a half-life in 10 minutes (i.e., half the remaining iodine is removed every 10 minutes) (Tr. 2881-2887). Thus while in the assumption half of the iodine plates out instantaneously and then there is no more plate-out, experimentation indicates that over the first thirty minutes of an accident plate-out would be expected to remove 7/8 of the iodine released (Tr. 2885).

112. Of the iodine initially available for leakage following 50% plate-out, Applicant calculated 5% to consist of organic and particulate forms of iodine and the remaining 95% to be elemental (PSAR Applicant's Ex. 1-B, pp 14-63; Tr. 1599). The Staff, however, assumes, in accordance with Safety Guide No. 4, that 85% is elemental, 10% organic and 5% particulate (Applicant's Ex. 6). Because the Staff assumes that only elemental iodine is removed by spray systems and the Applicant's

analysis utilizes much slower removal rates for particulate and organic forms of iodine than for the elemental form, the Staff's use of 85% elemental iodine rather than 95% represents a conservative factor (Tr. 1926-27, 2040). The chemical additive in the reactor building sprays rapidly reacts with the airborne iodine to form iodide ions which remain in solution in the building and, thus, cannot contribute to the off-site dose calculations (Tr. 1613). Applicant calculated a removal rate of 41.1 per hour for elemental iodine and 0.81 per hour for organic and particulate forms while the Staff utilized a removal rate of 2.5 per hour for the elemental iodine and no removal of organic and particulate forms (Applicant's Ex. 6). Applicant's testimony explained in detail the experimental basis underlying its calculated iodine removal rates (Tr. 1624-28, 2033-2038, 2836-2853; PSAR Applicant's Ex. 1-B, pp. 14-63 to 14-63d and 14A-1 to 14A-4; Applicant's Ex. 10, BAW-10024 "Effectiveness of Sodium Thiosulfate Sprays for Iodine Removal,") and the fact that its model had a 97% confidence level for predicting conservative removal rates (Tr. 2036-38). The Staff described its basis for calculating the much reduced removal rate which it utilized in its analysis and enumerated the conservatisms in this analysis (Tr. 1927, 2024-2027). The Staff indicated that its calculation rather than reflecting expected performance of the iodine spray removal system was a conservative number which resulted in a dose that it would not expect to see exceeded under any circumstances (Tr. 2025). Essentially, the Staff calculated the iodine removal rate by the same method as Applicant, but applied larger margin of safety factors, and assumed only one spray header working as opposed to the two assumed by Applicant (Tr. 2024-2027, 2030-31,

2049). The Staff also indicated that its calculational model is being reviewed to reflect recent industry-wide experimentation and is being revised to show faster iodine removal (Tr. 2038-39). If iodine removal rates were the only differences between the calculations of the Staff and Applicant, the Staff's dose calculations would be approximately 14 times greater than Applicant's as a result of the numerous conservatisms employed by the Staff (Tr. 2034, 2044).

113. Saginaw Intervenors sought to cross-examine witnesses for Applicant and Staff regarding the (1) comparative effectiveness of the iodine spray removal systems of the Babcock & Wilcox Company (B&W) (the system being used in the Plant) and Westinghouse Electric Corporation and (2) the adequacy of the B&W spray system on the basis of Westinghouse reports which Westinghouse claimed to be proprietary. Saginaw Intervenors' counsel had acquired such reports in the Point Beach #2 proceeding (AEC Docket No. 50-301) under a protective order which did not permit their disclosure in this proceeding (Tr. 2050-2062). The Board ruled that it did not need to evaluate the comparative effectiveness of the two systems in order to determine the "best available technology" and that instead its duty was to determine that Applicant had established that its system would meet applicable AEC safety standards (Tr. 2114). This decision was upheld by the Atomic Safety and Licensing Appeals Board (Order of September 21, 1971). Westinghouse objected to use of its documents to cross-examine into the adequacy of the B&W system on the grounds that there would be no way to protect the documents from disclosure to B&W and other competitors (Tr. 2060). The Board after reading the Westinghouse reports,

the B&W reports and articles from the available literature concluded, without deciding whether the Westinghouse documents were in fact proprietary, that the information in the Westinghouse reports was unnecessary for purposes of cross-examination (Tr. 2301). The Appeals Board upheld the Board's ruling on the mistaken impression that the Board had found the Westinghouse reports to be proprietary (Order of Appeals Board, September 21, 1971). The Board, therefore, ordered Westinghouse to demonstrate the proprietary nature of its reports, which it did by filing the affidavit of Robert A. Wieseman. The Board after hearing arguments from all interested parties concluded on the basis of its own examination of the documents and the available literature that the information contained in the Westinghouse reports had in fact been developed as a result of its own experimentation and expense and on the basis of Mr. Wieseman's affidavit that the documents are customarily held in confidence by Westinghouse and not customarily made available to the public (Board Order of March 16, 1972). The Board therefore found the documents to be in fact proprietary in accordance with applicable AEC regulations (10 CFR §2.744). Saginaw Intervenors having shown no need for the documents in spite of several Board invitations to demonstrate such need (Tr. 2058, 2726-27, 2734-35) were not permitted to use them.

114. The TID 14844 analysis does not include a reduction factor based on the use of iodine spray removal systems because use of a reagent in spray cooling systems to remove iodine was not an engineered safeguard that was employed at the time TID 14844 was written (Tr. 1785, 1839). In line with the direction of 10 CFR Part 100 that the AEC take into account in evaluating a site the safety features

that are engineered into the facility (10 CFR §100.10(a)(4)), the Board concludes that the extremely conservative analysis of iodine removal capabilities presented by the Staff and used in Staff Safety Guide No. 4 is a reasonable deviation from the TID 14844 calculational method and results in calculation of a dose much greater than that which could be expected from the unlikely fission product release postulated.

115. A leakage rate of 0.1% by weight of the total free volume of the reactor building for the first twenty-four hours of the accident and 0.05% per day for any remaining period analyzed was used by both Applicant and the Staff. The 0.1% figure is in agreement with TID 14844 calculational methods, however, TID 14844 assumes continuation of the 0.1% leakage rate throughout the course of the analysis (Tr. 1840). The deviation is justified on the basis that during the first twenty-four hours of the accident the building pressure will be reduced from a maximum of 58.7 psig to about 4 psig, thus greatly reducing the leakage rate and that TID 14844 assumed a steel reactor building shell rather than the massive steel lined concrete reactor buildings in use today (PSAR Applicant's Ex. 1-B, pp. 14-55 to 14-60; SSE pp. 63-64; Tr. 1837). This is particularly conservative because no credit was taken for penetration pressurization, weld pressurization and isolation valve seal water systems which have been developed since TID 14844 and would significantly reduce leakage rates and, thus, the resultant dose (SSE pp. 65-66).

116. The meteorology used by Applicant and Staff for calculating the transport of radioactivity released from the reactor building differed in that Applicant used meteorology developed from evaluations

of data gathered near the Plant site and the Staff used the more conservative Staff Safety Guide No. 4 model (Applicant's Ex. 7). The significant difference between the meteorology used by the Staff in calculating the two-hour dose and that used in TID 14844 is application of a building wake factor which has the effect of reducing the 2-hour dose by a factor of 3 (Tr. 1834-1836). Use of a building wake factor was based on experimentation performed by the National Oceanic and Atmospheric Administration (Tr. 3774-78). In calculating the 30-day dose the Staff further deviated from TID 14844 assumptions, which assume that the conditions of Pasquill Type F with one meter per second wind speed blowing in one direction will persist for 30 days, by assuming varying wind speeds and directions over the 30-day period (SSE p. 64-65; Tr. 1810-12). Extensive testimony was heard regarding the subject of the proper meteorology to utilize in this analysis as discussed in Paragraphs 53 through 67 above. As stated there, the Board finds that the meteorology used by the Staff was appropriately conservative and in accordance with AEC Safety Guide No. 4.

117. The Staff analysis further conservatively assumes an accelerated inhalation rate in the postulated individual at the exclusion area boundary during the first eight hours of the accident (Tr. 1805-06, 1853). The calculations of the dose to a postulated individual assumes he remains at the same location at the edge of the exclusion area for the duration of the two-hour period and at the edge of the low population zone for a 30-day period (Tr. 1807-08; 10 CFR §100(a)(2)). The unlikelihood of an individual standing at the same location even for two hours following a major accident is obvious and

the assumption of an individual remaining at one location 24 hours per day for thirty days is clearly sufficiently conservative.

118. Applicant's calculated dose to the hypothetical individual remaining at the exclusion area boundary for two hours during the accident is 8.7 Rem to the thyroid and less than 0.46 Rem to the whole body. Applicant's calculated 30-day dose to a similar individual located at the low population zone boundary for 30 days is 8.8 Rem to the thyroid (PSAR Applicant's Ex. 1-B, p. 14-64). The Staff-calculated doses for the same individuals, utilizing Safety Guide No. 4, were 270 Rem to the thyroid and 4 Rem to the whole body for the 2-hour dose and 280 Rem to the thyroid and 4 Rem to the whole body for the 30-day dose (SSE p. 65 and Errata, dated June 21, 1971). Testimony at the hearing indicated that radiation doses to the thyroid calculated strictly according to TID 14844 would exceed those calculated by the Staff by a factor of 9 in the case of the 2-hour dose (Tr. 1828-29, 1838-39) and a factor of 86 for the 30-day dose (Staff Ex. 3). The Board finds that all of the deviations from TID 14844 suggestions utilized by the Staff in calculating the radiation doses resulting from an MHA are justified, and that the factors utilized by the Staff and in Safety Guide No. 4 in place of those proposed in TID 14844 contain substantial margins of safety. Additionally the Board concludes that even the much lower doses calculated by Applicant are conservative. The Board further concludes that calculations of the radiation dose with the use of these conservative factors, in conjunction with the extremely conservative factors provided in TID 14844 and 10 CFR Part 100, demonstrate that the Plant can be located at the proposed site in conformance with the guidelines of 10 CFR Part 100 and that there is

reasonable assurance that the Plant can be operated without undue risk to the health and safety of the public.

119. Because of the fact that there are two reactors at the proposed site, Applicant considered the possibility of an accident at one reactor causing an accident in the other. The reactors, with some minor exceptions, are not interconnected and there are no shared active components in the engineered safeguards system (Tr. 2334). Applicant's design criteria provides that shared systems or interconnections between units will only be permitted when analysis of such sharing shows that such sharing will not affect the functional capability of the systems or components to perform adequately in the separate units (PSAR Applicant's Ex. 1-A, p. 1C-5). The effect of a LOCA in one unit on the other would be to require the other unit to shut down. Loss of availability of sufficient capacity in the three important shared systems, emergency generator, borated water storage tank and control room, as a result of an incident in one unit could require shutdown of the other unit (Applicant's Ex. 36). These are the only examples of significant shared systems between the Plants where an incident in one unit could have an effect on operation of the other unit. The Staff concluded that simultaneous LOCA's were so unlikely that they couldn't be considered as a design basis (Tr. 2497). The Board concludes that the reactors are sufficiently independent that an accident in one reactor will not initiate an accident in the other and that pursuant to 10 CFR §100.11(b) it is not necessary to evaluate the site on the basis of concurrent accidents.

120. In addition to accidents originating in the Plant, Applicant has evaluated the potential effects on the Plant of hypothetical accidents at the adjacent Dow Chemical Plant. All potential explosive hazards in the Dow Plant are located at least one mile from the reactor buildings and none of the potential accidents would cause measurable damage at distances greater than 1,000 feet from location of the maximum explosion hypothesized (PSAR Applicant's Ex 1-B, pp 13.5.1-1 and 13.5.1-2). Quantities of toxic chemicals are stored at the Dow Plant. Applicant has analyzed hypothetical accidental releases of these chemicals which might have detrimental physiological effects on the Plant operating personnel which would interfere with the safe operation of the Plant and has determined that chlorine is the most dangerous of the chemicals stored at Dow. Applicant has calculated under maximum conditions of chlorine release and worst case meteorology that a peak chlorine concentration of 3.6 parts per million could occur in the Midland Plant control room. The threshold limit value (TLV) established by the American Conference of Governmental Industrial Hygienists for continuous 8-hour exposure by industrial workers is 1.0 part per million for chlorine (PSAR Applicant's Ex. 1-B, pp 13.5.2-1, 13.5.2-2 and 13.5.3-1, 2.00-1, 2.00-2 and 2.00-3). The Staff reviewed Applicant's information and has stated that it will require the Applicant to limit the concentration in the control room to less than the TLV at all times following a chlorine release at Dow (SSE pp. 15-17). The Board finds that the Applicant has provided adequate information and the Staff has conducted adequate analyses of accidents which might occur at Dow Chemical Company and affect the Midland Nuclear Plant. In view of the improbability of such accidents

at Dow resulting in dangerous concentrations at the Plant and the Staff requirement that the control room be designed to limit concentrations to safe levels, the Board concludes that the accidents at Dow will not present a hazard to safe operation of the Plant. The Board particularly notes that Scott Air-Paks (self-contained breathing apparatus) will be available to Plant personnel in the event of any excessive concentration (PSAR Applicant's Ex. 1-B, p. 13.5.3-1).

121. The Board has concluded that Applicant has presented sufficient information and the Staff has conducted an adequate review with respect to the analysis of potential consequences of various abnormalities and accidents.

Emergency Core Cooling System

122. The issue of the performance of the emergency core cooling system (ECCS), described in paragraph 94 was not heard at the radiological health and safety portion of the hearing held during the summer of 1971, because on June 29, 1971 the AEC issued its Interim Criteria for Emergency Core Cooling Systems for Light-Water Power Reactors (36 F.R. 12247). The criteria themselves were similar to those that the AEC had been using for several years for evaluating performance of ECCS (Staff Ex. 8, p. 8). However, as a result of improvement of analytical techniques for analysis of performance over the previous five years, and as a result of small-scale experiments performed at the National Reactor Testing Station which indicated that certain analytical models might not have accurately forecast test results, the AEC promulgated the formal interim criteria incorporating conservative assumptions and procedures to be used in order to determine if a given system meets the Interim Criteria (Staff Ex. 8, pp. 2-5). Appendix A to the Interim Criteria specified three

analytical techniques with appropriate conservative assumptions that were designated as acceptable evaluation models for determining compliance with the Interim Criteria. The emergency core cooling system used in Babcock & Wilcox Company (B&W) plants had not been evaluated using any of the three acceptable evaluation models but had been evaluated using B&W evaluation models. The AEC's statement of June 29, 1971 stated that the B&W evaluation model was under review by the AEC. (36 F.R. 12248) The Board, therefore, deferred further consideration of the performance of the Plant ECCS until such time as the AEC completed its review of the B&W evaluation model (Tr. 1920, 1924, 2362-63, 4426). On December 18, 1971, the AEC determined that the B&W evaluation model was acceptable and amended Appendix A to the Interim Criteria to include the B&W evaluation model (36 F.R. 24082). Intervenors up to that time and for some time thereafter were challenging compliance of the Plant ECCS system with the Interim Criteria and the validity of the Interim Criteria.

123. Applicant in letters dated November 3, 1971 and January 6, 1972 incorporated in its application the analysis of ECCS performance contained in (1) the Babcock & Wilcox Company Topical Report BAW-10034, "Multi-node Analysis of B&W's 2568 MWE Nuclear Plants During a Loss-of-Coolant Accident", and (2) Supplement 10 in the Matter of Duke Power Company Oconee Station (Rev. 1 to BAW-10034), respectively. These topical reports were received in evidence by the Board's Order of June 28, 1972. The Staff evaluated these analyses and concluded that they had been performed using the B&W evaluation model described in Appendix A, Part 4 of the Interim Criteria (Staff Ex. 8, p. 5). The results of the analyses contained in BAW-10034 as revised demonstrated

that the ECCS system would perform so as to meet the Interim Criteria. Analysis of a spectrum of accidents, including double-ended rupture of the largest coolant pipe, indicated that the worst accident would have a peak cladding temperature of 2177°F (2300°F limit imposed by the Interim Criteria) and a maximum core metal water reaction of 0.26% (1% limit imposed by Interim Criteria). Analyses further indicated that the cladding temperature transient would terminate while core geometry was still amenable to cooling and that the core temperature is reduced and decay heat removed for an extended period of time. The Staff confirmed the results of the analysis and concluded:

> "the predicted functional performance of the Midland Emergency Core Cooling System for the full spectrum of postulated break sizes up to and including a double-ended break in the largest coolant pipe is in accord with the Commission's Interim Policy Statement and Acceptance Criteria and is acceptable." (Staff Ex. 8, p. 8)

The Saginaw (Tr. 5297) and Mapleton Intervenors (confirmed at post-hearing conference June 26, 1972, no transcript made) did not challenge the compliance of the Plant ECCS with the Interim Criteria. The Board has reviewed Applicant's and the Staff's submissions and concludes that all elements of the Interim Criteria have been adequately considered and complied with.

124. The AEC published in the Federal Register (36 F.R. 22774, November 30, 1971) a notice scheduling a rulemaking hearing concerning its Interim Criteria (AEC Docket No. RM-50-1). This provided in general terms how the hearing should be conducted. By its supplemental notice issued January 6, 1972 (37 F.R. 288, January 8, 1972) the AEC provided more detailed procedures and particularly provided:

> "Notice should also be taken that the conduct of a rulemaking hearing on the subject matter of this notice will not affect the orderly resolution,

> under the Commission's existing regulations, of the matter of emergency core cooling, in hearings on applications for light water-cooled power reactors pending before atomic safety and licensing boards." 37 F.R. 288, January 8, 1972

both the Saginaw Intervenors and the Mapleton Intervenors are participating as parties at the rulemaking proceeding as part of the Consolidated National Intervenor Group. The proceedings have proceeded with testimony from the Staff, various national laboratories, the various utility vendors, intervening groups and utilities. An extremely complex record has been produced with a transcript numbering 17,033 pages as of August 3, 1972. The rulemaking proceeding is continuing and no decision has been made by the AEC.

125. Saginaw and Mapleton Intervenors repeatedly indicated their intent to challenge the validity of the Interim Criteria in the Plant licensing proceeding. In its Order of March 10, 1972 the Board informed the parties of its views on challenges to the validity of the Interim Criteria:

> "The question of validity raises more difficult questions. As a result of the national hearing the interim criteria will either be repromulgated or changed. It is inconceivable to the Board that changed criteria will not be applied at least to reactors under construction which will almost certainly -- at the most optimistic schedule for applicants -- include this reactor. If the interim criteria are repromulgated after the hearing, the question of validity will ipso facto be settled (subject of course to judicial review). Under the Calvert Cliffs doctrine the most that could be accomplished by a hearing as to validity would be for the Board to receive evidence to the end of deciding whether there is a substantial case for reference to the Commission. In view of the fact that the 'case' to be made will be a substantial duplicate of the case being made at the national hearing, already being considered by the Commission, it would seem a logical absurdity for the Board to say that the

> showing is too insubstantial for Commission attention. The logical solution would be for the parties to stipulate to accept the national hearing as being in lieu of this proceeding. We are aware, however, that intervenors' counsel are afraid to do so would waive rights which they would have had in the adjudicatory proceeding.
>
> "In order to take maximum advantage of the pendency of the national hearing and preserve the intervenors' claim to additional 'rights,' the Board has tentatively concluded to proceed as follows.
>
> "1. We assume that the intervenors are challenging the validity of the regulations.
>
> "2. We further assume that the challenge consists of at least the showing being made in the national hearing.
>
> "3. On or before March 31, 1972 or such later date as shall be fixed by the Board, opposing intervenors shall make such requests for documents, subpoenas etc., denied to them in the national hearing as they deem necessary in this proceeding together with a statement as to their need and entitlement. Within fifteen days thereafter other parties shall serve objections etc. and the Board will rule thereon."

The intervenors, however, filed no requests for materials in addition to those permitted them in the national hearing and Saginaw Intervenors, in a letter dated March 27, 1972, asked for an extension and at the April 28 prehearing (Tr. 5281) indicated that they would probably not seek further documents regarding ECCS. Saginaw Intervenors in their March 27, 1972 letter attempted to incorporate into the record of the Midland proceeding the first 6333 pages of the ECCS proceeding and all documents that had been marked as exhibits or received in evidence in that proceeding. Subsequently, by motions dated May 8, 1972, Saginaw

Intervenors sought orders (1) accepting as an offer of proof, taking official and judicial notice of and accepting as admissions against the interest of Applicant, Staff, Dow and the Midland Nuclear Power Committee, all oral, written and documentary testimony on file in the ECCS proceeding (including testimony) and (2) that Applicant and Staff had failed to demonstrate reasonable assurance as to effectiveness of ECCS and that therefore the application be dismissed. The Board denied each of these motions (Tr. 7083, 7085). The Board is of the opinion, for the reasons expressed in its Order of March 10, 1972, that there is no useful purpose to be served in incorporating into the record of this proceeding the over 17,000-page ECCS transcript with the thousands of pages of exhibits. There are questions involved in the ECCS proceeding that will be determined in that proceeding. Receipt of an incomplete record in this proceeding and certification of that record to the Commission to whom it is already destined is a futile exercise. If, following review of the record in the ECCS rulemaking, the Commission determines to modify the Interim Criteria such action may or may not require modification of the Plant. To the extent such action requires modification, the AEC has all necessary powers to require modification (10 CFR §50.54(h)). Additionally, Applicant in response to questioning from the Board has committed itself to meeting any applicable ECCS regulation forthcoming from the proceeding and has furnished the Board with a compilation of dates by which major components involved in ECCS analysis are needed at the site in order to meet a schedule of commercial operation in May 1977 (Applicant's letter of June 6, 1972). This schedule indicates that no

major components involved in ECCS analysis are needed at the site prior to the spring of 1974. Applicant in furnishing the list also agreed that unless the ECCS rulemaking had been completed earlier, none of such major components would be shipped prior to the date needed on site without prior AEC approval (Applicant's letter of June 6, 1972). This indicates to the Board that if any modification in equipment is necessary, the equipment will still be in the shop where it can be more readily modified than if it had been shipped or installed. In addition to finding incorporation of the 17,000 plus pages of ECCS transcript and thousands of pages of exhibits into this proceeding to be useless, the Board finds Saginaw Intervenors' use of the concept of "admission against interest" to be absurd. The Board further finds that although every opportunity has been extended to intervenors to challenge the Interim Criteria in this proceeding, in a meaningful way, intervenors have made no such challenge.

126. The Interim Acceptance Criteria are an effective regulation of the AEC. As such, evaluation of performance of the ECCS in this proceeding consists of determination of whether the ECCS system will meet the Interim Acceptance Criteria unless it is determined the criteria are invalid (In the Matter of Baltimore Gas & Electric Company); AEC Memorandum, Docket Nos. 50-317, 50-318, August 8, 1969). The only challenge to the validity in this proceeding has consisted of reference to the incomplete record in the ECCS rulemaking proceeding. As discussed above, the Board does not believe it to be useful to certify this record to the AEC for review. The issue of the validity of the Interim Acceptance Criteria has been raised in numerous hearings as

well as the question of whether individual Atomic Safety and Licensing Boards can continue to make decisions while the ECCS rulemaking continues. The AEC in initiating the ECCS proceeding made its position very clear:

> "Notice should also be taken that the conduct of a rulemaking hearing on the subject matter of this notice will not affect the orderly resolution, under the Commission's existing regulations, of the matter of emergency core cooling, in hearings on applications for light water-cooled power reactors pending before atomic safety and licensing boards." 37 F.R. 288, January 8, 1972

The Atomic Safety and Licensing Appeals Board has ruled on these questions. In the Indian Point #2 proceeding, the Appeals Board concluded that the Interim Acceptance Criteria had been validly promulgated in accordance with the Administrative Procedures Act. (In the Matter of Consolidated Edison Co. (Indian Point #2), Docket No. 50-247, ASLAB Memorandum and Order March 3, 1972.) The Appeals Board in the Point Beach #2 proceeding, on being confronted with a challenge based on the record of the ECCS proceeding, determined:

> "The other substantive issue raised by intervenors is the Licensing Board's refusal to grant intervenors' request for the record in the ECCS rulemaking proceeding to be incorporated into the record in this proceeding. We fail to see how evidence in an ongoing rulemaking proceeding should be given any consideration by the Licensing Board in this proceeding, particularly inasmuch as the evidence has not been fully presented and at best can only present a partial picture of the ECCS controversy. We held in our Memorandum of March 10, 1972, in the Indian Point #2 proceeding, that the Interim ECCS Criteria were required to be followed by Licensing Boards until superseded by a later issuance. The Commission has thus far not taken action to supersede the Interim Criteria." (In the Matter of Wisconsin Electric Power Co. (Point Beach #2), Docket No. 50-301, ASLAB Memorandum and Order, May 25, 1972)

and in the Vermont Yankee proceeding the Appeal Board ruled:

"There has been extensive testimony in the rulemaking proceeding supporting and attacking the criteria in a considerable number of respects. The existence of differences of opinion on such complex and novel technical questions involving a rapidly developing technology would be no basis for a conclusion that these elaborate criteria are either in whole or in part to be declared invalid in this reactor licensing proceeding. The Coalition asserts that it challenges the criteria 'as applied to this plant', but it has presented no material fact or argument related to this plant as distinguished from others.

"As the Licensing Board correctly assumes in its first question, duplication with the pending emergency core cooling rulemaking proceeding is to be avoided. That pending proceeding, where the inquiry can be thorough and interested parties can participate, is the proper forum for a challenge to the regulation rather than an individual licensing proceeding such as this.

"The validity of the Interim Criteria, in whatever form may emerge from the pending rulemaking proceedings, will be considered by the Commission as part of its ultimate determination of that proceeding, and the Coalition and others may address to the Commission in that proceeding any arguments that could be raised here. The Commission's decision will of course be subject to judicial review. 42 U.S.C. 2239, 28 U.S.C. 2342, 5 U.S.C. 701-706. To allow the Coaltion to conduct in this proceeding a simultaneous parallel attack on the Interim Criteria would serve no useful purpose and would obstruct enormously the Commission's performance of its duty that it 'shall . . . within a reasonable time . . . act and complete proceedings . . . .' Administrative Procedure Act, Sec. 9(b), 5 U.S.C. 558(c). The Interim Criteria may well be modified to some extent as a result of the rulemaking proceeding. The Commission has explicitly reserved the power to modify any permit or license at any time (10 CFR Sec. 50.54(h)) and will be in position to apply to existing reactors, as appropriate, any new requirements which may be adopted. Under these circumstances the Licensing Board should not consider any challenge to the Interim Criteria in this proceeding or admit any evidence directed toward such an attack." (In the Matter of Vermont Yankee Nuclear Power Corp., Docket No. 50-271, ASLAB Memorandum and Order, June 20, 1972.)

Of particular significance is the fact that all of the above-quoted decisions dealt with operating license proceedings where plant operation is imminent rather than with construction permit proceedings where there is a great deal of time in which to revise systems prior to operation. The Interim Acceptance Criteria are a valid existing regulation of the AEC which the Board is required to follow. It cannot determine that they are insufficient based on an incomplete record in a rulemaking proceeding. The AEC has determined that individual licensing proceedings should continue under the effective regulations. If the AEC considered the incomplete record of the ECCS proceeding sufficient grounds to revoke its present regulation, it could do so at any time. It has not chosen to do so.

127. The Board finds that Applicant has presented sufficient information and the Staff has conducted an adequate review with respect to Applicant's compliance with the interim ECCS acceptance criteria. The Board further concludes that because the ECCS meets the Interim Criteria, because the AEC is making a thorough evaluation of ECCS which can be completed well in advance of operation of the Plant and because the AEC has the power to compel any modification deemed necessary to protect the public health and safety, there is reasonable assurance that the Plant can be constructed and operated without undue risk to the health and safety of the public.

Quality Assurance

128. Applicant has developed an extensive overall quality assurance program specifically for the Plant and has undertaken the ultimate responsibility for its execution (PSAR Applicant's Ex. 1-A, Appendix B; PSAR Applicant's Ex. 1-C, Amendment No. 6; Tr. 4350-51).

The objective of the quality assurance program is to yield maximum confidence that the Plant is designed and constructed so that it can and will be operated without undue risk to the health and safety of the general public and Plant operating personnel (PSAR Applicant's Ex. 1-A, p. 1B-1; Tr. 3954). Functionally, responsibilities under the quality assurance program are allocated among Applicant, Bechtel and B&W as detailed on Table I of the PSAR (PSAR Applicant's Ex. 1-C, Amendment Nos. 6 and 8, pp. 5-5g; Tr. 4076-77). The development, implementation, coordination and documentation of the quality assurance program from design through construction are the responsibility of Applicant (PSAR Applicant's Ex. 1-C, Amendment No. 6, p. 4), and, in addition to programs and plans described in the PSAR, it has promulgated detailed manuals for carrying out the programs: Midland Plant Project Procedures Manual (Saginaw Intervenors' Ex. 31) and Midland Plant Audit and Inspection Manual (Saginaw Intervenors' Ex. 33). Bechtel will perform the quality assurance for Plant engineering, shop fabrication (including the nuclear steam supply system, except fuel), field fabrication and construction (PSAR Applicant's Ex. 1-A, p. 1B-4; PSAR Applicant's Ex. 1-C, Amendment No. 6, p. 4), and its program is described in the PSAR (PSAR Applicant's Ex. 1-C, Amendment No. 6, pp. B-1 through B-11). Manuals detailing the implementation of the program as they existed at the time of the hearing were reviewed at the hearing (Saginaw Intervenors' Ex. 15, 16 and 28). B&W's program provides quality assurance for design, fabrication, construction and preoperational testing of the nuclear steam supply system (PSAR Applicant's Ex. 1-C, Amendment No. 6, p. 4) and is described in the Application

(PSAR Applicant's Ex. 1-A, pp. 1B-5 through 1B-12i). Detailed manuals implementing the program as they existed at the time of the hearing were discussed at the hearing (Saginaw Intervenors' Ex. 12 and 13). Applicant and Bechtel personnel will audit the Bechtel program and the B&W program (See p. 73). Applicant will conduct a comprehensive field testing program to insure equipment and systems perform in accordance with design criteria. Applicant is responsible for preparing preoperational test procedures and will be responsible for running the tests (PSAR Applicant's Ex. 1-B §13).

129. The quality assurance program of Applicant and its contractors has been and will continue to be under surveillance by the AEC Directorate of Regulatory Operation (Division of Compliance) which will audit the implementation of the quality assurance programs to ensure their effectiveness (Tr. 4018-20, 4505-4569). The Staff reviewed the quality assurance programs of the Applicant, Bechtel and B&W and concluded that the Plant quality assurance programs meet the requirements of the "Nuclear Power Plant Quality Assurance Criteria" Appendix B to 10 CFR 50 (SEE p. 72-73).

130. Over Applicant's strenuous objections, Saginaw Intervenors introduced a series of exhibits (Saginaw Intervenors' Exs. 17-27) in an attempt to assert a deficiency in the Plant quality assurance program based upon certain problems which allegedly occurred at Applicant's Palisades Plant. The Board, however, is satisfied from a comparison of the quality assurance programs of Applicant and Bechtel for the Plant with Applicant's quality assurance program for Palisades and Bechtel's quality assurance program for Palisades (Saginaw Intervenors' Exs. 30 and 32) that quality assurance programs of Applicant and Bechtel have undergone substantial expansion and revision since the construction of the

Palisades Plant was completed both as an evolutionary response to experience at Palisades and to conform with 10 CFR 50, Appendix B* (Tr. 4236-4241; written testimony of Dr. Sidney A. Bernsen, Manager of Quality Assurance for Bechtel dated July 29, 1971, pp. 1-2, 14-17). Furthermore, Bechtel has established training programs for its quality assurance engineers and other employees which provide for indoctrination and training of Bechtel employees performing activities affecting quality so as to assure that proper proficiency is achieved and maintained (written testimony of Dr. Sidney A. Bernsen, dated July 29, 1971, pp. 4-9; PSAR Applicant's Exhibit 1-A, Appendix 1B). While the Board has reviewed Saginaw Intervenors' Exs. 17-27, the Board has also reviewed the testimony at the hearing and Applicant's filed responses (Letters dated July 30, 1971, including written testimony of Dr. Bernsen and reference and testimony from Palisades proceeding), taken official notice of the fact that Applicant's Palisades Plant has been licensed and is operating at power levels up to 60% of power (AEC Docket No. 50-225), and concludes that any alleged problems uncovered at Palisades by virtue of the quality assurance program of Applicant or its contractors were adequately resolved and that the Palisades record does not support the many allegations made by counsel for Saginaw Intervenors. The Board also concludes for these same reasons that further review of alleged problems at Palisades is unwarranted and on that basis did not receive in evidence Saginaw Intervenors' proposed Exs. 37 and 38.

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*This is not intended to suggest that the Board finds any inadequacy in the Palisades quality assurance program which was developed prior to the promulgation of 10 CFR 50, Appendix B.

131. Mapleton Intervenors, although the area was totally unrelated to any of their sketchy contentions, probed into the matter of quality assurance of the Plant's reactor vessel. Fabrication of the reactor vessel had been commenced and the vessel was approximately 50% complete at the time of the hearing (Tr. 3923-26). At that time, the AEC's Division of Compliance had not inspected the reactor vessel for this Plant nor made audits of the documentation of this particular reactor (Tr. 3925-27). Testimony revealed that Applicant had inspected the reactor vessel (Tr. 4021) and had audited B&W's quality assurance program (Tr. 4340, 4542), and found it in compliance with AEC Criteria (Tr. 4340). It is common for the Division of Compliance not to have inspected a reactor vessel or audited the documentation for a reactor vessel only 50% complete (Tr. 4509, 4568). The Division of Compliance does, however, frequently inspect the B&W fabrication facilities and its quality assurance program (Tr. 4508) and the B&W quality assurance program is satisfactory (Tr. 4510). A witness from the Division of Compliance described generally the steps involved in reactor vessel fabrication, the documentation accompanying each step and the testing of the reactor vessel at the end of fabrication (Tr. 4539-41). At the end of this procedure the Division of Compliance audits the documentation and makes a physical inspection of the vessel (Tr. 4541, 4568-69). Any deficiencies would be brought to the attention of Applicant and it would be required to correct them (Tr. 4569). The Board concludes that the quality assurance program relative to the reactor vessel meets the AEC's regulatory requirements contained in Appendix B to 10 CFR 50, that Applicant has been diligent in auditing B&W's fabrication and quality assurance

program on the vessel and that the AEC Division of Compliance has properly maintained its review of B&W's quality assurance program and will make a final inspection to confirm proper fabrication. Mapleton Intervenors' argument that the AEC must inspect the reactor vessel as it is being fabricated is without merit.

132. The AEC's Division of Compliance audited Applicant at the Plant site, where initial construction activities were being performed pursuant to a construction exemption (Tr. 4513-29), and at the Applicant's offices (Tr. 4578-4625, 4779-81; Saginaw Intervenors' Ex. 36). A number of deficiencies were noted in various compliance reports. Although there were some problems with the pouring of concrete, the final structure was sound and free of significant voids (Tr. 4629). Most of the deficiencies were of a minor nature which were described as being typical problems in construction activities (Tr. 4608). The Compliance Division in the seventh and final report on site work found no noncompliance items (Tr. 4629). The Board is satisfied that the site work performed prior to Applicant's termination of such work in December of 1970 is of satisfactory quality.

133. Numerous other detailed areas of the quality assurance program were covered in the cross-examination, often involving differences of opinion between Applicant's witnesses and the attorney for Saginaw Intervenors as to whether various areas of the quality assurance program complied with Appendix B to 10 CFR Part 50. Saginaw intervenors indicated that they intended to offer direct testimony regarding quality assurance (Tr. 4671). However, they failed to file any such testimony in spite of opportunities extended in the Board's Orders of August 26, 1971 and December 22, 1971. The Board on review of all of

no detailed arrangements with local agencies nor made any specific studies relating to evacuation beyond the low population zone (Tr. 2235-36, 2244-47). The Board made an initial determination that the emergency plan contained in the application was not sufficiently detailed and needed further fleshing out (Tr. 2258, 2271).

135. In response to this conclusion of the Board, Applicant completed revision of its emergency plan based on its Palisades Plant operating license stage emergency plan and on more detailed contact with local agencies (Tr. 2604-2615). The revised plan contains and incorporates the State of Michigan emergency plan, the Midland County Civil Defense Plan and Dow Chemical evacuation procedures (Applicant's Ex. 22). Applicant presented a detailed table demonstrating how the revised plan conformed with the requirements of Appendix E to 10 CFR Part 50 (Applicant's Ex. 21). Testimony of the Applicant indicated that in preparation of the revised plan, it had had emergency planning discussions with various organizations who could be of potential assistance in the event of an emergency. These organizations included the Michigan State Police, county and city law enforcement agencies, five area hospitals and two ambulance services (Tr. 2620, 3056-68; Applicant's Exs. 15 to 20). A representative of one of the local hospitals testified as to its capability and willingness to respond to emergencies (Tr. 2757-2813). Extensive testimony was heard regarding the ability of the Dow Chemical complex to be evacuated (Tr. 2664-83, 3096-3266). Dow has in existence detailed emergency plans which are reviewed at least every two years and for which some kind of practice run is made four times a year (Tr. 2668-69, 3103). That

portion of the Dow complex within the low population zone can be rapidly evacuated by foot. Ninety percent of the employees of the whole Dow complex can be evacuated to their cars and out of the parking lot in about 20 minutes and all of the employees can be so evacuated in about 47 minutes (Tr. 2673-74, 3107-3131, 3262). Dow has had actual experience with evacuating portions of its complex under emergency conditions but has never had to evacuate the whole complex (Tr. 2671-73, 2682). A witness for Saginaw Intervenors questioned the ability of Dow to evacuate as rapidly as estimated, basing his criticism primarily on the possibility of traffic tie-ups (Tr. 4729-37), a major chemical accident concurrently with the nuclear accident (Tr. 4761-64), adverse weather conditions (Tr. 4748-49) or panic (Tr. 4751-52). He concluded that it would take from 2-1/2 to 4 hours to evacuate the Dow complex (Tr. 4774-75). He was, however, unable to break his estimate down into components so that one could determine what steps would occupy the time (Tr. 4816-19). In light of the extensive planning and drill that has gone into the Dow plan and the fact that there are many years over which the Dow and Plant plans can be refined, the Board finds Mr. Holmes' hypotheses unpersuasive.

136. The Staff had reviewed the original emergency plan and found it acceptable (SSE pp. 69-71). The Staff witness explained that the guide for preparation of emergency plans was merely a guide designed to assist Applicant in preparing a plan and the fact that Applicant's original plan did not contain at the construction permit stage all the information suggested in the guide was not a problem (Tr. 3276-77, 3296-3305). Appendix E to 10 CFR Part 50 became an effective regulation after the Staff approval of Applicant's original

emergency plan. The Staff made a general determination that for previously approved construction permit applications amendment would be required only if the emergency plan as outlined was incompatable with the characteristics set forth in the preamble to Appendix E (Tr. 3281-82) The preamble provides that:

> "The Preliminary Safety Analysis Report shall contain sufficient information to assure the compatability of proposed emergency plans with facility design features, site layout, and site location with respect to such considerations as access routes, surrounding population distributions, and land use." 10 CFR §50, Appendix E.

Upon reviewing Applicant's original plan, the Staff concluded that although it omitted some of the details contained in Appendix E, it did not reflect any incompatability with the characteristics set forth in the preamble (Tr. 3282). The Staff therefore did not require Applicant to amend the original plan, particularly because the three Appendix E items which were not addressed in sufficient detail, facilities for on-site emergency first aid and emergency transportation of individuals, emergency treatment of individuals at off-site facilities, and training programs for employees and other persons, lent themselves very well to resolution during the Plant construction phase (Tr. 3283). At the construction permit stage, the Staff is basically interested in receiving general information which indicates that preparation of a viable emergency plan is feasible (Tr. 3286-87, 3397-3400). The Staff indicated that the original plan satisfied it of the feasibility of evacuation of low population zone in event of accident. Its view is that advance planning should be done to protect populations in low population zones, however it can't envision a situation where it would

be necessary to evacuate all of the low population zone and the probability of having to evacuate people outside the low population zone is so low that advance planning is not required (Tr. 3331-3339). Although the Staff had not completed evaluation of Applicant's revised emergency plan, the Board informed it that it did not require such an evaluation (Tr. 3356).

137. Based upon review of both emergency plans and the testimony given, it is the Board's opinion that there are no substantial obstacles to emergency evacuation of the low population zone surrounding the Plant. In view of the fact that the Dow and Dow Corning complexes have relatively sophisticated emergency plans in existence at this time and that in order to rapidly evacuate employees from the low population zone it is only necessary for them to walk out, a maximum distance of 3/4 of a mile with over 80% having less then 1/4 mile to walk and only 144 having more than 1/2 mile (Applicant's Ex. 22, Appendix K, Attachments 7 and 8), it does not appear that there should be any great difficulty. While the Dow estimates of evacuation time cannot be considered exact, the Board deems them to be reasonable approximations of the times necessary to evacuate the whole complex. Although Applicant's original emergency plan was lacking in details required by Appendix E to 10 CFR Part 50, it does appear to have generally described a feasible plan. In any event, Applicant's revised plan clearly filled in the necessary details and is certainly acceptable at the construction permit stage. In fact, in the Board's opinion it is probably more complete than most construction permit stage plans and in many ways comparable to a final operating license stage plan. Applicant has provided sufficient information and Staff has performed an adequate review

with respect to Applicant's emergency plans. The Board finds also that Applicant has complied with Appendix E to 10 CFR Part 50 and that the site is acceptable from the standpoint of ability to implement an emergency plan.

Research and Development

138. The application listed several research and development projects to confirm various aspects of Applicant's design or to confirm predictions of behavior (PSAR Applicant's Ex. 1-A, §1.5; PSAR Applicant's Ex. 1-B, Amendment 5, Item 1.1, pp. 1.1-1 to 1.1-11). These projects included once-through steam generator tests, control rod drive line tests, self-powered detector tests, process steam monitoring tests, a core thermal and hydraulic test program, blowdown forces on reactor internals analysis, fuel rod clad failure tests, xenon oscillation analysis, iodine spray removal analysis (see paragraphs 97 and 113-115), catalytic hydrogen recombiner program, and internal vent valve testing.

139. In addition, the ACRS in its favorable review of the Plant listed the following items for further consideration during construction: (1) control room ventilation in the event of a chlorine spill; (2) improved multinode analysis techniques for ECCS evaluation; (3) addition of a diverse reactor trip signal; (4) more detailed procedures for installation and maintenance of independence of protection and emergency power systems; (5) effects of melting and subsequent disintegration of portion of a fuel assembly; (6) instrumentation for prompt detection of fuel failure; (7) development of systems to control post-accident buildups of hydrogen; (8) performance of studies on common mode failures; (9) development of detailed process steam monitoring

system and; (10) a number of generic items that the ACRS had listed in previous letters on other plants (ACRS letters, dated June 18, 1970 and September 23, 1970). Items (1), (3), (4), (7), (8) and (9) have been discussed in paragraphs 120; 81 and 84; 85-88; 97; 82 and 84; and 91 respectively, of this decision. In regard to item (2) above, the Babcock & Wilcox Company has done significant further development of multinode analysis techniques for ECCS evaluation (See BAW-10034). The Board is in agreement with the statement of the ACRS that the matters identified by the ACRS can be satisfactorily resolved during construction of the Plant.

140. The Staff reviewed Applicant's proposed areas of research and development and the programs of Applicant and B&W intended to implement them. It indicated that several of the programs had been completed, although Staff review was still under way, and that several others were well under way (SSE pp. 74-80). The Staff concluded that the programs are timely, are reasonably designed to accomplish their respective development objectives, will provide adequate information on which to base analysis of of design and performance and should lead to acceptable design of the systems involved (SSE p. 80). The Board concludes that the Applicant has provided sufficient information concerning and adequately identified the research and development programs being conducted, that the Staff has adequately reviewed such programs and that research and development programs reasonably designed to resolve any safety questions associated with reactor safety features and components have been or will be conducted; and that such programs of Applicant will be completed well before completion of construction of the Plant.

Financial Qualifications of Applicant

141. Applicant is a combination electric and natural gas utility incorporated under the laws of the State of Michigan. The Applicant will finance the total costs to construct the Midland Plant as an integral part of its normal construction program, using funds internally generated (cash on hand, undistributed earnings and depreciation and other accruals) and from the sale of securities (debt, equity and short-term notes) when and as required, in the same general manner as it finances other plant additions. It has a strong financial position, sound financing, adequate resources, a high level of earnings, excellent credit and bond ratings and a proven ability to borrow on a short-term basis (PSAR Applicant's Ex. 1-D and 38E; SSE Appendix H, and Staff Ex. 8). Although Saginaw Intervenors initially indicated that they were contesting this issue, they abandoned their attack prior to the commencement of the radiological health and safety hearing and this is, therefore, an uncontested issue.

Common Defense and Security

142. The application reflects that the activities to be conducted would be within the jurisdiction of the United States and that all of the directors and principal officers of the Applicant's organization are citizens of the United States. Applicant is not owned, controlled, or dominated by an alien, a foreign corporation, or a foreign government. The activities to be conducted do not involve any restricted data, but the Applicant has agreed to safeguard any such data which might become involved in accordance with Paragraph 50.33(j) of 10 CFR

Part 50. Applicant's activities will also be subject to AEC regulations for the safeguarding of special nuclear material. The applicant will rely upon obtaining fuel as it is needed from sources of supply available for civilian purposes, so that no diversion of special nuclear material needed for military purposes is involved (PSAR Applicant's Ex. 1-D; SSE p. 83, following Tr. 1674). Saginaw Intervenors at one time in the proceeding sought to investigate the possibility of industrial sabotage of the Plant. The Board, however, has determined that development of an industrial security program is a matter for consideration at the operating license stage and not in the construction permit proceeding. In re Florida Power & Light Co, AEC Memorandum and Order, February 20, 1967; see also Siegal v AEC, 400 F2d 778 (D.C. Cir. 1968); In re Virginia Electric & Power Co, CCH Atomic Energy L. Rep. Par. 11,593 at p. 17,733-6, Initial Decision ASLB, February 9, 1971; In re Pacific Gas & Electric Co, CCH Atomic Energy L. Rep. Par. 11,950, Initial Decision, ASLB, December 8, 1970. The Board concludes that the activities to be performed will not be inimical to the common defense and security.

ENVIRONMENTAL PREHEARING PROCEDURES

143. As a result of the July 23, 1971 decision of the United States Court of Appeals for the District of Columbia invalidating the AEC regulations regarding the scope of and procedures for review pursuant to NEPA, it became necessary for the AEC to issue new regulations, for the Applicant to file additional environmental material, for the Staff to further review the environmental aspects of the Plant and for the Board to hold environmental hearings and make environmental findings. The additional filings made by the Applicant and review by the Staff are described above in paragraph 13. The AEC issued proposed new environmental regulations on September 9, 1971. Although it was clear that additional filings would be required of Applicant and further review by the Staff, the Board, in an attempt to secure an expeditious proceeding and to avoid an unstructured hearing of the type held on radiological health and safety issues, ordered in its Order of August 26, 1971 "that all parties serve and file all motions for discovery concerning issues arising under the National Environmental Policy Act permitted under 10 CFR §§2.740, 2.741, and 2.744 by no later than September 30, 1971." In addition, the Board requested that all opposing intervenors file a preliminary statement of their views by September 30, 1971 in some detail. Mapleton and Saginaw Intervenors responded to the order by filing objections that they could not be expected to commence discovery or submit any contentions until the AEC's final environmental statement had been prepared. Saginaw Intervenors did set forth some very general statements of concern, filed a motion for production of documents that was "burdensome on its face" (Board Order of December 22, 1971) and a few interrogatories that largely repeated interrogatories

previously answered in the proceeding or as to which objections had previously been sustained without any statement of good cause as required by the regulations, 10 CFR §2.740 (Board Order of December 22, 1971). Of particular interest as regards the sincerity of Saginaw Intervenors' participation in the proceeding, Applicant, in an attempt to expedite the proceeding, did not object to a large number of Saginaw Intervenors' burdensome document requests and agreed to make such documents available to Saginaw Intervenors (Tr. 5047) only to have Saginaw Intervenors not avail themselves of the opportunity.

144. The Petition to Intervene of the State of Kansas, see paragraph 23 above, and the contentions of various opposing intervenors (Tr. 4848-53; Saginaw Statement of Environmental Contentions, Contentions 17-23, February 6, 1972) raised questions concerning the environmental affects of all aspects of the nuclear fuel cycle from the mining of uranium to the ultimate storage of high level waste. Both Applicant and the Staff opposed consideration of these questions at the hearing. (See "Applicant's Answer to the Petition to Intervene of the State of Kansas," dated October 11, 1971; "Answer of AEC Regulatory Staff to Petition of State of Kansas," dated September 29, 1971) Applicant basically argued that the various major steps of the nuclear fuel cycle were subject to specific licensing review by the AEC and would be subject to appropriate environmental review under NEPA. Additionally, Applicant pointed out that this Plant's contribution to the environmental effect of the various stages of the fuel cycle will be an insignificant increment and that Applicant has no control over the manner in which most steps of the fuel cycle are performed. The Board found Applicant's arguments persuasive, but finding the existence

of a substantial question certified the question to the Atomic Safety and Licensing Appeals Board. (Order of March 10, 1972)

145. The Appeals Board, (July 19, 1972) on the basis of its previous decision regarding consideration of reprocessing of spent fuel and ultimate storage of high level waste (In the Matter of Vermont Yankee Nuclear Power Corp., Docket No. 50-271, Memorandum and Order, June 6, 1972) determined that the Board need only review the operation and construction of the Plant and the transportation of new fuel to the Plant and spent fuel and waste from the Plant. The Appeals Board described the various processes involved in the fuel cycle: mining, milling, refining, enrichment, conversion, fabrication, irradiation and reprocessing. In order to illustrate the nature of the problem, the Appeals Board pointed out that there are over 200 uranium mines, of several different types, 20 mills, 4 conversion plants (as well as additional foreign plants), 3 enrichment plants, 9 processing plants and 14 fabrication plants. (p. 6) All of these facilities are subject to AEC licensing and environmental review. The Board concluded that NEPA did not place on the individual hearing boards the duty to conduct "environmental study of the present and future operations of an entire industry, including complex and perhaps unidentifiable operations performed by unidentifiable persons at unidentifiable locations under unidentifiable conditions," in each individual reactor licensing proceeding. (p. 12) Mapleton Intervenors have filed a notice of appeal from the Appeals Board decision (August 9, 1972).

146. On October 19, 1971, Applicant filed its three-volume, approximately 1000-page, Supplemental Environmental Report (ASER). Following a prehearing held on November 23, 1971, the Board in its Order

With Respect To Various Motions Filed in This Proceeding, dated December 22, 1971, set forth a prehearing schedule, which required the Staff to file its draft and final environmental statements by specififed dates and required intervenors to file contentions and requests for discovery based on the ASER, draft environmental statement, agency comments on the draft environmental statment and the final environmental statement, within specified periods following the availability of each of such documents. The Staff's Draft Environmental Statement was filed in advance of the deadline and its Final Environmental Statement was filed shortly after the deadline.

147. EDF failed to file any factual contentions by the December 31, 1971 deadline and on February 4, 1972 indicated that its remaining interest in the proceedings was related to legal issues. In the Board's Order of March 27, 1972, EDF was ordered to file by April 25, 1972 a brief supporting its contentions relating to the treatment of electrical demand. However, in late April 1972, EDF formally withdrew from the proceeding (Tr. 5337).

148. The purpose of the December 22 Order was "to encourage all parties to exercise their best efforts in good faith to refine contested environmental issues". On December 29, 1971, Mapleton Intervenors filed vague and general contentions that totally failed to apprise the Board or parties of their basis. Mapleton Intervenors' December 29, 1971 filing, contrary to the Board's December 29, 1971 Order, made no request for discovery. Mr. Like, attorney for Mapleton Intervenors, had at the November 23, 1971 prehearing informed the Board that Mapleton Intervenors opposed issuance of a permit (apparently without regard to

merits) and that if required to supply contentions, he would fall back on merely asserting the negative of every proposition advanced by Applicant (Tr. 4903). It is clear that this is all that had been done in their December 29, 1971 filing. Mapleton filed four further general contentions regarding the Draft Detailed Statement, which was issued January 7, 1971, before the deadline of February 4, 1971. The Board in its Order With Respect To Environmental Issues, dated March 27, 1972, struck three of Mapleton Intervenors' contentions, dated December 29, 1971, found that most of the remaining contentions in the December 29 filing were relevant to the proceeding but were "generally vague and conclusionary and . . . very much in need of additional specification" and found some of the remaining not germane to the proceeding. Of the four additional contentions, dated February 4, 1972, the Board excluded one, found one unintelligible and permitted the other two.

149. Saginaw Intervenors on December 24, 1971 filed their "Motion for Reconsideration of Certain Portions of Board Order Dated December 22, 1971" wherein they requested that the Board not require them to file their contentions and requests for discovery by December 31, 1971 and not set any further deadlines until the next prehearing conference because they had not completed review of the ASER and that Saginaw Intervenors' counsel, Mr. Cherry, would be on a trip until January 6, 1972 and would be "busily engaged in preparation for upcoming ECCS Rule Making Hearings" (AEC Dkt. No. RM-50-1) thereafter. The Board in its Order of January 6, 1972 granted Saginaw Intervenors an extension until February 4, 1972, the due date for their contentions on the Draft Detailed Statement and noted its unhappiness with the implications of

the request. The Board at that time pointed out that it was aware counsel for intervenors was thinly spread over a number of cases and that the Board had attempted to accommodate him on previous occasions to the great inconvenience of the Board and parties (e.g., permitting default on January 7, 1971, date for filing interrogatories, and permitting extension until March 22, 1971 as a result of his involvement in the Palisades proceeding and a Court case, postponement of the January 6, 1972 prehearing because of a hearing in the Point Beach No. 2 proceeding and prehearing conferences held in Chicago and Washington for his convenience). The Board then stated:

> "There are limits to the concessions which can properly be made. Unlike lawsuits the consequences of delay and postponement of this type of proceeding are potentially very serious. We will continue to try to accommodate hearing dates within reason but we cannot in good conscience regard participation in other proceedings to be justification for not meeting deadlines. If counsel are to participate in more than one case at a time they simply must be prepared to make arrangements for handling the case load."

150. On February 6, 1972, two days after the February 4 due date, Saginaw Intervenors filed 119 contentions covering some seventy pages attached to which was an Exhibit A which in essence stated that since there was at that time an unresolved controversy as to whether certain areas would be heard in the environmental hearing that they be permitted until fourteen days after resolution of any such matters to file any detailed discovery requests. Applicant on February 18, 1972 filed detailed responses to each of Saginaw Intervenors' contentions and stated:

> "In replying to these contentions Applicant has attempted to provide additional information in

> those few areas that were not in fact covered in the prior environmental filings and to reference previous filings that answer the many contentions that ignored such filings. Applicant has found these contentions in many cases to relate to matters which are not properly issues in this proceeding, in a number of cases to be frivolous, almost uniformly to fail to set forth any facts in support of broad conclusionary statements, in many cases to be clearly contrary to and to ignore facts already on the record, generally lacking in the specificity required by AEC regulations and in a number of instances to misrepresent Applicant's statements in previous filings. Applicant is particularly shocked by Saginaw Intervenors' repeated intimation of misfeasance and falsification directed at the Michigan Water Resources Commission and the Dow Chemical Company. The bulk of Saginaw Intervenors' contentions being mere conjecture, unsupported by any facts or scientific bases are an unworthy reply to the great bulk of data and detailed presentation made available to them in the numerous filings of the Applicant and the Staff."

Applicant in a filing, dated February 25, 1972, recognized that as to those matters which appeared at that time to be outside the scope of the hearing, Saginaw Intervenors had no obligation to seek their discovery prior to February 4, 1972 but stated that Saginaw Intervenors' continued refusal to seek discovery

> "with respect to those environmental matters discussed in applicant's environmental report and the Staff's draft statement is in flagrant disregard of the Board's earlier ruling since no valid justification for its failure has been set forth."

While the Board, in general, agreed with most of Applicant's points quoted above, it is of the opinion that some of Saginaw Intervenors' contentions provided some enlightenment as to their concerns and thus in its Order of March 27, 1972 permitted Saginaw Intervenors' contentions dealing with Plant thermal dissipation, discharge of chemical wastes (although requiring that these contentions be revised in light

of additional information furnished to Saginaw Intervenors by Applicant in response to them), decommissioning of the reactor, fuel and waste transportation accidents, reliability of nuclear plants, need for power generally and need for the specific plant and effects on domestic water supply. The Board found a number of areas to be without significant effects and ruled them out at least until Saginaw Intervenors could demonstrate some significance. A number of others were found wanting for dealing with matters unrelated to the issues before the Board, e.g. had Michigan Water Resources Commission properly issued its certificate, did Michigan Public Service Commission rate structure encourage growth of nuclear plants, or as being overly abstract or unintelligible. The Board's March 27, 1972 Order required Saginaw Intervenors to file by April 15, 1972 a revised statement of their contentions on chemical wastes in light of additional information supplied by Applicant, contentions on fuel supply other than on the AEC's breeder reactor program, on transportation accidents and any amended contentions concerning ECCS.

151. Numerous matters in addition to the acceptability of contentions were dealt with in the Board's Order With Respect to Environmental Issues, dated March 27, 1972. None of the intervenors had made any reasonable request for discovery pursuant to the Board's Orders of August 26, 1971 and December 22, 1971. The Board therefore found:

> "As a general rule, there would seem to be little purpose to be served by traditional pre-hearing discovery at this time. Applicant has filed its Environmental Report, its Supplemental Environmental Report, and responses to various questions and contentions. The Staff has filed its Final Statement with comments of various agencies. By and large, opposing intervenors know, or should know, Applicant's 'case' and the basis

> of the Staff position. Opposing intervenors have not, with minor exceptions, paid any attention to the Board's order that a good faith effort be made to make discovery requests as the environmental reports were filed. For the Board to allow, as Saginaw now requests, discovery to begin 14 days after the entry of this order would be to permit intervenors' intransigence to accomplish what their arguments did not.
>
> "In the circumstances, the Board will not permit the process of discovery to delay the proceeding. On the other hand, written detailed questions would undoubtedly be useful in further refining the issues to be contested by intervenors and answers to these questions may save hearing time. Accordingly, intervenors may serve and file detailed, specific questions and requests for documents within fourteen days following the date of this order. It should be clearly understood that the preparation of such requests is not to delay the filings provided for elsewhere in this order, and that such requests bear a heavier burden of showing 'good cause' than would have been the case a few months ago. Notwithstanding that burden, the parties to whom the requests are made shall exert their best efforts to comply with reasonable requests."

Additionally, the Board set a hearing date of May 17, 1972 and a prehearing date of April 28, 1972. The March 27 Order provided that by April 25, 1972 the Staff would file its views on decommissioning and that Saginaw Intervenors would file briefs regarding alleged procedural inadequacies and allegedly inadequate cost-benefit analysis with responses due by May 10, 1972. The Order also provided that opposing intervenors would file their written evidence in support of their contentions and detailed written specifications of areas as to which they intended to cross-examine.

152. In his letter of April 15, 1972, Mr. Cherry responded to the Board Order of March 27, 1972 by indicating that he did not

intend to comply with any of the deadlines set forth in that Order and by requesting that the May 17 date for the hearing be adjourned indefinitely. His letter set forth a decidedly biased and basically inaccurate statement of the history of the proceeding to date. The major basis of Mr. Cherry's request was that he was "unable to relieve myself of my duties in the ECCS hearings", and that "there is no other lawyer that knows the case [Midland] and the Intervenors' position as I do" and that:

> "If I were coming to this case without the background that I have set forth here and claiming that I have other work which prevents me from meeting the Board's schedule here, I could see such a motion being denied upon the grounds that lawyers should not take on too much work; but that is not the situation here."

He additionally urged that the Staff, Dow and Applicant had unclean hands because they had previously accepted the AEC environmental regulation that was overturned by the Court of Appeals, that there were numerous important issues outstanding and no permit could be issued in any case prior to resolution of such issues, that Saginaw Intervenors had made diligent, good faith efforts in the proceeding and that much needed to be done in the way of discovery. In letters dated April 20, 1972 and April 24, 1972, respectively, Dow and Applicant vigorously opposed Mr. Cherry's requests. At the April 28, 1972 prehearing, the Staff joined in opposing indefinite adjournment of the hearing:

> "I would like to say, if there is any possibility of working out a reasonable compromise date whereby Mr. Cherry could remain fully active in both cases, that I would certainly be in favor of exploring it. I think he is entitled to that consideration. But that really does not seem to be possible in this case. So I would urge the Board to deny the motion." (Tr. 5253)

Mr Cherry at the April 28, 1972 prehearing reiterated the points contained in his letter of April 15, 1972 and made the additional contentions that because a construction permit could not be issued prior to completion of the AEC's emergency core cooling system rulemaking proceeding, adjournment would not cause any overall delay (Tr. 5255) and that Applicant had made no showing of prejudice from adjournment. (Tr. 5259-5263) Following argument by the parties present, the Board decided to deny the motion and to proceed on the schedule previously postulated (Tr. 5285). The Board gave consideration to each of Mr. Cherry's arguments for adjourning the proceeding. As discussed elsewhere in this Order, the Board is of the opinion, contrary to Mr. Cherry's assertion that a construction permit cannot issue prior to conclusion of the ECCS rulemaking proceeding, that the AEC has effective regulations relating to the performance of the ECCS and that it is the Board's duty to proceed prior to conclusion of the rulemaking proceeding, which may well not occur for more than a year. While it is true that a number of unresolved issues were outstanding at that time, particularly certification to the Atomic Safety and Licensing Appeals Board of the Board's exclusion of environmental effects of certain portions of the uranium, coal and oil fuel cycles, this was certainly no reason not to proceed with those issues that were ripe for consideration. Mr. Cherry's alleged inability to appear at the hearing as scheduled could only be attributed to his taking on too much work or his intransigence. He has been employed on the Midland proceeding since fall 1970. Subsequent to that date he became involved in the Point Beach No. 2 proceeding (AEC Dkt. No. 50-301) and in

December 1971 or January 1972 in the ECCS rulemaking proceeding. Certainly at the time he became involved in the ECCS rulemaking he was fully aware of the intent of this Board to continue the hearing on a tight schedule. (See Orders of August 26, 1971 and December 22, 1971.) As early as January 6, 1972 the Board informed Mr. Cherry that he should not let himself become so involved in other proceedings that he could not properly perform his duties in the Midland proceeding:

> "We will continue to try to accommodate hearing dates within reason but we cannot in good conscience regard participation in other proceedings to be justification for not meeting deadlines. If counsel are to participate in more than one case at a time they simply must be prepared to make arrangements for handling the case load." (Order dated January 6, 1972)

At that time Mr. Cherry's letter of April 15, 1972 indicates that he had capable co-counsel in the ECCS rulemaking proceeding. Mr. Cherry, at the January 19, 1972 prehearing, clearly recognized that environmental issues should continue to be heard even while the ECCS proceeding continued (Tr. 5148). Yet in spite of the Board's warning of January 6, 1972 and Mr. Cherry's representations at the January 19, 1972 prehearing Mr. Cherry apparently, according to his letter of April 15, 1972 and his statements at the April 28, 1972 prehearing, had permitted himself to become the sole person capable of handling the ECCS proceeding and the Midland proceeding. As indicated by Mr. Cherry, it was apparently his clients' desire that he remain involved in the ECCS rulemaking proceeding at the expense of their participation in the Midland proceeding (Tr. 5310). Were this a case of Mr. Cherry needing a week or two weeks' adjournment, some reasonable accommodation might have been made. However, Mr. Cherry made it clear that only an indefinite adjournment would be acceptable. An additional commentary on Mr. Cherry's allegations that he could not

appear at Midland because he was indispensable at the ECCS proceeding is provided by the fact that the Consolidated National Intervenors were represented by Mr. Arnold, not Mr. Cherry, on the following days: June 6, 7, 8, 9, 13, 14, 15 and 16, and the ECCS proceeding was adjourned on May 30 and 31 and June 1 and 2, a period of time contemporaneous with hearings at Midland. In regard to his statements that Saginaw Intervenors had been reasonably diligent in this proceeding and that the period of adjournment could be usefully employed for discovery purposes, the Board can only point to a record that shows their refusal to make any reasonable attempt to seek discovery over an eight-month period in spite of the Board's continuing encouragement. The final argument that no prejudice will result from an indefinite adjournment is without merit. Both the ASER and the Staff Final Environmental Statement clearly demonstrated the need for the power that the Plant is to furnish and the increased cost of generating power from replacement units. Additionally, as made clear in Applicant's Ex. 38L, which was before the Board at that time, delay can increase Plant costs by in excess of $1,000,000 per month. It is the Board's opinion that both Mr. Cherry and his client willfully became involved in a proceeding knowing that their involvement would render them unable to continue meaningful participation in the Midland proceeding. The Board was unable to justify indefinite adjournment of the proceedings to suit their convenience. On May 8, 1972, Mr. Cherry requested certification of the Board's ruling. The Board denied the request on the basis that there was no novel issue involved and that it, being the body most familiar with the record, is the proper party to judge the matter (Tr. 7086). Saginaw

Intervenors did not in fact appear at or participate in the environmental hearings.

153. On April 17, 1972, in an attempt to correct the deficiencies found by the Board in Mapleton Intervenors' first three contentions of their December 29 filing, Mapleton Intervenors filed thirty-six additional contentions which largely consisted of a point-by-point breakdown of radiological health and safety affidavits which Mapleton Intervenors had previously filed. Attached to the April 17, 1972 contentions was a motion which stated that the AEC's Draft and Final Environmental Statements had omitted reference to and discussion of the findings and opinions of the witnesses subscribing to the various affidavits previously filed by Mapleton Intervenors and, therefore, moved the Board to order the Staff to circulate the affidavits to agencies to whom the statements were circulated asking for their comments, amend the Final Statement by including discussion of the named affidavits and any comments received thereon and postpone the hearing pending completion of the circulation of the affidavits and amendment of the Final Statement. The Board in its Order of May 17, 1972 denied the motion. The Board found that Mapleton affidavits consisted of some hundreds of pages, much of it reprints of articles appearing in the general literature and much of it bearing no specific relationship to the proposed project. No request was made by Mapleton Intervenors that the Staff include such affidavits in its Draft Statement nor did Mapleton Intervenors file any comments with respect to the Draft Environmental Statement. The Board in its Order found,

> "In the circumstances, its [Mapleton's] position amounts to a claim that the staff is either required to circulate anything, no matter how repetitive or irrelevant it may be, which a party chooses to put in the record in the pending proceeding, or that the staff at its risk, must cull the material to see whether it contains any 'respectable scientific opinions.'"

The Board concluded that under any circumstances that proposition is of doubtful validity and that under the circumstances of this case where the information in the affidavits is before the "person making the decision" and that pursuant to Appendix D to 10 CFR Part 50 any decision the Board makes based on the affidavits will automatically amend the Final Statement to the extent it varies from the Final Statement that proposition is without any merit. Although not spelled out in the Board's April 17 Order, the Board since viewing the various witnesses who signed the affidavits is now of the opinion that most of the affidavits did not contain "respectable scientific opinions" and those that did contain such opinions, i.e., Dr. Eckert and Dr. Epstein, were not substantially at variance with the contents of either the Draft Statement or the Final Statement.

154. Although Mapleton Intervenors filed no "detailed, specific questions and requests for documents" within the fourteen days permitted in the Board's March 27 Order, Applicant made available to them the documents listed on its list of documents relied upon in preparation of its environmental reports even though many of them were already in Mapleton Intervenors' possession or readily available to them (Tr. 5301, 5303, 5306-07). At the April 28, 1972 prehearing Mapleton Intervenors stated that they had no direct testimony beyond the previously discussed affidavits and that they would be filing

their detailed list of areas of cross-examination (Tr. 5325). Mapleton Intervenors filed a partial list of areas of cross-examination, dated May 1, 1972. Applicant responded with a motion, dated May 4, 1972, asking the Board to strike all or part of fifteen of Mapleton Intervenors' 32 areas of cross-examination, to preclude Mapleton Intervenors' cross-examination on the other areas until they filed a description in conformance with the Board's March 27 Order and for an additional prehearing conference to consider these matters. Applicant's motion was based on the fact that fifteen of the areas of cross-examination related to areas either previously covered in the radiological health and safety portions of the hearing or previously ruled upon by the Board and on the failure of Mapleton Intervenors to comply with the following directive in the Board's Order of March 27, 1972:

> "In order to focus the issues as precisely as possible, the specification of areas of cross-examination should, where feasible, be in the form of written questions capable of factual answer."

The Board, in its Order of May 9, 1972, stated:

> "The Board agreed with Applicant that Mapleton's specifications of areas of cross-examination is not in compliance with the spirit of the Board's earlier order and includes matters already ruled out of the proceeding."

The Board however did not grant Applicant's motion except as to the prehearing conference and urged Mapleton to provide a detailed specification of some of its areas of cross-examination before May 13, 1972. Subsequently, because of the difficulty of meeting on May 13, the Board requested that Applicant and Mapleton Intervenors agree on some initial areas of cross-examination so that the hearing could commence as directed. An initial area of cross-examination was identified and the hearing commenced as scheduled on May 17, 1972.

ENVIRONMENTAL HEARINGS AND FINDINGS

155. The Board held 14 days of public hearings on environmental matters relating to the Plant. These hearings were held on May 17, 18, 19, 22, 23, 24, 25, 30 and 31 and June 1, 12, 13, 14 and 15, 1972. The record in this proceeding was closed on June 15, 1972 (Tr. 8945) except for those items remaining open as described in the Board's Order of June 28, 1972. All of these items were completed by July 24, 1972 and the record officially closed.

Site Characteristics

156. Applicant in its evaluation of the site for radiological health and safety purposes evaluated many of the important aspects of the site and these aspects were considered by the Board in the radiological health and safety hearing and are discussed in that portion of this decision: geology, paragraph 50; soils and plant foundations, paragraph 51; surface water hydrology, paragraphs 46-48; ground water hydrology, paragraph 49; meteorology, paragraphs 53-66; seismology, paragraph 52; and population distribution and land use, paragraph 41 (See also ASER Applicant's Ex. 38F-3, Appendix O). In addition, for purposes of the environmental review, the Applicant and Staff investigated other parameters of the site as discussed in the following paragraphs.

Terrestrial Ecology

157. Applicant had an ecological survey made of the site by Dr. Leslie Gysel and Mr. Tim Reichard of Michigan State University (ASER Applicant's Ex. 38F-1, following p. 3-1, hereinafter cited as "Ecological Survey"). The Ecological Survey generally described the location, topography, climate and soils at the site (Ecological Survey, pp. 1-3). It

then described the vegetation communities estimated to have been at the site prior to commencement of preconstruction activity and found to be at the site at the time of the survey, with an emphasis on the diversity of the plant species (Ecological Survey, pp. 4-8). Having identified the common plant species the survey discussed the potential value of such species for wildlife food and cover (Ecological Survey, pp. 9-18). The survey identified dominent wildlife present at the site based on direct observation, observation of animal signs such as tracks, scats, den sites, and feeding activities and information received through conversation with plant security guards and local residents (Ecological Survey, pp. 19-21). The survey further discussed the interrelationship of the plant communities and wildlife species in relation to the overall ecology, both prior to construction activities and at the time the survey was made (Ecological Survey, pp. 22-24).

158. The Ecological Survey showed that prior to purchase of the site for the Plant the area was occupied by rural homes and farms and consisted primarily of cropland, pastures and old fields of various successional stages, interspersed by forest and predomonately second growth timber land (Ecological Survey, pp. 4-5). The site prior to preconstruction activities contained the basic components for a variety of animal species and was a moderately good site for wildlife (Ecological Survey, p. 22). Following preconstruction activities, most of the vegetation had been stripped from the site, except for a few isolated areas and a 120 acre parcel not yet acquired, and had been succeeded by a monoculture of an early stage forb community (Ecological Survey, pp. 5, 22-23). The survey concluded that the present condition of the

site results in it being a fairly unproductive wildlife area except for various seed-eating and insect eating birds (Ecological Survey, p. 24).

159. Midland Intervenors' witness, Dr. Holcomb, claimed that the Ecological Survey was incomplete or inadequate because (a) other nearby sites had not been surveyed, (b) the survey was conducted over a short period of a few weeks, (c) precise population estimates were not involved, and (d) the survey was done by inexperienced field personnel (Tr. 8522-8523). Further, Mapleton Intervenors' witness critized the survey for its failure to include three divisions of plants. containing twelve classes, including algae, bacteria, molds, other fungi, liverworts and mosses; several phyla of animals, including sponges, insects, one-celled animals, hydra, worms, amphibians and reptiles (Tr. 8521, 8524-25, 8527-29). He also criticized the survey for not listing as animals found at the site, species of birds and animals listed in reference books as appearing in this region of Michigan (Tr. 8529-42). As to Dr. Holcomb's point that the survey was conducted by inexperienced field personnel, the Board does not agree with this conclusion. Mr. Reichard, who acted as field biologist, has a Bachelor of Arts degree in biology and chemistry and is working on his Master of Science degree in wildlife (Tr. 6608-09 and 6611). The field survey was performed under the direction of Dr. Gysel, who is a Professor in both the Department of Forestry and the Department of Fisheries and Wildlife at Michigan State University (Tr. 6603-05). In addition to the survey conducted for this site, Mr. Reichard has conducted numerous surveys at potential power plant sites throughout the United States (Tr. 6609, 6611). The Board finds nothing in the record to indicate that he was not fully competent to perform an adequate survey.

160. The adequacy of a survey is to a great extent a matter of philosophy. It is the opinion of the Applicant and its witnesses that the purpose of the site survey was to characterize the site through identification of dominant species and their ecological relationships to the site environment (Written testimony of Dr. Gysel, dated July 8, 1972 p. 1). Applicant did not seek to create a definitive listing of every creature present at the site and does not feel that such a study would be particularly useful (Written testimony of Dr. Gysel, July 8, 1972, p. 2). It is the opinion of Dr. Gysel that the study performed was moderately detailed and sufficient to evaluate the plants and animals that might inhabit the site (Tr. 6639). Dr. Holcomb on the other hand clearly believes that it is necessary to have a detailed census of the animals at the site in order to evaluate the effects of Plant operation.

161. Regarding Dr. Holcomb's criticism of the survey for omitting various plants and lower orders of animals, Dr. Gysel indicated, even had all such plants and animals (including insects) been identified, the present state of scientific knowledge regarding food chain relationships would not permit meaningful evaluation of the roles of most of such plants and animals or the consequences of their removal from the ecosystem (Written testimony of Dr. Gysel, July 8, 1972, p. 4). Dr. Holcomb's further criticism that the study did not include various mammals and birds indicated in various wildlife manuals to occur in this region of Michigan does not appear valid. As pointed out by Applicant and stated in one of the manuals utilized by Dr. Holcomb, the fact that a map shows large areas in which certain animals occur does not mean that such animals can be expected at any particular site (Written testimony

of Dr. Gysel, July 8, 1972, p. 5; Tr. 6693, 6701-02). Applicant's survey was based on evaluation of the habitat, use of some of the manuals cited by Dr. Holcomb, direct observation of the animals and expert interpretation of animal signs such as tracks, scats, den sites and feeding activities (Ecological Survey, p. 19; Written testimony of Dr. Gysel, pp. 1-2; Tr. 6631). Additionally, the Michigan Department of Natural Resources field biologist in the area was consulted and was in general agreement with the content of the lists compiled on this basis (Applicant's Ex. 38K, p. 79; Written testimony of Dr. Gysel, July 8, 1972, p. 1). Based on their experience and the information available to them, Applicant's witnesses made population estimates according to the following general categories: abundant, common and rare. They did not deem more definite population estimates to be necessary because of the lack of unique site features (Tr. 6770). In addition to his consultation of manuals, Dr. Holcomb visited the site on only two occasions and testified that the only animal he saw at the site was a 13-lined ground squirrel (Tr. 8586-87). He then made numerous specific population estimates of the number of each species he would expect to find on the site. His estimates, however, are riddled with obvious errors indicating extreme lack of care on his part in compiling the list. He includes two mammals, the least shrew and boreal redback vole, which the area maps contained in his reference manuals do not indicate to occur at the Midland site (Written testimony of Dr. Gysel, July 8, 1972, p. 5). Although Dr. Holcomb's reference manual indicates that grey fox and badgers are very rare in the Great Lakes area [a fact that he misrepresented at the hearing (Tr. 6701, 6696, 6695)], he places 5 grey fox and 36 badgers at the site (Written testimony of Dr. Gysel, July 8, 1972, p. 6). He lists

4800 deer mice, 2400 prairie deer mice and 2400 woodland deer mice although his reference manual for mammals of the Great Lakes region clearly indicates that all deer mice present in Michigan's lower peninsula are either prairie deer mice or woodland deer mice (Written testimony of Dr. Gysel, July 8, 1972, p. 6; Burt, Mammals of the Great Lakes). His compilation additionally includes listing of tree swallows in two places and barn swallows in two places (Tr. 8554, 8555, 8605). Dr. Holcomb was unaware of any detailed census of a large site indicating the existence of the quantities of birds which he listed (Tr. 8619). His estimates of animal populations made no allowance for natural mortality factors (Tr. 8594-97; Written Testimony of Dr. Gysel, July 8, 1972, pp. 6-7) or territorial competition between species (Written testimony of Dr. Gysel, July 8, 1972, p. 7). The Board does not feel that it can place any confidence in the species or population projections made by Dr. Holcomb.

Impact of Site Occupation

162. While the Board is aware that more detailed estimates of site populations can be made than those made by Applicant, the Board does not believe that there is any particular use in making more detalied estimates. This reflects the basic difference of opinion between the parties as to how one evaluates the effect on the terrestrial wildlife and how one quantifies that effect. The Applicant and the Staff relied on a characterization of the site, related such characterization to the surrounding community and generalized the effect in terms of the effect it would have on the surrounding community. Dr. Holcomb, on the other hand, made his estimates of the numbers of birds and mammals, assigned an arbitrary dollar value to each animal and calculated his total value for the number of animals

lost from construction. He then multiplied this number by thirty to reflect loss of this amount of habitat for thirty years.

163. The Applicant's evaluation basically concluded that the animal populations lost had little value because (1) the site had no unique wildlife habitat and no rare or endangered species populations, (2) the site was not the type to be frequented by bird watchers, hunters or other nature enthusiasts (the Board notes in this connection that Dr. Holcomb, an experienced wildlife observer, only observed one animal on his two visits to the site (Tr. 8586-87)), (3) the site is located near a large industrial complex and is in fact partially zoned industrial and (4) the type of habitat available at the site is extremely common in Midland County, the county being approximately 50% forested and 39% devoted to agriculture (Written testimony of Dr. Gysel, July 8, 1972, pp. 9-10; Tr. 6640-41, 6642, 6692). Dr. Gysel summarized:

> "My conclusion remains that there is nothing unique or particularly desirable about the majority of the proposed site and that removal of the wildlife populations previously resident there will have no noticeable effect on wildlife populations in the Midland area." (Written testimony of Dr. Gysel, July 8, 1972, p. 10)

In particular reference to Dr. Holcomb's method of assigning a dollar value to each individual animal at the site and then calculating the loss for thirty years because of the lost habitat, Dr. Gysel, in addition to his objections to the manner in which the basic population estimates were made, indicated that he considered the valuation method used to be meaningless (Dr. Gysel's written testimony, July 8, 1972, p. 8). He thought that replacement cost was not a measure of value of something that nobody wished to replace and which couldn't be replaced (Dr. Gysel's written testimony, July 8, 1972, p. 8). He thought possibly

that a measure of the value of habitat might well be the value which the marketplace put on land of this type for use as habitat (Dr. Gysel's written testimony, July 8, 1972, pp. 8-9).

164. The Staff concluded that the major terrestrial impact of the Plant had already been realized as a result of preliminary site preparation and construction (FES, Staff Ex. 6, p. V-12). These activities had resulted in loss of 90% of the native vegetation cover and habitats (FES, Staff Ex. 6, p. V-12). The Staff stated the greater portion of native wildlife had been displaced and that the areas adjacent to and south of the site contained all of the habitats previously comprising the site, as well as the size and diversity necessary to support the displaced fauna (FES, Staff Ex. 6, p. V-13). However, the Staff recognized that, except for the larger and more mobile wildlife, territorialism and competition for suitable habitat would be expected to prevent the displaced fauna from establishing itself elsewhere (FES, Staff Ex. 6, p. V-13). The Staff concluded that as a conservative estimate all wildlife formerly and presently at the site should be considered lost as a result of the loss of habitat (FES, Staff Ex. 6, p. V-13). The Staff concluded that the effect would be a small loss of small mammals and birds which is unmeasurable (FES, Staff Ex. 6, p. X1-8; Tr. 7889).

165. Dr. Holcomb, whose methodology has been described previously, concluded that an annual value of $524,100 should be assigned for the loss of bird habitat (based on $10 per bird and all potential offspring for most birds and $20 for a few), $352,880 for loss of mammal habitat (varying cost per animal and all potential offspring) and $23,500 for amphibians and reptiles (at $5 each) (Tr. 8551-61).

Of his estimate of bird costs, $103,000 has been placed on six commonly recognized pest species: common grackle, crow, red-winged blackbird, starling, brown-headed cowbird and house sparrow (also called English sparrow) (Tr. 8555-58, 8610-12; Written testimony of Dr. Gysel, July 8, 1972, p. 8). The Board takes note that Dr. Holcomb assigns an annual value of $160,000 for four other types of common sparrows alone. Dr. Holcomb's list of mammals includes $5,000 for house mice, $60,000 for assorted shrews (including $12,000 for the least shrew discussed above), $48,000 for Dr. Holcomb's mistake in double counting deer mice and a number of other costs that the Board finds it very difficult to accept as a meaningful evaluation of the impact of the Plant (Tr. 8559-60).

166. Dr. Holcomb does not identify any unique habitat at the site. In fact, his testimony indicates that studies of adjacent areas would give a good indication of the character of the site before construction (Tr. 8522, 8568). He does not indicate that there would be any meaningful impact from the Plant on the wildlife populations in surrounding areas or Midland County. In fact, he indicates quite to the contrary that all surrounding habitat is probably fully occupied (Tr. 8569) and thus one would expect that following operation of the Plant, the numbers of animals in surrounding territories would be at least as great as at present.

167. The Board has concluded that Dr. Holcomb's population estimates are greatly overstated due to his failure to include cultural mortality factors, his apparent failure to take full account of all aspects of territorialism on the site and his numerous errors. Additionally, the Board does not believe that the dollar costs he assigns represent a meaningful evaluation of the environmental impact. Without questioning the subjective nature of his replacement cost figures, the Board is of the opinion that replacement cost is not a proper value to

assign to the number of animals that could have occupied the habitat had the Plant not been built. A meaningful value for habitat might well be the cost of such land. However, to the extent that this is the proper measure, it is already included in the Plant cost. Certainly the costs utilized by Dr. Holcomb have no relation to value of the animals involved to the surrounding community. Because of the inability to place any meaningful dollar figure on the animal losses and because the Board believes that the ecological impact of the Plant can be evaluated without detailed population estimates, the Board concludes that no further population estimates are necessary.

168. It is the Board's opinion that the impact of destruction of wildlife habitat at the site is an unmeasurable loss of small mammals and birds which is not quantifiable in dollar terms. The Board believes such cost to be insignificant in terms of any impact on the overall ecosystem of the area and in terms of any impact on the human community in the area. The Board accepts the opinion of Dr. Gysel, based on his extensive experience in Michigan and his view of the site, that it does not contain unique habitat and is very unlikely to contain any rare or endangered species. The Board particularly notes that even had such species been present, they have clearly been removed or destroyed by preconstruction site clearing activities (see paragraph 8 above). The area is partially zoned industrial with the rest residential. The Board has visited the site and concurs in the opinions expressed that it is not a particularly attractive wildlife habitat and that it is closely situated to several industrial complexes. The Board concludes that Applicant's site survey was sufficiently

detailed to characterize the site and permit evaluation of the impact of the Plant on the environment. The Board further concludes that the Staff adequately reviewed such information.

169. Mapleton Intervenors also alleged that some cost should be placed on the amount of oxygen that would no longer be put into the atmosphere as a result of the removal of most of the vegetation from the site (Tr. 8548-49). Applicant's witness said he found it hard to believe that Mapleton Intervenors were serious in light of the fact that about 90% of Midland County is covered with vegetation, either in the form of forests (50%) or agriculture (39%) (Written testimony of Dr. Gysel, July 8, 1972, pp. 4-5). The Board concludes that the removal of vegetation from the site will have no significant effect on the atmospheric oxygen resources of the Midland area.

Aquatic Ecology

170. While no aquatic environmental studies have been conducted by Applicant or the Staff, there have been numerous studies conducted by the Michigan Water Resources Commission, Michigan Department of Natural Resources and by the Dow Chemical Company over the years (ASER Applicant's Ex. 38F-1, §3.2.2). Applicant attached many of these studies to its ASER as the best available indicators of Tittabawassee River quality (ASER Applicant's Ex. 38F-1, §3.2.2.; ASER Applicant's Ex. 38F-2, Appendices C-L; Tr. 5752): "Report on Waste Assimilation Capacity - Tittabawassee River Below Midland, Michigan." C. J. Velz, November 1958; "Water Resource Conditions and Uses in the Tittabawassee River Basin," Michigan Water Resources Commission, 1960; "River BOD Abnormalities," John J. Gannon, The University of Michigan, November 1963; "Biological Survey of the Pine, Chippewa, and Tittabawassee Rivers,"

The Dow Chemical Company, September 6, 1963; "Biological Survey of the Pine, Chippewa, and Tittabawassee Rivers, 1968," The Dow Chemical Company, September 23, 1969; "Fish Kill in Tittabawassee River Caused by Discharge From Dow Chemical," Michigan Water Resources Commission memorandum, September 23, 1969; "Report of a Fish Mortality in the Tittabawassee River Below Dow Chemical Company, Midland, Michigan," Michigan Water Resources Commission memorandum, July 27, 1971; Plans for 1971 Surveys of the Tittabawassee River and Associated Waters by the Michigan Water Resources Commission and The Dow Chemical Company; Water Quality Data, Michigan Water Resources Commission; Physical Description of Intake Water and Discharge From The Dow Chemical Company. Subsequent to the filing of the ASER, the preliminary data on the Michigan Water Resources Commission's latest study of river water quality was made available to the Staff (FES Staff Ex. 6, pp. II-18 through II-32). The Staff of the Michigan Department of Natural Resources concluded from this recent study that the water quality parameters indicate generally good water quality in the Tittabawassee River, with the exception of high ammonia levels and high temperatures. Notwithstanding these indications, biological parameters of the river indicate poor water quality. Possible factors relating to depressed biological conditions (particularly in the vicinity of Dow Chemical) include low level discharges of chronically toxic materials, residual toxicity in stream sediments, marked fluctuation in rate of river flow and water levels, high heat loadings, and insufficient stream habitat and cover (FES Staff Ex. 6, p. II-23 & Appendix D).

171. While it appears that the biological productivity in the vicinity of the site is low and will not support a diverse resident

fish population at the present time (FES Staff Ex. 6, p. V-14), it is anticipated that the river will be substantially improved (ASER Applicant's Ex. 38F-3, Appendix N; FES Staff Ex. 6, p. V-15). The Michigan Water Resources Commission is implementing a program to improve discharges into the river and improve river water quality. The Tittabawassee River from Midland to its confluence with the Saginaw River is designated to be upgraded not later than January 1, 1974 for intolerant fish - warmwater species and agricultural uses (ASER, Appendix N; Tr. 5664-65). To meet this requirement dissolved oxygen must be present at levels above 5 ppm on a daily average and 4 ppm as an instantaneous value when the river flow is at the average low flow of 7-day duration expected to occur once in 10 years (ASER Applicant's Ex. 38F-3, Appendix N). This low flow would correspond to a river flow of about 240 cfs at Midland (ASER Applicant's Ex. 38F-2, Appendix E, p. 47), but the Midland Plant would not withdraw water from the river at flows below 350 cfs (ASER Applicant's Ex. 38F-1, p. 4.4-4). Only 40 cfs would be withdrawn at river flows between 390 cfs and 650 cfs and at no time would more than 200 cfs be withdrawn (ASER Applicant's Ex. 38F-1, p. 4.4-3).

172. In June 1972 Dow Chemical initiated continuous biomonitoring of the general wastewater effluent with fish and macroinvertebrates to identify any chronic toxicity aspects of the waste (FES Staff Ex. 6, Appendix D).

173. Construction of cooling facilities at Dow Chemical is currently under way that will reduce the existing heat load to the river which is presently about 1.8 billion Btu/hour maximum, to about 380 million Btu/hour (Tr. 6368, 6379-6381). Further a stipulation exists between Dow Chemical and the State of Michigan that by January 1, 1974 the temperature

rises due to Dow and all other sources will be less than five degrees Fahrenheit at the edge of a prescribed mixing zone (Tr. 6379-6381; Mapleton Ex. 26). The final Dow treatment plant will include a tertiary facility to both stabilize wastes and dissipate heat (Tr. 6386-6389).

174. In addition to the modifications of the Dow wastewater discharges, others discharging wastes upstream will be required to provide additional treatment to meet water quality standards of the State of Michigan and projections have been made of improved water quality conditions by 1974. In particular, there is expected to be a significant reduction in total dissolved solids (FES Staff Ex. 6, pp. II-23, II-24; Tr. 5611, 5663-5667).

175. Opposing intervenors claimed that the aquatic data are inadequate and noted that where certain organisms are not found in the Tittabawassee River, data should have been extrapolated from other rivers (Tr. 8525). Data have been presented which detail the composition of phytoplankton and benthic organisms (numerous surveys over several years) both in the vicinity of the Midland site, downstream of the site, and in upstream tributaries that could be considered characteristic of clean water communities (FES Staff Ex. 6, pp. II-27 - II-31; ASER Applicant's Ex. 38F-1, §3.2-2). Applicant's witness, Dr. Reynolds testified that it is not necessary to sample every type of aquatic organism at all times of the year to adequately characterize the condition of the aquatic environment; that selective sampling and analysis at specified times of the year can provide sufficient information for a thorough evaluation (FES Staff Ex. 6, p. II-31; ASER Applicant's Ex. 38F-2, Appendix A; Tr. 5831). The best qualitative indicator, the resident fish population, was sampled quite thoroughly by the Michigan Water

Resources Commission in 1971, both in the immediate vicinity of the site and in upstream and downstream control areas (FES Staff Ex. 6, pp. II-31 - II-32). Subsequent to a fish kill that occured on July 27, 1971, there were no significant resident game fish populations in the river from the Dow Chemical Company to the confluence with the Saginaw River (FES Staff Ex. 6, pp. II-31 and II-32). The Bureau of Water Management and the Water Resources Commission indicate that the earliest date in which fish could be successfully planted would be in the fall of 1972 or spring of 1973, pending reassessment of water quality and productivity (FES Staff Ex. 6, p. II-31, Appendix D). Benthic production in the area of the Midland site appears to be insufficient at the present time to support a resident fishery (FES Staff Ex. 6, p. II-31). In light of the presently depressed quality of the river and the extensive plans to improve its condition, it is clear that a further survey of present water quality would be neither useful nor desirable at this time. Applicant will be required to conduct a thorough ecological study of the site and its environs prior to Plant operation to establish base line values as recommended by the Staff (FES Staff Ex. 6, pp. iii-iv, V-21 and V-22). The Board concludes that with the numerous proposed changes in river quality and population, the most meaningful data would be that collected just prior to Plant operation.

Water Resources Commission

176. The Michigan Water Resources Commission (WRC) is charged with establishing pollution standards for Michigan waters, making regulations and orders restricting the pollution content of waste material or polluting substances discharged or sought to be discharged into state

waters and to take all appropriate steps to prevent pollution which WRC deems unreasonable and against public interest. (ASER Applicant's Ex. 38F-3, Appendix S, p. 8) On June 9, 1970, Applicant filed with the WRC a Statement of New or Increased Use of Waters of the State for Waste Disposal Purposes. Following discussions and public hearing the WRC issued an Order of Determination, dated October 15, 1970. (ASER Applicant's Ex. 38F-3, Appendix S, pp. 10-11) The Order of Determination required that all Plant discharges be treated or controlled so that, inter alia, they shall not contain solids, other substances or heat in amounts sufficient to create conditions which are or may become injurious to public health, safety and welfare or, to other uses of the river or to livestock, wild animals, birds, fish or aquatic life and not raise the river temperature outside a zone of mixing more than $5^{o}F$ nor above specified levels. (ASER Applicant's Ex. 38F-1, Appendix S pp. 11-12 and Appendix N) The order additionally required processing of Plant sanitary sewage at the licensed facilities of Dow, submission of design criteria to and approval of such criteria by the WRC chief engineer and the performance of pre- and post-operational acquatic environmental studies.

177. The WRC has promulgated water quality standards applicable to the Tittabawassee River which provide that by January 1, 1974 the quality of the river will be upgraded to the classification agricultural use-intolerant warm-water species. (ASER Applicant's Ex. 38F-3, Appendix N and Appendix S p. 9) These standards provide specific limits on coliform count, dissolved oxygen, suspended materials, floating material, toxic and deleterious substances, total dissolved solids, nutrients, temperature and hydrogen ions. (ASER Applicant's Ex. 38F-3 Appendix N) The WRC

has certified, in accordance with the Federal Water Pollution Control Act, 33 USCA §1171(b), that there is reasonable assurance, as determined by the WRC, that the construction and operation of the Plant will be conducted in a manner which will not violate applicable water quality standards. (ASER Applicant's Ex. 38F-3 Appendix N) Applicant has committed to discharges that are significantly lower than those permitted by the standards for thermal releases and total dissolved solids. As discussed in the following paragraphs, the Staff and the Board have independently considered the effects of Applicant's discharges on the aquatic environment.

River Water Usage

178. The water used for the Plant comes from two sources: the Tittabawassee River and Lake Huron. The water from the Tittabawassee River is utilized as cooling water for the Plant condenser cooling system and the Plant service water system (PSAR Applicant's Ex. 1-A, §2.2.8 and Appendix 2B; PSAR Applicant's Ex. 1-B, §§9.7, 10.2.5). As a means of cooling the river water after use and of providing storage of water during periods of low flow in the river, Applicant intends to install an 880-acre closed cycle cooling pond (PSAR Applicant's Ex. 1-A, Appendix 2B; PSAR Applicant's Ex. 1-B, §10.2.5). The pond dissipates heat primarily by evaporation, conduction and heat radiation. Any decrease in the pond level due to water losses (evaporation, seepage, windage, etc.) would normally be made up by water drawn from the river during periods of adequate flow (PSAR Applicant's Ex. 1-A, §2.2.8; ASER Applicant's Ex. 38F-1, p. 4.4-1). Water will be withdrawn from the river at rates up to 200 cfs (ASER Applicant's Ex. 38F-1, p. 4.4-3)

and introduced into the cooling pond through the Plant condenser inlet structure (ASER Applicant's Ex. 38G, p. 6.10-2).

179. Because of the marked fluctuations in river flow and in order to prevent its actions from seriously affecting such flow, Applicant has designed the pond to store water to reduce the need for make-up water from the river during extended periods of low river flow and has imposed the following limitations on its withdrawal of water: With river flow in excess of 650 cfs, Applicant can withdraw 40 cfs plus the excess river flow above 650 cfs up to the capacity of the pumps (200 cfs); with river flow between 350 cfs and 650 cfs, Applicant may withdraw the flow in excess of 350 cfs up to a maximum of 40 cfs; and with flow below 350 cfs, Applicant may not withdraw any water from the river (ASER Applicant's Ex. 38F-1, pp. 4.4-3, 4.4-4).

180. The Department of Interior (Applicant's Ex. 38A), indicated its concern for water supply and referenced a 1960 study by the Michigan Water Resources Commission (WRC) (ASER Applicant's Ex. 38F-2, Appendix D) which indicated that water requirements in the Midland area had already exceeded the supply. The Michigan United Conservation Clubs, Water Resources Committee (FES Staff Ex. 6, Appendix E, pp. 55-63), the Environmental Protection Agency and the Mapleton Intervenors (Tr. 5972) indicated a similar concern. As Applicant has pointed out, its manner of operation and developments since the 1960 report obviate any concern regarding this matter (ASER Applicant's Ex. 38F-1, pp. 3.2-2 and 3.2-3; Applicant's Ex. 38K, pp. 1-2). The WRC 1960 report indicates that any problems are with usage during low flow periods and that the best means of alleviating the problem is through the use of reservoirs that store water during periods of abundance (ASER

Applicant's Ex. 38F-2, Appendix D pp. 112-114), which is exactly what Applicant proposes to do. Additionally, Dow and Applicant are making use of water from Lake Huron as a means of decreasing their demands on river water (ASER Applicant's Ex. 38F-1, p. 3.2-3). The WRC who prepared the 1960 report and reached the conclusion contained therein has reviewed Applicant's plan for use of the river water, including its staged withdrawal plan, and has issued an Order of Determination and has certified that Applicant's discharges will comply with applicable water quality standards (ASER Applicant's Ex. 38F-3, Appendix N). The WRC filed comments on the Draft Detailed Statement indicated no concern over depletion of flow by Applicant (Staff Ex. 7). No evidence has been brought before the Board to indicate that Applicant's proposed usage will affect any other uses of the river. It is the opinion of Applicant that it has taken proper precautions and that its usage is reasonable in light of other uses of the river (ASER Applicant's Ex. 38F-1, pp. 3.2-2 and 3.2-3; Applicant's Ex. 38K, pp. 1-2). The Staff reviewed Applicant's proposed method of withdrawal and found no problems (FES Staff Ex. 6, p. V-10). The Board concludes that Applicant has furnished sufficient information, the Staff review has been adequate, and that Applicant, through its staged withdrawal plan, has properly acted to prevent significant effect on the river flow.

Impact of Intake of Water

181. The intake structure through which river water is withdrawn will be located in a stilling basin and will include a trash rack and adjustable weir for control of silting. Make-up flow is by gravity from the intake structure to the make-up pump structure. The intake

structure will have a traveling screen with 3/8 inch mesh (ASER Applicant's Ex. 38G, p. 6.10-1, 6.10-2). Although Applicant had proposed that the maximum velocity through the traveling screen be 2 feet/second (ASER Applicant's Ex. 38G, p. 6.10-2), adverse comment on this velocity was received from the Environmental Protection Agency (FES Staff Ex. 6, p. 48) and the Department of Interior (FES Staff Ex. 6, p. 27). Applicant indicated that its intake structure was a preliminary design and that following receipt of more information on reestablishment of fish populations in the river, it would develop final design criteria including fish protection criteria which would take into account the size and species of the fish expected to be present in the river (Applicant's Ex. 38K, p. 52; Tr. 7402). The Staff extensively considered the question and concluded that the intake structure should be designed to have an intake flow velocity of less than one foot per second (FES Staff Ex. 6, p. iii, V-16; Tr.7249). The biological witness for the Staff, Mr. Grube, testified that he had reviewed the scientific literature on sustained swimming speeds of fish and concluded that reduction of the velocity to below one foot per second would minimize impingement on the screen (Tr. 7400; 7251-52). Although Mapleton Intervenors objected to the fact that no final design of the intake structure has been completed, they had not read the Staff's recommendation in the Final Environmental Report and were unable to indicate to the Board any factors of concern other than those that had already been evaluated by Applicant and Staff (Tr. 6732-34). Mapleton Intervenors further argued that they couldn't determine whether the intake design was acceptable until they could judge the relative effects of different designs on zooplankton, phytoplankton, benthic organisms,

fish eggs and fish fry (Tr. 7251). The Staff patiently pointed out that the design of the intake structure was important in evaluating damage to fish but that organisms of the type described by Mapleton Intervenors were going to be taken in through the intake with the flow of water to the same extent regardless of intake design (Tr. 7251). It is the opinion of the Board that Applicant and Staff have adequately evaluated the design of the intake structure and that a proposed limitation on flow velocity of less than one foot per second will adequately minimize impingement of fish on the screen.

182. Mapleton Intervenors further contended that a cost must be assigned to loss of zooplankton, phytoplankton, benthic organisms and small fish as a result of being taken in through the intake and through the Plant condenser (Tr. 8548, 8549-51). Their witness, Dr. Holcomb, estimated that losses of phytoplankton and zooplankton each year might be about 4400 tons each, that such weight should be converted to fish weight at a ratio of 1000/1 and that the fish should be valued at $3.00/lb. (Tr. 8548, 8549). This calculation resulted in a cost of $26,400 per year for each type of plankton. Dr. Holcomb's methodology was the same as that prescribed for phytoplankton in a Staff Guide to Preparation of Environmental Reports issued in December 1971 that was used by Applicant in an amendment to its ASER (Applicant's Ex. 38H) except that he inexplicably increased the value per pound of fish from $1.00 to $3.00. He then assumed, without statement of any reason, that benthic organism loss would a[illegible] $26,400 (Tr. 8549). He also estimated an annual value of $18,900 for the loss of fish one inch or under (Tr. 8551). The AEC abandoned use of this methodology prior

to the hearing on the basis that the plankton loss would not affect the fish populations (FES Staff Ex. 6, p. XI-10; Tr. 7368-72). It is the opinion of the Staff's biological witness and Applicant's aquatic biologist that although the plankton would be killed, their nutrients would be returned to the river and the remaining plankton in the river would receive such nutrients and rapidly reproduce to restore concentrations in the river to normal levels (Tr. 7368-72; Written testimony of D. J. Seeburger, July 7, 1972, pp. 1-2). Mr. Seeburger stated that the quantity of plankton available was seldom the controlling factor on fish populations (Written testimony, July 7, 1972) and both witnesses agreed that no measurable loss of fish would occur as the result of the loss of plankton (Tr. 7372; Written testimony of D. J. Seeburger, pp. 1-2, July 7, 1972). Mr. Seeburger also stated that because benthic organisms were by definition bottom dwelling organisms, they could not be expected to become entrained in the intake with any frequency and that, therefore, Dr. Holcomb's cost was unreasonable (Written testimony of D. J. Seeburger, pp. 2-3, July 7, 1972). The Board finds that because of the uncertainty of the types and quantities of fish that will exist in the river following replanting that no meaningful estimates can be made of the quantity lost or the cost thereof. The Board concludes that the losses postulated by Dr. Holcomb will have no measurable effect on the aquatic ecology and that there will be no measurable loss of fish. The Board therefore does not find that any cost should be assigned to entrainment of organisms in the intake and passage through the condenser.

Use of Lake Huron Water

183. The other major source of water is from Lake Huron. This water is utilized for initial filling and make-up of steam systems and other auxiliary systems; continuous condensate return to the process steam system; potable water. Lake Huron water is brought to Midland by the existing Saginaw-Midland water system pipeline where a portion is delivered to Dow who in turn will supply an appropriate amount to Applicant. The Plant will use about 400,000 gallons per day of Lake Huron water for make-up and potable water and another 5,000,000 gallons per day will be used for the continuous condensate return to the process steam system. An equivalent amount of water is presently being used by Dow for its existing process steam system (Applicant's Ex. 38K, p. 11). The Staff reviewed this use of water and concluded that it would create no net change in water usage (FES Staff Ex. 6, p. V-10). Mapleton Intervenors argued that the Board ought to evaluate the environmental costs of the withdrawal of water from Lake Huron (Tr. 7892). The Board, however, is of the opinion that because the Lake Huron water system is a presently existing municipal water system which had and will have whatever effects it has whether the Plant is built or not, that any environmental costs of the withdrawal are not attributable to the Plant. The Board finds that Applicant has adequately described the proposed system, that the Staff has adequately reviewed the information and that the proposed use of Lake Huron water by the Plant will not create any incremental environmental effects.

Cooling Pond Size

184. The Environmental Protection Agency questioned the adequacy of the proposed cooling pond for drought years (FES Staff Ex. 6, p. 45), as did the Saginaw and Mapleton Intervenors (Saginaw Intervenors' Contentions No. 2 and 3; Tr. 5970-71). Applicant indicated that it had sized the cooling pond to provide sufficient storage capacity with no makeup additions from the river so as to provide sufficient water for continuous full power operation of the Plant during a one-hundred-day drought with continuous river flow below 350 cfs (PSAR Applicant's Ex. 1-B, §10.2.5; PSAR Applicant's Ex. 1-B, p. 2.6-1; ASER Applicant's Ex. 38F-1, §4.4.1; Applicant's Ex. 38K, p.41). Historical data on the river indicated that a 90-day drought with river flow less than 350 cfs has a probability of occurrence of one in five years (PSAR Applicant's Ex. 1-B, p. 2.6-1). However, this historical data was based on flow records which included years that did not reflect the recent upstream development of major storage dams (Applicant's Ex. 38K, p. 41). These storage dams result in storage of water, some regulation of river flow and increased river flow during droughts (Applicant's Ex. 38K, p. 41; Tr. 6122). Had only the later years of data, which reflected this development, been used, the probability of drought calculated by Applicant would have been lower and, thus, Applicant's estimate is conservative. In sizing the pond to meet a one-hundred-day period with river flow below 350 cfs, Applicant assumed that the Plant would operate at full power for the entire period, that it would get no makeup water from the river and that evaporation and seepage losses would average 40 cfs (Applicant's Ex. 38K, p. 41). The evaporation rate utilized was based on adding conservative margins to the maximum

monthly evaporation rates calculated (31.5 cfs) (Tr. 7521) using a generally recognized mass transfer equation (Tr. 6139-40; 6134). Plant operation would not have to be curtailed in the event of a drought for one hundred days (Tr. 6131-32) and only at the end of such period with no alternative supply of pond makeup water available might it become necessary to curtail Plant operation (Tr. 6115-18). The Board concludes that the Applicant has furnished sufficient information regarding water usage and the Staff has adequately reviewed such information (FES Staff Ex. 6, p. III-7; Tr. 7524-26). The Board further finds that the pond has been reasonably and conservatively sized as a result of the inclusion of conservative data in the Applicant's calculation of drought periods and the conservative estimate of water loss. Because of these conservatisms, the conservative assumption of continuous full power operation for 100 days (Tr. 6132) and the possibility of getting some additional water from Dow or the City of Midland, either from the existing Lake Huron pipeline or the City's waste water plant, in the event of a drought (Tr. 6796, 7525-26), the Board does not believe it likely that the Plant will have to reduce power as a result of low flow in the river. The Board recognizes the possiblity of some temporary restrictions on occasion but believes that because of the reserve margins Applicant maintains, temporary small power reductions, less often than once every five years, will not have any significant impact on Plant reliability or economics.

185. The Saginaw and Mapleton Intervenors contended, but offered no evidence, that the proposed cooling pond would be too small to adequately dissipate the heat rejected to it from the Plant during normal operations so as to result in adverse thermal loading of the Tittabawassee River and that

alternative cooling methods should be considered (Tr. 5901-5903). The proposed cooling pond is to be part of a closed-cycle cooling system from which discharges (blowdown) would be made only when necessary to control any dissolved solids built up in the pond (ASER Applicant's Ex. 38F-3, Appendix N, Attachment A, p. 3). Since it is a closed-cycle pond, it adjusts its temperature to the heat load (Tr. 6151-6152), and will reject all of the heat put into it. The resulting pond surface temperature is a function of the imposed heat load (Tr. 6151, 6189-92) and the area of the pond (Tr. 6344). The pond is loaded at 8.75×10^6 Btu/hr/acre (Applicant's Ex. 38P, p. 14). Any discharges from the pond would be cooled through use of an additional cooling system (such as a cooling tower, heat exchanger or spray pond) to within approximately $1^{\circ}F$ of the temperature of the river (ASER Applicant's Ex. 38F-1, §4.4.1; Tr. 1493-95) and therefore the size of the pond will have a negligible effect upon thermal loading of the river. Applicant had cooling pond model studies performed at Alden Research Laboratories (Applicant's Ex. 39) from which model cooling pond temperature differentials were scaled to the full-size pond. The studies optimized the pond baffle for heat load distribution and cooling effectiveness and data summarizing the procedures for calculating heat dissipation from the cooling pond and adjusting the model was utilized by Applicant and reviewed by the Board (Tr. 6320-6321 and 6565-68). The Board concludes that the cooling pond is adequately sized to reject the heat load imposed upon it.

Supplemental Cooling System

186. Applicant has committed to installation of a cooling tower or other appropriate cooling system to cool the pond blowdown to within approximately $1^{\circ}F$ of the ambient temperature of the river water

(ASER Applicant's Ex. 38F-1, §4.4.1; FES Staff Ex. 6, p. III-8). This criterion is substantially more stringent than state water quality standards which permit discharges which do not increase the temperature of the river by more than 5°F outside of a mixing zone (ASER Applicant's Ex. 38F-3, Appendices M and N; FES Staff Ex. 6, p. III-20). Testimony indicated that Applicant has not settled on a final design for this cooling system but has established that it is feasible to design a system to achieve the criteria set forth (Tr. 5675). Mapleton Intervenors agreed that limitation of discharges to within 1°F of ambient water temperature would not cause adverse thermal effects (Tr. 5903). This thermal increment is within the variation of the natural stream temperature and below levels which could cause any measurable changes or detrimental effects to aquatic organisms (FES Staff Ex. 6, p. V-17). The Environmental Protection Agency commended Applicant for anticipating environmental requirements in this respect (FES Staff Ex. 6, Appendix E, p. 44). Because of the supplementary cooling system, the pond discharge will be essentially saturated with oxygen and therefore will not violate any water quality standards for oxygen or interfere with the need of fish for oxygen (Applicant's Ex. 38K, p. 43). The Board concludes that Applicant has furnished sufficient information, that the Staff has adequately reviewed the information and that the thermal discharge standard that Applicant has imposed on itself is more than adequate to protect the aquatic environment.

Impact of Nonradioactive Plant Effluents on River

187. Applicant has identified the nonradioactive Plant effluents in great detail. (ASER Applicant's Ex. 38F-1, §4.4; ASER Applicant's Ex. 38G, pp. 6.3-1 to 6.3-3, 6.4-1 to 6.4-5, 6.11-1 to 6.11-2, and 6.14-1 to

6.14-4; Applicant's Ex. 38K, p. 51). The projected usage of chemicals in the Plant was determined from evaluations of similar operations in the industry using conservative assumptions (Tr. 5530) and therefore the listed quantities are higher than those actually expected to be necessary for Plant operation (Tr. 5531). Applicant, in its evaluation, considered Plant materials balances and chemical reactions which will occur in the Plant (Tr. 5529; FES Staff Ex. 6, p. III-31). During normal operation, the chemical composition of the effluent discharged into the Tittabawassee River is primarily the result of the following processes: (1) Evaporation of water from the cooling pond; (2) Condensate demineralizer regeneration; (3) Makeup demineralizer regeneration; (4) Laundry operations; (5) Tertiary system blowdown into the pond from heat exchangers and auxiliary boilers; (6) Injection of chlorine into the circulating water system for control of slime growth in the condenser and the cooling tower; (7) Injection of sulfuric acid into the circulating water system for control of carbonate scaling in the condenser; and (8) Chemical treatments of system components during maintenance periods (ASER Applicant's Ex. 38G, pp. 6.3-1 to 6.3-3, 6.4-1 to 6.4-3, 6.14-1 to 6.14-4; FES Staff Ex. 6, pp. III-30 and III-31). The major chemical wastes discharged to the Tittabawassee River during normal operation of the Midland Plant (FES, Table III-7) are: Ammonium sulfate and sodium sulfate from regeneration of demineralizers; sulfates from the addition of sulfuric acid for pH adjustment; chlorides from chlorination procedures; phosphates in blowdown from the process steam reboilers and the Plant auxiliary boilers; laundry wastes; and a dissolved solids increment attributed to concentration of the river water due to

evaporation (FES Staff Ex. 6, p. V-19; ASER Applicant's Ex. 38G, pp. 6.3-1 to 6.3-3, 6.4-1 to 6.4-5, 6.11-1 to 6.11-2).

188. The various processes can be categorized in three groups. The first process merely reflects the fact that there will be evaporation in the cooling pond and that therefore the normal chemical constituents (dissolved solids) of the river water will become more concentrated in the pond water and the discharge water from the cooling pond will have a higher total dissolved solids content than will the intake water (ASER Applicant's Ex. 38F-1, §4.4; FES Staff Ex. 6, pp. III-31 and III-37). In addition to the concentration resulting from evaporation, a second categorization is processes (5) through (8) above which result in direct addition of chemicals and waste effluents to the cooling pond (FES Staff Ex. 6, p. III-31). The third group of processes (2) through (4) are those that are discharged directly to the River following dilution in either the cooling pond discharge or when conditions are such that there is no pond discharge in a dilution stream (FES Staff Ex. 6, p. III-31).

189. The majority of the chemicals involved reach the river only as neutral salts or in some other form which naturally occurs in the river water (Tr. 5464). The Plant is designed to prohibit discharge of any chemicals into the environment in their raw form (Tr. 5416, 5417). Testimony indicated that the principal area of interest was the increase in total dissolved solids (TDS) resulting from pond concentration and addition of chemicals (Tr. 5853-57) and that only the specific chemical discharges discussed in the following two paragraphs might be of additional interest.

190. Chlorine will be used for biological control of the water circulating through the condenser and at the service water cooling tower

(ASER Applicant's Ex. 38G, p. 6.4-1 to 6.4-2, 6.11-1 to 6.11-2; FES Staff Ex. 6, III-38 and III-40). The chlorine will react with the water to form chloride and hypochlorite ions although some of the chlorine and hypochlorite will react with ammonium and amines present in the water to produce chloramines (ASER Applicant's Ex. 38G, p. 6.11-2; Applicant's Ex. 38K, p. 85; FES Staff Ex. 6, p. III-38; Tr. 5532, 7384-90). Both hypochlorite ions and chloramines are oxidizing biocides that will react with organic matter to produce chloride ions (Tr. 5533). Reaction rates are not well defined and the time required for the residual chlorine to diminish cannot be accurately predicted (Tr. 5532). However, the range of reaction rates involved (reaction time - 31 seconds to 100 minutes) and catalysis of the oxidation reactions of chlorine by light clearly indicate that the detention time in the cooling pond (three to five days) will be sufficient to reduce residual chlorine below the limits of detectability prior to entering the river as part of the cooling pond blowdown (ASER Applicant's Ex. 38G, pp. 6.11-1 to 6.11-2; FES Staff Ex. 6, pp. III-38 to III-39 and V-20; Tr. 7388-7390; Staff Ex. 9). The Staff has proposed that the cooling pond discharge be limited to 0.05 ppm of chlorine (FES Staff Ex. 6, pp. iv; Tr. 7391-7394). The Board probed the Staff's basis for this (Tr. 7397) and has been informed by the Staff that because of the operational characteristics of the cooling pond, the limitation on the discharge to 0.05 ppm chlorine effectively limits the maximum concentration in the river to 0.008 ppm with a blowdown of 100 cfs. Under the conditions of the discharge no significant kills of aquatic organisms or measurable adverse effect on the aquatic ecology is to be expected. (Staff letter of July 24, 1972). This conclusion agrees with other opinions expressed that no effects are to be expected at that level of

discharge (ASER Applicant's Ex. 38G, p. 6.15-3; Staff Ex. 9). The Board concludes that sufficient information has been furnished and that the Staff review has been adequate. With a limitation of 0.05 ppm chlorine in the discharge, there will be no significant effect.

191. The primary use of phosphates is to control total dissolved and suspended solid buildup in the process steam reboilers (tertiary heat exchangers) (ASER Applicant's Ex. 38G, p. 6.4-2). The National Technical Advisory Committee to the Secretary of Interior recommended "as a guideline that the concentration of total phosphorous should not be increased to levels exceeding 100 micrograms/l (0.1 ppm) in flowing streams or 50 micrograms/l (0.05 ppm) where streams enter lakes or reservoirs" (Tr. 7134-35; FES Staff Ex. 6, p. V-18). The current chemical parameters of the river exceed these levels in the vicinity of the Plant and are much higher downstream (FES Staff Ex. 6, p. V-18). The Staff initially recommended that Applicant limit its discharge of phosphates so that the resultant concentration of phosphorous in the river does not exceed 0.05 ppm (FES Staff Ex. 6, p. iv, V-20). In response to Board questions, the Staff indicated that its only real concern with Applicant's phosphate discharge was the relatively large quantity (174 lb) per day) being discharged from the reboilers during low flow periods and that it assumed the restriction would be reasonable in light of the improvements being made in the river water quality (Tr. 7412). Because of possible uncertainties beyond Applicant's control in the quality of the river water in 1977 and because the criteria for correct water management appears to be essentially that of minimizing phosphate discharges from any facility to decrease loadings, the Staff determined that placing a limitation on Applicant's discharge so that it

won't make a significant contribution to the phosphorous content in the river would be a more reasonable limitation (Staff letter dated July 24, 1972; Tr. 7418). The Applicant and Staff have reached agreement that phosphates discharged including laundry waste and startup waste based on the actual average shall not exceed 35 pounds per day exclusive of pond reconcentration of existing phosphate levels in the river (Tr. 7428; Staff letter dated July 24, 1972). This quantity of discharge will reduce the concentrations calculated by the Staff on page III-33 of the Final Environmental Statement by 80% to .032 ppm phosphates in the river during lowest river flow and .004 ppm during average flow (Staff letter dated July 24, 1972). Because the concentration of phosphates is a factor of three higher than the concentration of phosphorous which is the important parameter (Tr. 7415; Staff letter dated July 24, 1972) the increase in concentration of phosphorous in the river under worst theoretical conditions would be only about .01 ppm and under average conditions only .0013 ppm (Staff letter dated July 24, 1972). The Staff estimate for worst conditions is clearly excessive because it assumes pond blowdown during periods of a very low flow (200 cfs) (FES Staff Ex. 6, p. III-33). However, the testimony clearly indicates that because of Applicant's TDS limitations it cannot discharge from the pond at such low river flows (Tr. 5808-09). The Board finds that sufficient information has been furnished, that the Staff has made an adequate conservative review and concludes that such discharges will protect the quality of the river. Intervenors took no position on this matter.

192. The Michigan Water Resources Commission requires, beginning in 1974, that discharges of wastes not be made when the effect would be to increase the total dissolved solids (TDS) content of the

river above 700 ppm outside of a mixing zone (ASER Applicant's Ex. 38F-3, Appendices M and N; FES Staff Ex. 6, p. III-30; Tr. 5666). Applicant has committed itself to the much stricter limit of not discharging from its cooling pond when the effect would be to increase TDS above 500 ppm (ASER Applicant's Ex. 38F-1, p. 4.4-4; FES Staff Ex. 6, p. III-30; Tr. 5672). Based on projected water quality, beginning in 1975, the largest increase in river TDS during the average year would be 10 ppm in the month of October and the largest increase in the drought year would be 18 ppm in April. However, both of these increases would be subject to the overall 500 ppm limitation and in most months the increases would be much less (ASER Applicant's Ex. 38F-1, §4.4; FES Staff Ex. 6, p. III-37; Tr. 5671-72). These projections take into account projected discharges from the Dow Chemical Company in ensuring that the river will remain below 500 ppm (ASER Applicant's Ex. 38F-1, p. 4.4-3).

193. Intervenors argued that Applicant should have knowledge of the specific contents of all Dow Chemical releases in order to be able to evaluate possible synergism between Applicant's and Dow's chemical releases (Tr. 5599, 5772). However, it was the view of Applicant that because of the innocuous nature of its releases and the fact that the materials it released were basically identical to materials already present in the river, that there could be no adverse synergistic effects of any consequence (Tr. 5450, 5469). However, knowledge of Dow's discharges could be desirable at a later date so that Applicant's monitoring program could distinguish between any effects of Applicant's discharge and any effect of Dow's discharges (Tr. 5455-61, 5480-81, 5483-84). Intervenors presented no evidence regarding chemical interaction and in cross-examination displayed a lamentable lack of

understanding of the behavior of chemicals, even alleging that ordinary chemicals present in concentrations of parts per billion could have some significant interaction (Tr. 5518-20, 5449-50, 5790-5802, 5857-5860). Additionally, their cross-examination constituted extensive discovery of matters already plainly on record that they apparently had never seen before (Tr. 5444-49, 5467, 5470-72).

194. A witness for Mapleton Intervenors, Dr. Orrie Loucks, discussed total dissolved solids concentrations in Saginaw Bay and their effects (Tr. 8718-93). He indicated that the Saginaw River to which the Tittabawassee River is a major tributary is the largest source of total dissolved solids to Saginaw Bay (Tr. 8732-33) and expressed his concern about the effect of Plant discharges on the ecology of Saginaw Bay (Tr. 8732). He advocated that there be a leveling off in the discharges of chlorides, sulfates, total dissolved solids, phosphorous and other chemicals (Tr. 8732-33). He specifically ascribed the decline in fishing in Saginaw Bay over the fifteen-year period from 1952-1967 to environmental contamination and stated that the Plant discharges would hasten such contamination (Tr. 8733, 8771). He stated that Applicant could not predict the effects of its discharge unless it did a complete materials balance study of the Saginaw Bay drainage system (Tr. 8743). His testimony as to the quality of Saginaw Bay was based primarily on two papers: "Physical Limnology of Saginaw Bay-Lake Huron" by Beaton, Smith and Hooper and "Changes in the Environment and Biota of the Great Lakes" by Beaton, included in the symposium "Eutrophication: Causes, Consequences and Cures" (Tr. 8768). The Board has evaluated the various statements of Dr. Loucks in light

of the information contained in his references and information contained in the filings and testimony of other parties. Contrary to Dr. Loucks' statement, it appears from his references that environmental contamination is not the primary cause of decline of fishing in Saginaw Bay but that the sea lamprey is the major culprit (Tr. 8771-72; 8951-8953). Additionally, as noted in his principal source, overfishing has been another major factor (Tr. 8772, 8951-53). His source does indicate that environmental contamination may be of importance but that similar declines have also been experienced in the relatively unpolluted Georgian Bay area of Lake Huron (Tr. 8951-53). It is clear that the inflow into the Bay from the Saginaw River has not been of good quality and that its effect has probably been detrimental (Tr. 8735). However, the biological indications to which the witness directed the Board do not appear to have resulted primarily from the pollution. Particularly when specifically questioned about this and after he admitted that sea lamprey and overfishing might also have contributed to some decline, he stated that sea lamprey and overfishing had not been a factor in the decline of sauger, walleye and whitefish in Saginaw Bay (Tr. 8772, 8735). Yet his main reference states that the whitefish's initial decline resulted from overfishing (Tr. 8951) and "The continued decline of the whitefish was probably caused by heavy sea lamprey predation." (Tr. 8952) Dr. Loucks references the sauger fishing as being an important industry (Tr. 8735) and yet his reference states "The Sauger (. . .) has not been an important commercial species . . . ." (Tr. 8952) The Board was also disturbed by the manner in which the witness presented his discussion of Plant discharges to the river. The witness stated that Saginaw Bay had approximately 200 parts per million of chloride

and then stated the Plant would discharge 1440 pounds per day of chlorine (Tr. 8721-22). If he were actually attempting to make a valid comparison, it should not have been to the pounds of chlorine which are all converted to chloride but to the fact that the chloride discharge from the Plant would increase the concentration in the river only 0.17 ppm, less than 1% of the Tittabawassee River chloride content which will be further reduced by dilution in the Saginaw River and Saginaw Bay (FES Staff Ex. 6, pp. III-32 and III-40). Again in comparing sulfates, he compared a Saginaw Bay concentration of 28 ppm with a Plant release to the cooling pond of 1175 pounds of sulphuric acid (Tr. 8729-30). Such release must be converted to sulfates and combined with other sulfate releases to make a meaningful comparison. Sulfate discharges will result in an increase in Tittabawassee River sulfates of about 1.5 ppm under average conditions and of about 2.5 ppm during low river flow and which are further diluted downstream (FES Staff Ex. 6, pp. III-32 and III-33). Clearly his testimony was not designed to make any meaningful comparison. Even if he had directly compared the Plant discharge in terms of concentrations with Saginaw Bay water, the comparison would suffer as not accounting for dilution in the Saginaw River and Saginaw Bay. Dr. Loucks did not offer the Board any guidance as to how to evaluate the effect of the relatively small release being made by the Plant or why it should be concerned about the sulfate or chloride levels in terms of fishing in Saginaw Bay. Dr. Loucks had not bothered to read the numerous references regarding the Saginaw River and the Saginaw Bay contained in Applicant's Supplemental Environmental Report, Sections 3.2.2 and 3.2.3 (Tr. 8769). The Board does not believe that the burden of doing a materials balance of the 2620 sq. mi. Tittabawassee River

Basin (ASER Applicant's Ex. 38F-2, Appendix C, p. 18) and the much larger Saginaw River Basin of which it forms a part should be placed on the shoulders of an insignificant contributor to that watershed. While such a study may be a scientifically desirable and useful tool for other purposes, it does not appear to the Board to be necessary to evaluate the impact of the Plant.

195. Where total dissolved solids are composed of innocuous materials, as are those which Applicant discharges, harmful effects are limited to osmotic effects that only occur at very high concentrations (FES Staff Ex. 6, p. V-19). Limiting concentrations for fresh water fish appear to range above 5000 ppm (FES Staff Ex. 6, p. V-19). The National Technical Advisory Committee to the Secretary of the Interior recommended that relatively innocuous dissolved materials not be increased by more than one-third of the concentration that is characteristic of the stream in its natural condition and in no instance above a concentration equivalent to 1500 ppm NaCl (FES Staff Ex. 6, p. V-19). The proposed Plant TDS discharge will increase river TDS less than 2% on the average and result in a total concentration at which no measurable changes or detrimental effects have been reported or anticipated (FES Staff Ex. 6, p. V-19). The average river concentrations of TDS, sulfates and chlorides projected for the river at the time of Plant operation are within the ranges which have been noted for supporting good mixed fish population in 95% of U. S. inland waters (FES Staff Ex. 6, pp. V-19 to V-20). Applicant's aquatic biologist, who spent many years with the Michigan Water Resources Commission, stated that the chemicals to be discharged were in concentrations too insignificant to have any adverse effect on the ecosystem (Tr. 6780-82). The

Board further notes that while Dr. Loucks merely proposed a leveling off in discharges of chlorides, sulfates, TDS, phosphorus and other chemicals (Tr. 8732-33), the Michigan Water Resources Commission in conjunction with Dow and others is engaged in an extensive program to significantly reduce these discharges (Mapleton Ex. 26; FES Staff Ex. 6, pp. II-23 and II-24; Tr. 5611, 5663-67, 6368-81). Dr. Holcomb, Mapleton Intervenors' biological witness, was requested by the Board to provide it with just one citation indicating that releases of TDS comparable to Applicant's could cause an adverse biological effect (Tr. 5813-15). He failed to produce any citation to this effect. The Board concludes that Applicant has furnished sufficient information on its chemical discharges and the aquatic ecology and that the Staff has adequately reviewed this information. The Board further concludes that the chemical discharges from the Plant will have no significant effect.

Radiological Impact from Normal Operation

196. As discussed in Paragraph 101 supra, Applicant's liquid radioactive waste system is designed to collect, process and reuse or dispose of off-site all liquid wastes, except for laundry waste, containing radionuclides generated during normal operation of the Plant. The gaseous radioactive waste system, as discussed in Paragraph 102 supra, is designed to provide for holdup of radioactive gases for up to sixty days to permit decay of all radioactive gases, except Krypton-85, to essentially zero. Since the filing of its application in January 1969, Applicant has modified the designs of these systems to incorporate the most effective technology currently available in order to keep releases of radioactivity in Plant effluents as low as practicable (PSAR

Applicant's Ex. 1-B, §11.0; PSAR Applicant's Ex. 38E; ASER Applicant's Ex. 38F-1, §4.2; Staff Ex. 8, pp. 8-11; FES Staff Ex. 6, pp. III-21 to III-30). Analysis of the resultant dose of releases from these systems were calculated for purposes of health and safety analysis using extremely conservative assumptions. For purposes of analyzing the environmental impact of these releases, Applicant used more realistic assumptions.

197. Applicant for purposes of calculating a realistic radiation dose from release of laundry wastes during normal Plant operation assumed 0.1% failed fuel instead of the previously assumed 1.0% and conservatively estimated the resultant radioactivity content of its laundry waste on the basis of experience at its Big Rock Point Plant (ASER Applicant's Ex. 38F-1, p. 4.2-4; Applicant's Ex. 38K, p. 15). After making appropriate adjustment for dilution in the river and reconcentration in fish, Applicant calculated the dose to an individual eating 37 pounds of fish a year from the river to be 0.006 mrem/yr. Assuming 1% of the population within a thirty-mile radius eats 37 pounds of fish annually a potential exposure of 0.03 man-rem/yr was calculated. This was compared to an estimated population exposure from natural background radiation in the area and other sources of 215 mrem/yr and 90,000 man-rem/yr (ASER Applicant's Ex. 38F-1, p. 4.2-4). No dose was assumed for the consumption of water since the Tittabawassee River is not a known source of drinking water.

198. Applicant's calculation of exposure to radioactive gases was based on exposure from the release of Krypton-85 from the radwaste system, purging of the containment building during refueling and purging of the auxiliary building for one year with a

reactor coolant leakage rate of 8 gal/day (ASER Applicant's Ex. 38H, §4.2.1.2 and pp. 6.16-1, 6.16-2 and 6.21-4; ASER Applicant's Ex. 38G, pp. 6.7-1 to 6.7-2, 6.21-1 to 6.21-3 and 6.21-5, Tables 21-1 to 21-7 following p. 6.21-5). The site boundary doses calculated were 0.46 mrem/yr to the whole body for the waste gas release, 0.04 mrem/yr to the whole body for the containment building purge and 0.03 mrem/yr to the whole body and 0.0003 mrem/yr to the thyroid from the auxiliary building purge. Calculating the dose in terms of man-rem to the population within a thirty-mile radius results in a figure of 2.01 man-rem (Applicant's Ex. 38H, p. 4.2-7). Again these doses compare to natural background and other source doses of 215 mrem/yr and 90,000 man-rem/yr within 30 miles.

199. The Staff made its analysis assuming releases essentially equivalent to the guidelines of proposed Appendix I to 10 CFR Part 50 (Applicant's Ex. 38M; FES Staff Ex. 6, pp. V-24 and V-25). This is an extremely conservative assumption because it assumes that 75% of the dose from the gaseous release is composed of radioactive gases that will decay prior to release during the 60-day holdup period. Thus no credit has been given for 60-day holdup and the gaseous release doses are in effect four times greater than would be expected using 60-day holdup (FES Staff Ex. 6, p. V-25). Additionally, the Staff calculation is based on the assumption that the radioactive waste system will not be able to operate at all times at peak efficiency (FES Staff Ex. 6, pp. III-21, V-23, V-26) and therefore apparently assumes some liquid releases other than laundry wastes, including release of tritium. Applicant disagreed with this philosophy because of the fact that its system is designed not to discharge radioactive wastes other than laundry

wastes, including recycle of tritium (Applicant's Ex. 38K, pp. 15-17). While the Board finds that Applicant's proposed system is likely to operate with much smaller releases than those utilized by the Staff, it is of the opinion that because the guidelines of proposed Appendix I exceed the releases calculated by Applicant and that these guidelines are likely to be the standard to which Applicant will be held, the Plant should be evaluated at the levels permitted by proposed Appendix I.

200. Utilizing the releases assumed, the Staff calculated doses to the surrounding population. The Staff calculated the dose from liquid releases to an individual who ate 20 g of fish per day from the Tittabawassee River and Saginaw Bay, who drank water from the Tittabawassee River and Saginaw Bay, who swam 100 hours per year in Saginaw Bay and picnicked on its shores for 500 hours per year. Appropriate dilution and bioaccumulation factors were applied. Presently there is extremely little fishing in the Tittabawassee River below the Plant site and it is not used for drinking water supply. The Staff, however, conservatively assumed that at some time in the future the river might be used for these purposes (FES Staff Ex. 6, pp. V-26, V-27). It is interesting to note that the individual assumed spends 75 8-hour days swimming and picnicking on the bay. The calculated doses are well within the guidelines to proposed Appendix I to 10 CFR Part 50 and only a very small fraction of 10 CFR Part 20 limits. The resultant dose from gaseous releases was also calculated. The site boundary dose calculated was only 4.0 mrem/yr (FES Staff Ex. 6, p. V-28).

201. The dose to the general population in terms of man-rem was calculated in order to evaluate the effects of the Plant on the general environment. Using conservative assumptions, the Staff calculated a total annual dose in 1980 from gaseous releases of about 25

man-rem, which corresponds to an average individual dose of about 0.002 mrem/yr (FES Staff Ex. 6, p. V-30). This can be put into perspective when one realizes that a conservative figure for background radiation exposure to a given individual in the same area is in excess of 100 mrem (FES Staff Ex. 6, p. V-30) and that Applicant has assumed a total exposure from natural and other radiation sources of 215 mrem (ASER Applicant's Ex. 38H, p. 4.2-4). The Staff calculated integrated doses for the consumption of fish to be about 3 man-rem and for drinking of water to be 1.3 man-rem. The integrated dose figures of 25 man-rem, 3 man-rem and 1.3 man-rem compare to an integrated dose to individuals within a fifty-mile radius of the Plant from natural background radiation of 112,000 man-rem (FES Staff Ex. 6, p. V-30). The Staff concluded that since fluctuations of the natural background dose may be expected to exceed the small dose increment contributed by the Plant, this increment will be unmeasurable in itself and will constitute no demonstrably meaningful risk to be balanced against the benefits of the Plant (FES Staff Ex. 6, p. V-30).

202. The Board throughout the radiological health and safety portion of the hearing sought to have intervenors set forth the basis for their concern that releases within the limits of the AEC's 10 CFR Part 20 and that met the "low as practicable" test of 10 CFR §50.34a and the proposed guidelines contained in Appendix I to 10 CFR Part 50 would constitute some risk to the health and safety of the public. (See paragraphs 98 and 99 supra) The Board as early as April 2, 1971 made it clear that issues of radiation effects were issues for the radiation health and safety proceeding and intervenors should at that time come forward with any evidence on radiological matters (Tr. 659, 662, 664).

The Board further indicated that it did not expect that there were any radiological issues that were not properly at issue in the radiological health and safety portion of the hearing and that failure to deal with such issues might well be considered as foreclosure (Tr. 721). The only radiological issue any group of intervenors argued to be uniquely environmental at that time was the effect of radioactive material releases on animals (Tr. 708). Mapleton Intervenors did not present any radiological evidence at the hearing but following repeated opportunities offered by the Board did belatedly respond with four affidavits which have been discussed above (paragraphs 101 to 104) and which the Board found insufficient to raise any significant question as to radiation effects. The Board in its Order of March 10, 1972, therefore closed the record as to all radiological issues except two enumerated issues. At the commencement of the radiological health and safety proceeding, Mapleton Intervenors indicated their intent to cross-examine on radiological matters. The Board informed them as it had previously, in its Order of March 30, 1972 and its Order of April 27, 1972, that as parties to the radiological health and safety hearing they had had an opportunity to present evidence on radiological matters, the evidence they had filed had not been adequate and that the record on such matters was now closed (Tr. 6021). The Board is of the opinion that, in the absence of any unique site feature or any responsible evidence to the contrary, radiation releases at the lowest levels practicable in accordance with the AEC's 10 CFR §50.34a and with the AEC's guidelines in proposed Appendix I to 10 CFR Part 50 will result in no meaningful cost from releases of radioactive material from the Plant. The releases projected for the Plant will be such a small increment to doses presently

received from natural background radiation in the area that one must strain credibility to expect any significant or measurable impact. The Board did however, as discussed below, permit exploration of whether there were any unique aspects of the site that could create concern regarding the low levels of radiation.

Synergism

203. Intervenors alleged that because of the unique location of the Plant adjacent to a large chemical complex that the effects of radioactive effluents from the Plant might combine with the effect of chemical effluents to produce a combined effect greater than the sum of the separate effects of each (Tr. 4185, 4188-90, 5584-86). During the proceeding, this was called a synergistic effect or synergism. The synergistic effects considered included both the physiological effect of combined dosage of the chemical and radiological effluents on the tissue of human recipients and the interaction of the radiological and chemical effluents in the environment to produce a reactant which could have a different effect on the human recipient.

204. As discussed herein in Paragraphs 102 and 103, the Board repeatedly offered Saginaw Intervenors opportunities to make a showing that there might be questions as to the validity of AEC radiological regulations on any basis including the basis that synergistic effects would significantly alter the effects of otherwise insignificant releases of radioactive materials. In an apparent effort to develop such a showing, Saginaw Intervenors requested a list of all chemical effluents discharged to both the air and water from the Dow complex (Tr. 1500) and the Board ordered Dow to submit such a list (Tr. 1502). Dow submitted its list based on effluents to be discharged from their facilities in

1975, the year in which the Plant was then scheduled to start operation (Mapleton Ex. 40). Both Saginaw and Mapleton Intervenors failed to come forth with any sort of evidence during the 1971 sessions of the hearing which would indicate that the combination of radioactive and chemical effects were a matter for concern. Even though the Board foreclosed most non-environmental issues (Board's August 26, 1971 Order), both Saginaw and Mapleton Intervenors were allowed to file written evidence of synergistic effects as a challenge to the regulations up to December 31, 1971 (Board's December 22, 1971 Order). Saginaw and Mapleton Intervenors both again failed to file any written evidence on synergism.

205. Even though the Board had procedurally foreclosed the synergism issue on December 31, 1971, the Board remained willing and anxious to hear anything the intervenors could provide which might show that synergistic effects exist at radiation levels low enough to be of concern with this Plant (Tr. 5498). When the Board expressed this during the 1972 evidentiary hearing sessions, Mapleton Intervenors produced an unpublished draft of a paper by a Dr. Most which discussed synergism and had handwritten across it "This is in process of being revised." (Mapleton Ex. 41) The Board thereupon determined that witnesses on synergism would be permitted.

206. Mapleton Intervenors produced three witnesses on synergism, Dr. Meierotto, a biologist, Dr. Nordahl, a biologist, and Dr. Sternglass, a physicist. Dr. Meierotto included as synergism any interactions that produced additive, substractive or no changes in effects (Tr. 8263). Dr. Meierotto made numerous general statements about interactions between radiation and chemicals, radiation and temperature

and radiation and fogs and inversions. He did not provide any detail regarding these interactions and could not cite any concentrations which could produce measurable effects (Tr. 8248-8265, 8299-03). Dr. Meierotto cited as a specific example of a synergistic reaction at the Plant the possibility of zinc released from the Dow plant to the river being subjected to neutron bombardment in the reactor resulting in the discharge of radioactive zinc-65 to the environment (Tr. 8266). Dr. Meierotto was unaware of the location of the Dow discharge in relation to the Plant intake (Tr. 8268), was unaware that the primary coolant water that came into contact with the core came from Lake Huron, not the river (Tr. 8288), was unaware that river water was separated from the core and primary coolant water by a separate secondary steam cycle within the Plant (Tr. 8267-69) and was unable to postulate any realistic mechanisms by which releases of zinc from Dow might get concentrated to the level where they would be a hazard even if it could be assumed that all of the zinc were activated (Tr. 8269-72).

207. Dr. Meierotto had no experience in this area, had conducted no research and based his testimony regarding synergism primarily on Dr. Most's paper (Mapleton Ex. 41, Tr. 8274-77). The Board reviewed Dr. Most's paper and found that it cited a great many references and that it expressed a lot of hypotheses and concerns. The Board considered it a research proposal at most and nothing more (Tr. 8278). Dr. Frigerio, the Staff witness, found that the Most paper reached no conclusions and after checking each of Dr. Most's references, found that none of them were pertinent. Dr. Frigerio added that if Dr. Most's paper were considered to have any relevance it was only in regard to extremely high radiation doses (Tr. 8938-39). The Board is unaware of

Dr. Most's credentials and Mapleton Intervenors were unable to explain why the paper, dated August, 1971, had not yet been revised or published by June, 1972 or even what revisions were contemplated (Tr. 5500, 5680-84). In short, Dr. Most's paper, rather than providing any useful information to the Board and parties, was merely an unsubstantiated reiteration of the concerns previously expressed by attorneys for intervenors. The Board concluded that Dr. Meierotto's testimony was worthless (Tr. 8292). It was clearly a mass of hypotheticals not based on any direct knowledge or research or any extensive analysis of the literature in this area and clearly based on misunderstandings of reactor design and ignorance of proposed radiological releases (Tr. 8292).

208. Dr. Nordahl, Assistant Professor of Biology, University of Nebraska, testified that he would expect anywhere from zero percent to a hundred percent synergistic effects between the levels of radiation from the Plant and the anticipated Dow effluents. His testimony dealt with the effects of these substances at a biological cell level. Dr. Nordahl testified that on the basis of the expected effluents from both facilities, he felt there was a possibility of synergistic reactions based on evidence in the literature. He cited a list of substances which could produce synergistic effects as follows: (1) Bromouracil and other halogenated uracil compounds are X-ray sensitizers; (2) Pyrimadine analogues incorporated into DNA molecules make them more vulnerable to breakage by radiation; (3) Purine analogues are radiation sensitizers; (4) Cigarette smoke and polonium 210 can initiate bronchogenic carcinoma; (5) Polyaromatic hydrocarbons have carcinogenic effects which can be augmented by radiation; (6) Carbon tetrachloride performs necrogenic activity in the presence of radiation; (7) Phenols have carcinogenic effects which

might be increased by radiation; (8) Additive concentrations might produce concentration gradients that would cause one of the low concentration harmful constituents to act as if at higher concentration (Tr. 8498-8512). Dr. Nordahl testified that he had not made any calculations and he was not aware of the concentration limits which would be applicable to the effluent releases (Tr. 8515). In the Board's opinion, Dr. Nordahl had merely researched the literature for materials that had been found to have synergistic effect with radiation. Although Mapleton Intervenors had a list of the Dow effluents, Dr. Nordahl was still willing to imply that chemicals not listed were of concern because Dow is a large company (Tr. 8501, 8516-17). His was again merely a statement of general concerns without any basis in the actual releases and concentrations involved.

209. Dr. Sternglass, Professor of Radiation Physics, University of Pittsburgh, defined synergism as any physical, chemical or biological interaction between various substances which tends to enhance or mutually promote their effectiveness in producing a certain health effect (Tr. 8389). Dr. Sternglass in his testimony cited examples of synergism possibilities in the same way as Dr. Most did in his paper, that is, by reviewing the literature. He is a physicist and engineer with no apparent training in biological sciences although he does teach one health physics course. He does not indicate that he has been involved in any biological or medical research on synergism. He said that radioactive material can be concentrated by rainfall washout and dust trapping of radioactive gas molecules. He also said that radioactive gases increase the formation of liquid aerosol droplets by

electromagnetic ionization. Dr. Sternglass listed a group of substances that facilitate the effects of radiation. They were: (1) Dust particles acting to carry chemical or radioactive particles into the body; (2) Hematite and low doses of polonium -21 produce cancer in hamsters; (3) Uranium ore dust and low doses of radioactive radon gas produced lung cancer in uranium miners; (4) Cigarette smoke and radon gas increased the likelihood of lung cancer; (5) Nitrogen oxides and carbon dust produce lung damage; (6) Sulfur dioxide and polynuclear hydrocarbons produce lung cancer; (7) Polynuclear hydrocarbons with radioactive particles can hypothetically produce lung cancer; (8) Volatile aldehydes, hydrogen cyanide, nitrogen oxides, volatile acids and volatile phenols with radioactive particles in the lungs can hypothetically produce higher radiation doses; (9) Respiratory infections combined with radioactive elements increase the radiation dose up to ten times; (10) Estrogenic hormones combined with Strontium -90 increases bone tumors in mice (Tr. 8367-8385). Dr. Sternglass additionally extensively discussed his views on low level radiation effects. Dr. Sternglass was asked if the effects he was discussing occurred at low concentrations which could be applicable in analysis of releases from the Plant (Tr. 8419). He stated that the experiments he was discussing did indeed involve low doses making specific references to a number of articles in his possession (Tr. 8419-28). Dr. Sternglass concluded that:

> ". . ., the Plant at Midland, Michigan, being proposed for construction in close proximity to a large chemical plant and urban area introduces the potentially serious complications of possible synergistic effects between the chemical emissions and the radioactive gases discharged from nuclear plants in the normal course of operation which could increase the effect on health of the population well beyond that produced by either the chemical or radioactive air pollutants alone." (Tr. 8367-68)

210. Applicant presented three witnesses on this issue: Dr. John H. Rust, Professor of Pharmacology and Radiobiology, University of Chicago (Tr. 8796-8816); Dr. Merrill Eisenbud, Professor of Environmental Medicine, New York University Medical Center and Director of the Laboratory of Environmental Studies, Institute of Environmental Medicine (Tr. 8773-74; 8817); and Dr. G. Hoyt Whipple, Professor of Radiological Health, Department of Environmental and Industrial Health, School of Industrial Medicine, University of Michigan (Tr. 8818-21). Dr. Rust holds doctorates in veterinary medicine and pharmacology and is on the World Health Organization's Expert Committee - Radiation, on the National Academy of Science's Committees on Food Protection (Chairman of subcommittee on radiation in foods) and Radioactive Waste Disposal and Chairman of the U. S. Public Health Service's Long-Term Radiation Effects Advisory Committee. (Tr. 8796-8800) He has extensively published the results of his many studies on radiation effects and the combined effects of radiation and chemicals. (Tr. 8801-14) He has spent the past 25 years working on the effect of ionizing radiation on man and animals from internal and external sources. (Tr. 8825-26) Dr. Eisenbud's doctorate is honorary, his academic degree being in electrical engineering. (Tr. 8773) He has been involved in the environmental field for 36 years. He is a member of the Board of Directors of the National Council on Radiation Protection and Measurements, is on the World Health Organization Expert Panal on Radiation, was Chairman of the Public Health Service Committee on Environmental Radioactivity Exposure, was alternate U. S. Representative on a Board of the United Nations Scientific Committee on the Effects of Atomic Radiation, was President of the American Health Physics Society, was on the Board of Governors of the American Public Health Association,

was on the Board of the American Nuclear Society and on the Board of the American Industrial Hygiene Association. (Tr. 8773-8774) In addition, he was the first Environmental Protection Administrator for the City of New York. (Tr. 8774) Dr. Whipple has degrees in chemistry and biophysics, has had extensive experience in radiation protection and has been a consultant to the U. S. State Department, the AEC and the World Health Organization. (Tr. 8818-8821)

211. Dr. Rust had filed prepared testimony that was included in the transcript as if read (Tr. 8873-8900). Dr. Rust's testimony was based on extensive review of the scientific literature on the subject and his extensive personal experimentation in this area. Dr. Rust stated that based on his personal testing of several thousand agents (Tr. 8832) the interaction most to be expected between radiation and chemical agents is one in which the radiation effect is reduced (Tr. 8831). He did however state that there had been extensive searches for chemicals that would enhance the effects of radiation and that a few such chemicals had been found (Tr. 8833, 8894-95). However, again based on his own experimentation and his search of the literature, none have been shown to have enhancing effects at low levels of radiation (Tr. 8833-34, 8895). Dr. Rust concluded:

> "In summary there is no direct or indirect evidence that will lead to the conclusion that the effluents of either the Dow plant or the Midland nuclear power station will interact in any way to make the very minimal ionizing radiation release or the minimal chemical effluents expected, harmful to man in the ecosystem or the biosphere in general now or in the future." (Tr. 8835, 8895-96).

212. Dr. Rust and Dr. Eisenbud were asked if they had heard Dr. Sternglass' testimony and if they had any comments thereon. Dr. Rust

indicated that he had heard Dr. Sternglass' testimony and that he had read the references in the volume "Inhalation Carcinogenisis" on which Dr. Sternglass had relied (Tr. 8835). Dr. Sternglass stated that these studies involved "levels of radiation, and effluent close to those that would be expected or have actually been encountered in the case of nuclear plants . . . ." (Tr. 8390-91) Dr. Rust proceeded through the cited experiments sequentially - inting out that none of them involved low level radiation even remotely resembling releases from a nuclear plant and that in fact they involved surgical implantation of radiation sources in the animals with resultant doses in a range of 600 rem to 50,000 rem (Tr. 8835-8839). By way of comparison, the Staff's conservatively calculated dose from gaseous releases from this Plant is about .004 rem per year (FES Staff Ex. 6, p. V-28). Thus the lowest dose in the experiments cited by Dr. Sternglass was almost 180,000 times greater than the calculated dose from the Plant. It must also be noted that the experimental doses are administered at one time while the Plant doses are spread over a whole year. Dr. Rust was a particularly appropriate individual to discuss Dr. Sternglass' use of referenced experiments in that he has been personally involved in a number of the miscited experiments (Tr. 8851). Dr. Rust concluded that he found Dr. Sternglass' use of the referenced material very misleading and scientifically irresponsible (Tr. 8840).

213. Dr. Eisenbud agreed with Dr. Rust that Dr. Sternglass had made a number of misstatements of fact and that he was surprised at a number of things that are familiar to people who work with radiation that Dr. Sternglass did not appear to be aware of (Tr. 8843-44). Dr. Eisenbud was surprised at the importance Dr. Sternglass appeared to

give to hypothesized interactions of radioactive gases with dust, explaining that this is a well-known phenomenon (Tr. 8844). He pointed out that the major gaseous release from the Plant is made up of noble gases (krypton and some xenon) which do not adsorb on dust and therefore cannot result in any potentiation of the type described by Dr. Sternglass (Tr. 8844). The other class of gases that may be released are halogens, particularly I-131, which is readily adsorbed by dust and upon being taken into the body 30% goes to the thyroid gland and the rest is eliminated. This fact is taken into account in making standard dose calculations (Tr. 8845). Dr. Eisenbud also took issue with Dr. Sternglass' description of an experiment combining radon gas with what Dr. Sternglass described as a relatively low concentration of uranium ore dust comparable to the concentrations of organic dust from Dow (Tr. 8848, 8373-74). Dr. Eisenbud pointed out that the concentrations of dust used in the experiment were nowhere near that which could be expected from Dow (over one hundred times more concentrated) and even more importantly that the dust used was not an inert dust of the type Dow emits but was carnotite which contains uranium, silica and vanadium and produces silicosis and thermal pneumonitus (Tr. 8848-51). Dr. Eisenbud pointed out that Dr. Sternglass' statement that uranium miners showed excess cancers at levels of experience as low as 40 rads represented a lack of understanding of the calculational technique (Tr. 8851-55). Correct calculation of the actual dose results in a minimum figure of 2800 rem (Tr. 8855). Although both Applicant and the Staff were prepared to continue through Dr. Sternglass' paper point by point to explain its misrepresentations and inaccuracies, the Board ruled that it had heard

enough about Dr. Sternglass' testimony and the technical members would examine it themselves (Tr. 8870-71).

214. Dr. Frigerio, the Staff witness from Argonne National Laboratory, also examined interaction between effluents from Dow and the Plant and concluded that there will be no synergistic effect (Tr. 7564). Dr. Frigerio is employed by Argonne National Laboratory and has a Phd in biophysical chemistry. (Tr. 7467) He has published extensively in the areas of biology, biophysics and medicine. (Tr. 7505-11) He also agreed that the most likely effect of the Dow effluents on the Plant effluents would be to reduce the radiation effect (Tr. 7560).

215. Mapleton Intervenors cross-examined Drs. Rust, Eisenbud, Whipple and Frigerio as a group, spending an inordinate amount of time proving that there were no significant differences between Dr. Rust's filed testimony (Tr. 8873-8900) and an earlier draft (Mapleton Ex. 43) (Tr. 8914-27). The testimony of Dr. Frigerio and Dr. Rust indicated that they would expect no effects from interaction of Dow effluents and radioactive effluents from the Plant in excess of mere addition until the concentrations of both approached near lethal levels (Tr. 8929-37).

216. The technical members of the Board have reviewed Dr. Sternglass' testimony and his references and have reviewed the testimony of the other witnesses. The Board takes official notice that the Atomic Safety and Licensing Board in the Davis-Besse decision found Dr. Sternglass' testimony unconvincing (In the Matter of Toledo Edison, Dkt No. 50-346, March 23, 1971), and that the Atomic Safety and Licensing Appeals Board in the Columbia reactor decision spent many pages giving a detailed analysis of Dr. Sternglass' testimony and concluded that

his ". . . statistical methodology and selective sampling techniques are not scientifically credible and, indeed, raise serious questions as to whether his presentation is consistent with even a moderate degree of scientific responsibility." (In the Matter of Columbia University, Dkt. No. 50-308, May 18, 1972). The Board finds that Dr. Sternglass in his testimony consistently misrepresented or misunderstood the content and import of the references that he used. The Board further finds that Dr. Sternglass failed to support his position in a scientifically credible manner and that the Board can give no credence to his conclusions. The Board must unfortunately conclude that the reputation that preceded Dr. Sternglass is justly deserved.

217. The Board having examined all of the evidence presented regarding possible interactions between chemical effluents from Dow and radioactive effluents from the Plant concludes that there is no evidence to support a conclusion that there will be any interaction which would tend to increase radiation effects. To the contrary the record before the Board clearly indicates that the most likely interaction between the Dow chemicals and radioactivity is a reduction in radiation effects. The witnesses for Applicant and the Staff uniformly had extensive experience and knowledge in the area of radiation effects and were familiar with the vast experimentation which has been undertaken regarding the effects of the interaction of radiation and chemicals. Witness for Mapleton Intervenors had apparently just discovered the possibility of such a phenomenon and were clearly not knowledgeable as to the details or important parameters of the experimentation that they were discussing. Dr. Rust concluded that with the chemicals and radioactivity involved there would be no synergism at any concentration

(Tr. 8930, 8932). Dr. Frigerio testified that "the probable radiation effects can honestly be considered negligible" (Tr. 7561) and that with the radiation levels expected for the Plant he would not expect to see any significant summation of effects at any level of chemical emission (Tr. 8935). It is the Board's opinion that there is nothing unique about this site which would indicate that radiation would have any different effect here than anywhere else.

Radiological Impact from Plant Accidents

218. In addition to assessing potential radiological impact from normal operation, Applicant furnished information with respect to potential public exposures to radioactivity from postulated accidents in the course of Plant operation (ASER Applicant's Ex. 38F-1 as amended by Applicant's Ex. 38G, §4.2.2). The information submitted by Applicant was in accord with guidance issued generally to applicants by the Commission on September 1, 1971 ("Scope of Applicants' Environmental Reports With Respect to Transportation, Transmission Lines and Accidents," September 1, 1971). Accidents at the Plant in relation to the health and safety aspects of siting the Plant were thoroughly covered in the radiological health and safety hearing (Paragraphs 105 through 121 supra). The accidents evaluated for environmental purposes utilized more realistic assumptions than the extremely conservative assumptions utilized in evaluating the accidents for public health and safety purposes. As in the case of estimated exposure from normal operation, the Staff estimates of exposures due to accidents are somewhat higher than Applicant's estimates (FES Staff Ex. 6, pp. VI-1 to VI-6). The Staff estimates utilized the standard accident assumptions and guidance contained in the presently proposed annex to Appendix D

to 10 CFR Part 50 (36 F.R. 22851, December 1, 1971). Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious are identified in the proposed annex. The Staff estimates are tabulated on Table VI-2 and range from less than 0.1 man-rem to 750 man-rem (FES Staff Ex. 6, pp. VI-3 and VI-4). Again this can be compared to an integrated population dose to the population within a 50-mile radius from natural background radiation of 110,000 man-rems. However, in order to make an analysis of the environmental risk involved from these possible accidents, the Staff found it necessary to take into account their probabilities of occurrence. The classes of accidents range from those that can be expected to occur during the life of the Plant and have trivial consequences to those that are never expected to occur but could have more severe consequences (FES Staff Ex. 6, p. VI-3). However, those accidents with more severe consequences have a probability of occurrence so small that their environmental risk is extremely low (FES Staff Ex. 6, p. VI-3). The Staff concluded that when one took into account the probability of occurrence, the annual potential radiation exposure to the population due to accidents is well within naturally occurring variations in natural background radiation (FES Staff Ex. 6, p. VI-6). Intervenors furnished no evidence with respect to the reasonableness of the estimates. The Board finds that Applicant submitted sufficient information and Staff has conducted an adequate review with regard to the potential radiological impact of accidents in reactor operation. The Board further finds the Staff's estimates to be reasonable and conservative estimates of radiological exposures to the population as the result of operating and transportation accidents.

219. Mapleton Intervenors argued that the accident to be evaluated for its environmental effects is an accident in which the emergency core cooling system (ECCS) fails to function and there is a complete meltdown of the core (Tr. 5354-55). Mapleton Intervenors argued that in light of the testimony at the ECCS rulemaking proceeding (Dkt. RM-50-1; see Paragraphs 124 to 127, supra) failure of the ECCS to prevent meltdown must be considered a credible accident (Tr. 5354-55). The AEC in its proposed Annex to Appendix D, 10 CFR Part 50, has classified this accident as a Class 9 event. This means that it is so improbable as to not even be used for safety analysis and that because of this improbability of occurrence the environmental risk is so low that it cannot meaningfully be evaluated in an environmental context. The Board takes official notice that Mapleton Intervenors are parties to the ECCS rulemaking and that the AEC plans to circulate a draft detailed environmental statement and issue a final environmental statement regarding the ECCS rulemaking proceeding in compliance with NEPA. It is the Board's opinion, as discussed above in Paragraphs 122 to 127 that the proposed ECCS system complies with the existing regulation and that until such time as the regulation is modified by the AEC as a result of the rulemaking proceeding, the ECCS must be considered to perform properly. Because the AEC in issuing its new regulations will prepare an environmental statement including a cost-benefit analysis, the Board believes that Mapleton Intervenors' concerns will be adequately satisfied in that proceeding to which they are a party.

Cooling Pond Atmospheric Effects

220. Applicant has evaluated possible fogging and icing effects arising from operation of the Plant's cooling pond (ASER, Applicant's Ex. 38 F-1, §4.3; ASER, Applicant's Ex. 38-G, Response to Question 22; Applicant's Ex. 38-P, "The Environmental Effects of the Midland Plant Cooling Pond - Summary Report," dated April 28, 1972). The Summary Report incorporated the data contained in the Interim Report, which was included with Section 4.3 of the ASER, and contained additional data gathered during the fall and winter of 1971-72 and thus superseded the Interim Report (Applicant's Ex. 38-P).

221. The Summary Report describes field studies of cooling pond fog made at the Coffeen Plant cooling pond in central Illinois and at the Four Corners Plant cooling pond in northwest New Mexico (Applicant's Ex. 38-P, p. 6). The principal source of data for the Summary Report was the Four Corners Plant cooling pond and the data were collected mainly in the early sunrise hours from midfall through early winter (Applicant's Ex. 38-P, Table 3). The winter air temperatures, the humidities, cooling pond heat loading and surface water temperatures at the Midland and Four Corners plants are similar (Tr. 6222-6226, 6415-16). The Summary Report examines the major physical factors related to fog occurrence for the purpose of determining in connection with ambient air data, the probability of steam fog occurrence. On the basis of observation of fog occurrence and the atmospheric characteristics present at the time of such occurrences, the Summary Report develops the concept of a fog index number to provide a method for statistical analysis of all fog, fog-stratus, stratus, slight-fog and no-fog situations (Applicant's Ex. 38-P, p. 25). The fog index number is used to predict the occurrence of fog on the basis of temperature differences between the pond and the ambient air with

consideration given to atmospheric humidity (Tr. 6211-12). The Summary Report indicates that the fog index number concept is considered generally applicable for cooling ponds at all geographical locations for all seasons of the year (Applicant's Ex. 38-P, p. 1; Tr. 6226).

222. Application of the fog index number analysis to the Plant cooling pond yielded estimates of the frequency of occurrence of cooling pond steam fog not coincident with natural fog with the wind from various directions. This analysis showed a maximum annual occurrence of steam fog not coincident with natural fog when the wind was from any one direction of 3.3% (Applicant's Ex. 38-P, p. 52). When natural fog is present, the intensity of the fog may be increased but its duration and extent are not increased (Applicant's Ex. 38-P, p. 44). This analysis does not, however, indicate that because pond steam fog may occur with a certain frequency when the wind is from a given direction that areas downwind of the site will receive the fog. Applicant used three methods to calculate the extent of the fog and all yielded similar results (Applicant's Ex. 38-P, pp. 53-57; Tr. 6231). Studies of fog extent indicated that the fog could extend from the pond about 600 feet on the average winter morning and from 1600 to 5000 ft. on extremely cold winter mornings (a few mornings a month) (Applicant's Ex. 38-P, p. 59). In order to determine the impact of such fog, taking into account the shifts of wind and factors influencing extent, Applicant made frequency estimates for the few nearby populated areas during winter months when fogging would be most frequent. These estimates indicated that fog in winter would be expected at the nearest residences on Stewart Road 0.2 miles west of the pond only about one hour per month, at the nearest school 0.5 miles from the pond only about one or two hours per month, on Gordonville Road just south of the pond 150 hours per month, and at Mapleton 1.6 miles east of the pond no fog

would be expected (Applicant's Ex. 38-P, pp. 62-65 and Figures 17-22; Tr. 6324-35). Light friable frost or ice could deposit on upright objects in conjunction with the fog, generally only a few times a month and limited to within 600 feet of the pond on the typical winter morning (Applicant's Ex. 38-P, p. 59). Icing at the various locations would not be expected to have any significant effect in light of its frosty nature and the fact that natural fog in winter occurs much more frequently than would the steam fog (Applicant's Ex. 38-P, pp. 43, 62-66). Applicant's witness stated that the evidence at the other cooling ponds did not indicate any damage to plant or bird life from pond fog or ice (Tr. 6250-52). The pond fog or ice would not be expected to increase the breakage of transmission wires (Tr. 6254).

223. Applicant also evaluated the effect that operation of the service water cooling tower and the proposed auxiliary cooling system on the pond blowdown might have on fogging effects (Applicant's Ex. 38-P, p. 68). This analysis indicated that the service water cooling tower, which would only operate during the summer months when fog was at a minimum, is such a small source of water vapor compared to the cooling pond that it would have no effect on the results of the cooling pond analysis (Applicant's Ex. 38-P, p. 68). The auxiliary cooling system is not of sufficient size to alter the results calculated for the cooling pond although it will produce a small plume which may on occasion merge with that from the cooling pond (Applicant's Ex. 38-P, p. 68).

224. The Staff has reviewed the Summary Fog Report, and, according to its witness, Dr. J. C. Carson, who gave testimony as to his extensive research and numerous on-site visits to operating cooling ponds, the Summary Report overpredicts fog (FES, Staff Ex. 6, pp. V-1 through V-6; Tr. 7363-64, 7455-61). Dr. Carson agreed that the Summary Report is the first systematic

study of steam fog from a cooling pond that attempted to relate data to atmospheric conditions for the purpose of prediction of fog formation (Tr. 7441-42). While Dr. Carson disagreed with many of the factors which went into the report, he stated that, on the whole, use of those factors resulted in overprediction of fogging (Tr. 7442-55, 7461-62). He questioned the ability of a model developed on the basis of winter data to predict fogging at all times of year and the fact that the definition of fog used in the report would tend to result in the reporting of fog when there was really no significant decrease in visibility (Tr. 7442-47). It was the conclusion of Dr. Carson that the Summary Report is conservative in nature and that the fog and icing effects due to the cooling pond would not significantly affect the surrounding area with respect to potential damage to existing structures, residential occupancy, air traffic from nearby airports or traffic on nearby roads, except possibly some increase in fogging on Gordonville Road immediately to the south of the pond (Tr. 7462). However, fogging on Gordonville Road would not be expected to decrease visibility below 200 feet (Tr. 7699).

225. The Board also considered various agency comments which had been based on the Interim Report contained in the ASER. The National Weather Service of the Department of Commerce for the most part supported the Bechtel Interim Report (which was superseded by the Summary Report), but expressed concern about the frequency of steam fog at airports (FES, Staff Ex. 6, Appendix E, p. 10). However, this concern is not significant because the steam fog plume would reach the Midland (Barstow) Airport no more often than 0.4 hours per month during winter and it is uncontested that there might be stratus plumes (low altitude clouds) for only about 8.4 hours per year at the Tri-City (Saginaw) Airport (Applicant's Ex. 38-P, p. 66, Tr. 6333). The Environmental

Research Laboratories of NOAA (National Oceanic and Atmospheric Administration) agreed that the Bechtel Interim Report was conservative but were concerned that steam fog could extend eastward for one-quarter mile and westward for one-half mile from the pond and onto Gordonville Road on the south (FES, Staff Ex. 6, Appendix E, p. 13). However, NOAA agreed that any occurrences would be rare and limited to below freezing temperatures. Applicant's estimates discussed in Paragraph 222 above demonstrate the infrequent nature of such occurrences (Applicant's Ex. 38-K, p. 20; Applicant's Ex. 38-P, pp. 62-65). Additionally, the testimony of Dr. Carson indicated that visibility never decreased to below 200 feet on a road whose situation in relation to the Dresden Plant cooling pond is very similar to that of Gordonville Road at Midland (Tr. 7699-7700). The Environmental Protection Agency commented that the high heat load of the pond may have some relation to the fogging issue and desired further amplification regarding pond site location and its relation to fogging (FES, Staff Ex. 6, Appendix E, p. 55). Applicant explained that although a larger pond might slightly reduce fogging, it would evaporate more water, resulting in a greater makeup requirement from the river, would consume added acreage of land and would not be economically desirable. The pond design followed correct calculating procedures, and was based upon model studies at Alden Laboratories and the pond arrangement maximized heat rejection (Applicant's Ex. 38-K, p. 75-77; Applicant's Ex. 39). The Environmental Protection Agency also noted that Midland is a Priority 1 air pollution region with respect to nitrogen oxides and a Priority 2 air pollution region with respect to sulphur dioxide and particulates and thus consideration should be given to the possibility of interaction of these chemicals and fog produced at the cooling pond to produce acid mists (FES, Staff Ex. 6, Appendix E, p. 54). Applicant and the

Staff pointed out that the major source of these pollutants would be eliminated on operation of the Plant and that, therefore, it was not to be expected that acid mists would be a problem (Applicant's Ex. 38-K, p. 74; Tr. 7886). The Staff also concluded that if any real problem were to be expected, it would have already manifested itself in the Midland area where natural fog is a frequent occurrence and air pollution is presently high (FES, Staff Ex. 6, p. XII-4; Tr. 7264). There is, however, no indication of such a problem in the Midland area at the present time (FES, Staff Ex. 6, p. XII-4).

226. The Saginaw Intervenors, on February 6, 1972, made various contentions and listed nine hypothetical adverse effects of cooling pond fog. However, none of the hypotheticals were ever supported by evidence, many ignored facts contained in the record, most lacked the specificity required by AEC regulations and many misrepresented Applicant's statements in previous filings. All those of concern were adequately covered in the filings by the Applicant and Staff and in testimony at the hearing.

227. The Mapleton Intervenors, prior to seeing Applicant's fogging studies, asserted that cooling pond fog and icing would create a safety and traffic hazard to the residents of Mapleton, Michigan (Sworn Affidavit of Edward Epstein, July 11, 1971, Contention 2). Dr. Epstein subsequently testified that the Bechtel Summary Report was a unique study of cooling pond fogging (Tr. 8314), and that there was a lot of substance in the Report (Tr. 8315). He contended that questions do exist as to the definition of fog and the timing of some observations, but stated that he did not know how to study the question of fog density (Tr. 8316). He did, however, agree that steam fogs are generally characterized by wispiness (Tr. 8348). He added that the fog index number

created by the Report was reasonable (Tr. 8317) and that the report of fog frequencies was acceptable (Tr. 8322). Indeed, he felt that the definition of fog in the Summary Report, to the extent that it was used, would overpredict (Tr. 8327). Dr. Epstein did admit that he has performed no fogging studies on ponds (Tr. 8338), that he is not familiar with the Four Corners Plant (Tr. 8339) and that he had not studied fog reference literature (Tr. 8348). He stated that the trees near the pond would likely act as a barrier and prevent shallow fog from spreading (Tr. 8341). Thus, the fog index, which was developed on the basis of data from the Four Corners Plant where vegetation is lacking, would be conservative with respect to shallow fog. He stated that Mapleton (1.6 miles from the pond) may expect a few hours of fog on one or two days per year with 40-50 yards of visibility (Tr. 8351), but that a good part of the time there would not be a fog/ice effect on the roads a mile from the pond (Tr. 8352). The Mapleton Intervenors' witness contended that the application of the fog index number derived at the Four Corners Plant cooling pond and applied to the Plant cooling pond may be difficult because the Midland area is more humid (Tr. 8319) and the air contains more hygroscopic particles to aid the growth of fog particles (Tr. 8319). Applicant's expert testimony, by Dr. Crawford, however, showed that the fog index number did contain a humidity term that accounted for the excess water holding capacity of the air (Tr. 6211) and that the fog study did not include a study of hygroscopic particles (Tr. 6243) because the condensation nuclei were sufficient at both Midland and Four Corners (for a full fog) and consideration of the effect of hygroscopic particles would not change the conclusion (Tr. 6248).

228. Testimony by Dow indicated that Dow would be constructing cooling towers and air-cooled condensers (hereinafter "cooling towers") to dissipate

heat from their operations and that following operation of the Plant, these cooling towers would be dissipating from 2.2 to 2.5 billion Btu per hour (Tr. 6389-90). Prior to the operation of the Plant, Dow would be installing cooling towers to handle 1.8 to 2.0 billion Btu per hour and the remaining cooling towers would be added at the time the Plant became operable (Tr. 6389-90). Dow has concluded, on the basis of experience with presently operating towers and the fact that large numbers of small, spread-out towers would be used instead of a few large towers, that fog creation would be limited to the immediate vicinity of the individual cooling towers (Tr. 6392, 6395, 6402). Testimony by Dr. Epstein indicated that he believed that the moisture added to the air by the proposed cooling towers might have some effect on the frequency of fogging from the Plant cooling pond (Tr. 8324). However, he also agreed that he would make no significant changes in the estimates of fog frequency contained in the Summary Report (Tr. 8322, 8339). While the Board agrees that the proposed cooling towers might have some effect, the effect cannot be quantified and it is the Board's conclusion that because the small cooling towers are spread over the vast area of the Dow complex, any effect on fogging frequency at the cooling pond will be insignificant.

229. The Board in reviewing the testimony and filings presented at the hearing, the contentions of intervenors and the comments of various agencies finds that Applicant properly set forth the design of the proposed cooling pond and identified and thoroughly studied the fogging characteristics of the pond. The Staff adequately reviewed the Applicant's studies and concluded, on the basis of extensive investigation into the area, that the Summary Report over-predicts fogging and is conservative. The opinions of Dr. Epstein must be

discounted on the basis that he had not visited or studied any cooling ponds nor had he researched any scientific literature on cooling pond fogging. The Board concludes that the Applicant's study represents a conservative projection of the potential fogging effects from the cooling pond and according to it the most significant recipient of fog might be Gordonville Road south of the pond. In light of the fact that Applicant's study is clearly conservative and that the Staff witness, Dr. Carson, testified that similar roads adjacent to similar ponds have not had any significant problems, the Board concludes that fogging and icing effects from the pond will be infrequent and are not likely to be significant.

Effects of Decommissioning

230. In considering the effect of the Plant upon the environment and making a cost-benefit analysis of the desirability of authorizing issuance of a construction permit, the Board has evaluated considerable data regarding the possible decommissioning of the Midland Nuclear Plant after thirty to forty years of use. Although none of the witnesses presented had personal experience with decommissioning nuclear facilities, Bechtel Corporation has had experience in the dismantling of non-nuclear structures (Tr. 6897). The AEC has actually decommissioned a number of nuclear facilities. In addition numerous facilities will be commissioned prior to commissioning of the Plant and it is to be expected that they will be decommissioned prior to the Plant (Tr. 6893-6894).

231. Decommissioning would probably involve: (1) the removal of all fuel, radioactive and chemical wastes from the Plant site; (2) the decontamination of structures, equipment and components; (3) the isolation, sealing, and barricading of the nuclear steam system (NSS);

and (4) the grading of the cooling pond (Tr. 6891-6892; 10 CFR 50.82). The initial step in decommissioning would be removal of spent fuel. Removal of the spent fuel would not be a unique undertaking because the fuel removed has the same activity level and make-up as the fuel removed during normal refueling operations and removal would be by the same procedures utilized approximately 40 times during the life of the Plant (Tr. 6915-6922). The fuel pool has the design capability of storing and cooling the spent fuel of one and two-thirds of the fuel elements of one reactor vessel (Tr. 6920; PSAR Applicant's Ex. 1-B, §§ 9.4.1 and 9.9.2.3) and there is thus adequate fuel po capacity to unload the reactors one at a time. Personnel would be fully protected during fuel removal (Tr. 6916-6922).

232. The next step would be removal of the coolant water and decontamination of irradiated systems and components to remove residual radioactivity. Based upon present-day knowledge and technology, the methods of decontamination include chemical as well as mechanical means such as flushing with acids, bases or plain water, mopping, scrubbing, and even the physical removal of surface layers. The total amount of decontamination liquid used for flushing was estimated at 240,000 gallons. Its handling, concentration and off-site removal would be completed in the same manner as the general liquid radwaste would be handled during the 40-year life of the Plant (Tr. 6923-6927). Removal of the concentrated and drummed radwaste would be carried out by government-licensed contractors (Tr. 6926-6927). Following decontamination procedures, the only remaining radioactivity would be various neutron activation products including Iron-59, Iron-60, Nickel-49, Cobalt-58, Cobalt-59, Zinc-60,

Cobalt-60, Zinc-65, and Manganese-54, which remain in the metal of the reactor vessel, reactor vessel internals, the primary loop, the steam generators, and the concrete shield surrounding the reactor vessel (Tr. 6907-6912). Parts of the turbine could be slightly contaminated at the time of decommissioning; however, special handling would most likely not be required and they could be decontaminated (Tr. 8190-8191). The equipment necessary for supplying process steam to Dow would not be affected by residual radioactivity and would not require decontamination (Tr. 6914-6915).

233. Although most of the NSS will be below ground level, it will be isolated by capping and sealing all pipes and sealing building openings (Tr. 6929-30; 6891). Inside the reactor building, a concrete slab shield several feet thick would most likely be placed above all parts protruding above ground level (Tr. 6929-6930; 8197-8198). The entombment of the remaining radioactive Plant parts would be so safe that exposures to individuals would be not more than natural background levels (Tr. 6938). Only if an individual broke in through locked fenses and doors and removed or excavated into the large and extremely heavy concrete cover shielding could overexposure occur (Tr. 8157-8177). The facility would be monitored regularly and surveillance would be maintained following decommissioning to ensure that no problems developed (Tr. 6936, 8195, 8215). The radioactivity remaining in the facility would be contained in big chunks of concrete and steel and thus seepage is not a problem (Tr. 8217-18). If there were a possibility of containment foundation contamination due to fluid leaks, surveillance and corrective actions could be taken (Tr. 8190-8193). It is estimated that the tools used in the decommissioning would also become contaminated but these could be easily cleaned

(Tr. 8221). Removal of non-radioactive superstructures would be by conventional methods. The Staff estimated that this decommissioning procedure could be accomplished within six months to a year, the actual time required being a function of Applicant's desires (Tr. 8193).

234. Alternate methods of decommissioning the Plant were also presented by the Applicant and Staff. The complete removal of the NSS with complete demolition of all superstructures would be one alternative. This would involve burial of some components of the system, such as the reactor vessel and internals, biological shield and the steam generators (Tr. 8198), and removal of other components to governmental burial sites (Tr. 6971-78). A large concrete shield would cover the entombment (Tr. 8198). This alternative would take longer than the first (Tr. 8203). Another alternative would involve the complete dismantling of all structures. The reactor vessel would be cut up and removed in pieces, or it would be taken out in one piece and buried nearby. Dismantling time for this alternative would be estimated at about two years (Tr. 8204-8209).

235. In general, it would be Applicant who would determine to what extent the Plant was to be dismantled (Tr. 8161, 8215-16). It is Applicant's duty to submit an application to the AEC, containing its dismantling plan, for a license permitting decommissioning pursuant to 10 CFR §50.82. The application for permission to decommission the facility would be reviewed by the Staff prior to the granting of authority (Tr. 8161-62). Staff inspectors would also visit the site and make periodic inspections during the dismantling program (Tr. 8162). The different costs of the different schemes of decommissioning were compared and possible large cost differences recognized. Applicant's estimate for decommissioning under the first alternative was $35 million (Tr. 6980-7006). That cost would be present cost and would include removal of the

turbine building and other auxiliary buildings which are non-nuclear portions of the Plant and filling and grading the cooling pond (Tr. 6945-6946, 6990). It would not include future surveillance nor the loss of the productive use of the land during the sealed facilities existence (Tr. 6945-6946). Testimony indicated that surveillance and land costs would be de minimis (Tr. 7852-7856). The Board particularly notes that only a few acres would be occupied by the sealed buildings and no credit was made in the estimate for the fact that approximately 1000 acres of the site will be made available for other productive use (Tr. 7863). Testimony indicated that application of escalation to the $35 million figure for inflationary increases over 35 years could increase it to about $90 million, but that when present worthed to make it comparable to the other costs evaluated in the cost-benefit analyses it would come to a figure of only about $8 million (Tr. 7820-21). The estimate was not contradicted and the Staff, based on its review of actual costs at other facilities, concluded that the Applicant's estimate of the $35 million was satisfactory and that $8 million was a reasonable present worth value (Tr. 7824-7826, 8195-96). The testimony indicated that no significant environmental effects could be expected from decommissioning of the facility (Tr. 8157). The AEC has had extensive experience with the decommissioning of nuclear facilities (Tr. 8222-8237) and between now and the year 2010, when decommissioning might be expected to take place, it will acquire much more experience (Tr. 8238-40). The Board finds that decommissioning will be subject to thorough AEC regulatory review and approval at the end of the 30 to 40 year Plant life and there is reasonable assurance that it will have no significant

environmental effects. The Board concludes that an adequate presentation of this distant occurrence has been made and that the best estimate of the cost of decommissioning is a present worth value of less than $8 million.

Impact from Transportation of Fuel

236. Transportation of unirradiated fuel elements to the Plant, spent fuel elements from the Plant and packaged radioactive waste from the Plant will be made in shipping containers approved and licensed by the Department of Transportation and will be made in accordance with detailed regulations of the Department of Transportation and the AEC (ASER Applicant's Ex. 38F-1, pp. 4.5-1 to 4.5-11). Such regulations limit external radiation to the public from containers used in transport to extremely low levels (ASER Applicant's Ex. 38F-1, pp. 4.5-2, 4.5-7 and 4.5-10). Applicant pointed out that since 1962 it had made more than 50 shipments of fuel elements to its facilities and 17 shipments of spent fuel from such facilities without incident and with negligible effects on the environment (ASER Applicant's Ex. 38F-1, p. 4.5-1). The Staff evaluated exposures that could be expected under non-accident conditions. For transport of new fuel the Staff concluded that the dose that could reasonably be expected to a member of the public could be about 0.005 mrem per shipment and that therefore there would be no effect during normal transportation (FES Staff Ex. 6, p. V-36). Evaluation of transport of spent fuel yielded a potential dose to a member of the public of only about 1.3 mrem and an integrated population dose along the route of the shipment of about 0.2 man-rem (FES Staff Ex. 6, p. V-37). In view of natural background levels and other ordinary exposures to radiation, this must

be viewed as negligible. The Staff also evaluated the potential heat release from spent fuel shipments and found it to have negligible environmental effects (FES Staff Ex. 6, p. V-37). Estimated dosages from shipment of radioactive waste would be equivalent to those from spent fuel, except that transportation of recycled tritium would result in no external dose (FES Staff Ex. 6, p. V-38). The Board concludes that the Applicant furnished adequate information regarding normal transportation and the Staff adequately evaluated the information. Intervenors did not participate in this matter. The Board concludes that the environmental effects of fuel and waste transportation under non-accident conditions are negligible.

237. The environmental effects of transportation accidents were also evaluated. Applicant described the detailed accident analyses and tests that are performed on shipping containers to ensure that they meet the stringent criteria promulgated by the Department of Transportation (ASER Applicant's Ex. 38F-1, pp. 4.5-4 to 4.5-6). The Staff analyzed the potential consequences from accidents to new fuel, spent fuel and wastes (FES Staff Ex. 6, pp. VI-6 to VI-8). Because of the design of the container and limitations on quantities transported, it is considered extremely improbable that new fuel could become critical even in the event of an accident (FES Staff Ex. 6, p. VI-6). Even if it were to become critical, the serious exposures would be limited to about 100 feet from the accident (FES Staff Ex. 6, p. VI-6). Evaluation of spent fuel shipments indicated that under extremely improbable circumstances an accident could result in the release of some of the gases and some of the coolant from the containers which would result in exposures of a few hundred millirem within about 100 feet downwind from the cask (FES

Staff Ex. 6, p. VI-7). Solid waste shipments would be unlikely to cause any significant exposure in the event of an accident because of the fact that the solid materials, even in the remote probability of a breach of packaging, would not spread as would liquid or gases (FES Staff Ex. 6, p. VI-8). Liquid waste shipments are of such a low level of activity that even in the highly unlikely event of an accident it would not be expected that any significant exposure could result (FES Staff Ex. 6, p. VI-8).

238. The Staff indicated that the consequences of such accidents must be evaluated in the context of the probability of an accident (FES Staff Ex. 6, pp. VI-6 to VI-8). In response to the Board's inquiry on the likelihood of an accident to a shipment from the Plant (Tr. 7613), the Staff indicated that radioactive shipments over the life of the Plant could be expected to approximate 930,000 miles by truck (Staff letter dated July 24, 1972, p. 2). Recent accident statistics indicate one truck accident per 750,000 shipment-miles which would indicate the possibility of one truck accident over the life of the Plant (Staff letter, dated July 24, 1972, p. 3). In the event of accident, depending on packaging, the probability of any release of radioactive material ranges from 1 in 10 to 1 in 100 (Staff letter, dated July 24, 1972, p. 3). It is therefore extremely unlikely that there will be any transportation accident that will have any environmental significance.

239. The Environmental Protection Agency generally agreed with the Staff conclusion that postulated transportation accidents are highly unlikely and that environmental risk is extremely low (FES Staff

Ex. 6, Appendix E, p. 37) but encourage analyses of accidents on a generic basis. The Staff indicated that it did have such an analysis under way and that results have progressed to the point that it appeared that the results of the study would be in agreement with the conclusions contained in the FES (Staff letter, dated July 24, 1972, p. 1). In response to Board questions regarding the use of the most direct rail routes and the interstate highway system for fuel shipments (Tr. 7610, 7611), the Staff concluded that there were offsetting considerations in use of various routes and that it did not believe that any special routing would be indicated (Staff letter, dated July 24, 1972, p. 2). The Mapleton Intervenors did not involve themselves in this matter. The Board finds that the Applicant supplied sufficient information and the Staff adequately evaluated it. The Board is of the conclusion that the probability of any significant effect from a transportation accident is so low as to not be meaningfully quantifiable in terms of environmental cost.

Effect of Thermal Releases to Dow

240. Much discussion was had at the hearing as to whether it is necessary to consider the impact of Applicant's thermal releases to Dow (Tr. 5917-44). As described in paragraph 90 above, Applicant utilizes the heat in steam in the Plant to make process steam which is sent to Dow. Applicant argued that the manner in which the heat put into the process steam is utilized or eventually dissipated is not a legitimate concern of this Board. Applicant analogized the situation to evaluation of the ultimate disposition of electricity generated at the Plant and sold to its customers throughout the state (Tr. 5924). Mapleton Intervenors, on the other hand, argued that all heat releases

should be accounted for in considering the effect on the environment and the fact that the heat is released in the form of the commercial product, process steam, rather than as discharge to the cooling pond was irrelevant (Tr. 5920, 5930). All parties agreed that the disposition of electricity and its specific uses was not in issue (Tr. 5922). The Board concluded that it would inquire into the environmental effects of the thermal dissipation of the process steam (Tr. 5950, 6273).

241. Mr. Edwin Shannon, Manager of the Waste Control Department, Midland Division, Dow Chemical (Tr. 6356-6359) testified on the manner in which the thermal content of the process steam would be dissipated and as to how such dissipation related to Dow's present use of process steam (Tr. 6363-6411; 6431-40). Presently Dow utilizes process steam containing a maximum of 3.2 billion btu per hour (Tr. 6369). This heat is roughly dissipated to the waste treatment pond (200 million Btu per hour), to the No. 6 brine pond (300 million Btu per hour), through building vents and heating (700 million Btu per hour) and to the Tittabawassee River (1.8 billion Btu per hour) (Tr. 6369). Following operation of the Plant a maximum of 4.8 billion Btu per hour would be sent to Dow. Of this 300 million would be returned to the Plant as condensate (Tr. 6376). The remainder, except for 380 million Btu per hour discharged to the river, would be dissipated to the atmosphere by the waste treatment plant (200 million Btu per hour), tertiary treatment pond (400 million Btu per hour), No. 6 brine pond (300 million Btu per hour), building vents and heating (700 million Btu per hour) and cooling towers or air cooled condensors (2.2 to 2.5 billion Btu per hour) (Tr. 6373-74, 6377-78). Dow will thus be disposing of 1.3 million Btu per hour more than presently, an approximately 40% increase. All of

this increase will apparently be dissipated to the atmosphere through ponds and towers, because of the dramatic decrease to the river. Dow has stipulated with the Water Resources Commission to reduce its thermal discharge to the river so as not to increase the temperature in combination with others more than 5°F above ambient outside of a mixing zone (Tr. 6379-80; Mapleton Ex. 26). The Board is of the opinion that this discharge, within water quality standards and only about 1/6 of the present discharges, will not cause any significant adverse impact on the river. (See written testimony of D. J. Seeburges, dated July 7, 1972) Heat dissipated to the atmosphere from the various ponds does not change significantly between the two periods of time and thus no significant effect can be assigned to Dow's increased usage of process steam. It is clear from the testimony that the cooling towers will produce some fog in their immediate vicinity (Tr. 6392), but that they will be spread out over a large area so that no significant effect should result (Tr. 6395). Additionally, a major portion of releases from cooling towers will come from towers being installed to handle present needs and thus only an increment is attributable to the increased usage of process steam (Tr. 6389-90). The relationship between the Dow cooling towers and the Plant cooling pond has been discussed above at paragraph 228.

242. The Board concludes that transfer of heat to Dow will not significantly affect the river and will cause some environmental fogging from cooling towers at the Dow Plant. However, much of the heat to be dissipated results from usage of process steam at Dow's present level of use and it could well be that even if the Plant were not built at Midland Dow would increase its usage of process steam and

need to dissipate heat. There is no reason to suppose that the fogging will be of any significance and because of the spread out location of the towers and the productive use made of the steam sent to Dow it is clear that this means of dissipation is superior to any method that could be employed at the Plant site to dissipate this heat.

Impact of Transmission Lines

243. All transmission lines associated with this project have been routed, designed and will be constructed and maintained according to Environmental Criteria for Electric Transmission Systems developed by the United States Departments of Interior and Agriculture; Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design and Location of Rights of Way and Transmission Facilities published by the Federal Power Commission; Transmission and Distribution Rights of Way Selection and Development and Substation Site Selection and Development developed by Johnson, Johnson and Roy, Inc, landscape architects, specifically for Consumers Power Company (ASER Applicant's Ex. 38F-1, §4.6.1; ASER Applicant's Ex. 38F-3 Appendices P, Q and R; FES Staff Ex. 6, III-3, III-4). The energy generated at Midland will be delivered to the Applicant's existing system at Tittabawassee Substation through two, 2.3 mile, single circuit, 345 kV lines. There will be from 13 to 15 towers over the 2.3 mile stretch (Tr. 6751 and 6757). The route for these lines is over land which is generally flat in nature and best described as industrial or waste land. The route does not pass through areas with natural, historic, scenic or recreational value (ASER Applicant's Ex. 38F-1, §§4.6.2.1 and 4.6.4). A second line will be constructed in conjunction with the Plant in order to tie the Plant into the existing system.

This line will extend south from the Tittabawassee Substation to loop the existing Kenowa-Thetford 345 kV line into the Tittabawassee Substation. Route selection for the above 28 miles of line avoids areas with natural, historic, scenic or recreational value. (ASER Applicant's Ex. 38F-1, pp. 4.6-2 and 4.6-3) The 28-mile line from Tittabawassee Substation to the Kenowa-Thetford 345 KV line will have approximately 140 towers installed (Tr. 6751). The maximum height of these towers will be about 133 feet (Tr. 6752). The lands covered by these rights of way do not lend themselves to secondary uses with exception of that land which is used for farming. In the latter case, farming is allowed to continue in the right of way and is restricted only around the immediate base of the towers. This results in essentially no loss of land productivity because of the transmission line (ASER Applicant's Ex. 38F-1, §4.6.3.3). A 138-kV startup line will cross the river from the Plant to a proposed Dow substation (FES Staff Ex. 6, p. V-8). Because of the industrial nature of the area it will have no environmental effect; however the Staff has proposed that it be relocated so as to use the same river crossing as the 345 kV lines (FES Staff Ex. 6, pp. iii, V-8). The Applicant has agreed to relocate this line (Tr. 7155).

244. A number of municipal utilities and elective cooperatives (FES Staff Ex. 6, pp. 75-79) and the Mapleton Intervenors (Tr. 6756) stated that they thought that various large transmission lines from the Tittabawassee Substation north should be evaluated for their environmental impact. However, the evidence clearly indicates that those lines are part of Applicant's over-all system, will be constructed and operated well in advance of Plant operation to meet system needs and will be constructed and operated whether or not the Plant is ever built. (ASER Applicant's Ex. 38F-1, p. 4.6-2; Tr. 6754; FES Staff Ex. 6, p. V-7)

Mapleton Intervenors' theory that they should be evaluated because they will eventually carry energy from the Plant is without merit as every line on Applicant system will eventually carry electricity from the Plant (Tr. 6756). During the hearing the question of the adverse environmental impact of transmission lines on birds was raised by the Mapleton Intervenors. Dr. Larry Holcomb (Tr. 8517), an Associate Professor of Biology at Creighton University in Omaha, Nebraska, testified for the Mapleton Intervenors and also examined witnesses during the environmental hearing. Although Dr. Holcomb had taught courses in ornithology (Tr. 8518) he was unable to supply the Board with any evidence that birds would be endangered by the type of towers Applicant intended to build (Tr. 8628-41). The Board accepts the testimony of Dr. Leslie Gysel, Professor in the Departments of Forestry and Fisheries and Wildlife of Michigan State University (Tr. 6604), that the probabilities of birds striking the towers are remote (Tr. 6758). Professor Gysel's testimony was supported by Mr. Donald D. Grube of Argonne National Laboratory (Tr. 7148), a biologist who testified that his research on the subject caused him to conclude that there would be no large or material impact on birdlife as a result of the towers of the height contemplated to be built by the Applicant (Tr. 7215-16). In the opinion of the Board, the criteria and guidelines to which the towers will be designed and constructed are satisfactory to prevent significant impact on the envrionment and the Board further finds that Applicant's manner of land use will minimize the amount of land lost from other uses and that birdlife will not be endangered by the structures. Applicant has furnished sufficient information in this area and the Staff has adequately reviewed the matter.

Plant Construction Effects

245. Applicant has described the construction activities that will be performed at the site (ASER Applicant's Ex. 38F-1, §4.1). Some noise, dust and traffic can be expected during normal operation of the Plant as would be the case of any large construction project. These effects are temporary and should be minimal because of the location of the Plant with respect to the surrounding population and the preventive measures to be taken during the construction period (ASER Applicant's Ex. 38F-1, p. 4.1-1). Measures to reduce or limit the impact of Plant construction on the surrounding population include: control of dust by means of water sprinklers; control of earthmoving equipment near the site boundaries; prohibition of blasting of rocks and tree stumps and construction of a temporary access road to avoid interference with traffic along Miller Road (ASER Applicant's Ex. 38F-1, pp. 4.1-1 and 4.1-2; FES Staff Ex. 6, p. IV-3). During construction of the Plant, approximately 700 construction workers will be employed, most of them residents of the tri-cities (Midland, Saginaw and Bay City) area (FES Staff Ex. 6, p. IV-1). Staff investigation confirmed that adequate housing is available in the Midland area to handle the projected influx of new workers and that the Midland school system can accommodate any likely increase in school population (FES Staff Ex. 6, pp. IV-1 and IV-3). The capacity of the school system was confirmed in the comments from the Midland Public Schools (FES Staff Ex. 6, p. 59). Applicant has supplied sufficient information regarding construction activities and the Staff has adequately reviewed such information. The Board concludes that the effects

of construction activities will be temporary and that proper precautionary measures have been taken to minimize these temporary effects.

Aesthetics

246. Applicant has given consideration to the aesthetics of the Plant and will set the cooling pond back from the site boundary a minimum distance of 160 feet (FES Staff Ex. 6, p. V-1), plant appropriate trees and shrubs along the pond dike to screen the pond and fence from nearby residences (ASER Applicant's Ex. 38F-1, p. 4.1-5; FES Staff Ex. 6, p. IV-4, V-1), relocate its start-up transmission line from the Dow Substation to minimize its visual impact (FES Staff Ex. 6, p. iii, Tr. 7155), design the Plant buildings to be functionally attractive (FES Staff Ex. 6, p. III-2) and leave a several-acre parcel of land which would have been contained in the northwest corner of the cooling pond in its natural state (ASER Applicant's Ex. 38F-1, p. 4.1-5). The Board concludes that Applicant and the Staff have given adequate consideration to the aesthetic impacts of the Plant.

Noise

247. Applicant, in response to a question from the Staff, has estimated the noise levels at the Dow Complex and the nearest residences resulting from Plant operations (ASER Applicant's Ex. 38G, p. 6.23-1). The estimated noise levels were equivalent to that of moderate traffic in the case of Dow and light traffic at the nearest residence (ASER Applicant's Ex. 38G, p. 6.23-1). The average combined noise level at the nearest residence falls within the Housing and Urban Development's classification "normally acceptable" (ASER Applicant's Ex. 38G, p. 6.23-2).

Applicant will also monitor noise levels as required by the Occupational Safety and Health Administration (FES Staff Ex. 6, p. V-9). Applicant has furnished sufficient information and the Staff review has been adequate. The Board concludes that noise levels from the Plant will not create any significant effects.

Historical and Archeological Considerations

248. There are no historic sites listed on the State or National Registers in the area of the Plant site (ASER Applicant's Ex. 38F-1, §3.3). Because the Tittabawassee River is associated with sites of the Woodland's Indians, Applicant has extended permission to the local archeological society to inspect the site (ASER Applicant's Ex. 38F-1, p. 3.3-1). The Department of Interior indicated that its concerns for historical and archeological resources had been satisfied but requested that Applicant cooperate with interested agencies to the extent deemed appropriate by the AEC (FES Staff Ex. 6, Appendix E, p. 26). Applicant agreed to immediately notify the AEC and take all reasonable actions in the event of any discovery (Applicant's Ex. 38K, pp. 88-89). Applicant provided sufficient information and the Staff adequately reviewed such information (FES Staff Ex. 6, p. 11-8). The Board concludes that historical and archeological matters have been properly considered and will be adequately protected.

Monitoring

249. Applicant has described a comprehensive environmental and radiological monitoring program (ASER Applicant's Ex. 38F-2, Appendices A and B; Applicant's Ex. 38K, pp. 62-71). The preoperational radiological environmental monitoring program will be conducted for a minimum of two

years prior to operation in order to establish base line values for radiation levels in the area. Operational radiological environmental surveys will be made around the site and the results thereof will be compared with the base line data and with data obtained from similar surveys that Applicant will conduct at reference areas beyond the Plant's potential influence (Applicant's Ex. 38K, pp. 62-71). Samples will be taken of river water, Saginaw Bay water, well water, air and aquatic organisms (ASER Applicant's Ex. 38F-1, Appendix A; Applicant's Ex. 38K, pp. 62-71). Applicant's preoperational environmental surveys will include analyses of fish and benthic populations at the site and will be used as background data for later operational surveys (ASER Applicant's Ex. 38F-3, Appendix A). In addition, Applicant will maintain at least two continuous water temperature monitors to insure that its discharge is within approximately 1°F of ambient river water temperature (Applicant's Ex. 38K, p. 63). Applicant will also maintain monitors on numerous other parameters of its discharges (Applicant's Ex. 38K, p. 63; Tr. 7479-82). The Staff has reviewed Applicant's monitoring programs and has determined that such programs should provide for the following:

> "c) At least two years prior to plant operations, initiate an ecological (including radiological) study of the site and environs to establish base line values. The study should have a scope and frequency which will:
>
> > "1) Identify the economically and environmentally important species. Determine their abundance and life history when pertinent to the site, and define the extent and location of their habitat,
> >
> > "2) Characterize the ecological community, defining the community structure with special attention to stability or fluctuations, and

"3) Obtain background data on the radioactivity in important indicator organisms (See Section V., pages 13, 21 and 33).

"d) Develop a surveillance and monitoring program of significant parameters based upon the ecological study which will document the impact of the plant operations upon the ecology of the site and environs. The ecological surveillance and monitoring program actions to be developed should serve to identify actual effects on the environment from plant operations (See Section V., pages 13, 21 and 33)." (FES Staff Ex. 6, pp. iii-iv)

Applicant has agreed to make the necessary modifications when it details its program (Tr. 7155). The Board concludes that an adequate detailed program to monitor radiological and environmental effects can be developed on the basis of the criteria contained in the record (including the Staff requirements) and building on the programs as proposed.

Adverse Effects That Cannot Be Avoided

250. The Staff summarized the adverse effects of the proposed action which cannot be avoided (FES Staff Ex. 6, §VII). The Staff concluded that the minimal adverse environmental effects of cooling pond fog, displacement of wildlife and aesthetic impact of transmission lines cannot be avoided (FES Staff Ex. 6, §VII). All of the other environmental effects either have an impact so small as to be undetectable or are not adverse. Many of the potential adverse impacts will be avoided as a result of the actions of the Applicant and Staff to protect the environment. The Board concurs in the Staff's enumeration of unavoidable adverse effects.

Short-Term Uses and Long-Term Productivity

251. Both the Applicant and the Staff discussed the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity (Applicant's Ex. 38, p. 10; FES

Staff Ex. 6, p. VIII-1). The Staff took into account the present industrial and residential zoning of the site and the land's previous and potential uses (FES Staff Ex. 6, p. VIII-1). The portion zoned industrial would probably have developed in an industrial manner in any event in that it is only marginally productive for agriculture and is adjacent to areas of heavy industry. The pond area is zoned residential and could support agriculture on about 50% of its soil. It can be restored for residential use on decommissioning of the facility. Neither the site nor the river shore area had been used for recreational purposes and the river is not presently of a quality that would support meaningful recreational use (FES Staff Ex. 6, p. VIII-1).

252. While, as discussed above, potential short-term uses of the site will not be adversely affected by the Plant, it is clear that the existence of the Plant which will provide both electricity and process steam at a reasonable cost will have a beneficial effect on long-term productivity (Applicant's Ex. 38, p. 10). In view of the type of site involved, its past manner of usage and its likely potential uses, the proposed use of this site for the Plant would appear to maximize its potential for productivity.

Irreversible and Irretrievable Commitment of Resources

253. There are only two irreversible and irretrievable commitments of resources associated with the Plant (FES Staff Ex. 6, §IX). On decommissioning of the facility, Applicant may choose to seal it off and permanently restrict access to it. In such event the small portion of the site on which it is located would be lost to almost all productive use (FES Staff Ex. 6, p. IX-1). The remainder of the site, however, can be

returned to other productive use. Additionally some of the nuclear fuel is irretrievably consumed. This could total approximately 900 metric tons of uranium fuel. However, plutonium will be produced from the fuel and some urarium is recoverable (FES Staff Ex. 6, p. IX-1). The Staff also lists the water consumption as irretrievable, but points out that the consumption is not really a loss but a redistribution (FES Staff Ex. 6, p. IX-2). The Board concurs with the Staff's analysis of the irreversible and irretrievable commitments of resources.

Need for Power

254. Applicant presented extensive detailed electric sales forecasts through 1980, converted these sales forecasts to estimates of peak demand for electricity and related such projections to its existing generation, its construction and retirement program and projections for the Michigan Electric Power Pool to demonstrate the need for electricity from the Plant. (ASER Applicant's Ex. 38F-1, §2; Applicant's Ex. 38G, revised Ex. 1 to §2; Applicant's Ex. 38K, pp. 108-114) Applicant projects sales growth by class of service based primarily on historical trends modified to reflect other data indicating changes in these trends such as population forecasts, projections of various economic indicators, projected energy use, customer saturation for major appliances and other factors judged to have an effect on future sales. (ASER Applicant's Exhibit 38F-1, §2.2) Applicant's past projections have been extremely accurate. (ASER Applicant's Ex. 38G, Appendix B to Ex. 1 of §2) A witness from the Federal Power Commission (FPC) testified regarding factors to be considered in determing the

need for power, testified as to the FPC's review of projections for Applicant and the Michigan Electric Power Pool (Tr. 8012-8149), testified that the differences between the FPC projections and Applicant's are insignificant (Tr. 8148-49) and confirmed that historically Applicant's projections had been accurate (Tr. 8093). The Staff compared Applicant's projections with data gathered from other sources, including trends shown for population increases in the United States, and concurred in the reasonableness of Applicant's projections. (FES Staff Ex. 6, §X; Tr. 8090-91) The projected increases in sales over the next ten years result from population increases, particularly large increases in the adult population which result in increased household formation, and increased usage per consuming unit, including a significant increase in electricity being used for control or elimination of air and water pollution (ASER Applicant's Ex. 38F-1, pp. 2-6 to 2-9; Tr. 6528-33). The Board concludes that projections of 5,500,000kW, 6,020,000 kW and 6,920,000 kW (ASER Applicant's Ex. 38G, Table DEM-1 to revised Ex. 1 to Section 2; Applicant's Ex. 38K, pp. 109,111), respectively, for Applicant's summer peak load in 1977, 1978 and 1980 are reasonable and that projections of 14,845,000 kW, 16,075,000 kW (ASER Applicant's Ex. 38G, Table DEM-1 to revised Ex. 1 to Section 2; Applicant's Ex. 38K, pp. 109, 111) and 18,450,000 kW (ASER Applicant's Ex. 38F-1, p. 2-5), respectively, for the Michigan Electric Power Pool's summer peak load in 1977, 1978 and 1980 are reasonable. Projections of 5,720,000 kW, 6,230,000 kW (Applicant's Ex. 38K, pp. 109,111) and 7,150,000 kW (ASER Applicant's Ex. 38G, revised Table DEM-1 to revised Section 2) are reasonable for Applicant's peak loads for the winters of 1977-78, 1978-79 and 1980-81, respectively.

255. The present installed capacity of Applicant's system is approximately 3,897,000 kW plus 114,000 kW from the Thetford Plant and approximately 400,000 kW for the Palisades Plant (60% of capacity, AEC Docket No. 50-255) and, less retirements in 1972 of 126,000 kilowatts totalling 4,285,000 kilowatts (ASER Applicant's Ex. 38F-1 § 2.1 and p. 2-12; Tr. 6537). This indicates a need for additional capacity of 1,435,000 kW just to meet its projected peak load in the winter of 1977 and 1,945,000 to meet its load in the winter of 1978. However, Applicant in addition to its need to install capacity to meet its peak load must install additional capacity to provide reserves in the event of unscheduled Plant outages and scheduled Plant refueling and maintenance (ASER Applicant's Ex. 38F-1, p. 2-9). Also, Applicant being a member of the Michigan Electric Power Pool ("Pool") is fully integrated with The Detroit Edison Company (Detroit Edison) and must schedule its units in conjunction with Detroit Edison so that the Pool will also have adequate reserves (ASER Applicant's Ex. 38F-1, pp. 2-4, 2-9; Applicant's Ex. 38K, p. 108). Applicant and the Pool seek to maintain an 18% reserve to provide sufficient additional capacity against outages (ASER Applicant's Ex. 38F-1, p. 2-9). Applicant has detailed its construction schedule through 1980, including in its schedule addition of the 485,000 kW Midland Unit No. 1 in 1977 and the 815,000 kW Unit No. 2 in 1978 (ASER Applicant's Ex. 38F-1, pp. 2-12 through 2-13; Applicant's Ex. 38K, p. 108). Applicant's calculations show that unavailability of the Midland Unit No. 1 in the summer of 1978 will result in a reserve margin on the Applicant's system and on the Pool system (taking into account reserve sharing) of 9.8% (Applicant's Ex. 38K, p. 113). With the Midland units in operation

this reserve margin would be 17.9% (Applicant's Ex. 38K, p. 113). This reserve margin assumes that other plants scheduled for completion between now and 1978 are completed on schedule and are operable in 1978 (ASER Applicant's Ex. 38F-1, p. 5.3-1).

256. In planning generation additions, Applicant not only takes into account the quantity of generation needed but also must provide a proper generation mix in terms of meeting the various portions of its load (ASER Applicant's Ex. 38F-1, pp. 2-9 through 2-11). As explained by Applicant, a utility has a fluctuating demand over the course of a day and the course of a year. Thus, system peaks occur during the coldest parts of the year and the warmest parts of the year and at certain times of day (ASER Applicant's Ex. 38F-1, p. 2-9). It is to these peaks which Applicant must design its total capacity, but in addition Applicant must have different types of generation to meet portions of this peak (ASER Applicant's Ex. 38F-1, pp. 2-5 and 2-10). Base load units are designed to operate twenty-four hours a day to meet the portion of the demand that is always present. Such units are characterized by high capital costs which can be spread over many units of production and low operating costs resulting in the lowest cost production of electricity on the system (ASER Applicant's Ex. 38F-1, p. 2-10; Tr. 6571). Intermediate load units meet the intermediate portion of the demand, i.e., when the load increases above base load, and are designed to operate from 10 to 60 percent of the time. Such units because they operate less frequently can be economical with somewhat higher fuel costs than base load units but must have lower capital cost (ASER Applicant's Ex. 38F-1, p. 2-11). Peaking units are designed to operate infrequently and for

short periods of time to meet the peak of the demand curve and to replace forced outages. These are usually high fuel cost, low capital cost units although they may also be older, less efficient base load and intermediate load units (ASER Applicant's Ex. 38F-1, p. 2-11). In order to maximize system efficiency and reliability and create the most economical generation, a proper balance of these three types of generation must be maintained (ASER Applicant's Ex. 38F-1, p. 2-10). Applicant has indicated that because of the delay in licensing the Plant, several intermediate load units (because of their shorter lead time from planning to operation) have been moved forward into the time period for which the Plant was originally intended (1974-75) (ASER Applicant's Ex. 38F-1, pp. 2-13 through 2-14; Tr. 6572-73). This will result in a situation in which Applicant has too much intermediate load capacity and too little base load capacity and is thus required to utilize intermediate load units with their higher fuel costs as base load units. This will result in a less effecient system producing higher cost electricity (ASER Applicant's Ex. 38F-1, pp. 2-13 through 2-14; Tr. 6572-73).

257. The Board queried Applicant as to its basis for an 18% reserve margin (Board Order of March 27, 1972). Applicant stated that the criterion for Applicant and the Michigan Pool is to maintain a level of reserve such that the probability of loss of load is once in 20 years (Applicant's Ex. 38N, p. 1). It is their judgment that such a criterion is sufficiently conservative to provide reasonable assurance that reliable electric service will be available. Based on probability studies run by Applicant utilizing the various system parameters in 1978, an 18% reserve margin equates with loss of load once in 20 years. Applicant stated that reduction of reserves to 15% increased loss of load

probability to once in five years and a decrease in reserves to 10% increased loss of load probability to once in seven months (Applicant's Ex. 38N).

258. A witness from the Federal Power Commission (FPC) testified that Applicant's load projections were reasonable (Tr. 8148-49), and demonstrated that the FPC projected reserve margins for the Pool similar to those projected by Applicant (Tr. 8026). He further testified that the FPC generally uses a guideline for reserve margins of between 15 and 25 percent with utility systems of Applicant's type (i.e., a system characterized by large coal-fired units) being recommended to be in the higher end of the range (Tr. 8080-8136-38). The FPC witness also discussed the consequences of failure to maintain an adequate reserve margin and the steps that utilities would take before interrupting customers' service (Tr. 8023). He agreed with Applicant that for the Michigan Pool the Midland Units No. 1 and 2 or equivalent base load capacity is required in 1977 and 1978 (Tr. 8143) and recognized that lead times for constructing nuclear plants are now from seven to ten years and that even construction of fossil fired base load units is subject to delays and vagaries (Tr. 8146).

259. Mapleton Intervenors argued that the Plant was being built to supply power to Canada (Tr. 6550-51; 8064-65). Applicant's contract with the Ontario Hydro-Electric Commission provides for exchange of several types of energy, (emergency, economy and diversity) but provides for interruption of any transaction when the energy is needed on the sender's system (Mapleton Intervenor's Ex. 38 and 39; Tr. 6541-42, 8040-51). Applicant's witness testified that all of the capacity being installed at Midland is for Applicant's and the Pool's

letter of June 7, 1972). Cross-examination by Mapleton Intervenors was lengthy and, while this is not intended to be criticism, primarily revealed their lack of understanding of utility operations. They tried to compare kilowatts directly to kilowatt hours (Tr. 6530), they confused transmission capacity with generating capacity (Tr. 8065), and apparently misunderstood the concept of circulating power and the bases of utility planning (Tr. 8061-65).

260. Based on the exhibits and testimony presented, it is the Board's conclusion that Applicant has demonstrated its need for 486,000 kW of base load generation in 1977 and 815,000 kW of base load generation in 1978 to meet its projected demand and Pool obligations and to provide adequate reserve margins to protect against forced outages and permit scheduled outages. Applicant has justified the need for this amount of capacity on the basis of the needs of its own system and the Pool system and not on the basis of the need to have power available to export to other systems.

Alternatives

261. Applicant has extensively considered alternative means of satisfying its need for 1,300,000 kW of base load capacity in 1977-78 including alternate means of generation (ASER Applicant's Ex. 38F-1, §§ 5.1 and 5.2, as amended by Applicant's Ex. 38H and 38I), purchase of the capacity from another utility (ASER Applicant's Ex. 38F-1, § 5.3) and location of generation at another site. (ASER Applicant's Ex. 38F-1, § 5.4; Applicant's Ex. 38L, pp 72b-72f.) Applicant's consideration extended to construction of the Plant as a single purpose Plant with Dow constructing its own plant to meet its process steam and electrical needs.

(Applicant's Ex. 38L, pp 72-72f.) In addition, Applicant considered alternate cooling systems (ASER Applicant's Ex. 38F-1, § 5.5), alternate radioactive waste disposal systems (ASER Applicant's Ex. 38F-1, § 5.6) and alternate chemical waste systems (ASER Applicant's Ex. 38K, p 45). The Staff thoroughly evaluated the various alternatives available to Applicant including comments of other agencies. (FES Staff Ex. 6, § XI; Tr. 7624-29, 7721-28, 7775-77, 7818-19, 7914-58, 7736-92.)

Alternative Means of Generation

262. The Applicant discussed and evaluated alternate sources of power including hydroelectric, pumped storage, fossil-fired conventional plants, combustion turbine generators, combined cycle plants and diesel generating units. (ASER Applicant's Ex. 38F-1, §5.2.) There are no potential sites in Applicant's service area for developing 1,300,000 kW of hydroelectric generation. (ASER Applicant's Ex. 38F-1, p 5.2-1.) Pumped storage plants rely upon base load units for pumping power in off-peak hours and therefore are not alternatives for base load capacity. (ASER Applicant's Ex. 38F-1, p 5.2-1.) Problems, such as noise and magnitude of numbers of units, as well as highly unfavorable economics, make diesel-generating units undesirable alternatives for base load (ASER Applicant's Ex. 38F-1, § 5.2.1.6). Therefore, only fossil-fired conventional units and oil-fired combined cycle units are alternatives to the Midland Plant.

263. Evaluation of alternate means of generation was based on analysis of the cost of electricity generated (ASER Applicant's Ex. 38F-1, § 5.2.1), the availability of fuel (ASER Applicant's Ex. 38F-1, § 5.2.3) and the environmental effects of the alternatives (ASER Applicant's Ex. 38F-1, § 5.2.2.). Applicant summerized its evaluation in an elaborate

cost benefit analysis prepared according to a model issued by the Staff as a proposed guide in December 1971. (ASER Applicant's Ex. 38H and 38I, pp 5.1-11 to 5.1-46.)

264. Both Applicant and the Staff concurred that gas is not a feasible alternate fuel because it is in short supply in Applicant's area and there are presently restrictions on its use. (ASER Applicant's Ex. 38F-1, § 5.2.3.2; FES Staff Ex. 6, p XI-1; Tr. 6559, 6583, 7919.) Applicant considered a number of alternative means of acquiring gas; importation of natural gas, importation of liquified natural gas, coal gasification, and reformation of liquid hydrocarbons, and found all such possible remedies to be inadequate or too remote for purposes of an alternate to this plant. (ASER Applicant's Ex. 38F-1, pp. 5.2-11 and 5.2-12.)

265. Oil is still available as an alternative, however domestic oil reserves have decreased nine out of ten years between 1960 and 1970 (ASER Applicant's Ex. 38F-1, p 5.2-13; Tr. 6578-79), and domestic oil production is expected to peak in the next two to three years with domestic production decreasing thereafter (Tr. 6578-79). With domestic oil in short supply, the National Petroleum Council projects dependency on foreign oil to increase from the present 23% to 56.5% in 1985 (ASER Applicant's Ex. 38F-1, p 5.2-15, Tr. 6579). Under the present Federal Oil Import Program, Applicant, in the past, has not been permitted to import offshore foreign oil. (ASER Applicant's Ex. 38F-1, p. 5.2-15.) Applicant in addition to considering the possibility of importation of offshore oil, evaluated the potential alternatives of synthetic petroleum from coal liquefaction processes, production from western oil shale deposits, and production from tar sands. (ASER Applicant's Ex. 38F-1, pp 5.2-13 and 5.2-14.) While the two former

possibilities hold out great potential, neither are commercially feasible in the near future and the third alternative, while technically feasible, cannot be expected to be of sufficient magnitude to resolve supply problems. (ASER Applicant's Ex. 38F-1, pp 5.2-13 and 5.2-14.)

266. Low-sulphur coal is available at relatively high cost which, with electrostatic precipitators, would meet Environmental Protection Agency requirements (Tr. 6577, 6583). However, technology is lacking to use high-sulphur coal in an acceptable manner (ASER Applicant's Ex. 38F-1, p 5.2-17; Tr. 6578). A considerable portion of the low-sulphur coal is presently committed to the metallurgical and export markets (ASER Applicant's Ex. 38F-1, p 5.2-17; Tr. 6578).

267. The Staff pointed out that uranium is not a rare element; its availability being more a matter of economics than a matter of depletion. (FES Staff Ex. 6, p XII-5.) Proven uranium reserves at a cost of production of $8 per pound will expire before 1985 (Tr. 6590), but additional proven reserves are available at $10 a pound or $15 per pound (Tr. 6589). The Staff witness stated that there is still a lot of exploration to be conducted for uranium and that uranium is available from foreign sources if the domestic supply should diminish (Tr. 7920). The testimony revealed that uranium reserve projections are developed on a more meaningful basis that includes cost of production and cumulative future requirements than are the reserve projections for coal, oil and gas (Tr. 6587-94).

268. The Board also thinks that it is important in evaluating the availability and desirability of utilizing various fuels to take into account their potential uses. Uranium has little or no usefulness outside of its present application for base load electric generating plants

(ASER Applicant's Ex. 38F-1, p. 5.2-21). However, gas and oil are used in a wide variety of applications including home heating, industrial processing and transportation as well as electric generation (ASER Applicant's Ex 38F-1, p. 5.2-21). Coal is primarily used only as a fuel for base load generation (ASER Applicant's Ex. 38F-1, p. 5.2-21). However, its potential for conversion to oil and gas cannot be ignored (ASER Applicant's Ex. 38F-1, pp. 5.2-11, 5.2-13). Thus, all of these dwindling fuel resources have valuable competing uses except for uranium. Any decision to utilize these other resources should keep such fact in mind.

269. Comments received from other agencies generally took no issue with estimates of fuel availability. (FES Staff Ex. 6, Appendix E.) However, the United States Department of Interior indicated that it thought that Applicant had overestimated Michigan oil and gas production and recoverable oil from oil shale and tar sands. (FES Staff Ex. 6, Appendix E, pp 22-23.)

270. Fuel cost projections for coal, oil and nuclear fuel were presented by Applicant (ASER Applicant's Ex. 38F-1, § 5.2.1.3, pp 5.2-2 and 5.2-5). Applicant's witness and the Staff's witness detailed the various components of the fuel cycle that they had considered in making their cost projections and the manner in which they escalated the component costs. (Tr. 7011-42, 7917-23.) The record of this proceeding reflects extensive cross-examination on fuel availability and fuel costs of both the Applicant's witness (Tr. 6577-94, 7010-42) and the Staff's witness (Tr. 7911-73).

271. It is projected that the Plant will generate about 8.9 billion kilowatt hours per year. Alternative plants were evaluated by replacing the Plant with each alternative one at a time in the computer model of

the Michigan Power Pool utilizing projected capital, fuel and generating costs. (ASER Applicant's Ex. 38H, p 5.1-12.) Because of the high fuel costs of the alternatives, much of the replacement electricity would not in fact come from the alternate plant but would instead come from other plants on the system. (ASER Applicant's Ex. 38H, p 5.1-12.) The results of this analysis showed that over the life of the plants, the closest alternate plant would result in a total system cost for the 8.9 billion kilowatts per year of electricity which exceeded the cost of the same amount of electricity from the Plant by over $200 million. (ASER Applicant's Ex. 38I, p. 5.1-35.)

272. The Staff utilized similar methodology in evaluating the alternatives. The Staff utilized the same capital costs as Applicant and calculated fossil fuel costs both without escalation and with 2% per year escalation. (FES Staff Ex. 6, p XI-6.) The calculations resulted in a cost for the proposed Plant of $859 million; for a single purpose coal-fired steam plant, $903 million (without escalation) and $1,013,000 (with escalation); for a single purpose oil-fired steam plant, $927 million (without escalation) and $1,061,000 (with escalation); and for a single purpose oil-fired combined cycle unit, $821 million (without escalation) and $948 million (with escalation). (FES Staff Ex. 6, Table XI-1.) Because the alternatives are all single purpose plants, the comparison understates the cost differential. A single purpose nuclear plant to produce 1,300,000 kW of electricity would have a cost of only $678 million (FES Staff Ex. 6, Table XI-1). This figure can be calculated by using the Staff cost for a single purpose nuclear plant with a natural draft cooling tower and subtracting the price of the cooling tower ($36 million). Thus even without

assuming escalation, the nuclear alternative result in costs over 30 years which are at least $125 million lower than the nearest alternative. The Board, however, believes on the basis of the testimony at the hearing regarding escalation and the growing scarcity of oil and dependence on foreign sources, that fossil fuel should be escalated by at least a 2% annual differential from nuclear fuel and that the cost advantage to nuclear is closer to $200 million.

273. The Board is satisfied from its review of the data submitted by Applicant (ASER Applicant's Ex. 38H, § 5.1.3, as amended by Applicant's Ex. 38I; ASER Applicant's Ex. 38F-1, § 5.2) and the Staff (FES Staff Ex. 6, § XI), and the testimony of Applicant and Staff at the hearing (Tr. 6577-97, 7011-43, 7914-58) that these estimates are reasonable and that the Applicant and Staff correctly concluded that the cost of fossil-fuel alternatives would greatly exceed the cost of the proposed nuclear plant. No evidence was submitted by intervenors which tends to impeach these conclusions.

274. In addition to the economic comparison, Applicant and the Staff estimated that a coal-fired plant could be expected to release, even with a 99% efficient precipitator system, 4,500 tons per year of fly ash and approximately 65,000 tons per year of sulphur dioxide when using low sulphur coal. (ASER Applicant's Ex. 38F-1, p 5.2-7; FES Staff Ex. 6, Table XI-8.) In addition, it would be necessary to dispose of the 500,000 tons/year of fly ash collected by the precipitators and the coal plant would release a sizeable amount of radioactivity. (ASER Applicant's Ex. 38F-1, p. 5.2-7 and Applicant's Ex. 38C, Response to Department of Interior; FES Staff Ex. 6, Table XI-8) Oil could, under present Federal emission standards, release up to 43,000 tons/year of sulphur dioxide and 10,700

tons/year of particulate matter. (ASER Applicant's Ex. 38F-1, p. 5.2-8; FES Staff Ex. 6, Table XI-1.) While the consumption of water and occupation of land for each alternative may vary somewhat, the effects are similar as are the effects relating to transmission lines (FES Staff Ex. 6, Table XI-8). The Board concludes that there are no environmental advantages to fossil fired alternatives and that there may well be environmental disadvantages.

Alternative Production of Process Steam

275. Applicant submitted substantial information as to the alternatives available to the Dow Chemical Company for obtaining process steam. (ASER Applicant's Ex. 38L, pp 72-72f.) The requirements of Dow Chemical Company for process steam are 2.9 million pounds per hour in 1972 and in 1980, the average consumption on an annual basis will be approximately 3.5 million pounds per hour. (ASER Applicant's Ex. 38L, p. 72a.) This represents a 90% demand factor for a total capability of 4.05 million pounds per hour. Dow's requirements for electric power are 160 megawatts in 1972 and 200 megawatts in 1980. The figures for 1980 are related to the prices for steam and electricity to be charged by the Applicant in connection with operation of the first nuclear unit of the Midland Plant starting in 1977. (ASER Applicant's Ex. 38L, p 72a.) An alternative to the construction by the Applicant of a dual-purpose plant for providing both electricity and process steam is for Dow to continue to operate and later replace its own plants in order to meet its process steam and electricity requirements and for the Applicant to construct single-purpose plants to provide electricity only. (ASER Applicant's Ex. 38L, p 72a.) In order to reduce air pollution, Dow would need to change from burning coal to burning low-sulphur oil. This would result in annual emissions of approximately 2,500 tons of

particulates and 10,000 tons of sulphur dioxide when and if steam generation reached the ultimate rate of approximately 3.5 million pounds per hour. (ASER Applicant's Ex. 38F-1, p 5.2-8; Tr. 7785-87.)

276. A comparison of the costs of process steam and electricity to Dow from Dow-owned generating facilities and from the Plant is given below. (Applicant's Ex. 38L, pp 72a-72b; FES Staff Ex. 6, p XI-2.) The figures for 1972 and 1980 include the costs of fuel, labor, and other operating expenses but not any return on investment in existing Dow facilities. The figures for 1980 have been adjusted for assumed escalation of operating costs and include the cost of converting existing facilities from coal to oil. The figures for new Dow facilities, which would have to be constructed to replace existing facilities soon after 1980, include a return on the investment in new facilities at a rate of 8% per year after taxes.

Cost to Dow Chemical Co.	Existing Dow Facilities		New Dow Facilities	Midland Nuclear Plant
	Burning Coal 1972	Burning Oil 1980	Burning Oil 1980	1980
Process Steam ($/1000 lb)	0.71	1.145	1.6	0.62
Electricity (¢ kW-hr)	1.08	1.5	2.1	1.078

The Staff evaluated the 1980 cost for fuel oil to be $0.92 per 1000 pounds of process steam produced without allowing for thermal losses during combustion. Excluding the costs for operation, maintenance and plant amortization, the cost of producing 3.5 million pounds per hour of process steam in an oil-fired plant would be approximately $9,500,000 a year more than the total cost of process steam produced by the Plant. Taking into account the

adverse effect of increased air pollution from an oil-fired steam plant, in addition to the added cost of steam production, this is not considered a viable alternative by the Staff. (FES Staff Ex. 6, pp XI-2 and XI-3; ASER Applicant's Ex. 38F-1, p 5.2-6 and Applicant's Ex. 38L, pp 72a-72b; Tr. 7736-92.) No evidence was submitted by intervenors on this matter. The Board finds that Applicant submitted sufficient information and the Staff conducted an adequate review with regard to alternatives for production of process steam. The Board finds that the production of process steam by the proposed Plant is preferable to production of process steam by Dow in fossil-fueled production plants.

Alternative Sites

277. There are other sites in the Applicant's service area where power plants could be built, but there is no other site for a dual-purpose plant which not only generates electricity but supplies economical process steam to the Midland Division of Dow. (Tr. 6857-60) The problem of thermal losses in transmitting steam makes the cost prohibitive if the steam is not used near where it is produced. As discussed by Applicant, the costs of moving the Plant one, five and ten miles from the present location are approximately $80 million, $170 million and $300 million, respectively. (ASER Applicant's Ex. 38C, p 2 of Response to Assistant Secretary of Commerce; ASER Applicant's Ex. 38F-1, p 5.4-1.) Evidence at the hearing clearly established that the proposed dual purpose Plant could not economically be constructed at alternate sites and economically serve its intended purposes. Applicant's witness, William Dunlop, Bechtel's Chief Cost Engineer, who has had extensive cost estimating experience (Tr. 6865-66), testified that moving the Plant one mile would entail $80 million extra cost,

five miles would cost $170 million and ten miles $300 million. These costs include the differential costs for transmission of steam, condensate, cooling make-up and blowdown, electrical auxiliaries and start-up, site costs of the cooling system, and some miscellaneous other cooling systems items (Tr. 6867-68). Included also are some unrecoverable costs due to delay and to completed work already at the present site. These costs do not include any cancellation cost which might be incurred if the nuclear steam system and turbine ordered had to be changed because of a change in Plant location (Tr. 6869). No costs resulting from decreased electrical output from the Plant are included (ASER Applicant's Ex. 38F-1, p 5.1-12).

278. Intervenors' witness, Dr. Ernst R. G. Eckert (Tr. 8668-8673), contended that it was technically feasible to locate the Plant at a greater distance from the Dow Plant. He offered three alternatives for locating the nuclear Plant one or more miles away from the proposed site but did not evaluate costs of his alternatives (Tr. 8666-8686). He indicated that he considered Applicant's estimate of capital costs of the various alternative sites to be somewhat high. He further indicated that in his review of Plant location he did not address himself to the environmental effects, operating problems, and routing problems involved with proposed long steam lines (Tr. 8699-8703). He also agreed under questioning by Dr. Hall that he did not have any reason to doubt that the Applicant did a responsible engineering job and made responsible cost estimates in connection with alternate siting (Tr. 8698-99). Although the parties could not agree on a specific figure, it is clear that movement of the Plant pursuant to Dr. Eckert's proposals would reduce the electrical output by from 5 to 10% (Tr. 8713-15). No witness indicated any good reason for making such a move.

279. In addition to consideration of the possibility of moving the dual purpose plant some distance from its present site, Applicant considered the possiblity of abandoning the Plant's dual nature and constructing a nuclear plant at another site (ASER Applicant's Ex. 38F-1, § 5.4; Applicant's Ex. 38L, pp 72b-72f.) This alternative would of course require Dow to pursue the alternative discussed above (paragraphs 275 and 276) of continuing to operate fossil fired units to satisfy its own needs. Because of Applicant's projected power needs and the possible licensing delays in building the proposed units at another location, Applicant indicated that it would probably move the larger unit (815,000 kW) to its existing Palisades site to minimize licensing delays and build a fossil fired unit to produce the rest of the power needed. (Applicant's Ex. 38L, p 72b.) Part of the reason for the abandonment of the smaller electrical capacity unit (485,000 kW) would be the fact that it was designed as a dual purpose unit and in order to use it at another site it would be necessary to redesign it as a single purpose unit producing 815,000 kW which is more electricity than Applicant can use (Applicant's Ex. 38L, p 72b.) Applicant evaluated the costs of such a move, assuming unreasonably short delays (estimated in excess of $1,000,000 per month) which tended to understate its costs, and concluded that the minimum cost of such an alternative would be:

"1. Capital costs of in excess of $29,600,000 resulting in higher cost of producing electricity than the Midland alternative.

2. Fixed charges during first 22 months totaling $13,7000,000.

3. Need for Applicant to construct fossil-fired unit to make up for cancellation of second nuclear unit:

a. Higher cost of producing electricity than Midland alternative. ASER Sections 5.1 and 5.2.

b. Resultant increases in fossil emissions. Section 5.2.2.

4. Need for Dow to continue producing process steam and perhaps electricity.

a. Increase in 1980 price per 1000/lb of process steam of in excess of $0.50. Assuming Dow continues to use even 3,000,000 lb/hr this is an increased cost of $1500 per hr and into the tens of millions over the life of the plant. This cost would increase another 40% when, because of obsolescence, Dow is required to replace its present units. [Staff estimate $9,500,000 per year (FES Staff Ex. 6, p X1-3)]

b. Increase in Dow's cost of electricity to the extent it continued to generate its own. Possible increase in Dow's cost of electricity from Applicant, depending on effects on rates as a result of increased costs of producing electricity.

c. Continued emissions from Dow's fossil units. See ASER Section 5.2.2.

5. Necessity to operate Applicant's older less efficient units greater percentages of the time, resulting in increased emissions and increased costs." (Applicant's Ex. 38L, pp 72e-72f)

Applicant concluded that in light of the nonexistent environmental benefits of such a move, there would be no justification for the enormous costs (Applicant's Ex. 38L, p 72f.) The Staff reviewed the Applicant's projections and agreed that any such move would involve augmented generation costs and enhanced air pollution, including those costs applicable to continued operation of fossil facilities by Dow (FES Staff Ex. 6, p X1-3.) Mapleton Intervenors argued that the $13,700,00 cost in Applicant's estimate attributable to the fixed charges on constructing a transmission line 22 months early should have reflected escalation that was saved as a result of the early construction (Tr. 6852-6857.) Applicant supplied a calculation of $4,385,000 for the escalation saved by early construction

(Applicant's letter dated June 8, 1972.) The Board believes that Mr. Like is correct in this point and that such saving should be taken account of in evaluating the move. The Board concludes that, aside from the correction proposed by the Mapleton Intervenors, Applicant supplied sufficient information on the matter of alternate sites and the Staff adequately reviewed such information. The Board finds that construction of the Plant at an alternate site either as a single purpose plant, with Dow constructing its own plant or as a dual purpose plant would result in significant increases in economic and environmental costs and is clearly a less desirable alternative than that chosen.

Purchase of Power

280. Applicant evaluated the possibility of purchasing 1,300,000 kW of power as an alternative to constructing the Plant. Applicant's system is integrated with that of The Detroit Edison Company to form the Michigan Power Pool which in turn is interconnected for emergency and diversity power with adjacent utilities in the United States and Canada (ASER Applicant's Ex. 38F-1, § 5.3.) Applicant, on the basis of reserve margins projected for adjacent systems and construction and licensing delays that all generating plants are facing, concluded that the necessary amount of power would not be available on a basis comparable to base load (ASER Applicant's Ex. 38F-1, § 5.3-4.) Applicant also pointed out that any such alternative would merely export any environmental problems of generating electricity, would require construction of numerous additional transmission lines, and would most likely require adjacent systems to operate older less efficient plants more often thus increasing pollution (ASER Applicant's Ex. 38F-1, p 5.3-5.) The Federal Power Commission also

reviewed the availability of surplus power of this magnitude and concluded that there was no such spare capacity that Applicant could hope to utilize on a regular basis in 1977 and 1978 (Tr. 8070-71, 8076-78.) The Staff reviewed Applicant's information and concluded that there were not adequate power supplies available for purchase (Tr. 7727, FES Staff Ex. 6, p XI-1.) The Board concludes that Applicant supplied sufficient information and the Staff made an adequate review. It is clear that there is not sufficient capacity available for Applicant to consider purchase of power as a viable alternative to the Plant.

Alternative Cooling Systems

281. Applicant evaluated the possibility of using alternative cooling systems to cool water discharged from the Plant (ASER Applicant's Ex. 38F-1, §5.5 as amended by Applicant's Ex. 38H revised page 5.5-4). Because of river flow characteristics, any alternate means of cooling chosen would still require construction of a large pond to store water. (ASER Applicant's Ex. 38F-1, pp. 5.5-3 and 5.5-4 as amended by Applicant's Ex. 38H). The possibility of using once through cooling and discharging the heated water directly to the river was rejected because of river flow fluctuation and the resultant high river temperature rise (ASER Applicant's Ex. 38F-1, page 5.5-1). Dry cooling systems were rejected because of high capital and operating costs and lack of industry experience with large size systems (ASER Applicant's Ex. 38F-1, page 5.5-1). Spray pond and mechanical draft cooling towers were rejected because the environmental effects would be so similar to those of the cooling pond as to offer no significant advantage (ASER Applicant's Ex. 38F-1, page 5.5-1). The remaining alternative studied was natural draft cooling towers (ASER Applicant's Ex. 38F-1, page 5.5-1). Applicant's

evaluation demonstrated that natural draft cooling towers could be expected to eliminate the potential for ground fogging although they could be expected to create visible vapor plumes extending up to 3,500 feet, create drizzle of 0.37 thousandths of an inch per hour up to 1,500 feet with some drizzle out to 6,500 feet and deposit salts from the river water at distances up to 6,500 feet with the maximum deposition at 1,500 feet (ASER Applicant's Ex. 38F-1, pages 5.5-2 and 5.5-3). Additionally, natural draft cooling towers would be about 500 feet in height (ASER Applicant's Ex. 38F-1, page 5.5-2) and could be expected to have a significant visual impact. (See drawing following ASER Applicant's Ex. 38F-1, §5.5.) The estimated capital cost of such a system was about $36,000,000. Applicant concluded that such an expenditure was not justified (ASER Applicant's Ex. 38H, page 5.5-4).

282. The Staff evaluated both dry cooling towers and wet cooling towers (i.e. mechanical draft and natural draft) (FES Staff Ex. 6, §XI.A.4, §XII.F). Dry cooling towers would eliminate problems of fog formation and alleviate problems of river water usage (FES Staff Ex. 6, page XI-4). However, dry towers would result in higher approach temperatures to the turbine condensers with a resultant loss of thermal efficiency (FES Staff Ex. 6, p. XI-4). Overall the use of dry cooling towers results in a less efficient system at higher capital costs. The use of wet cooling towers would increase the consumption of water both from increased evaporation and from the increased need to blowdown TDS (FES Staff Ex. 6, page XI-4). The Staff doubted that the Tittabawassee River could accommodate the increased usage resulting from use of wet cooling towers (FES Staff Ex. 6, page XII-8). In addition, the Staff found that wet cooling towers would entail a larger pond storage capacity than presently required, substantial addition of capital costs, possible

small improvement in thermal efficiency, greater total fog formation and chemical drift resulting in a minimum deposition in surrounding areas of 70 tons per year (FES Staff Ex. 6, pages XI-4 and XI-5). The increased fog from the mechanical draft cooling towers would be a ground level while that from the natural draft towers would be in the form of an elevated plume (FES Staff Ex. 6, page XI-4).

283. The Board concludes that Applicant has furnished sufficient information regarding alternate cooling systems and that the Staff review of such systems has been adequate. The Board does not find any significant advantage to using an alternate cooling system and finds that use of any alternate system would entail sizable increases in capital costs: $36,000,000 being the cost of the most feasible alternative.

Alternate Radioactive Waste Systems

284. Applicant considered two potential alternates to eliminate the radioactivity release in the laundry waste (ASER Applicant's Ex. 38F-1, page 5.6-1). Use of disposable clothing over regular clothing would reduce the level in laundry waste by as much as a factor of 10 although the disposable clothing would have to be shipped offsite at a total cost of about $20,000 per year. Offsite laundering of clothing at a cost of about $8,000 if facilities were available would be the other possible alternative (ASER Applicant's Ex. 38F-1, page 5.6-1). The Staff reviewed these alternatives and concluded that neither of them are necessary to keep releases within the guidelines of proposed Appendix I to 10 CFR Part 50 (FES Staff Ex. 6, p. XI-5). The Board concludes that Applicant has furnished sufficient information and the Staff review has been adequate. Because of the minimal amounts of present releases there appears to be no advantage in further reductions. The Board

notes that either of these alternatives can be initiated at any time and there is no reason to attempt to reach a final decision at this time.

Alternative Treatment of Chemical Discharges

285. Applicant considered the possibility of adding additional chemical treatment systems to reduce the quantities of chemicals discharged to the river (Applicant's Ex. 38K, pages 47-50). The alternatives studied were (1) removal of most of the solids from Plant discharges, (2) removal of chlorine and sulphuric acid constituents from cooling pond water, and (3) removal of practically all dissolved solids, including those native to the river, from the cooling pond water. All of these methods would consume large amounts of energy (Alternative (3) utilizing 18,000 kW) and would generate concentrated streams of slurry ranging from 70,000 pounds per day for alternative (1) to 890,000 pounds per day for alternative (3) (Applicant's Ex. 38K, pages 48-49). In addition, alternative (2) would require addition of large quantities of chemicals and alternative (3) would increase heat rejection to the environment by 60×10^6 Btu per hour (Applicant's Ex. 38K, pages 48-49). Applicant stated that the alternatives studied are theoretically possible but have never been used in the size required for these applications. Considerable research and development would be necessary and capital and operating costs for such systems are presently pure conjecture (Applicant's Ex. 38K, pages 47 and 50). Because of the insignificant consequences of Applicant's present chemical discharge and the uncertainty, cost and adverse effects of the alternatives available, Applicant determined that all of the alternatives should be rejected (Applicant's Ex. 38K, page 50). The Staff, however, found that releases of phosphates should be reduced and Applicant has agreed to reduce such releases as discussed in paragraph 191, supra.

(FES Staff Ex. 6, page iv). The Board concludes that Applicant has furnished sufficient information regarding alternative methods of treatment of chemical wastes and that the Staff has properly reviewed such alternatives. Additionally, the Board finds that in light of the insignificant impact from presently proposed discharges and the developmental nature and probable large expense of alternate systems, the chemical waste treatment as modified by Staff requirements, is the preferable alternative.

Cost-Benefit Analysis

286. Applicant submitted a cost benefit analysis as part of its environmental report (ASER Applicant's Ex. 38F-1, §5.1, as amended by Applicant's Exhibits 38H and 38I) and the Staff submitted its cost benefit analysis in the Final Environmental Statement (FES Staff Ex. 6, §XI-B). Mapleton Intervenors input into a cost-benefit analysis consisted primarily of the testimony of Dr. Holcomb discussed above in paragraphs 162 to 169 and 182. As discussed in those paragraphs the Board is unable to accept the costs proposed by Dr. Holcomb or his proposed methodology for calculating such costs. Even assuming the Board were able to consider his $1,196,680 (Tr. 8563) annual cost to be credible, his total cost for 30 years of $35,900,400 (Tr. 8563) is an incorrect figure. All costs in the cost-benefit analysis have been converted to their present worth for comparability purposes. (FES Staff Ex. 6, p. XI-6) Computations of the present worth of Dr. Holcomb's figure from a series of compound interest tables results in a figure of $12,530,000. The Board also, concludes that if one uses Dr. Holcomb's method almost all alternatives to the Plant would have similar costs.

287. Both Applicant and the Staff have made reasonable efforts to quantify the principal factors which should enter into the cost-benefit analysis. As might be expected, there are differences in the kinds of quantified values, and in the degree or amounts of value, placed upon particular elements of the analysis by Applicant and Staff. These differences do not represent a conflict in evaluation but rather the kinds of differences which should be expected to occur in any effort to assign objective or specific values to factors which are inherently highly subjective. As we read the National Environmental Policy Act and the AEC's regulations under which Applicant's and Staff's cost-benefit analyses were prepared, a precise reduction to objective values of all the many potential environmental cost-benefits is not what is required or expected of either the parties or the Board, but rather a reasonable quantification which is useful as an aid in determining, and in aiding reviewing bodies such as this Board to determine, how to strike the final cost-benefit balance so as to assure that appropriate consideration and weight is given in decision making to environmental amenities and values. We think that both Applicant and Staff have prepared cost-benefit analyses which are useful for this purpose and which comport with the requirements of NEPA. The record in this proceeding clearly demonstrates that the information of the kinds described in Sections 102c and d of NEPA and applicable regulations and guides of the AEC have been developed and filed in this proceeding and have been appropriately considered by Applicant and Staff in the development of their cost-benefit analyses.

288. The Board, therefore concludes that, in accordance with the testimony and evidence in this proceeding, the Staff cost-benefit analysis (FES Staff Ex. 6, pp. XI-5 to XI-11) adequately assesses and balances the costs and benefits of the proposed Plant except that:

a. The Staff estimate of a cost for decommissioning of $3,000,000 would more conservatively be $8,000,000 (see paragraph 235). This would increase the Staff's estimated operating costs of the facility (FES Staff Ex. 6, p. XI-6) by $5,000,000 with no significant effect on the comparison of alternatives.

b. The Staff estimate that 958 acres of farm or undeveloped land will be reassigned for 28 miles of transmission line (FES Staff Ex. 6, Table XI-1, p. ii) is inaccurate. Although Applicant will acquire 958 acres of farm and undeveloped land for transmission line right-of-way (Applicant's Ex. 38K, p. 5), Applicant permits the use of such land for farming purposes and there is essentially no loss of productivity (ASER Applicant's Ex. 38F-1, p. 4.6-4).

The Board finds that the principal costs associated with the Plant are:

a. Total cost for construction and operation of the facility of $864,000,000 made up of $554,000,000 in capital costs and $310,000,000 (including $8,000,000 for decommissioning) in present-worthed operating costs. (FES Staff Ex. 6, p. XI-6 and Table XI-1)

b. Transfer of 1,200 acres of land (zoned industrial and residential) from agricultural and residential use (the cost of land is reflected in the $554,000,000 capital cost calculated for the Plant) resulting in a dislocation of approximately 25 residences, relocation of the Midland County farm and a small loss of mammals and birds. The loss of mammals and birds should have no significant impact on the surrounding areas. (See paragraphs 162 to 169; FES Staff Ex. 6, pp. XI-10 and XI-11, Table XI-1)

c. Consumption of water through evaporation and seepage in an amount not exceeding 3% of the average river flow. Because most of this water will be withdrawn from the river during periods of high flow, this should have no significant impact. (FES Staff Ex. 6, p. XI-7)

d. Use of about 380 tons of nuclear fuel per year (this cost is included in the operating cost estimate of $310,000,000) (FES Staff Ex. 6, p. XI-7).

e. Small increase in steam fog and some occasional icing in areas adjacent to the cooling pond which should not significantly affect surrounding areas. (See paragraphs 220 to 229 supra; FES Staff Ex. 6, p. XI-9).

f. Small release of radioactive material to air and water being of small fraction of the limits of

10 CFR Part 20, well within proposed Appendix I to 10 CFR Part 50 and resulting in a dose of about 30 man-rems per year to the population within a 50 mile radius of the Plant (this can be compared with a natural radiation background dose in the same area in excess of 100,000 man-rems per year) (see paragraphs 201 and 202; FES Staff Ex. 6, pp. XI-5 and XI-6).

g. Destruction of aquatic life in intake water from river, largely phytoplankton but possibly including zooplankton, fish eggs and some fish fry. This is expected to have no measurable effect on aquatic ecology and quantities destroyed are subject to conjecture as a result of the present depressed quality of the river (see paragraph 182; FES Staff Ex. 6, pp. XI-9 and XI-10).

h. Increase of a few percent in total dissolved solids in river with no significant effects on the environment (see paragraph 195; FES Staff Ex. 6, p. XI-10).

i. Creation of a very low probability risk of an accident in the Plant or during transportation of radioactive material (see paragraphs 218 and 239; FES Staff Ex. 6, p. XI-11).

289. The Board further finds that the principal benefits of the Plant consist of production of 1,300,000 kW of base load electricity, and 4,050,000 lb/hr of process steam for use by The Dow Chemical Company. In

addition the Plant will provide Dow with an acceptable means of replacing its present fossil fueled facilities which are not in compliance with air pollution standards, provide employment for up to 700 men during construction and about 100 men during operation and result in payment of local property taxes of around $10,000,000 per year. (FES Staff Ex. 6, p. XI-10) These local benefits although not determinative are of significance. Applicant and the Staff considered several alternatives to providing these same or similar benefits and conclusively demonstrated that all available alternatives are much more expensive than the proposed Plant. Additionally because of the insignificant environmental cost associated with the proposed Plant, it is clear that none of the alternative means of supplying power could produce any significant environmental advantages. In fact, all of the proposed alternatives because they eliminate the dual purpose feature of the Plant would of necessity result in increases in the cost of process steam in excess of $9,500,000 per year and would ensure continuance of Dow's fossil-fired units in Midland. The Board concludes that the enormous benefits from the Plant far exceed the combined economic and environmental cost and that the Plant, as proposed, is clearly the preferable alternative for providing these benefits. The Board further concludes that both Applicant and Staff have given full and thoughtful consideration to environmental impact and that the Plant as proposed has been designed to limit environmental impact to insignificant levels.

Other Agencies

290. In addition to the approvals necessary from the AEC, the Plant is subject to regulation by numerous other agencies and under numerous statutes. Applicant commenced its efforts to satisfy these requirements as early as 1968 and has described in detail the various approvals required and

has furnished copies of those received. (ASER Applicant's Ex. 38F-3, Appendices N and S; Applicant's Ex. 38B) As described above in paragraphs 176 and 177, Applicant has received an Order of Determination regulating its discharges to the river from the Michigan Water Resources Commission and the Water Resources Commission has certified, pursuant to Section 21(b) of the Federal Water Pollution Control Act, (33 USC §1171(b)) that there is reasonable assurance that construction and operation of the Plant can be conducted in a manner which will not violate water quality standards. (ASER Applicant's Ex. 38F-3 Appendices N and S) Additionally, the United States Army Corps of Engineers has approved Applicant's dredging and installation of inlet and outlet structures and widening of the channel of the river, and the United States Coast Guard approved the construction of the proposed railroad bridge associated with the Plant. (ASER Applicant's Ex. 38F-3, Appendix S pp. 1-3, 6-7; Applicant's Ex. 38B) The Plant's liquid discharges will be subject to Army Corps of Engineers' approval under the Refuse Act of 1899 (33 USC §407) and Executive Order 11574 (35 F.R. 19627) and the Plant's gaseous discharges must comply with the Federal Clean Air Act of 1970 (P.L. 91-604). (ASER Applicant's Ex. 38F-3, Appendix S, pp. 3-6) In addition to the previously described actions of the Michigan Water Resources Commission, it has given Applicant permission to perform various construction activities in the flood plain of the river subject to conditions and restrictions to prevent erosion and protect public health and safety. (ASER Applicant's Ex. 38F-3 Appendix S, pp. 9-10; Applicant's Ex. 38B) The Michigan Department of Natural Resources pursuant to the Inland Lakes and Streams Act permitted dredging of a portion of the river. (ASER Applicant's Ex. 38F-3, Appendix S, pp. 14-15; Applicant's Ex. 38B)

The Michigan Public Service Commission has approved the Plant railroad spur, as has the Midland City Council, and the Midland Township Board approved the widening of the river channel to minimize flooding potential. (ASER Applicant's Ex. 38F-3, pp. 15-16, 20-21; Applicant's Ex. 38B) The Plant proper is located in an industrial zone and the cooling pond is located in a residential zone pursuant to a special exception from the Midland Township Zoning Board of Appeals which placed several limitations and conditions on the use of the property. (ASER Applicant's Ex. 38F-3, Appendix S, pp. 16-20; ASER Applicant's Ex. 38H, Appendix T) The Midland County Road Commission evaluated the abandonment of roads at the site, the Midland County Board of Supervisors approved construction of the railroad bridge and the Midland County Drain Commissioner approved relocation of site drains. (ASER Applicant's Ex. 38F-3, pp. 22-23, Applicant's Ex. 38B)

291. Numerous comments were received from many agencies. The Applicant and Staff gave consideration to the comments in their filings. (Applicant's Ex. 38K and 38L; FES Staff Ex. 6, §XII) The Board has also given consideration to all comments received and has mentioned a number of them specifically in the text of this decision. However, because of the number of the comments received the Board has not attempted to repeat every comment and respond to it. The Board does, however, find that the Staff has in the Final Environmental Statement taken into account the various comments received from other agencies and the public.

CONCLUSIONS

292. Upon consideration of the entire record of this proceeding and the foregoing findings of fact and conclusions, the Board has determined that:

(1) In accordance with the provisions of 10 CFR 50.35(a):

(a) The Applicant has described the proposed design of the facility, including, but not limited to, the principal architectural and engineering criteria for the design, and has identified the major features or components incorporated therein for the protection of the health and safety of the public;

(b) Such further technical or design information as may be required to complete the safety analysis and which can reasonably be left for later consideration, will be supplied in the final safety analysis report;

(c) Safety features or components which require research and development have been described by the applicant and the applicant has identified, and there will be conducted, a research and development program reasonably designed to resolve any safety questions associated with such features and components; and

(d) On the basis of the foregoing, there is reasonable assurance that:

(i) such safety questions will be satisfactorily resolved at or before the latest date stated in

the application for completion of construction of the proposed facility, and

(ii) taking into consideration the site criteria contained in 10 CFR Part 100, the proposed facility can be constructed and operated at the proposed location without undue risk to the health and safety of the public.

(2) The Applicant is technically qualified to design and construct the proposed facility;

(3) The Applicant is financially qualified to design and construct the proposed facility;

4) The issuance of a permit for the construction of the facility will not be inimical to the common defense and security or to the health and safety of the public.

293. Upon consideration of the entire record of this proceeding and the foregoing findings of fact and conclusions, the Board has in accordance with the provisions of Section A.11 of Appendix D, 10 CFR 50:

(1) Determined that the requirements of Section 102(2)(C) and (D) of the National Environmental Policy Act and Appendix D of 10 CFR 50 have been complied with in this proceeding;

(2) Independently considered the final balance among conflicting factors contained in the record of the proceeding with a view to determining the appropriate action to be taken;

(3) Determined that the appropriate action to be taken is to authorize issuance of the contruction permit;

(4) Determined that the record of the proceeding demonstrates that:

(a) Applicant has given appropriate consideration to environmental values in developing plans for the location, design, construction and operation of the proposed Midland Plant;

(b) The Applicant has provided sufficient information and the Regulatory Staff has performed an adequate review with respect to environmental matters under 10 CFR 50, App. D;

(c) The proposed facility and plans set forth for its design, construction and operation include appropriate facilities, equipment and programs to protect environmental values;

(d) That operation of the facility will be subject to the regulatory authority and licensing approval of the Atomic Energy Commission under the Atomic Energy Act of 1954, as amended, and the National Environmental Policy Act; and that

(e) No further conditions be imposed at the construction permit stage to protect environmental values.

ORDER

294. Based on its findings and conclusions in both the radiological and environmental phases of the hearing and pursuant to the Atomic Energy Act and the AEC regulations, IT IS ORDERED that the Director of Regulation issue a construction permit to Consumers Power Company. IT IS FURTHER ORDERED in accordance with 10 CFR 2.760, 2.762, 2.764, 2.785 and 2.786 of the AEC Rules of Practice that this Initial Decision shall constitute the final decision of the AEC subject to the review thereof pursuant to the above cited rules.

Respectfully submitted,

/s/ John K. Restrick
John K. Restrick
Counsel for Consumers Power Company

Of Counsel:

Robert Lowenstein
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Dated: August 15, 1972