UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, ILLINOIS 60137

April 28, 1982

MEMORANDUM FOR: C. C. Williams/R. B. Landsman

FROM: W. D. Shafer

SUBJECT: MIDLAND

At 3:15 p.m. on April 28, 1982, Mr. Walt Bird called and notified me that while drilling a dewatering well in a Q area they struck an electric duct bank. He stated they should not have hit the duct because they were probing for such obstacles and their drawings indicated that the duct bank was elsewhere. Investigation continuing.

W. D. Shafer
W. D. Shafer

& Alarm System

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
Charles Bechhoefer, Chairman
Dr. Frederick P. Cowan
Ralph S. Decker

In the Matter of	Docket Nos. 50-329 OM 50-330 OM
CONSUMERS POWER COMPANY	Docket Nos. 50-329 OL 50-330 OL
(Midland Plant, Units 1 and 2)	
	April 30, 1982

MEMORANDUM AND ORDER
(Imposing Certain Interim Conditions
Pending Issuance of Partial Initial Decision)

Pending before this Licensing Board are consolidated proceedings arising out of the NRC Staff's December 6, 1979 Order Modifying Construction Permits No. CPPR-81 and No. CPPR-82 (OM proceeding), and the application by Consumers Power Co. for operating licenses for Midland Nuclear Power Plant, Units 1 and 2 (OL proceeding).[1/] The facility, currently under construction, consists of two pressurized water reactors located in Midland, Michigan.

The Modification Order was generated as a result of the excessive settlement which occurred with respect to the facility's diesel generator

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1/ The proceedings were consolidated at the request of Consumers Power Co., the Applicant in the OL proceeding and the Licensee in the OM proceeding (hereinafter referred to as "Consumers"). See Prehearing Conference Order, dated October 24, 1980 (unpublished).

building and other plant structures. Hearings which have been held to date concern the soils settlement issues raised by the Modification Order, as well as related contentions of intervenors in each of the proceedings. (The majority of the soils settlement contentions have been sponsored by Ms. Barbara Stamiris, an intervenor in the QM proceeding.) As reflected in our Memorandum 2/ of October 2, 1981, we have determined to issue separate partial initial decisions dealing with various aspects of the soils issues. The first, now under preparation, deals with quality assurance/quality control (QA/QC) and management attitude issues, as delineated in the October 2, 1981 Memorandum. With limited exceptions, the record on these matters was closed on February 19, 1982, following some thirty-five days of hearings. 3/ The second will deal with proposed remedial actions to correct the soils settlement problems. Hearings on these matters are not yet completed, partially as a result of the as-yet developing positions of all parties on these questions.

With respect to the QA/QC and management attitude issues, proposed findings of fact and conclusions of law, and supplemental proposed findings and conclusions covering matters as to which the record was reopened, have been received from all interested parties, and Consumers has just recently filed its replies to each of the proposed and supplemental proposed findings and conclusions of the other parties. During the course of our

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2/ Memorandum (Concerning Telephone Conference Call of September 25, 1981 and Applicant's Motion for Partial Decision), dated October 2, 1981 (unpublished).

3/ Certain aspects of these issues will remain open until our second partial initial decision.

review of these various filings, as well as of the entire record, we have determined that certain conditions governing further construction, as set forth in Section VI of this Memorandum and Order, should be put into effect immediately, pending the completion of our review and the issuance within approximately two or three months of our first Partial Initial Decision.[4/] Our reasons follow.

I. Background

Under construction permits such as are in effect for the Midland plants, a permittee may normally engage in construction activities in accordance with the principal architectural and engineering criteria and environmental commitments set forth in the application for the facility and the construction-permit hearing record, without seeking prior approval of the NRC Staff. The permittee undertakes such activities at its own risk; they are subject to Commission approval before an operating license may be granted. See 10 C.F.R. §50.57; Cf. Northern Indiana Public Service Co. (Bailly Generating Station, Nuclear-1), CLI-79-11, 10 NRC 733 (1979), reversed on other grounds, sub nom. People of the State of Illinois v. NRC

4/ This procedure has been previously utilized by the Appeal Board with respect to these very same reactors. ALAB-106, 6 AEC 182 (1973).

We note that, in a telephone conference call on April 28, 1982, the Staff indicated that it might reconsider certain earlier testimony expressing reasonable assurance that Consumers' QA program will be appropriately implemented with respect to future soils construction activities (Keppler, prepared testiony, p. 9, fol. Tr. 1864). It requested that we cancel certain near-term hearings which we had scheduled, and we did so. Memorandum and Order (Cancelling Evidentiary Hearings and Conference of Counsel or Representatives), dated April 28, 1980 (unpublished). As a result, our first Partial Initial Decision could be delayed beyond the time frame we are now projecting.

(iii) removal and replacement of fill beneath the feedwater isolation valve pit area

(iv) placing caissons at the ends of the auxiliary building electrical penetration areas

(v) compaction and loading activities;

(c) construction work in soil materials under or around safety-related structures and systems such as field installation of conduits and piping.

Had the hearings in the OM proceeding not been requested, Consumers could not have undertaken any of the foregoing activities without submitting an amendment to its application and obtaining construction- permit amendments authorizing such activities. Since the hearing was requested, the normal construction permit authority remains in effect, and no construction permit amendment (or other NRC authorization) needs to be sought in order for Consumers to engage in the activities in question.

Both the Modification Order (Part V) and the Commission's Notice of Hearing of March 14, 1980 (45 Fed. Reg. 18214, March 20, 1980) stated that this Board is to consider and decide the following issues:

(1) Whether the facts (concerning quality deficiencies) set forth in Part II of the Order are correct; and

(2) Whether that Order should be sustained.

II. Facts Underlying Modification Order

One of the bases for the Modification Order was the allegation that there had been a breakdown in quality assurance related to soils. Another

(D.C. Cir. No. 80-1163, July 1, 1981). The December 6, 1979 Modification Order would have modified this regime by prohibiting certain construction activities with respect to safety-related structures and systems affected by the soils settlement problems which have been aired in the ongoing consolidated proceeding. The prohibited activities could not be undertaken absent (1) submission of an amendment to the application seeking approval of remedial actions, and (2) issuance of an amendment to the construction permits authorizing the remedial actions.5/ The Modification Order further provided that a hearing could be requested by Consumers or other interested person and, if it were, the Order would go into effect only as a result of an order made following the hearing.6/

The construction activities which the Modification Order would have prohibited consist of the following:7/

(a) any placing, compacting, or excavating soil materials under or around safety related structures and systems;

(b) physical implementation of remedial action for correction of soil-related problems under and around these structures and systems, including but not limited to:

(i) dewatering systems

(ii) underpinning of service water building

5/ Modification Order, Part IV. The Modification Order has been admitted into evidence as Stamiris Exh. 3, Attachment 15 (Tr. 2479).

6/ Modification Order, Part V.

7/ Modification Order, Part IV.

basis was that Consumers had not provided the information which the Staff and its consultants required to permit a thorough safety review of proposed remedial actions.[8/] As a result of these deficiencies, the Staff concluded that it did not have reasonable assurance that the safety-related portions of the Midland facilities would be so constructed that they could be operated without undue risk to public health and safety.

With regard to the first basis, Consumers and the Staff entered into a stipulation on June 5, 1981, in which Consumers conceded that prior to December 6, 1979 there were quality assurance deficiencies related to soil construction activities. Consumers agreed not to contest the Staff's conclusion that these deficiencies constituted a breakdown in quality assurance with respect to soils placement at Midland, and it acknowledged that the deficiencies constituted an adequate basis for issuance of the Order.[9/] With regard to the second basis for the Order, the Staff and Consumers entered into two additional stipulations in which Consumers agreed not to contest that, as of December 6, 1979, the NRC Staff had insufficient information to evaluate the proposed remedial actions for the auxiliary building, for the borated water storage tanks and underground piping.[10/]

8/ We are here making no findings and reaching no conclusions with respect to a third basis for the Order, an alleged material false statement. Hearings on that subject are not yet completed although we have heard testimony on the management-attitude aspects of the alleged statement.

9/ Applicant/Staff Joint Exh. 1, following Tr. 1175, admitted at Tr. 1188.

10/ Applicant/Staff Joint Exhs. 2 and 3, dated December 1, 1981 and February 9, 1982, respectively (Tr. 5447, 7164).

As a result of these stipulations, we are able at an early stage of our review to conclude, with respect to the first hearing issue, that the facts set forth in Part II of the Modification Order (to the extent they relate to soils QA deficiencies and the adequacy on December 6, 1979 of the Staff's information to review remedial actions) are correct and constituted an adequate basis for issuance of the Order. Consumers, the NRC Staff, and intervenor Barbara Stamiris each submitted proposed findings to this effect.11/

III. Facts Giving Rise to Interim Requirements

We have not yet completed our review of the second hearing issue--i.e., whether and, if so, to what extent, the Modification Order should be sustained. Consumers has described this issue as "whether the safety issues [giving rise to the facts set forth in Part II of the Modification Order] have been resolved so that the quality assurance program with respect to soils is now being properly implemented and there is reasonable assurance such implementation will continue through the construction process."12/ Ms. Stamiris has described it somewhat similarly, as "whether as a result of revisions, improved implementation, and other factors, this Board has reasonable assurance that the QA and QC programs will be appropriately implemented with respect to future soils construction and remedial activities".13/ However, they reach different answers to this question.

11/ Consumers Proposed Findings ¶ 35; Staff Proposed Findings, ¶¶ 236-237; Stamiris Proposed Findings, ¶ 10.

12/ Consumers Proposed Findings, ¶ 37 [sic; should be 36].

13/ Stamiris Proposed Findings, ¶ 10.

Consumers asserts that, as a result of organizational and procedural changes which it has put into effect since the issuance of the Modification Order, its QA program is now being properly implemented. It urges us to find reasonable assurance that the future soils construction activities including the remedial actions taken as a result of inadequate soils placement will be accomplished in accordance with QA principles of public health and safety.14/ On the other hand, although Ms. Stamiris concedes that Consumers' organizational changes represent a "positive response",15/ she nonetheless concludes that the implementation of QA at Midland is inadequate16/ and that the same kind of problems and weaknesses currently exist as had lead to problems in the past.17/ She would have us put the Modification Order into effect and shut down soils-related construction immediately.18/ The NRC Staff also gave its reasonable assurance that the QA program would be properly

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14/ Consumers Proposed Findings, ¶¶ 81-83.

15/ Stamiris Proposed Findings, ¶ 222.

16/ Stamiris Proposed Findings, ¶ 221.

17/ Stamiris Proposed Findings, ¶ 225.

18/ Stamiris Proposed Findings, ¶ 254; Part III.C.

implemented,[19] although at least one of its witnesses expressed some reservations (Tr. 2441-42 (Gallagher)).[20]

We do not at this point in our review express any opinion with respect to those positions--except to note that none of them is baseless and all have evidentiary support. The resolution of this broad issue will, as we have seen, affect the degree to which and the manner in which soils-related construction activities (and particularly remedial actions) will be permitted to continue.[21]

As background for our approach to this question, we deem it important to note that the QA/QC deficiencies which are addressed by the Modification Order are not the first instances where Consumers has experienced difficulty in properly implementing its QA/QC program. The Appeal Board pinpointed one such instance in ALAB-106 (fn. 4, supra), and it imposed conditions designed to alleviate the deficiencies which it found to exist. Later, questions were raised concerning the QA/QC organization being utilized for this facility. ALAB-132, 6 AEC 431 (1973); ALAB-147, 6 AEC 636 (1973); ALAB-152, 6 AEC 816 (1973). Subsequently, the Staff issued a show-cause order which

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19/ NRC Staff Proposed Findings, ¶ 375.

20/ Mr. Gallagher stated that he supported Mr. Keppler's conclusions concerning implementation of the QA program "entirely" but added that he "would like to see some other things to be included" (Tr. 2455). See also fn. 4, supra, ¶ 2.

21/ As we have pointed out (pp. 4-5, supra), the most stringent condition we could impose on those activities under the Modification Order would be to prohibit such activities pending submission of an amendment to the applications and issuance of construction-permit amendments authorizing remedial action. All or any portion of that condition could be put into effect. Cf. Public Service Co. of Indiana (Marble Hill Nuclear Generating Station, Units 1 and 2), CLI-80-10, 11 NRC 438 (1980); Wisconsin Electric Power Co. (Point Beach, Unit 1), CLI-80-38, 12 NRC 547 (1980).

was founded on other QA/QC deficiencies, and additional corrective actions were mandated: ALAB-283, 2 NRC 11 (1975), clarified, ALAB-315, 3 NRC 101 (1976). During that show-cause proceeding, the Appeal Board remarked that "non-compliance with the Commission's quality assurance regulations is * * * a problem which has plagued the construction of this facility." ALAB-270, 1 NRC 473, 476 (1975).22/

With this history before us, early in this proceeding we expressed concern about the adequacy of and the potential safety impact of ongoing construction activities (Tr. 754-55). On the opening day of the hearing, the Staff responded to our inquiry by presenting testimony regarding soils-related construction of the type that would be going on during the period of time before we could issue a decision governing construction encompassed by the Modification Order.23/ From that testimony, it appeared to us that Consumers was at that time consulting with and seeking approval of the Staff before engaging in any of the construction activities there under consideration--i.e., installation of 20 permanent back-up interceptor wells in the area near the Service Water Structure and the Circulating Water Intake Structure, and surcharging of the two valve pits

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22/ See also Board Exhs. 1A and 1B (Tr. 1875), which contain a summary of problems experienced at Midland since the start of construction.

23/ Testimony and Supplemental Testimony of Darl S. Hood, both following Tr. 1097.

which are adjacent to each of the Borated Water Storage Tanks.24/ Although all of the outstanding questions raised by the Staff concerning those proposed remedial activities had not then been resolved, the Staff expressed its "reasonable assurance" that the activities would be performed in an acceptable manner.25/ We interpret that reasonable assurance conclusion as premised upon Consumers' affording the Staff the opportunity to review the proposed resolution of the unresolved questions.26/

In addition, Consumers advised us that, in February, 1980, it had voluntarily committed not to proceed with further remedial actions without Staff review and concurrence.27/ (Insofar as the record reflects, this commitment appears to have been an oral one, not reduced to writing prior to its incorporation into testimony in this proceeding.) That Consumers will provide the Staff with sufficient information to permit a thorough safety review is inherent in this commitment.

We find no indication in the record that Consumers has failed to honor this commitment. For its part, the Staff agreed that it would accept information through meetings and presentations rather than an amendment to

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24/ Hood, prepared testimony, p. 2. Those were the only two soils-related activities then under way or planned to be undertaken by Consumers in the near term (Tr. 1112).

25/ Hood, supplemental testimony, p. 3. Subsequently, on December 10, 1982, the Staff approved the installation of 5 additional temporary dewatering wells. Staff Exh. 13 (Tr. 6901).

26/ Hood, prepared testimony, p. 3; supp. test., pp. 2,3; Tr. 1113-14, 1119.

27/ Testimony of Gilbert S. Keeley, fol. Tr. 1163, p. 13.

the application. Beyond the two matters about which the Staff initially testified, the Staff has utilized this arrangement to approve such activities as construction of access shafts and a freezewall in preparation for underpinning the auxiliary building and feedwater isolation valve pits,[28] and any drilling activities near seismic Category I underground utilities and structures (Tr. 5485-86). During the hearing, Consumers agreed that the commitment would be extended to the matter of crack evaluation, a question which Consumers judged to be less important than does the Staff (Tr. 5735-38). As far as we are aware, certain additional remedial actions to which the commitment is being applied are currently under review or in progress.

From the present stage of our review, it appears that Consumers' voluntary agreement has resulted in adequate Staff surveillance of the proposed remedial actions covered thereby, prior to Consumers' commencement of the remedial actions. Consumers itself has acknowledged the usefulness to it of its consultation with the Staff prior to the initiation of remedial activities (Tr. 5660-61). At this time, we are making no changes to the procedures utilized under this arrangement.

It is important to note, however, that Consumers' commitment does not extend to all the activities which Part IV of the Modification Order would have prohibited (Tr. 1202-1212, 1390). The scope of the oral commitment is not clearly defined. While it appears essentially to cover those major

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28/ Letter dated November 24, 1981, from Darl Hood (NRC) to James W. Cook (CPC) (Staff Exh. 5, Tr. 5467).

remedial actions within the scope of Section 1(b), but not activities falling within Sections 1(a) and 1(c), of Part IV of the December 1979 Order (Tr. 1420-1422), there is some ambiguity whether certain activities may fall within Section 1(b) or one of the other categories.

Although we have no objection to the Staff/Consumers working relationship for those portions of the remedial work to which the commitment applies, several matters of record cause us to be dissatisfied with the limited scope of activities covered. More specifically, as a result of the matters described in this section of this Memorandum and Order, augmented by the related information appearing in Part IV, we are of the view that certain activities outside the scope of Consumers' commitment but within the coverage of the prohibition in the Modification Order should be subject to prior Staff review and approval.

The first of these matters which gives us concern is that of underground piping. Consumers proceeded with work associated with underground piping which carries cooling water essential to safety without seeking or receiving formal Staff concurrence (Tr. 7784, 7788a). This work would clearly have been prohibited under Part IV, Section 1(c) of the Modification Order, and it could also be interpreted as falling within Section 1b (Tr. 7788c). The record is confusing as to whether the Staff regarded Consumers' commitment as in fact covering that type of remedial action (Tr. 7781-7783, 7788a-7790, 7894-7901).[29/] The Staff expressed

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29/ We disagree with Consumers' response to Ms. Stamiris' Proposed Findings and Conclusions, ¶ 8, pp. 6-7.

the opinion that underground piping should be covered by the commitment (Tr. 7788c, 7789, 7899). Underground piping was of concern to the Staff prior to its issuance of the Modification Order.30/ One reason we believe it essential that safety-related activities such as the rebedding of piping should have prior full Staff review and concurrence is that once such work is performed and the piping then recovered with earth, it is no longer accessible for inspection for such concerns as have been identified during the course of this hearing--e.g., corrosion (Tr. 7683-86, 7827-35), deformation (Tr. 7913-14), quality of foundation soils (Tr. 7911), pipe welds (Tr. 7652-56), and condition of pipe wrapping materials (Tr. 7860, 7914-15). Therefore, adequate QA/QC surveillance is fundamental to assuring safety. The Staff has expressed its desire, in fact, to review such matters as compaction criteria and procedures prior to the work taking place, and to be able to inspect the work while being performed (Tr. 7899). Moreover, the Staff has stated that it had insufficient soil-profile information to evaluate distortion in pipes buried in soils which have settled.31/

The second reason for our requiring further Staff review and approval prior to the start of soils-related construction differs from the first in that it does not stem from a single type of construction activity. Rather, it pervades the entire spectrum of soils-related construction activities. As a result of Board questioning, we have some doubt whether, in the absence

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30/ I.E. Rept. 79-06, dated April 4, 1979 (Stamiris Exh. 3, Att. 8, at p. 5).

31/ Kane, prepared testimony, fol. Tr. 7752, p. 3.

of Staff review and approval, Consumers would carry out certain remedial soils activities using appropriate QA procedures and principles. Its witnesses presenting the remedial plans for the auxiliary building were unsure of the manner in which QA principles would be applied to that operation (Tr. 5530-32). With respect to the engineering of the remedial actions, Consumers was able to describe the QA procedures it had already followed (Tr. 5718-20), but it also indicated that it did not consider the engineering a problem area and was therefore not applying any specialized procedures to those activities (Tr. 5622)--despite the fact that it had to formulate and rework its plans four different times before it obtained a system acceptable to the Staff (Tr. 5647-58). Consumers does not appear to have obtained Staff approval with respect to the engineering QA procedures which it had followed (Tr. 5750). Furthermore, Consumers seems to have a tendency to treat as many structures as possible as non-Q-listed (and, hence, as not subject to QA controls) (Tr. 5626, 5671-72).

For these reasons, we are not completely satisfied as to the extent to which QA plans and controls are to be applied by Consumers to underpinning activities. In particular, we are concerned about areas adjacent to, but not necessarily directly under, safety-class structures. These activities include boring of large diameter, closely spaced holes for soldier piles which would penetrate low shear-strength soil layers at elevations below the foundations of adjacent safety-class structures (Tr. 5674-79; 5765-71), and essentially all underpinning activities beneath the turbine building the failure or tilting of which might influence the safety or future seismic

resistance of the adjacent safety-class structures (Tr. 6083-85; 7125-27). These potential QA/QC gaps lead us to believe that, at least in the near future, the commencement of safety-related activities of this type should be subject to the Staff's approval--particularly as to whether specific activities are to be covered or not covered by an appropriate QA plan.32/

IV. Related Matters Substantiating The Need for Interim Conditions

Certain matters which have been the subject of notifications by various parties to the Board tend to accentuate what we regard as the need for the interim conditions we are imposing. These matters have not yet been the subject of evidentiary hearings, and we express no final view as to their accuracy or import. Nonetheless, we regard these matters as closely relevant to the facts on which we have taken evidence and pertinent to our determination that interim conditions should be imposed.

As one example of this type, representing an activity we believe should be covered by the commitment, the Board has been informed by way of a Consumers' Non-Conformance Report that a 42-inch diameter hole was drilled to a depth of 40 feet within the "Q" fill area, apparently without proper authority; without the development of, or adherence to, written procedures;

32/ We understand that Consumers later indicated that monitoring instruments would be placed before commencing underpinning activities to measure horizontal movements between the turbine building and adjacent structures "in response to questions raised by the Atomic Safety and Licensing Board". Memorandum dated March 11, 1982 from Darl Hood, Summary of March 8, 1982 Telephone Conversation Regarding Soil Spring Stiffnesses for Auxiliary Building Underpinning and Phase II Construction.

without the participation of the On-Site Geotechnical Engineer; and without adequate QA/QC surveillance, if any.[33/] We hasten to point out that we have not yet heard evidence on this report and express no view as to its accuracy. It appears, however, to describe the type of activity which is encompassed by the prohibition in Part IV, Section 1(a) of the Modification Order. Moreover, if the NCR is accurate, the activity would constitute a prime example of the kind of work which we believe should be subject to prior Staff review and concurrence.

Additionally, we have also recently been notified of loose sands located in the plant fill north of the Service Water Structure and Circulating Water Intake Structure. This loose sand reportedly underlies about 500 feet of seismic Category I pipe. We understand that Consumers has decided to remove and replace this material to avoid potential liquefaction problems.[34/] Once again, we express no view as to the validity of this information. But considering the vagueness as to the limits of Consumers' commitment and the apparent potential effect on public safety of these construction activities should the plant later be allowed to operate, we deem it necessary at this time to eliminate any uncertainty and

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33/ NCR # M01-4-2-008 Rev.1, dated February 25, 1982, transmitted to the Board and parties by letter dated March 12, 1982, from James E. Brunner, CPC. The Board requested that it be provided with audit reports of this type (Tr. 5975-76).

34/ Memorandum from Darl Hood, Notification of Loose Sands Beneath Service Water Piping, March 16, 1982. See also letter from James W. Cook to Harold R. Denton, Additional Information Concerning Safety Grade Buried Piping, March 16, 1982.

to require that any remedial actions intended to rectify this matter receive full Staff review and concurrence before being undertaken.

Finally, the Board notes that the Staff has disagreed with Consumers[35/] over the extent of QA coverage and control of the underpinning activities beneath the safety-class and adjacent non-safety class buildings. The disagreement apparently has been resolved by Consumers' agreeing that essentially all underpinning activities would be subject to Q-controls, except for certain already completed activities and certain agreed-upon non-critical activities.[36/]

Although the Board recognizes that these disagreements may reflect genuine differences of interpretation of requirements in Appendix B to 10 C.F.R. 50, we deem it important to public safety that, pending the completion of our QA review, the Staff's more conservative interpretation should apply to remedial-work activites, some of which are, or shortly will be, in progress. Accordingly we have made the elements of that agreement part of this Interim Order. Again, while we express no views as to the validity of those matters brought to our attention outside the actual hearings, they represent the kinds of issues that were alleged in the December 6, 1979 Modification

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35/ Memorandum dated March 12, 1982, from Darl Hood, subject: Summary of March 10, 1982 Meeting Concerning Quality Assurance To Be Applied To Remedial Foundation Work.

36/ Letter, James W. Cook (CPC) to J. G. Keppler (NRC), dated April 5, 1982, subject: Quality Assurance for Remedial Foundation Work.

Order, and that were the subject of ongoing efforts by the Staff and Consumers to resolve them.

V. Description of Interim Requirements

As a result of the various safety problems which we have described in Section III, above, the potential and related problems described in Section IV, above, and the imminence of the commencement of additional safety-related work activities on remedial measures for the soils settlement problems which we have been considering, we find it necessary to act now to remove ambiguities in Consumers' commitment to obtain prior Staff approval for remedial measures. Pending the completion of our review of the record and issuance of a partial initial decision, we are requiring that the construction permits be amended to prohibit (in the absence of Staff approval) the same activities as would have been prohibited by Section IV of the Modification Order. (We are updating the requirement to take account of certain developments which have occurred since December 6, 1979.) This requirement would not apply to any of the activities as to which the NRC has already given its approval. Nor does it dictate the manner in which the Staff may exercise its review--i.e., whether piecemeal (individual construction steps) or as an integrated package. In addition, for the reasons we have outlined, we are requiring that certain of these activities

be governed by a QA plan.38/ We have pointed out that some of the material which we have considered in this order has not yet been the subject of a completed evidentiary hearing; indeed, the scope of our QA requirement is premised in part upon an apparent agreement between Consumers and the Staff contained in material of this sort. Letter of James C. Cook, fn. 36, supra. We expect Consumers and the NRC Staff to present testimony on these open items at a later evidentiary session.

We stress that in our forthcoming Partial Initial Decision we will reexamine the terms and conditions which we are here imposing on an interim basis. At that time, we may reaffirm, expand or remove them. Until such time, however, we find that the Modification Order should be made effective to the extent which we have described. We stress that we are not at this time requiring the submission or approval of any amendments to the applications for construction permits (as provided by the Modification Order). In our opinion, the Staff consultation and approval which we are requiring will achieve the substantive results we believe necessary without adding certain procedural requirements of an application for a construction permit amendment which, in the present context, do not appear to be necessary to attain the safety goals which we believe should be achieved.

38/ To require a QA plan for safety-related remedial soils construction activities is consistent with the requirements of 10 C.F.R. §50.34(a)(7). We note that the large-scale underpinning and other remedial activities which are being undertaken are sufficiently distinct from the activities contemplated during the construction-permit review as to warrant a supplementation of the applicable QA program.

VI. Order

Based on the foregoing, it is, this 30th day of April, 1982

ORDERED

That the Director of Nuclear Reactor Regulation, in accordance with 10 C.F.R. §2.764(b), is authorized to amend Construction Permits CPPR-81 and CPPR-82 as follows:

(1) Construction Permits CPPR-81 and CPPR-82 shall be amended to require that the permit holder obtain explicit prior approval from the NRC Staff (to the extent such approval has not already been obtained) before proceeding with the following soils-related activities, and that these activities, with the exception of those already approved by the NRC, and those that the Staff agrees are not critical, shall be controlled by a Staff-approved Quality Assurance Plan:

(a) any placing, compacting, excavating, or drilling soil materials around safety-related structures and systems;

(b) physical implementation of remedial action for correction of soil-related problems under and around safety-related structures and systems, including but not limited to:

(i) dewatering systems

(ii) underpinning of service water building

(iii) removal and replacement of fill beneath the feedwater isolation valve pit areas, auxiliary building electrical penetration areas and control tower, and beneath the turbine building

(iv) placing of underpinning supports beneath any of the structures listed in (iii) above

(v) compaction and loading activities;

(c) construction work in soil materials under or around safety-related structures and systems such as field installation, or rebedding, of conduits and piping.

(2) Paragraph (1) above shall not apply to remedial actions approved by the NRC Staff prior to the effective date of this Order, nor to any exploring, sampling, or testing of soil samples associated with determining actual soil properties on site which has the approval of the Director of Region III, Office of Inspection and Enforcement. These testing activities, however, shall be controlled by a Staff-approved Quality Assurance plan which includes procedures for controlling excavation or drilling activities more than 6-feet deep in "Q" areas.

In accordance with 10 C.F.R. §§ 2.760, 2.762, 2.764(a), 2.785 and 2.786, this Memorandum and Order shall be effective immediately upon issuance and shall constitute the final action of the Commission on the matters considered herein forty-five (45) days after issuance, subject to any review pursuant to the above-cited Rules of Practice. Exceptions to this Memorandum and Order may be filed by any party within ten (10) days after its service. A brief in support of the exceptions shall be filed within thirty (30) days thereafter (forty (40) days in the case of the NRC Staff). Within thirty (30) days of the filing and service of the brief of

the appellant (forty (40) days in the case of the NRC Staff), any other party may file a brief in support of, or in opposition to, the exceptions.

THE ATOMIC SAFETY AND
LICENSING BOARD

Charles Bechhoefer

Charles Bechhoefer, Chairman
ADMINISTRATIVE JUDGE

Frederick P. Cowan cs

Dr. Frederick P. Cowan, Member
ADMINISTRATIVE JUDGE

Ralph S. Decker

Ralph S. Decker, Member
ADMINISTRATIVE JUDGE

Dated at Bethesda, Maryland

this 30th day of April, 1982.

Judge Jerry Harbour, who has served as a technical interrogator and an alternate Board member during portions of the hearings concerning management attitude and quality assurance matters, and who has replaced Judge Decker for the forthcoming segments of the consolidated OL-OM proceeding (with the exception of the first Partial Initial Decision and orders, such as this one, which are integral to that Decision), supports the rulings and reasoning included in this Memorandum and Order.

James W Cook
Vice President - Projects, Engineering and Construction

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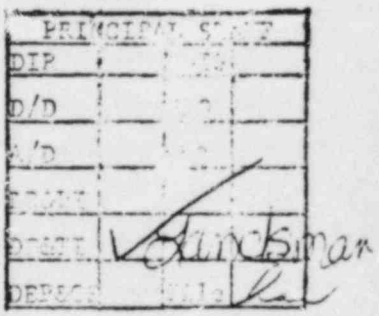
April 30, 1982



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MIDLAND PROJECT
MIDLAND DOCKET NO 50-329 50-330
EFFECTS OF CRACKS ON SERVICEABILITY OF CONCRETE STRUCTURES AND REPAIR OF CRACKS
FILE: 0485.16 SERIAL: 16884

REFERENCES:
(1) J W COOK LETTER TO H R DENTON, EVALUATION OF FEEDWATER ISOLATION VALVE PITS AT MIDLAND PLANT, SERIAL 15493, DATED JANUARY 25, 1982
(2) J W COOK LETTER TO H R DENTON, EVALUATION OF AUXILIARY BUILDING CONTROL TOWER AND ELECTRICAL PENETRATION AREAS AT MIDLAND PLANT, SERIAL 15527, DATED JANUARY 29, 1982
(3) J W COOK LETTER TO H R DENTON, EVALUATION OF THE EFFECT ON STRUCTURAL STRENGTH OF CRACKS IN THE WALLS OF THE DIESEL GENERATOR BUILDING, SERIAL 15978, DATED FEBRUARY 16, 1982
(4) J W COOK LETTER TO H R DENTON, EVALUATION OF CRACKING IN SERVICE WATER PUMP STRUCTURE AT MIDLAND PLANT, SERIAL 16009, DATED MARCH 2, 1982

ENCLOSURE: EFFECTS OF CRACKS ON SERVICEABILITY OF STRUCTURES AT MIDLAND PLANT

References 1 through 4 above transmitted a series of reports which presented an evaluation of the effect on structural strength of cracks observed in the feedwater isolation valve pits, the auxiliary building control tower and electrical penetration areas, the diesel generator building, and the service water pump structure. These four reports were provided as the result of discussions with the NRC Staff and its consultants at meetings held on December 10, 1981 and January 11, 1982. During these meetings, Consumers Power agreed to provide the NRC with an evaluation of the effects of cracks on the longterm serviceability of concrete structures and with recommendations on the sealing of cracks.

In response to this commitment, we are providing the enclosed report entitled, "Effects of Cracks on Serviceability of Structures at Midland Plant," by Messrs W G Corley, A E Fiorato and D C Stark of Construction Technology

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Laboratories, a division of the Portland Cement Association. This report contains a discussion of the effects of observed cracks on the serviceability of the feedwater isolation valve pits, the auxiliary building, the diesel generator building and the service water pump structure and provides our recommendations for the sealing of cracks in these structures. Please note that the enclosed report does not apply to the borated water storage tank foundations. The repair of cracks by pressure grouting of the borated water storage tank foundations has been addressed in a seperate 50.55(e) report forwarded to the NRC by our recent correspondence, Serial 16172, dated April 23, 1982.

Based on the conclusions reached in the enclosed report we wish to recommend the following: (1) sealing of cracks in walls by epoxy injection for cracks above the permanent water table is considered unnecessary; (2) sealing of cracks by means of epoxy injection or other means for walls below the permanent water table, which show visible leakage of water, will be performed; and (3) the south wall of the service water pump structure will be coated on the exterior surface within the splash zone area adjacent to the cooling pond, i.e., between Elevation 626' and Elevation 637.5'. The epoxy injections can be applied from the interior surface. We are also advising that the work to seal cracks will be performed after completion of the underpinning operations.

James W. Cook

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Report to

CONSUMERS POWER COMPANY
JACKSON, MICHIGAN

EFFECTS OF CRACKS ON SERVICEABILITY OF STRUCTURES AT MIDLAND PLANT

by

W. G. Corley, A. E. Fiorato, and D. C. Stark

Submitted by
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April 19, 1982

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EFFECTS OF CRACKS ON SERVICEABILITY OF STRUCTURES AT MIDLAND PLANT

by

W. G. Corley, A. E. Fiorato, and D. C. Stark*

INTRODUCTION

A series of previous reports have presented an evaluation of the structural significance of cracks observed in the Feedwater Isolation Valve Pits, Auxiliary Building Control Tower and Electrical Penetration Areas, Diesel Generator Building, and Service Water Pump Structure at Midland Nuclear Power Plant Units 1 and 2.[1-4]** Observed cracks in these structures were described and the significance of the cracks with regard to future load carrying capacity was discussed. A site plan for the Midland Plant, which indicates buildings evaluated, is shown in Fig. 1.

This report contains a discussion of effects of observed cracks on serviceability of the structures evaluated. Primary emphasis is given to durability of the concrete structures over their service life. Recommendations for repair of selected areas are also made.

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**Numbers in parentheses refer to references listed at the end of this report.

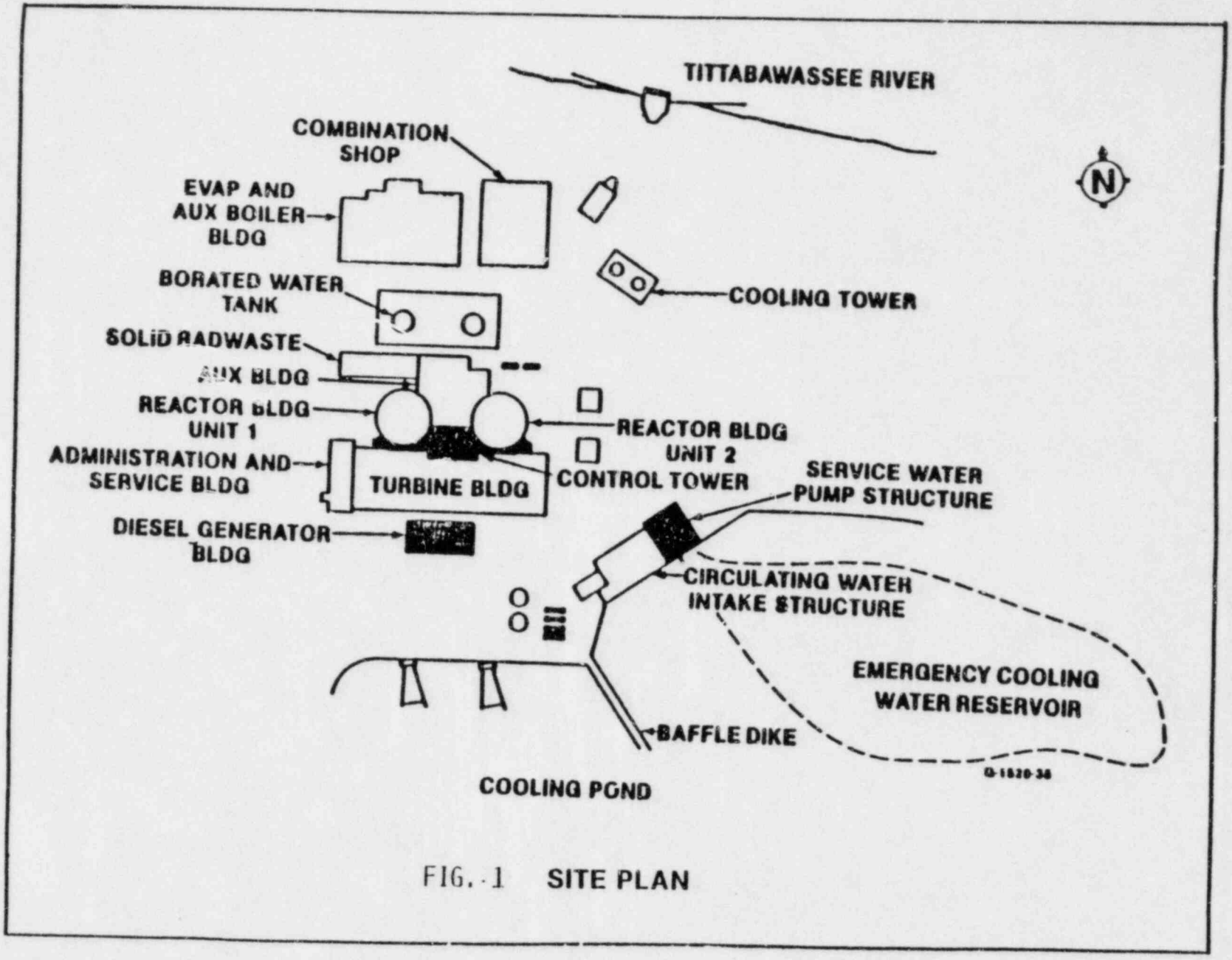

FIG. 1 SITE PLAN

OBSERVED CRACKS IN MIDLAND PLANT STRUCTURES

Cracks observed in the Feedwater Isolation Valve Pits and the Auxiliary Building Control Tower and Electrical Penetration Areas of Midland Plant Units 1 and 2 were primarily attributed to restrained volume changes that occurred during curing and drying of concrete. Cracks observed in the Diesel Generator Building were attributed to restrained volume changes, and reported differential settlement between duct banks under the building and the north and south portions of the building. Cracks observed in the Service Water Pump Structure were attributed primarily to restrained volume changes although the occurrence of settlement related cracking could not be entirely dismissed.

In terms of future serviceability of these structures, and potential problems with durability, cracks located in exterior exposed surfaces would be expected to have the most significant influence. This is because exposure conditions for exterior surfaces are more severe than those for interior surfaces. Maximum reported crack width in exterior surfaces of structures investigated at Midland was approximately 0.025 in. However, most observed cracks were significantly smaller than this maximum value. The fact that observed crack widths were spread over a wide range is consistent with most observations of cracking in concrete members. Crack widths are inherently subject to wide scatter.[5,6]

American Concrete Institute Committee 224 lists "tolerable crack widths" for reinforced concrete members as a function of

different exposure conditions.[6] For interior members, a "tolerable crack width" of 0.016 in. is listed. For exterior members subject to humidity, moist air, or in contact with soil, the "tolerable crack width" is listed as 0.012 in. ACI Committee 224 emphasizes that "it should be expected that a portion of the cracks in the structure will exceed these values by a significant amount."[6] Committee 224 also notes that their tabulation of width limits "is a general guide for tolerable crack widths at the tensile face of reinforced concrete structures for typical conditions and is presented as an aid to be used during the design process."[6] The crack widths are related to service conditions.

The presence of crack widths in excess of selected tolerable values occurs because crack limits can only be related to equations that predict "probable" maximum widths.[6] Although this probable value usually means that approximately 90 percent of crack widths in the member are below the calculated value, isolated cracks in excess of twice the width of the computed maximum can occur.[6] Research data also indicate that the range in randomness of crack widths increases with size of member.[5]

It should also be noted that equations for evaluating crack widths of flexural members are related to instantaneous or short term loading. Volume changes related to shrinkage, creep, or temperature and humidity variations, are not taken into account. For beams under nominally constant loading, research data have shown that crack widths can increase significantly with time.[7]

Thus, the maximum width would not be expected to remain constant after a crack initially forms. Therefore, in evaluating cracks in an existing structure, tolerances developed for design can not be arbitrarily applied.

For structures evaluated at the Midland Plant, most of the cracking, and crack growth, related to restrained volume changes should have taken place since construction was completed. Future movement of cracks related to normal volume and temperature changes should not affect conclusions developed in this report. However, cracks that may develop as a result of unanticipated settlement or from underpinning operations should be evaluated to determine their effects. The need for repair of such cracks can only be determined after their significance has been evaluated. Evaluation of such cracks has been included as part of the "Recommended Program for Monitoring Structural Integrity" of Midland Plant structures.[1-4]

Based on the above discussion, crack widths observed in structures investigated at the Midland Plant are judged to be within the range implied by published tolerable crack width limits.

DURABILITY OF CONCRETE STRUCTURES AT MIDLAND

This discussion covers durability of concrete as related to structures investigated at the Midland Plant. Emphasis is given to durability questions relevant to observed cracks in the Feedwater Isolation Valve Pits, Auxiliary Building Control Tower and Electrical Penetration Areas, Diesel Generator Building, and Service Water Pump Structure. Prior to discussing specific

measures for each structure, a basic discussion of durability of concrete structures is presented.

Durability of concrete is defined as "its ability to resist weathering action, chemical attack, abrasion, or any other process of deterioration."[8,9] With regard to questions of potential durability problems in Midland Plant structures, three types of concrete deterioration were considered: freezing and thawing, chemical attack, and corrosion of reinforcement.

Freezing and Thawing

Although the actual mechanism is quite complicated, freeze-thaw damage is basically caused by expansion and diffusion of freezing water in the pore system of cement paste and aggregates.[8,9,10] Freeze-thaw cycles cause progressive deterioration as a result of continued expansive pressures from excess water that freezes in concrete. Since freeze-thaw deterioration requires the presence of absorbed water that can be frozen, the occurrence of freeze-thaw deterioration on vertical surfaces is rare.

Resistance to freeze-thaw damage is obtained by designing structural members to minimize exposure to moisture, by using concrete having low in-place permeability, by using a low water-cement ratio, by using air-entrainment, and by using sound aggregates.[8,9,10] Concrete with low permeability does not absorb as much water which can later freeze.

According to information provided by Bechtel, concrete mixes used in walls of the buildings investigated at the Midland Plant had water-to-cementitious material ratios ranging from 0.41 to

0.47. These ratios are within the limit of 0.50 recommended by American Concrete Institute Committee 201 for concrete resistance to freeze-thaw damage.[8] In addition, since exterior exposed surfaces in walls of the structures are unlikely to collect or transmit water, occurrence of freeze-thaw damage is judged to be unlikely. It is not expected that cracks of the type observed in the inspected structures would have potential to collect and retain water.

Chemical Attack

Dry concrete does not react with dry chemicals.[8,9] For deterioration to take place, chemicals must be in solution and in sufficient concentration to provide an aggressive environment.[8,9] Although buildings are exposed to a number of potentially corrosive chemicals under normal environmental and atmospheric conditions, concretes generally resist chemical attack from normal conditions of exposure.

American Concrete Institute Committee 515 has prepared detailed tables on effects of chemicals on concrete.[11] General types of chemical attack include acid or alkali attack, or sulfate attack. Concrete's resistance to chemical attack is dependent upon the type and concentration of the chemical solution in contact with the concrete, the temperature and pressure of the solution, and the quality of the concrete.[9]

Deterioration of concrete by acids is primarily the result of the reaction of acids with calcium hydroxide in the hydrated portland cement paste.[8,11] This results in the formation

of water-soluble reaction products and subsequent disintegration of the concrete. Strong alkaline solutions (over 20%) attack other constituents in the hardened paste to cause disintegration.[8,11] Sulfate attack results from complex chemical reactions between sulfate solutions and constituents of hydrated portland cement paste that result in expansive compounds which cause progressive disintegration of concrete.[8,11] In all cases the rate of chemical attack is more rapid in warmer climates.[8-11]

Conditions at the Midland Plant suggest the following hypothetical situations as being conducive to chemical attack:

1. Highly concentrated acid solutions in the cooling pond that could attack concrete in walls of the Service Water Pump Structure.
2. High sulfate contents in the soil, in the cooling pond, or in groundwater adjacent to the concrete structures.
3. Atmospheric pollution that could, in combination with moisture, form "acid rain."

According to Michigan MPDES Permit Application, Amendment 3, dated September 30, 1981, the pH* level of the cooling pond water can range from 7.0 to 9.0. This pH level can be compared to that of potable groundwater which has a pH of approximately 7.0. Seawater has a pH range from 8.0 to 9.0 Thus, pH levels of the cooling pond water are not unusual.

*The pH value of a solution is a measure of its acidity on basicity. A neutral solution, or pure water, has a pH of 7. Stronger acids have lower pH values.[9]

With regard to sulfate attack, no unusual levels of sulfates in soils or groundwater at the Midland Plant have been reported to Construction Technology Laboratories staff. Sulfate levels in the cooling pond are listed in the Michigan MPDES Permit Application, Amendment 3, dated September 30, 1981. According to the permit, sulfate levels can reach maximum values of 908 mg/l (908 ppm of SO_4). This compares to values of 2500 to 3000 mg/l of sulfate present in seawater. Potable ground water has a sulfate level of approximately 30 mg/l.

American Concrete Institute Committee 201 considers sulfate levels in water of 150 to 1500 mg/l as a "moderate exposure" condition, and recommends a maximum water-cement ratio of 0.50 for this exposure condition. As mentioned previously, structures at the Midland Plant have water-to-cementitious material ratios of 0.41 to 0.47. These ratios are below the limit recommended by ACI Committee 201. Committee 201 also recommends that Type II cement be used for "moderate exposure" conditions. According to Bechtel, Type II cements were used in concretes for the structures evaluated. Therefore, the structures should have adequate resistance to sulfate attack.

Generally, air pollution severe enough to cause damage to concrete structures would not be tolerated on the basis of environmental concerns. Therefore, it is not anticipated that external walls which are exposed to the atmosphere at the Midland Plant would be susceptible to any more damage than would occur in any concrete structure located in a similar environment.

With regard to concrete's resistance to chemical attack, the presence of cracks would expose more surface area to chemical solution. However, considering the exposure conditions and concrete quality for structures at the Midland Plant, it is concluded that chemical effects would not be any more severe than for other concrete structures in the area.

Corrosion of Reinforcement

Concrete normally provides a high degree of corrosion protection for embedded reinforcement.[8,9] This protection occurs because high alkalinity of the concrete provides a passive environment for the steel. In addition, air dry concrete provides a relatively high electrical resistivity which helps to resist corrosion.[8]

Corrosion of reinforcing steel is considered to be an electrochemical process.[8,9] Electrochemical corrosion results from flow of electric current and accompanying chemical reactions within the concrete. Flow of electric current can be induced by stray electrical currents, by contact between different metals in concrete, or by differential concentration cells that may develop within the concrete. The principal type of electrochemical corrosion in concrete structures occurs as a result of corrosion cells that develop within the concrete and steel.[8]

Normally corrosion is prevented because a passive iron oxide film forms on the surface of the steel. This film occurs in the presence of moisture, oxygen, and water-soluble alkaline products formed during hydration of cement. However, the

passive film can be destroyed if the alkaline environment of the concrete is lost. Reduction in alkalinity can occur by carbonation of the hydrated portland cement or by ingress of chloride ions in the presence of oxygen.[8,9] Penetration of oxygen and chloride ions through concrete can result in corrosion cells being formed. The cells form when anodic and cathodic areas develop along steel reinforcement because of differences in moisture content, oxygen concentration, and chloride ion concentration.[8] Corrosion is initiated at anodic areas on reinforcement.

Since products of corrosion ("rust") take up a larger volume than the original steel, expansive forces are eventually generated as corrosion becomes severe. These forces can cause cracking and spalling. Primary elements essential for electrochemical corrosion in reinforced concrete are:

1. Presence of an electrolyte
2. Presence of oxygen

An electrolyte is a solution capable of conducting electric current by ionic flow.[8] For example, moisture and chloride ions will form an electrolyte capable of conducting a "corrosion current."

Generally, steps taken to prevent corrosion are related to providing a low permeability concrete with adequate cover over reinforcing steel. While it would appear that presence of cracks in concrete structures would increase risk of corrosion, no conclusive evidence has been found to indicate that any relationship exists between crack widths and corrosion.[12] It

has been found that cracks with widths less than 0.06 in., which run approximately transverse to the direction of reinforcing steel, have little influence on corrosion.[8,12] A greater risk of corrosion occurs from cracks that run along the line of the reinforcing bar.[8,12]

For structures investigated at the Midland Plant, it is not anticipated that corrosion would be a problem with regard to future durability. The presence of cracks in exterior wall surfaces above grade will have little effect on corrosion because these areas are not subject to moisture conditions conducive to corrosion damage. The same is true for walls that are below grade level but above the water table.

For walls below the water table and for the south wall of the Service Water Pump Structure adjacent to the cooling pond, the potential does exist for build up of chloride ions as a result of alternate wetting and drying of concrete.

It should be noted that the chloride level in the cooling pond adjacent to the Service Water Pump Structure is relatively low. According to the Michigan MPDES Permit Application, Amendment 3, dated September 30, 1981, chloride (Cl) concentration in the cooling pond can reach a maximum of 425 mg/l. This concentration can be compared to the level of chloride in seawater which can be 19,000 mg/l. Potable ground water would have chloride levels of approximately 20 mg/l. Thus, the cooling pond environment is not severe. However, as a precaution against possible build up of chloride ions in the splash zone

of the cooling pond, it is recommended that this area of the wall be coated to prevent possible ingress of chloride.

The Michigan MPDES Permit Application also indicates that the pH level of the cooling pond water can range from 7.0 to 9.0. This pH level can be compared to that of seawater which ranges from 8.0 to 9.0 and that of potable groundwater, which is approximately 7.0. The pH level in the cooling pond water is not considered to be low enough to severely reduce the alkaline environment that the concrete provides for reinforcement.

RECOMMENDATIONS FOR REPAIR

Epoxy injection of existing cracks above the water table in the Feedwater Isolation Valve Pits, the Auxiliary Building Control Tower and Electrical Penetration Areas, the Diesel Generator Building, or the Service Water Pump Structure is not required to ensure future structural integrity. Epoxy injection would have no influence on capacity of these structures since the existing cracks are not detrimental to capacity.

Although epoxy injection would increase overall stiffness of the cracked structures, it is unlikely that original stiffness would be recovered,[13] nor is it necessary to recover the original stiffness.

Epoxy injection of existing cracks in exterior and interior walls above the water table is not considered essential to ensure durability of the structure. Freeze-thaw damage is not considered likely in the walls because the vertical surfaces provide adequate drainage to prevent water from being trapped.

Freeze-thaw deterioration does not occur in unsaturated concrete. In addition, atmospheric exposure conditions at the Plant are not reported to be unusually severe. Therefore, deterioration from chemical attack is not anticipated. Finally, in the absence of chloride ions, the alkaline atmosphere at the level of the reinforcing bars will prevent damage from corrosion in walls above the water table.

For cracks in walls below the water table, epoxy injection or other means of stopping leakage is recommended. This recommendation represents a precautionary measure against possible durability problems that could result from a gradual build up of chlorides or sulfates as concrete is subjected to repeated wetting and drying. Epoxy injection can be applied from the interior surface. Only cracks with visible signs of leakage need to be injected. A water insensitive epoxy system should be used. General guidelines on epoxy injection have been reported by American Concrete Institute Committee 546.[14]

It is recommended that a surface coating be applied to the exterior of the south wall of the Service Water Pump Structure. This coating should cover the splash zone area of the wall adjacent to the cooling pond.* This recommendation is a precautionary measure against possible corrosion problems that

*It is reported that the water level in the south cells of the Service Water Pump Structure is maintained at the same elevation as the cooling pond. Since conditions in these cells are not conducive to repeated wetting and drying, as in the exterior splash zone, coating of interior walls is not considered necessary.

could result if a gradual build up of sufficient chloride ion occurs as the concrete adjacent to the cooling pond is subjected to repeated wetting and drying. The coating will restrict ingress of chloride ions carried by the cooling pond water.

The splash zone can be generally defined as the portion of wall subject to repeated wetting and drying. According to the Midland Plant Final Safety Analysis Report, Revision 33, dated April 1981, the maximum operating water level in the cooling pond is at elevation 627 ft. The minimum level is at elevation 618 ft. The minimum level is based on a 100-day drought with no stream withdrawals made from the Tittabawassee River. Thus, the minimum level would not be reached under normal conditions. The normal operating level of the cooling pond ranges from elevation 626 ft to elevation 627 ft.

It is recommended that the exterior surface of the entire width of the south wall be coated between elevation 626 ft and elevation 637.5 ft. This will provide protection from chloride build up caused by repeated wetting and drying under normal operating conditions.

Peformance criteria for the coating material include:

1. The coating material should cover cracks
2. The coating material should have a low enough modulus to permit natural movement of cracks
3. The coating should be able to withstand the range of environmental conditions that can be encountered at the site
4. The coating should be water resistant

5. The coating should bond to damp concrete

6. The coating material should resist debonding from moisture movement or vapor pressure within the wall

7. The coating should exhibit long-term stability

8. The coating should not react with chemicals in cooling pond water

According to manufacturers' data, the following coatings are considered suitable for the intended application:

1. Rubberstone Hi-Fill Fibrated.

   United Coatings, Inc.
   1130 E. Sprague Avenue
   Spokane, Wash. 99202

2. Aquaflex

   Dural International Corp.
   95 Brook Avenue
   Deer Park, N.Y. 11729

3. Sika-Top 144

   Sika Chemical Corp.
   Box 297
   Lyndhurst, N.J. 07071

Other suitable coatings may be available. American Concrete Institute Committee 515 provides recommendations for use of waterproofing barrier systems on concrete.(11)

It is recommended that repairs be made after completion of underpinning operations.

SUMMARY AND CONCLUSIONS

This report presents a discussion of observed cracks in the Feedwater Isolation Valve Pits, Auxiliary Building Control Tower and Electrical Penetration Areas, Diesel Generator Building, and Service Water Pump Structure located at Midland Nuclear Power

Plant Units 1 and 2. Effects of observed cracks on future durability of the structures are discussed.

Observed cracks in walls above the water table are not expected to have a significant influence on future durability of the structures. Therefore, epoxy injection of these cracks is not considered necessary.

For cracks in walls below the water table, it is recommended that epoxy injection or other means be used to stop leakage. This precautionary measure is intended to prevent possible corrosion problems that could result from gradual build up of chloride ions.

It is also recommended that the south wall of the Service Water Pump Structure be coated within the splash zone area adjacent to the cooling pond. The coating represents a precautionary measure against possible corrosion problems that could result from gradual build up of chloride ions.

It is recommended that repairs be made after completion of underpinning operations.

Epoxy injection of existing cracks is not required to ensure future structural integrity.

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