UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

NRC STAFF RESPONSIVE FINDINGS TO APPLICANT'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW ON REMEDIAL SOILS ISSUES

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NRC STAFF RESPONSIVE FINDINGS TO APPLICANT'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW ON REMEDIAL SOILS ISSUES[1/]

I. The Staff does not contest this proposed finding.

II. The Staff does not contest this proposed finding except for the following. We would replace footnote i with the following:

> i. A surcharge or Preload is a pressure that is applied to the ground surface for the purpose of stressing the subsoil to some desirable extent. In connection with the DGB, the specific purpose of the surcharge was to accelerate the settlement process so as to substantially reduce settlement that will take place after the building has been put into service. Peck, Tr. 3212. See also paragraphs 93-138 below.

III-VI. The Staff does not contest these proposed findings.

VII. The Staff would replace the text of this proposed finding with the following. We do not contest the footnotes.

Applicant's remedial actions for DGB had already been carried out prior to issuance of the Modification Order.

1/ On November 9, 1983, during the evidentiary hearing, the Licensing Board permitted the Staff to postpone filing its proposed findings of fact and conclusions of law with respect to the diesel generator building. These findings, therefore, do not address that structure.

Even though by requesting a hearing Applicant stayed the effectiveness of the Modification Order, in February 1980 Applicant voluntarily agreed not to proceed with certain further soils remedial actions without NRC Staff review and concurrence. As indicated below, CPC's voluntary commitment did not cover all activities prohibited by the Modification Order. On April 30, 1982 we issued a Memorandum and Order (Imposing Certain Interim Conditions Pending Issuance of Partial Initial Decision), LBP-82-35, 15 NRC 1060, which required Applicant to obtain explicit prior approval from the NRC Staff (to the extent such approval had not already been obtained) before proceeding with further soils remedial actions. As explained at greater length in LBP-82-35, we found no indication in the record that Applicant had failed to honor its commitment. However, we were concerned that there might be certain activities, such as work associated with underground piping, outside the scope of Applicant's commitment but within the coverage of the prohibition in the Modification Order that should be subject to Staff approval. In addition, we had some doubt whether, in the absence of Staff review and approval, Applicant would carry out certain remedial soils activities using appropriate QA procedures and principles. The effect of issuing LBP-82-35 was to update the requirements of the Modification Order to reflect developments since December 6, 1979 and sustain those updated requirements on an interim basis. The only exception is the requirement for submission and approval of amendments to the applications for construction permits, a procedural requirement which was not necessary to attain the safety goals which we believed should be achieved.

VIII-X. The Staff does not contest these proposed findings.

SEISMOLOGY AND SEISMIC MODELS

A. INTRODUCTION

1. and 2. The Staff does not contest these proposed findings.

3. The Staff does not contest this proposed finding, but adds the following. In footnote 7, CPC discusses the difference between magnitude and intensity, referencing exhibit 4 to the prepared testimony of Holt (fol. Tr. 4539). The Staff notes that the same subject is addressed on page 8 of the prepared testimony of Staff witness Kimball (fol. Tr. 4690). The Staff discussion does not differ from CPC's discussion in any material way.

4. The Staff does not contest this proposed finding except as follows. In footnote 9, CPC states that the two alternative proposals for establishing an SSE which were set forth in the October 14, 1980, Tedesco letter (Holt exhibit 3) used as a controlling earthquake, the 1937 Anna, Ohio event. The Tedesco letter actually stated that the controlling earthquake the Staff would require to be used in determining the SSE for Midland is "similar" to that which occurred in Anna, Ohio in March, 1937 and has a body wave magnitude of 5.3 m_{blg} and a MMI of VII-VIII. As discussed at page 5 of Mr. Kimball's testimony, the Staff did not rely solely on the 1937 Anna, Ohio event, but also considered the several other events described by Mr. Kimball.

5. through 7. The Staff does not contest these proposed findings.

B. THE CONFORMANCE OF THE SITE SPECIFIC RESPONSE APPROACH WITH 10 C.F.R. PART 100, APPENDIX A

8. The Staff does not contest this proposed finding.

9. The Staff does not contest this proposed finding, but adds the following. At the end of footnote 17 on page 16 of CPC's proposed findings, CPC cites Holt and Kimball in support of a statement that extensive investigations have established that there are no capable faults or tectonic structures in the vicinity of the Midland site. The extensive investigations referred to are discussed in the Staff's Safety Evaluation Report (Staff exhibit 14) at pages 2-41 through 2-44. The Staff agrees that those investigations have established that there are no capable faults or tectonic structures in the vicinity of the Midland site.

10. The Staff does not contest this proposed finding except as follows. CPC states that seismicity, which it defines as the relative frequency of earthquakes in a particular region, is a probablistic consideration. The authority cited for that statement is 10 C.F.R. Part 100, Appendix A, Section V(a). The Staff does not believe that the authority cited supports that definition. 10 C.F.R. Part 100, Appendix A, Section V(a) does not define seismicity. The Staff does not agree that, within the context of the regulation, seismicity is solely the relative frequency of earthquakes in a particular region and therefore only a probablistic consideration. To the extent that the regulation would assist in defining seismicity, the Staff notes that CPC has ignored the deterministic considerations of seismic history. The Staff believes it appropriate to make this clarification because of the Board's expressed concerns as to whether probablistic considerations used

in connection with the site specific response spectra are appropriate under 10 C.F.R. Part 100, Appendix A. This matter is addressed further in ¶ 14 of the Staff's proposed findings.

In footnote 21 of ¶ 10, CPC cites the October 14, 1980 Tedesco letter as authority for their statement that both the NRC staff and the Applicant agreed that while Appendix A contemplates a deterministic or "cookbook" approach to establish the SSE which involves defining tectonic provinces and maximum potential earthquakes, it does not bar the use of any seismological information, including seismicity and other probablistic considerations, in making the judgments about tetonic province boundaries and maximum potential earthquakes within such tectonic provinces. The Staff finds no support in the October 14, 1980 Tedesco letter for CPC's assumption that a deterministic approach is the same as a "cookbook" approach. The Staff also does not believe that the Tedesco letter supports Applicant's implication that seismicity is a probablistic consideration (implied in their clause "including seismicity and other probablistic considerations").

In footnote 22 of ¶ 10, CPC cites Holt and Kimball in support of a statement that because empirical methods for ascertaining geologic structure at depths are not well developed, historic seismicity affords one of the most accurate means available for inferring information about the geologic structural features of a site. Further support for this statement can be found at pages 3-4 and 20 of Mr. Kimball's prepared testimony (fol. Tr. 4690).

11. The Staff does not contest this proposed finding except as follows. The citation in footnote 23 should be 10 C.F.R. Part 100,

Appendix A, § V(a)(1)(iv). The citation in footnote 24 should be 10 C.F.R. Part 100, Appendix A, § VI(a)(1).

The last sentence in ¶ 11 of CPC's proposed findings states that when scaled to an assumed zero period ground acceleration value (0.19g) representative of a VII-VIII or Magnitude 5.3 earthquake, as suggested as in the October 14, 1980 Tedesco letter, the Regulatory Guide 1.60 response spectrum generally defines a level of ground motion in excess of that which the site would experience due to the occurrence of such an earthquake at the site. The Tedesco letter does not state or suggest that an assumed zero period ground acceleration of 0.19g is representative of a VII-VIII or magnitude 5.3 earthquake. (The Staff set forth its views as to the application of Regulatory Guide 1.60 at pp. 10-12 of its "NRC Staff Brief in Support of the Use of a Site Specific Response Spectrum to Comply with the Requirements of 10 C.F.R. Part 100, Appendix A" filed on September 29, 1981.) If the Board agrees with CPC and the Staff that the site specific response spectra is appropriate at Midland, CPC's statement is moot.

12. The Staff does not contest this proposed finding except as follows. CPC cites Holt exhibit 3 in support of its statement that site specific response spectra corresponding to specific site foundation conditions can be constructed for most sites. Holt exhibit 3, which is the October 14, 1980 Tedesco letter, does not contain such a statement.

13. The Staff does not contest this proposed finding, but adds the following. CPC cites Holt, prepared testimony on Midland SSRS at pages 6-7, following Tr. 4539 and Holt exhibit 3 for its statement that the October 14, 1980 Tedesco letter dictates the use of a magnitude range of

5.3 ± 0.5 m_{blg}, epicentral distances of less than 25 kilometers, and recording instruments on soil. Those matters are also discussed at pages 6 and 7 of the prepared testimony of Staff witness Kimball (fol. Tr. 4690). The Staff discussion does not differ from CPC's in any material way.

14. The Staff does not contest this proposed finding except as follows. Starting in the seventh line of the paragraph, through the end of the paragraph CPC tries to support its opinion that the construction of response spectra is a probablistic analysis. The citation given is "Applicant's Brief, at p. 11." The Staff does not agree with CPC's position and believes that for NRC's position and legal argument on such issues the Board should refer to the brief filed by the Staff (referenced in ¶ 11 above). (CPC filed "Applicant's Brief On Compatibility Of Site Specific Response Spectra Approach With 10 C.F.R. Part 100, Appendix A" on September 29, 1981).

15. The Staff does not cotest this proposed finding except as follows. The Staff does not agree with the last sentence of Applicant's proposed findings which states that the SSRS methodology, because it attempts to match earthquake records to site conditions, is actually more consistent with Appendix A than is use of the site independent Regulatory Guide 1.60 response spectrum. CPC cites no authority for that statement. The Staff maintains the position it took in its September 29, 1981 brief at page 10, which is that both methodologies for designing and applying a response spectrum are consistent with the requirements of Appendix A (both methodologies being (1) a site independent response spectrum as defined in Regulatory Guide 1.60 and (2) the site specific response

spectrum suggested by the Staff for use in this proceeding). The Staff does not believe there is any record evidence in this case to support Applicant's claim that SSRS methodology is more consistent with Appendix A than the use of the site independent Regulatory Guide 1.60 response spectrum.

16. The Staff does not contest this proposed finding, but adds the following. In footnote 32, CPC discusses the methodology used by the Staff in developing site specific response spectra for the Staff's Systematic Evaluation Program (SEP), citing Applicant's brief at page 6, note 3. The Staff notes that a similar (consistent) discussion is contained on page 14 of the Staff brief.

C. THE SELECTION OF THE PROPER TECTONIC PROVENCE AND APPROPRIATE CONTROLLING EARTHQUAKE FOR MIDLAND

17, 18. and 19. The Staff does not contest these proposed findings.

20. The Staff does not contest this proposed finding except as follows. In the first sentence of ¶ 20 of CPC's proposed findings it states that the NRC staff was reluctant at first to accept the Applicant's designation of the Michigan Basin as the proper tectonic province for Midland. The Staff wants to negate the inference that could be read into that statement that u'timately the Staff did accept CPC's designation of the Michigan Basin as a proper tectonic province for Midland. The Staff's seismotectonic province for Midland does not coincide with the tectonic province that was submitted by the applicant; i.e., the Michigan Basin. (See discussion in ¶ 23)

In the last sentence of ¶ 20 of CPC's proposed findings, it again states (erroneously) that the 1937 Anna, Ohio earthquake is the

controlling earthquake for Midland. As discussed in ¶ 4 of the Staff's findings, the 1937 Anna, Ohio earthquake is not the controlling earthquake for Midland. As stated on page 1 of Holt exhibit 3 (the October 14, 1980 Tedesco letter) the controlling earthquake is "similar" to the Anna, Onio earthquake.

21 & 22. The Staff does not contest these proposed findings.

23. The Staff does not contest this proposed finding except as follows. In the last sentence of CPC's proposed findings, CPC states that the Staff eventually concurred with the Applicant that the Central Stable Region could be subdivided into a smaller tectonic province including the Midland site. The Staff consistently used the expression seismotectonic province as opposed to tectonic province. See Kimball prepared testimony page 4 and page 20. The Staff testified that they equated these two terms, Tr. 4699 and 4757-58. The Staff would make the same comment in response to CPC's proposed findings in the first sentence of ¶ 23, and ¶¶ 28 and 29.

24 & 25. The Staff does not contest these proposed findings.

26. The Staff does not contest this proposed finding except as follows. In footnote 53 CPC cites the prepared testimony of Holt and Kimball in support of its statement that the Applicant's formal probabilistic analysis confirms that the Midland site is in an area of relatively lower seismic hazard as compared to other sites surrounding the Michigan Basin in the Central Stable Region. The citation to the prepared testimony of Staff witness Kimball is incorrect. At page 18 of his prepared testimony, Staff witness Kimball concluded, after examining the seismic hazard analysis performed by the Applicant for five sites,

that the Midland site has lower expected intensities than the other five sites at all exceedence probabilities and, therefore, the Midland site is associated with lower seismic hazard than other parts of the Central Stable Region. Mr. Kimball did not reference the Michigan Basin in his testimony, and the above noted comparisons were not performed to define the Michigan Basin.

27. The Staff does not contest this proposed finding.

28. The Staff does not contest this proposed finding, but adds the following. In footnote 61 the Applicant cites Tr. 4769 and 4787 in support of their statement that Mr. Kimball testified that the largest historical earthquakes for the Staff's seismotectonic province have a magnitude range of 4.7 to 5.0 with a maximum intensity of VII or less. The Staff notes that a consistent discussion is found in Mr. Kimball's prepared testimony at page 20 and 21 where he lists the largest events in the Staff's seismotectonic province.

29. The Staff does not contest this proposed finding except as follows. In footnote 64 CPC cites the testimony of its witness Holt and Staff witness Kimball in support of a statement that the Anna, Ohio earthquake may be reasonably related to tectonic structures, in which case Appendix A would not require postulating it to occur at the boundary of the tectonic province. The cited transcript pages (4715-16), clarify that the Staff is reluctant to conclude that the Anna, Ohio earthquake is tied to a local tectonic structure in the vicinity of Anna, Ohio.

30. The Staff does not contest this proposed finding.

D. THE CHARACTERIZATION OF GROUND MOTION FOR MIDLAND

31. The Staff does not contest this proposed finding except as follows. In footnote 71 CPC provides a considerable number of citations to support its statement that there was initial disagreement as to the appropriate spectral level at which the response spectra generated from different records should be statistically combined to form the SSRS. The Staff does not believe the citations provided support that statement. Further, the testimony of Applicants' witness Holt demonstrates that this discussion is moot. At Tr. 4594 Applicant's witness Holt was asked in light of the agreement that the safe shutdown earthquake should be a 5.0 magnitude event whether he agreed that the 84 percentile spectra drawn to that event would be an appropriate representation of ground motion. Mr. Holt agreed that the 84 percentile was appropriate.

32. The Staff does not contest this proposed finding except as follows. In its discussion of the criteria for selecting earthquake records to construct the SSRS for Midland, CPC refers to the epicentral distance of less than 25 kilometers which they state is dictated by the Tedesco letter. CPC states that the epicentral distance of 25 kilometers or less was selected to simulate the occurrence of the selected earthquake "at the site" of the nuclear power plant. In support of that statement CPC cites the prepared testimony of its witness Holt and Holt exhibit 3. The Staff notes that at Tr. 4729-4734 the Board and parties interrogated Staff witness Kimball as to the Staff interpretation of the expression "at the site" (found at 10 C.F.R. Part 100, Appendix A § V(a)(1)(ii)). The discussion of the expression "at the site" relates to the regulatory requirement that an earthquake within a tectonic province that is not associated with structure should be assumed to take

place "at the site". The Staff explained that it interpreted that expression to mean, where no capable faults have been identified, that the earthquake would be assumed to occur very close to the site.

33-44. The Staff does not contest these proposed findings.

I. THE USE OF THE PARKFIELD RECORDS

45-46. The Staff does not contest these proposed findings.

47-50. The Staff adopts CPC's proposed findings in ¶¶ 47 through 50 except where the Applicant sets forth in each of these paragraphs reasons that it believes the Parkfield records should not be included in developing a site specific response spectrum for an Anna type event at Midland. As set forth by Staff witness Kimball at pages 13 through 16 of his prepared testimony, the Staff believes that in the event it was appropriate to develop a site specific spectrum for an Anna type event at Midland, it would be appropriate to include the Parkfield records.

51-54. The Staff does not contest these proposed findings.

II. SELECTION OF THE 84TH PERCENTILE AS THE REPRESENTATIVE SPECTRAL LEVEL

55-57. The Staff does not contest these proposed findings.

58. The Staff does not contest this proposed finding except as follows. In the event the Board is not able to subdivide the Central Stable Region and concur with the Applicant and the Staff that a magnitude 5.0 event is appropriate, the Staff submits that the 84th

percentile spectrum with the Parkfield records included is a conservative representation of ground motion for the Midland site. Prepared testimony of J.Kimball, p.10.

E. THE DEVELOPMENT OF DYNAMIC MATHEMATICAL MODELS FOR THE AUXILIARY BUILDING, SWPS AND BWST

59-76. The Staff does not contest these proposed findings.

F. APPLICANT'S USE OF 1.5 x FSAR SSE RESPONSE SPECTRA HAS SUBSTITUTE FOR SSRS

77-78. The Staff does not contest these proposed findings.

DIESEL GENERATOR BUILDING

79-209. On November 9, 1983, during the evidentiary hearing, the Licensing Board permitted the Staff to postpone filing its proposed findings of fact and conclusions of law with respect to the diesel generator building. These findings, therefore, do not address that structure.

AUXILIARY BUILDING

210-214. The Staff does not contest these proposed findings.

215. The Staff does not contest this proposed finding except as follows. In the last two sentences of ¶ 215, CPC reports that the NRC Staff's review of the borings taken to evaluate the backfill of the north and south ends of the auxiliary building led the Staff to conclude that the plant fill was indequately compacted, not only beneath the FIVP's and the electrical penetration areas, but also beneath the control tower. CPC then states "in particular, a one-foot deep void was discovered in one of the borings beneath the mud mat under the control tower". The Staff is concerned that the last sentence could lead the Board into believing that the one foot deep void was the only cause for the Staff's concern with respect to the foundation capability of the fill beneath the control tower.

The Staff was also concerned that the remedial fix for the auxiliary building not impose additional loads which the control tower would be unable to carry. In evaluating an earlier proposed remedial fix, requiring caisson support of the EPAs, the Staff determined that the plan did not satisfactorily address the ability of the control tower to safely carry the additional load imposed by underpinning the extremeties of the EPAs with caissons. (Testimony of Darl Hood, Joseph Kane and Hari Singh concerning the Remedial Underpinning of the Auxiliary Building. fol. Tr. 5839, pp. 13-14, 19). The problem of overstressing the fill foundation soils of the control tower has been eliminated by the current underpinning proposal, which requires the new foundations to be placed

228-230. The Staff does not contest these proposed findings, except to note the following. First, we add to ¶ 229 after the second sentence, the following discussion regarding the method of addressing long term settlement. Anticipated long term differential settlements used in design will be checked by extrapolation of the trend of the measured differential settlements, while the jacks are still active, to estimate future differential settlements during years of plant operation. (Applicant's testimony on the auxiliary building, fol. Tr. 5509, p. 54 and SSER #2, p. 2-50).

Second, ¶ 229 should discuss the fact that pier W-11 at the auxiliary building has been load-tested. During the pier load test, a pressure equal to 130% of the maximum predicted bearing pressure ~~will be~~ was applied to the bearing stratum. The load will eventually be lowered to the design jacking load. The Staff found these load test procedures acceptable. (SSER #2, p.2-51 and Tr. 14,370).

As was discussed by Dr. Landsman before this Board on April 27, 1983, the pier-load test at Pier W-11, completed in the Spring of 1983, did not go "the way it is supposed to." (Tr. 14370-1). As a result, CPC reevaluated the structure using a reduced value of the soil modulus. Staff audited the calculations on September 14 and 15, 1983. The audit raised questions concerning the reasonableness of CPC's statement in the second sentence of ¶¶ 229 and 230 and the Staff's conclusion in SSER #2, p. 2-40 that differential settlement between the control tower and the main portion of the auxiliary building should not be more than 0.25 inches. This matter is still being considered by NRC and CPC. The Board will be notified of the resolution of this matter.

231. The Staff does not contest this proposed finding.

232. The Staff does not contest this proposed finding but would add to the end of footnote 437 the following. The Staff now has strong evidence that the auxiliary building can withstand loads that would be imposed by a Site Specific Response Spectra Earthquake. (Testimony of Frank Rinaldi on Intervenors' Contentions, fol. Tr. 12,080 at p. 8.)

233. With the following exception, the Staff does not contest this proposed finding. There is a need to correct CPC's statement that the replacement fill under the FIVPs will be compacted to a "95% relative density." Rather, the fill will be compacted to a 95% maximum dry density as determined by ASTM test D-1557 or ASTM test D-2049, whichever results in the greater maximum dry density. (SSER #2, p.2-17). We also call the Board's attention to the difference between glacial till and lacustrine clay as described in the Staff's response to ¶ 219.

234-237. The Staff does not contest these proposed findings.

238. Except for the following, the Staff does not contest this proposed finding. The Staff would agree that the action levels for deflection of the auxiliary building are "conservative", but would not go as far as to call them "very conservative." The Staff has specifically stated that the underpinning design, construction procedures, and the instrumentation to monitor underpinning are "conservative." (SSER #2, p.2-23). Instrumentation records and as built records will permit the Staff to continue to assess the extent of conservatism of these levels of deflection. (SSER #2, pp. 2-52 to 2-53).

239-241. The Staff does not contest these proposed findings.

242. The Staff does not contest this proposed finding except as follows. CPC states that it has adequately and conservatively taken into account the dynamic responses of the control tower, electrical penetration areas and FIVPs with regard to dewatering effects, differential soil settlement and seismic effects in the design and evaluation of those remedial soils measures. The Staff agrees, but notes that the concerns expressed by Ms. Stamiris in this and other contentions are similar to the concerns that caused the Staff to issue the December 6, 1979 Order. As is discussed in the Staff's reply to ¶¶ 228-230, questions about whether the Applicant has adequately taken into account differential soils settlement at the auxiliary building were raised at a design audit on September 14 and 15, 1983. As is also discussed in the response to ¶¶ 228-230, resolution of this matter will be brought to the Board's attention.

243-244. The Staff does not contest these proposed findings.

SERVICE WATER PUMP STRUCTURE

245. The Staff does not contest this proposed finding.

246. Applicant's Exhibit 28 shows that the backfill extends below the line connecting points A and B. Therefore, the northern portion of the SWPS rests on more backfill than the triangular wedge described in this proposed finding and drawn on Exhibit 28. Otherwise, we do not contest this proposed finding.

247-248 The Staff does not contest these proposed findings.

249. The Staff does not contest this proposed finding except as follows. The Staff approached the cracks in the SWPS in a different way then did CPC. We did not discount any of the cracks in the SWPS on the assumption that they were caused by shrinkage. In fact, we have noted that some of the cracks in the SWPS have appeared at locations where one would expect to find cracks caused by differential settlement. (SSER # 2, pp. 2-23, 3-27). ~~In assessing the effects of cracking~~ In assessing the effects of cracking we have directed our attention to whether the cracks significantly diminish the strength of the structure (SSER #2, pp. 3-27 to 3-28). ~~Rather than dwell on the cause of the cracks, we have directed our attention to whether the cracks significantly diminish the strength of the structure. (SSER #2, pp. 3-27 to 3-28).~~ As with the auxiliary building, ~~the Staff~~ submits that, since concerns about future differential settlement have been addressed by the ~~subsequently~~ remedial measures, it was not necessary to further address ~~dwell on~~ the reasons for the cracks.[5/] We base our approval of CPC's evaluation of the SWPS cracks on

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5/ In fact, Dr. Corley testified that since the structure will be underpinned, a more detailed analysis to determine the precise cause of the cracks was not necessary. (Corley, prep. test, foll. Tr. 11204 at 29).

the fact that CPC has demonstrated that the cracks do not significantly affect the strength of the structure. ~~(Id.)~~ (SSER #2, pp. 3-27-32).

A close look at the record indicates that it is uncertain what role differential settlement played in causing the SWPS cracks. As discussed above, the Staff believes cracks have appeared at locations where cracks induced by differential settlement would be anticipated to form. (SSER #2, p. 2-23). In his analysis of Bechtel crack mappings, Dr. Corley did not see the pattern that would be expected from cracks caused by differential settlement. However, he acknowledged that certain cracks in the roof are located where one would expect to see cracks caused by differential settlement. (Corley, prep. test, foll. Tr. 11204 at 16, 23). As for Dr. Corley's own observations of certain cracks in the SWPS, he did not see the pattern expected from cracks induced by differential settlement. However, during his inspection, access to most areas was difficult and lighting was poor. (Corley, prep. test, foll. Tr. 11204 at 26-29). Those factors lessen the weight that can be given to Dr. Corley's personal observations of the cracks. Although Dr. Corley concludes that volume changes were the primary cause of the cracks, he repeatedly emphasizes that he cannot rule out differential settlement as causing some of the SWPS cracks. (Corley, prep. test, foll. Tr. 11204 at 23-24, 29, 40, B1).

Based on the above, the Board should rely on the following factors in determining that the cracks in the SWPS are no longer of significant concern.

(a) In December, 1978, a crack mapping program was initiated for all seismic category I buildings founded on plant fill. Pursuant to this

program, several crack mappings for the SWPS have been done. (CPC prep. test on SWPS, foll. Tr. 9490, at 3-5). Among other places, cracks have appeared at locations where one would expect to find cracks caused by differential settlement. (Corley, prep. test, foll. Tr. 11204, at 16, 23, SSER #2, p. 2-23).

(b) The significance of the cracks in the SWPS was assessed by Construction Technology Laboratories (CTL). The results of that analysis were presented at the hearing by Dr. W. G. Corley of CTL. (Corley, prep. test. fol. Tr. 11204).

(c) Dr. Corley testified that cracks attributable to differential settlement of the SWPS would appear in the east and west walls. (Corley, prep. test, foll. Tr. 11204 at 25). Cracks have appeared in those walls. (See, e.g., Corley, prep. test, foll. Tr. 11204 at 11.) ~~The Staff also noted that cracks have appeared in areas in the SWPS where one would expect to find cracks carved by differential settlement. (SSER #2, pp. 2-23, 3-27)~~

(d) Two types of analyses were performed to determine whether the cracks in the east/west walls significantly diminish the strength of the SWPS. First, the available tensile capacity of the structural reinforcement was compared to the tensile stress that uncracked concrete would be assumed to carry. For all but the center west wall, the available tensile capacity of the reinforcement exceeded the tensile stress that the uncracked concrete would be assumed to carry (Corley, prep. test, foll. Tr. 11204 at 30-32). For the center west wall, a limit analysis showed the wall to be sound. (Id. at 33). Subsequently, at the Staff's request, limit analyses were performed for all of the east/west

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walls. They further confirmed that the cracks do not indicate distress to the structure. (Id., Appendix B).

(e) Because the Applicant satisfactorily demonstrated that the cracks in the SWPS do not significantly affect the strength of the structure, the Staff found CPC's crack evaluation acceptable. (SSER #2, pp. 3-27 to 3-28).

(f) In addition, CPC has developed a crack monitoring and repair program. If a new crack greater than 0.01 inch develops or if an existing crack exceeds 0.03 inch in width, an evaluation will be done to determine whether underpinning procedures should be altered or halted. (SSER #2, p 2-50). All cracks will be repaired by epoxy injection if they are 20 mils or larger. The length of the crack that will be injected will be limited to a crack width of 10 mils or larger. As for cracks which show weeping characteristics and are below the groundwater table, they will be repaired by epoxy injections regardless of their length. Inaccessible cracks need not be repaired. Also, the portion of the wall of the SWPS that comes into contact with cooling pond water will be coated with water proofing compounds (SSER #2, p. 3-29).

(g) The Staff finds CPC's crack monitoring and repair program acceptable. (Id.)

250-257. The Staff does not contest these proposed findings.

258. The Staff would add the following to this proposed finding. As has been done at the auxiliary building, a pier load test will be completed at Pier 1E for the SWPS. The procedures for the load test are described at the Staff's response to ¶¶ 228-230 of the Applicant's proposed findings. However at the SWPS, an additional pier will be load

tested if the bearing level for any of the piers is on the dense sandy alluvium rather than the hard sandy clay till. (SSER #2, p. 2-51). For a discussion of the acceptability of alluvial sand as a foundation footing, see CPC's prepared testimony on SWPS at pp. 11, 30-31.

259. The Staff does not contest this proposed finding.

260. The Staff disagrees with the last sentence. Mr. Kane did testify that the two sections of the retaining wall are structually independent from each other and that they can settle separately. (Tr. 9725). However, he did not testify that there could be no stuctural distress to the wall if its two sections settled in different amounts. Mr. Kane did not address the question of whether there could be structural distress stemming from the two sections of the wall settling different amounts. (See Tr. 9687-9694, 9723-9738).

261-269. The Staff does not contest these proposed findings.

Mr. Kane did testify that explorations in the area of the retaining walls did not reflect loose or soft soil materials and that settlement had been small and therefore the retaining wall foundations were not a part of the plant fill problem. (Tr. 9672)

BORATED WATER STORAGE TANKS

270-276. The Staff does not contest these proposed findings.

277. The Staff believes that ¶ 277 of the Applicant's proposed findings does not adequately present the settlement discussions on the BWSTs and could mislead the Board. In that paragraph Applicant correctly recites that Dr. Hendron was of the opinion that the primary settlements observed for the BWST (about 1.3 inches) at the edge of the foundation, were not excessive, and that the structural cracks at the boundary between the valve pit and ring wall indicated that the foundations were not really designed to take distortions that they would get due to the fact that the valve pits were lightly loaded and the ring walls were more heavily loaded. Dr. Hendron's opinion was in response to a question by Judge Decker at Tr. 1715 asking Dr. Hendron to express his opinion whether the problems associated with the settlement of the borated storage tanks were due to poorly compacted soil or whether those problems resulted from design error. Dr. Hendron's view was that the problem was a design problem. As stated by the Applicant Mr. Boos agreed with Dr. Hendron's evaluation.

The Staff expressed a different view. At Tr. 7449 Darl Hood expressed the Staff's view that the differential settlement at the borated water storage tank was a soils related problem. At Tr. 7451 Mr. Kane expressed his own view that the problem was a soils settlement problem.

The aspect of this finding that could mislead the Board relates the amount of settlement involved. In expressing his opinion, Mr. Kane referred to the total settlement that the BWSTs had experienced - not

just the settlement from the time the tank was filled with water. There were 1.3 inches of settlement at BWST 1 subsequent to the time it was filled with water in October 1980. Mr. Kane's testimony, however, is that there were 1.1 inches of settlement prior to October 1980, while the tank stood empty, and that that influenced his judgment that the matter was a soils related problem. (Tr. 7494). The settlement prior to October, 1980 is not mentioned by the Applicant in paragraph 277.

At Tr. 7217, Judge Harbour specifically asked applicant's witnesses about the "absolute amount of settlement" of either of the borated water storage tanks. Judge Harbour indicated there that that figure could not be determined from the testimony and he emphasized again that he was concerned with absolute settlement, not differential settlement. Applicant witnesses Boos referred the Board to figure BWST-8 attached to the "Testimony of Alan J. Boos and Dr. Robert Hanson on Behalf of the Applicant Regarding Remedial Measures for the Midland Plant Borated Water Storage Tank" (fol. Tr. 7173). The witness's reference to BWST-8 was not responsive to Dr. Harbour's question because figure BWST-8 shows 1.3 inches of settlement only after the load test started on October 8, 1980. Judge Cowan asked at Tr. 7218 whether the settlement shown on figure BWST-8 showed differential settlement or total settlement. Applicant witness Boos responded that it was a plot of total settlement for that point. (Tr. 7218).

The settlement illustrated by figure BWST-8 is not the total settlement for marker TF-1 since it presents only the settlement after the tank was filled in October 1980. As indicated in SSER #2, page 2-41, the settlement history of the BWST's is shown in FSAR figures to 2E.1-17,

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walls. They further confirmed that the cracks do not indicate distress to the structure. (Id., Appendix B).

(e) Because the Applicant satisfactorily demonstrated that the cracks in the SWPS do not significantly affect the strength of the structure, the Staff found CPC's crack evaluation acceptable. (SSER #2, pp. 3-27 to 3-29).

(f) In addition, CPC has developed a crack monitoring and repair program. If a new crack greater than 0.01 inch develops or if an existing crack exceeds 0.01 inch in width, an evaluation will be done to determine whether underpinning procedures should be altered or halted. (SSER #2, p 2-50). All cracks will be repaired by epoxy injection if they are 20 mils or larger. The length of the crack that will be injected will be limited to a crack width of 10 mils or larger. As for cracks which show weeping characteristics and are below the groundwater table, they will be repaired by epoxy injections regardless of their length. Inaccessible cracks need not be repaired. Also, the portion of the wall of the SWPS that comes into contact with cooling pond water will be coated with water proofing compounds (SSER #2, p. 3-29).

(g) The Staff finds CPC's crack monitoring and repair program acceptable. (Id.)

250-257. The Staff does not contest these proposed findings.

258. The Staff would add the following to this proposed finding. As has been done at the auxiliary building, a pier load test will be completed at Pier 1E for the SWPS. The procedures for the load test are described at the Staff's response to ¶¶ 228-230 of the Applicant's proposed findings. However at the SWPS, an additional pier will be load

ested if the bearing level for any of the piers is on the dense sandy alluvium rather than the hard sandy clay till. (SSER #2, p. 2-51). For a discussion of the acceptability of alluvial sand as a foundation footing, See CPC's prepared testimony on SWES at pp. 11, 30-31.

259. The Staff does not contest this proposed finding.

260. The Staff disagrees with the last sentence. Mr. Kane did testify that the two sections of the retaining wall are structually independent from each other and that they can settle separately. (Tr. 9725). However, he did not testify that there could be no stuctural distress to the wall if its two sections settled in different amounts. Mr. Kane did not address the question of whether there could be structural distress stemming from the two sections of the wall settling different amounts. (See Tr. 9687-9694, 9723-9738).

261-262. The Staff does not contest these proposed findings.

BORATED WATER STORAGE TANKS

270-276. The Staff does not contest these proposed findings.

277. The Staff believes that ¶ 277 of the Applicant's proposed findings does not adequately present the settlement discussions on the BWSTs and could mislead the Board. In that paragraph Applicant correctly recites that Dr. Hendron was of the opinion that the primary settlements observed for the BWST (about 1.3 inches) at the edge of the foundation, were not excessive, and that the structural cracks at the boundary between the valve pit and ring wall indicated that the foundations were not really designed to take distortions that they would get due to the fact that the valve pits were lightly loaded and the ring walls were more heavily loaded. Dr. Hendron's opinion was in response to a question by Judge Decker at Tr. 1715 asking Dr. Hendron to express his opinion whether the problems associated with the settlement of the borated storage tanks were due to poorly compacted soil or whether those problems resulted from design error. Dr. Hendron's view was that the problem was a design problem. As stated by the Applicant Mr. Boos agreed with Dr. Hendron's evaluation.

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do not delete

-18, -20, and 21. FSAR figure 2E.1-17 shows 1.1 inches of settlement prior to October 8, 1980, for TF-1, the settlement marker that is reported in figure BWST-8. The 1.1 inch of settlement reported there occurred between January 1979 and the Spring of 1980. This confirms Mr. Kane's testimony at Tr. 7494 and is a further basis for concluding the problem with the BWST was related to poorly compacted fill.

278. The Staff does not contest this proposed finding, but adds the following. Applicant correctly cites Tr. 7367 to support the view of Applicant witness Kennedy that the under-reinforcing of the ring wall, which he states to be the third of three causes of the problems at the borated water storage tanks, was the major cause of the problem. Dr. Kennedy admitted at Tr. 7368 that it was "very difficult" for him to determine which of three causes was the primary cause. The Staff differs with Dr. Kennedy's opinion as to the major cause of differential settlement. As discussed by the Staff in ¶ 279 below, differential settlement was primarily caused by inadequately compacted fill. Without the inadequately compacted fill, there would have been no significant differential settlement. It appears that Dr. Kennedy has confused the effect of differential settlement with the cause of the problem.

279. In the first sentence of ¶ 279, CPC states that Staff witness Kane expressed his opinion that inadequately compacted fill contributed to the problem for the Unit 1 BWST and stated as his basis for that, that the settlement that was experienced at the Unit 1 BWST was greater than he would have expected if the soil had been properly compacted. For a more complete statement as to the Staff's basis of its opinion that the differential settlement problem was primarily the result of inadequately

compacted fill, see ¶ 2.5.4.4.3 at p. 2-34 of SSER #2. The Staff states there that its conclusion is based on (1) results of the soils investigations of the fill in the tank farm area, (2) results of plate load tests, and (3) the observed total and differential settlements that occurred.

The Staff disagrees with the implication of the second sentence of ¶ 279 in which the Applicant states that Mr. Singh, while not disagreeing with Mr. Kane that inadequately compacted fill contributed to the problem for the Unit 1 BWST, also testified that the unsymmetrical foundation design was a factor in creating the observed differential settlement. The Staff does not believe it appropriate to contrast Mr. Singh's statement with that of Mr. Kane. In response to a question (Tr. 7451), Mr. Kane was discussing the cause of the BWST settlement problem, whereas Mr. Singh, at Tr. 7477-82, was responding to a different question by testifing as to how the tank foundation had settled and how the unsymmetrical foundations of the valve pits and ring foundations have an influence on the observed differential settlements.

Applicant states that more than a year after the evidentiary hearing on the BWST was concluded, Dr. Ross Landsman, a soil specialist employed by the NRC's Office of Inspection and Enforcement, Region III, volunteered his personal opinion that the unsymmetrical BWST foundation design was a design deficiency. The statement is correct but it is not clear why the statement is in CPC's proposed findings. If the statement is there because it is perceived to relate to the debate between the Staff and the Applicant as to the primary cause of the BWST settlement problem, the statement is not probative. Even assuming the unsymmetrical

BWST foundation design was a design deficiency, that fact is not probative of the primary cause of the BWST settlement problem. The Staff believes the statement should be deleted. In the last paragraph 279, CPC states that Dr. Landsman was under the mistaken impression that this issue had not previously been addressed in the hearing and cited Tr. 16,581-591. The meaning of this last sentence is also uncertain. Dr. Landsman did state at Tr. 16,591 that the record did not show that anyone had ever said that the original designs were inadequate. Applicants' last sentence appears to be inaccurate and in any event does not lead to any resolution of issues or meaningful findings or conclusions in these proceedings and should be stricken.

280-289. The Staff does not contest these proposed findings.

290. The Staff does not contest this proposed finding. For completeness of the record, the Staff believes that the following statement from ¶ 2.5.4.4.3, p. 2-35 of SSER #2 should replace the first sentence on page 206: "The Applicant has committed to provide a Technical Specification for long-term settlement monitoring during plant operation and to providing FSAR documentation of the as-built conditions for the new ring beam foundations and releveling operations, once they are completed."

291. The Staff coes not contest this proposed finding.

292. CPC states that it has adequately evaluated and analyzed the dewatering, differential soil settlement and seismic effects for the remedial surcharging of valve pits, construction of a new ring beam and releveling BWST-1, contrary to Ms. Stamiris' Contention 4 C(c). The Staff agrees but notes that the concerns expressed by Ms. Stamiris in

this and other contentions are similar to the concerns that caused the Staff to issue the December 6, 1979 Order.

293-298. The Staff does not contest these proposed findings.

299. In the last sentence of this paragraph CPC states that Staff approved methods of monitoring the BWST's for settlement, concrete cracking and strain provide additional assurance that any unanticipated future differential settlement would be detected and corrected before presenting any risk to the public health and safety. Pages 2-35, 2-52 and Table 2.8 of the SER Supplement #2 show that the technical specification details for future settlement monitoring remain to be resolved.

In footnote 536 CPC states that the Staff criticized Ms. Warren's definition of "backfill". The Staff does not believe such a statement is appropriate. At pages 16 through 18 of the "Testimony of Darl Hood, Hari Narain Singh, and Joseph Kane Concerning the Remedial Measures for the Borated Water Storage Tanks" (fol. Tr. 7444), the Staff attempted to indicate how a technically more accurate description of the random fill at Midland differed from the description indicated in Ms. Warren's contention. The Staff was able to understand the concerns expressed by Ms. Warren but we do not agree that we criticized her in our testimony.

The Board concludes that the primary cause of the differential settlement problem at the BWSTs was inadequately compacted fill.

DIESEL FUEL OIL TANKS

300-303. The Staff does not contest these proposed findings.

304. The Staff does not contest this proposed finding except as follows: At the end of footnote 544, CPC cites Tr. 7444 as the citation for the prepared testimony of Joseph Kane regarding the effects of the plant fill problem on foundation support for the seismic Category I underground piping. The Staff suggests that in some transcripts that testimony follows Tr. 7752.

305-308. The Staff does not contest these proposed findings.

309. The Staff concurs in CPC's proposed findings in ¶ 309 except as follows: In the second sentence the Applicant references ¶ 6 of its own findings as stating that following dewatering the tanks reached a maximum settlement of half an inch. The correct paragraph number is 304, not 6.

310-313. The Staff does not contest these proposed findings.

UNDERGROUND PIPING

A. INTRODUCTION

314-316. The Staff does not contest these proposed findings.

B. UNDERGROUND PIPING OTHER THAN SEISMIC CATEGORY I

317. The Staff does not contest this proposed finding.

318. Except as follows, the Staff does not contest this proposed finding. The diesel generator building is not supported by a base mat, but by continuous reinforced concrete wall footings. (SSER #2, § 3.8.3.4, p. 3-22). Also, contrary to Footnote 565, the circulating water discharge lines are not shown on Figure 2.11 of SSER #2. They are, however, shown on FSAR Figure 2.5-1, 77.

319-323. The Staff does not contest these proposed finding.

C. SEISMIC CATEGORY I UNDERGROUND PIPING--IN GENERAL

324-331. The Staff does not contest these proposed findings.

332. The Staff does not agree that no correlation can be established between pipe settlement profiles and areas of stiff or soft foundation soils. Mr. Kane's review of pipe settlement profiles permitted him to observe a pattern by which the major settlement of pipes occurred under the greatest surcharge loading. ~~For one pipe,~~ there was one high spot in the surcharge area (where the piping experienced smaller settlements) which can be explained by recognizing that other pipes, ~~some~~ encased in concrete, had put a discontinuity into the foundation support beneath the ~~pipe~~ buried piping. ~~for that pipe~~ (TR. 7902-7903). Mr. Kane also explained that one reason that the Staff requested development of soil ~~provided~~ profiles along

the alignment of the underground piping was to identify the softer soils areas as evidenced by the low blow counts recorded in the soil borings. Based on this information the Staff was able to determine where settlement ~~markers~~ should be installed. (Tr. 9053, 9088, 9090). In fact, in November 1982, Mr. Lewis testified that it was decided to place settlement markers at locations where loosely compacted soil may exist, based on borings taken throughout the plant. (Lewis, prep. test at 5, fol. Tr. 8868),

333-335. The Staff does not contest these proposed findings.

336. The Staff disagrees with the assertion that "[t]he maximum differential settlement along the longitudional axis of buried piping is anticipated to occur at anchor points." Dr. Chen does not believe that maximum differential settlement occurs only at anchor points. Rather, he believes that, due to the variable soil properties, settlement could occur at any point along the length of the piping. (Tr. 7765-7766. See also Tr. 7864-7865). Since the Staff is satisfied with CPC's strain and settlement monitoring program, the question is moot as to precisely where one would expect to find the maximum differential settlement (See SSER #2, to 2-52, 3-39 to 3-40). Otherwise, we do not contest this proposed finding.

D. ASSURANCE OF SERVICEABILITY OF BURIED SEISMIC CATEGORY I PIPING

1. Stress Analysis and Design Criteria

337. We comment on footnote 572 as follows. Rather than speaking of "single point differential settlement stresses", the current ASME Code addresses single deflection of a pipe through a discussion of "single

nonrepeated anchor movement." (CPC's prep test on underground piping fol. Tr. 7619 at 25). Otherwise, we do not contest this proposed finding.

338. The Staff does not contest this proposed finding.

a. STRENGTH CRITERIA

339-340. The Staff does not contest these proposed findings.

341. The equation for Criterion 1 is inaccurate. It should not read "SS--3Sc", but rather $S_s \leq 3S_c$. (SSER #2, p. 3-36). Otherwise, we do not contest this proposed finding.

b. BUCKLING CRITERIA

342. In the first sentence of this proposed finding, CPC defines buckling as "a deformation of a portion of the wall of the pipe." None of CPC's citations in support of this proposed finding offer this definition of buckling. Accordingly, the Staff would delete the first sentence. Otherwise, we do not contest this proposed finding.

343. The Staff does not contest this proposed finding but would change footnote 607 to read as follows; "Tr. 7892, SSER #2, 3.9.3.1.3, p. 3-36."

344. The Staff does not contest this proposed finding.

c. MINIMUM RATTLESPACE CRITERIA

345-347. The Staff does not contest these proposed findings.

II. SERVICE WATER PIPING

a. INTRODUCTION

348. The Staff does not contest this proposed finding.

349. The Staff does not contest this proposed finding, but feels that the following clarification is necessary. The "1982 profiling" referred to in Footnote 611 and the "1981 data" mentioned in the proposed finding are one and the same. Not stated on the record, the profiling data was compiled in 1981 and furnished in early 1982.

350-352. The Staff does not contest these proposed findings.

b. SCOPE OF REINSTALLATION PROGRAM

353-354. The Staff does not contest these proposed findings.

c. MATERIALS USED IN THE REINSTALLATION PROGRAM

355-356. The Staff does not contest these proposed findings.

357. In his affidavit, Dr. Shunmugavel states that ethafoam, when surrounding the 26 inch pipe encased in backfill, "[creates] a transition that will eliminate concentrated shear strain to the piping caused by differential settlement." Affidavit of Palanichamy Shunmugavel on Ethafoam, dated August 2, 1983, p. 8). Dr. Shunmugavel's description of how ethafoam function differs from the assertion in this proposed finding that ethafoam locally isolates the pipe from differential settlement and suspends the pipe at tne transition from old fill to new fill. The Staff consider Dr. Shunmuvgavel's description of how ethafoam works to be more accurate and would replace this proposed finding with the following;

The pipe will be encased in a 6 inch thick layer of a compressible polyethylene material known as "Ethafoam", which will create a transition that will eliminate concentrated shear strain to the piping caused by differential settlement. (SSER #2 § 2.5.4.4.5, pp. 2-36 to 2-37, § 3.9.3.1.3, p. 3-39. Affidavit of Palanichamy Shunmugavel on Ethafoam, dated August 2, 1983. p. 8). By so doing, the ethafoam will minimize the effects of differential settlement.

d. REINSTALLATION PROCEDURE

358-359. The Staff does not contest these proposed findings.

360. This proposed finding needs to be clarified in the last sentence. The replacement of the fill will eliminate the potential for liquefaction. ~~Increasing~~ Encasing the pipes in ethafoam will reduce the adverse effects of diffential settlement. (SSER #2, pp. 2-36 to 2-39).

361. The Staff does not contest this proposed finding.

362. The Board's April 30, 1982 Order did not "establish" the Work Authorization Procedure, as CPC claims. Rather, CPC and the Staff entered into the work authorization procedure as a means of implementing the requirements which the April 30, 1982 Order imposed. (Testimony of James G. Keppler With Respect to Quality Assurance, fol. Tr. 15,111, at p. 6 and Attachment H.) Otherwise, we do not contest this proposed finding.

e. APPLICANT'S ASME ANALYSIS OF THE REINSTALLED PIPE

363. As discussed in our response to ¶337, the current ASME Code does not speak of "single point settlement stresses." Rather, it discusses "single non repeated anchor movement." (CPC's prep. test on

underground piping fol. Tr. 7619 at 25). Otherwise, we do not contest this proposed finding.

364. The Staff does not contest this proposed finding.

III. DIESEL FUEL PIPING

365-367. The Staff does not cortest these proposed findings.

IV. BORATED WATER PIPING

368-369. The Staff does not contest these proposed findings.

V. CONTROL ROOM PRESSURIZATION LINES

370. We do not contest this proposed finding except to note that footnote 648 should read "SSER #2 § 3.9.3.1.1, p. 3-34", not "SSER #2, § 3.9.3.1.1, p. 3-24".

VI. PENETRATION PRESSURIZATION LINES

371. The Staff does not contest this proposed finding.

VII. THE MONITORING PROGRAM

a. STRAIN GAUGE MONITORING

372. The Staff does not contest this proposed finding.

373. We do not contest this proposed finding except to note a typographical error in the first sentence. The word "erived" should be "derived."

374. Mr. Kane expressed concern about whether the strain gauges would function over the forty year lifetime of the plant.

(Tr. 7763-7764). For example, relaxation of the wire of the vibrating strain gauge or movement of the anchors may impede reliable readings. (Tr. 7880-7881). While Mr. Lewis believes the strain gauges will be reliable for up to twenty years, and potentially longer, he admits a sparse data base for predicting the reliability of strain gauges for up to forty years. (Tr. 7704) CPC has committed that, during the first five years of monitoring, strain gauges providing faulty data will be replaced or repaired. (CPC proposed findings, ¶379). It is however not expected that strain monitoring will end after five years. (Chen, Tr. 9003). The Staff therefore may impose a Technical Specification requiring replacements of faulty strain gauges for a period exceeding five years. (Cf. Tr. 9007-9014). We submit that this matter may be left for the Staff and CPC to resolve later. Based on the above, the Board should find that there are concerns about whether the strain gauges will be able to function over the lifetime of the plant, but that through appropriate Technical Specifications worked out between the Staff and CPC, these concerns can be resolved.

b. CRITICAL SETTLEMENT MARKERS

375. We do not contest this proposed finding, but would add to Footnote 654, "SSER #2, § 2.5.4.6.2, p. 2-52."

376-377. The Staff does not contest these proposed findings.

c. STRAIN AND SETTLEMENT MONITORING FREQUENCY

378. We do not contest this proposed finding, but would add to Footnote 657, "SSER #2, § 2.5.4.6.2, p. 2-52."

d. PROPOSED TECHNICAL SPECIFICATONS ACCEPTANCE CRITERIA AND ACTIONS

379. The Staff does not contest this proposed finding.

e. RATTLESPACE MONITORING

380. There is an inconsistency between this proposed finding and ¶ 395. See Staff's response to ¶ 395.

f. LAYDOWN LOADS AND SAFETY GRADE UTILITIES

381. The Staff does not contest this proposed finding but would add the following. Mr. Kane testified that the Staff had some questions on how CPC arrived at its laydown load allowables. This issue will be considered as part of the Staff's review of CPC's technical specifications. (Tr. 8599, see also Tr. 9011-9013).

VIII. FREEZEWALL CONCERNS

382. The Staff does not contest this proposed finding.[6/]

6/ The Staff's concern for category I utilities crossing the freezewall was extensively discussed at the hearing sessions held November 1 - November 10, 1983.

E. CORROSION

I. INTRODUCTION

383. The Staff does not contest this proposed finding.

II. PROTECTION OF UNDERGROUND PIPING FROM EXTERNAL CORROSION

384. The Staff does not contest this proposed finding.

385. Neither Section 3.12.1 of SSER #2 nor Dr. Weeks' testimony states that an "independent check of the conditions of the pipe wrappings will be performed when the 36-inch pipes are excavated and replaced before startup of the plant." (Emphasis added) Rather, the testimony is that such a check is possible. (SSER #2, § 3.12.1, p. 3-42, Weeks, Tr. 9149). Otherwise, we do not contest this proposed finding.

386. The Staff does not contest this proposed finding.

387 & 388. Except as follows, the Staff does not contest these proposed findings. We do not agree with the claim in ¶387 that concerns about encasing anodes in concrete were "groundless". It is true, and the record so reflects, that the anodes encased in concrete are presently working (Woodby, Tr. 9225, 9256, Weeks, Tr. 9303, R.Cook, Tr. 9304[7/] However, well-founded concerns

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7/ Two of the Applicant's citations in footnote 669 do not support the assertion in ¶387 that the concrete embedded anodes are performing within acceptable limits. At Tr. 9232, all Mr. Woodby says is that when the anodes were encased in concrete, they met all design requirements and technical specifications. That has nothing to do with whether the anodes are currently working. At Tr. 9238-9239, there is no testimony.

do exist about the ability of concrete encased anodes to function in the future. One reason that the concrete encased anodes have functioned well

is the high porosity of the concrete (R.Cook, Tr. 9304). Should the concrete become dry, however, it would act as an insulator, thereby defeating the purpose of the anodes. (Woodby, Tr. 9225, 9256-57).[8/] Dr. Weeks explained that the satisfactory performance of the concrete encased anodes can also be attributed to the fact that the resistivities of the soil and concrete are probably about equal. If the site were to be flooded with water of higher conductivity, the concrete encased anodes might not be as effective. (Weeks, Tr. 9303). Hence, there was a sound basis for discarding the concrete encased anodes and replacing them with anodes encased in coke breeze.

Furthermore, of the approximately 120 anodes now in place, about fourteen will be abandoned because they are encased in concrete. (Tr. 9223-9226). Hence, the Staff would replace the last sentence of this finding with the following; "Moreover, the Applicant is currently upgrading the galvanic protection system by installing about 190 new anodes in addition to the approximately 106 that will continue to be in operation." (Tr. 9223-9227).

8/ Mr. Woodby explained that the concerns about the effectiveness of the anodes encased in concrete were conveyed to him by someone else (Tr. 9289).

389. The Staff does not contest this proposed finding.

390. The Staff does not contest this finding but would add the following citation to footnote 673, "Weeks, Tr. 9303-9305."

391. The Staff does not contest this proposed finding but notes that the reference in Footenote 674 to "SSER #2, §3.12.1, p. 3-42," is incorrect. The correct reference should be "SSER #2, 3.12.2, p. 3-43."

392. The Staff does not contest this proposed finding, but notes that the reference in Footnote 676 to "SSER #2, §3.11.2, p. 3-42," should be "SSER #2. §3.12.2, p. 3-42 and errata p. 2 (Staff Exhibit 14)."

393. This finding implies that the Staff is certain that pitting in the stainless steel piping was due to stray currents resulting from improper grounding during field welding. Rather, we assert that to be a likely reason for the pitting. (SSER #2, § 3.12.3, p. 3-43, Weeks, Tr. 9147). Hence, we would replace the last sentence, "[t]he Staff has concurred with this explanation for this pitting" with the following; "The Staff believes this to be a likely explanation for the pitting." Otherwise, we do not contest this proposed finding.

394. Contrary to this proposed finding, Mr. Lewis never testified that "proper grounding of field welding equipment is now in practice at the Midland site." All Mr. Lewis testified was that "the field was advised to exercise greater care in assuring a firm grounding path existed when welding is taking place." (Tr. 8880). In fact, when questioned by the Chairman, Mr. Lewis stated that he did not know whether the field was actually following those instructions. (Id).

Also, this proposed finding should include a discussion of an examination, during the summer of 1982, of portions of a stainless steel BWST line. At that time, all portions of the line that could be readily excavated were examined. The pipe came from the same area where at least one example of pitting had previously been found. During this inspection, however, no pitting was discovered. (Weeks, Tr. 9435, 9442).

Otherwise, we do not contest this proposed finding.

395. The Staff offers the following comment on this proposed finding. As indicated earlier, there is an inconsistency between this proposed finding and ¶ 380. This proposed finding asserts that all pipes leading into the DGB will be subject to rattlespace monitoring. ¶ 380 however states that only pipes that have not been rebedded or and reanalyzed will have their rattlespace monitored. Staff counsel discussed this inconsistency with Applicant's counsel, who indicated that with respect to piping entering the DGB, it was CPC's intention that only service water piping that has not been rebedded or reanalyzed would be monitored for rattlespace.[9/] The Staff submits that the question of precisely which pipes will be monitored for rattlespace can be resolved as part of the Staff's review of CPC's proposed technical specifications. ~~Contention 2, fol. Tr. 2530, p. 18).~~

396-398. The Staff does not contest these proposed findings.

9/ At FSAR § 16, p. 3/4.13-18, there is a table that lists the piping that will be monitored for rattlespace.

ELECTRICAL DUCT BANKS AND CONDUITS

399-405. The Staff does not contest these findings.

406. The Staff does not contest these proposed findings expect as follows. In the last sentence of ¶ 406 CPC states that although voids are not expected beneath the duct banks during the life of the plant, Dr. Shunmugavel testified that the duct banks have the capacity to span distances of up to ten feet without any soil support. The Staff agrees that the record supports that statement but notes that there is nothing in the record to indicate that the statement would be true in the event of a cracked duct bank.

407. The Staff does not contest this proposed finding.

408. The Staff does not contest this proposed finding except to note that the Staff has identified in SSER #2, pg. 2-36 the information required to be provided by the Applicant at freezewall crossings and to indicate the issue of duct banks crossing the freezewall were extensivley covered in the November 1-10, 1983 hearing session.

409-418. The NRC staff does not contest these proposed findings.

419. The NRC staff does not contest these findings except as follows. In footnote 717 CPC refers to a NRC staff audit of Dr. Shunmugavel's Analyses of Category I Buried Electrical Duct Banks Conduits and Cable. Footnote 717 states that during the audit the Army Corps of Engineers, on behalf of the NRC, investigated the loads used in the evaluation, the model that was used, and finally the evaluation results in order to conclude that they were acceptable. The transcipt pages cited do not support that that evaluation was performed by the Army

Corps of Engineers. Mr. Rinaldi testified that it was performed by "one of my consultants" (Tr. 12,118).

420-421. The Staff does not contest these proposed findings.

LIQUEFACTION AND DEWATERING

422. The Staff does not contest this proposed finding.

423. The Staff does not contest this proposed finding except as follows. In footnote 719 CPC cites Dr. Richard D. Woods for his statement that liquefaction has not occurred at locations where there have not been several acres of liquefiable material that is in connection and fully saturated. The Staff agrees that that is the thrust of the testimony presented at Tr. 9771. Although CPC also cited transcript pages 11,550-1 in the footnote, CPC failed to indicate that at those later transcript pages Dr. Woods attempted to correct his previous testimony. At Tr. 9771 Dr. Woods testified that he suspected he examined between 50 and 100 events to determine the necessary lateral extent of the sands in order for liquefaction to occur. He particularly cited a reference by Swiger and Christian where 49 events were listed. Dr. Harbour asked, at Tr. 9771, whether it was true that in none of those cases liquefaction occurred if the extent of the sand was an acre or less. Dr. Woods responded that that was correct. At Tr. 11,550 Applicant's counsel alluded to a possible ambiguity in the record and asked Dr. Woods (Tr. 11,551) whether the Swiger and Christian reference actually included information on the lateral extent of the liquefaction incidents discussed in the Swiger and Christian reference. Dr. Woods responded that it did not. The clarification of the record at Tr. 11,550-1 should be included in footnote 719.

At Tr. 9793, Judge Harbour interrogated NRC witness Kane concerning the necessary lateral extent of sands in order for

liquefaction to occur. Mr. Kane responded that he believed liquefaction could be a problem in areas under one acre, and that he hesitated to approach the evaluation of liquefaction on an area basis. At Tr. 9704 Mr. Kane responded that the amount of lateral strength provided by the overburden soil adjacent to a building foundation also influences whether liquefaction will occur. Mr. Kane also indicated that in the consideration of lateral restraint one is required to consider how deep the layer bed is that has potential for liquefaction and where the layer is located with respect to the structure. Mr. Kane also indicated that if a loose layer were located where it would be the layer most heavily stressed by the foundation pressures and that layer's strength was lost (due to liquefaction), then there is a risk of losing the foundation support of that structure. Mr. Kane also expressed his opinion that with the water table below 610 feet the Staff's problems with respect to liquefaction were resolved. Tr. 9795.

424. The Staff does not contest this proposed finding.

425. The Staff does not contest this proposed finding except as follows. CPC identifies two seismic category 1 structures where there was a potential for liquefaction in the event of an earthquake, because these structures are founded in part on loose sands. Those two areas are (1) the railroad bay area of the auxiliary building and (2) the diesel generator building. CPC also identified another area with pockets of loose sand near the northwestern end of the surface water pump structure where category 1 service water piping is buried. The Staff believes this finding is potentially misleading by not citing the other two areas where loose granular backfill soils were discovered and were potentially

liquefiable. These areas are the EPAs and the cantilevered portion of the SWPS (SSER # 2, p. 2-43, 3rd paragraph). Unlike the railroad bay area and the DGB which rely on the permanent dewatering system to eliminate the potential for liquefaction, the liquefaction problem at the EPAs and cantilevered portion of the SWPS and the service water piping was acceptably resolved by the proposed underpinning or by excavation and backfill remedial measures. (SSER # 2, p2-43, last complete paragraph).

In footnote 721, CPC states that after the preparation of Dr. Wood's testimony, some additional borings became available which identified further isolated pockets of loose sand. They then state that one of these pockets of loose sand was located near the diesel fuel oil tanks. At Tr. 9762 Dr. Woods identifies the additional borings with loose sand pockets as ME-27B and MP-10. At Tr. 9764 their location is stated in coordinates. The testimony at Tr. 9765-66 shows, however, that these additional borings are not located in the diesel fuel oil tank area.

At Tr. 9799 Staff witness Kane identified boring DF-5 as the one that showed loose sand in the diesel fuel oil tank area. Figure 2.5-191 of the FSAR presents the soil boring information at boring DF-5. The log for boring DF-5 in Appendix 2A of the FSAR shows that DF-5 was drilled in March, 1979. It was available for a considerable time prior to November, 1982. Mr. Kane explained at Tr. 9799-9800 that the Staff has no present concerns relating to the loose sand indicated by boring DF-5.

426. The Staff does not contest this proposed finding.

427. The Staff does not contest this proposed finding except as follows. In the beginning of ¶ 427, CPC refers to pockets of loose sand which lie under and around service water piping in the vicinity of the

northwestern end of the service water pump structure. In the last sentence of ¶ 427 CPC states that these pockets will be excavated and replaced with nonliquefiable material in order to eliminate the potential for liquefaction affecting the integrity of the category 1 duct banks in this area. There is an inconsistency in CPC's description of the specific utilities that are impacted by the loose soils and liquefaction potential. The Staff recommends the last sentence of ¶ 427 be corrected to read as follows: These pockets will be excavated and replaced with nonliquefiable material in order to eliminate the potential for liquefaction affecting the integrity of the category 1 service water piping and duct banks located in this area. (underlined words added by the Staff)

428. The Staff does not contest this proposed finding. The first footnote at the bottom of the page, which is numbered 432, should be 732.

429-431. The Staff does not contest these proposed findings.

432. The Staff does not contest this proposed finding. The footnote at the end of the paragraph, which is numbered 736, should be 737.

433-456. The Staff does not contest these proposed findings.

SLOPE STABILITY OF BAFFLE AND PERIMETER DIKES

457. The Staff does not contest this proposed finding, but would add to Footnote 769, "SER, Par. 2.5.6.1, pg. 2-47, 2-48."

458. The Staff does not contest this proposed finding.

459. The Staff does not contest this proposed finding, but would add to Footnote 773, "SER, Par. 2.5.6.2, pg. 2-48."

460. The Staff does not contest this proposed finding, but would add to Footnote 775, "SER, Par. 2.5.6.1, pg. 2-48."

461. The Staff does not contest this proposed finding, but would add to Footnote 776, "SER, Par. 2.5.6.5, pg. 2-49."

462. The Staff does not contest this proposed finding, but would add to Footnote 777, "SER, Par. 2.5.6.3 and Par. 2.5.6.4, pgs. 2-48 and 2-49."

463. The Staff does not contest this proposed finding.

464. The Staff does not contest this proposed finding, but would add to Footnote 779, "SER, Par. 2.5.6.5, pg. 2-49."

465-467. The Staff does not contest these proposed findings.

468. The Staff does not contest this proposed finding, but would add to Footnote 784, "SER, Par. 2.5.6.6, pg. 2-50"

469. The Staff does not contest this proposed finding, but would correct the numbering of this paragrapth to 469 instead of 460 and would add to Footnote 785, "SER, Par. 2.5.6.6, pg. 2-50.

470. The Staff does not contest this proposed finding except as follows. Applicant chose not to cite the Staff's SER in setting forth its findings on Slope Stability of Baffle and Perimeter Dikes. Since the

SER addresses this matter at length, we set out below the relevant sections of the SER applicable to CPC's findings.

471. The Staff does not contest this propsoed finding, but would add to Footnote 790, "SER, Par. 2.5.6.7, pgs. 2-50 and 2-51."

472. The Staff does not contest this proposed finding, but would add to Footnote 791, "SER, Par. 2.5.6.7, pg. 2-50."

473. The Staff does not contest this proposed finding, but would add to Footnote 793, "SER, Par. 2.5.6.7, pg. 2-50."

474. The Staff does not contest this proposed finding.

475. The Staff does not contest this proposed finding, but would add to Footnote 797, "SER, Par. 2.5.6.7, pg. 2-50."

476-483. The Staff does not contest these proposed findings.

484. The Applicant's findings indicate that Mr. Singh testified the PMF should not cause dike slope stability problems and cites Tr. 4117-4121 as the reference. The record does not support this finding. On Tr. 4118 Mr. Singh testified that if the PMF were to occur and cause a breach in the perimeter dike, then "the damage will be done to the perimeter dike, mainly because of the erosion from the outside."

485. The Staff does not contest this proposed finding, but would add to Footnote 820, "SER, Par. 2.5.6.7, pg. 2-50."

487-488. The Staff does not contest these proposed findings.

486. The Staff does not contest this proposed finding but would add to Footnote 824, "SER, Par. 2.5.6.7, pg 2-50."

Document Name:

PROPOSED CONCLUSION OF LAW

Requestor's ID:

ROSEANNB

Author's Name:

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Document Comments:

Midland

PROPOSED CONCLUSIONS OF LAW[1/2/]

The Licensing Board has reviewed the evidence submitted by the parties in regard to Applicant's remedial soils measures, and the "Order Modifying Construction Permits" dated December 6, 1979, and Intervenors' contentions. The Board has also considered the proposed findings of fact and conclusions of law submitted by the parties on contested issues. Based on the preponderance of the reliable, probative and substantial evidence of the record in this proceeding and the foregoing findings of fact, the Board makes the following conclusions of law:

489. Applicant entered into stipulations in which it agreed, among other things, not to contest whether the NRC Staff had in sufficient information, as of December 6, 1979, to evaluate the adequacy of the proposed

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1/ In the Staff's proposed findings of fact, we responded to the Applicant's proposed findings of fact. We will not follow that procedure in presenting our proposed conclusions of law. Here we set forth the Staff's proposed conclusions of law. They incorporate some of the proposed conclusions of law set forth by the Applicant.

2/ In ¶ 498 of its proposed conclusions of law applicant seeks to have the Licensing Board reconsider the ruling it made on May 5, 1981 in its Prehearing Conference Order (Ruling Upon Applicant's Motion to Defer Consideration of Seismic Issues Until the Operating License Proceeding and upon other matters). In response the Staff will follow the guidance of Maine Yankee Atomic Power Company (Maine Yankee Atomic Power Station) ALAB-166, 6 AEC 1148 at 1150 (1973). The Appeal Board noted there that it would never be necessary for a party to respond to a petition for reconsideration filed with the Appeal Board unless that Board has specifically requested it to do so.

soils remedial actions, (see Joint Exhibits 2, 3, 4 and 5). Accordingly, the Board concludes that the facts set forth in Part II of the Modification Order are correct and constituted an adequate basis for the issuance of the Modification Order. See LBP-82-35, 15 NRC 1060, 1064.

490. With the exception of the diesel generator building, (which is not addressed in these findings) the Applicant has now provided the NRC Staff and the Licensing Board with the appropriate technical information and acceptance criteria necessary to evaluate the adequacy of the Applicant's implemented and proposed remedial measures.

491. There is reasonable assurance that, if properly implemented, the remedial measures described in the foregoing findings of fact (other than those for the DGB) are adequate and sufficient to (1) correct all safety concerns raised in (2) enable such safety related structures and systems to perform their intended functions without endangering the health and safety of the public.

492. This Board's Order of April 30, 1982 (LBP-82-35, 15 NRC 1060) continues in effect.

493. This Partial Initial Decision on remedial soils measures is subject to the outcome of our Partial Initial Decision on quality assurance and management attitude issues.

494. This Partial Initial Decision shall be immediately effective.

495. In accordance with 10 C.F.R. §§ 2.760, 2.762, 2.764, 2.785 and 2.786, this Partial Initial Decision and shall constitute, with respect to matter resolved herein, the final decision of the Commission forty-five (45) days after issuance hereof, subject to any review pursuant to the above cited Rules of Practice. Exceptions to this decision may be filed

within ten (10) days after service hereof. A brief in support of such exceptions may be filed within thirty (30) days thereafter, or forty (40) days in the case of the Staff. Within thirty (30) days after service of the brief of the appellant, or forty (40) days in the case of the Staff, any other party may file a brief in support of, or in opposition to such exceptions.

Respectfully submitted,

William D. Paton
Counsel for NRC Staff

Michael N. Wilcove
Counel for NRC Staff

¶91. None of the citations for this finding support the Applicant's claim that duct banks were causing the DGB to tilt to the south. All Mr. Weidner's testimony states is that the four duct banks were restraining settlement and causing cracks. (Weidner, prep. test at 2). Similarly, neither Dr. Shunmugavel's testimony nor Attachment 10 of Mr. Marguglio's testimony discuss tilt. (See generally, Shunmugavel prep. test. foll. Tr 12056, Marguglio, Exhibit 10, pp. 2-14 to 2-16). Dr. Hendron suggested a different reason for the tilt; the rotation of the DGB resulted from compression settlement under the south side of the building. (Tr. 8661). Mr. Kane agreed with Dr. Hendron. (Tr. 8737). Dr. Sozen lent support to both soil compressibility and duct bank impingements as reasons for the southern tilt. He asserted that the tilt was indicated by the fact that the southeast corner was settling more perceptibly than the northeast corner. Dr. Sozen also explained that the eccentricity of the reaction provided by the duct banks coming into contact with the DGB would make the building tilt to the south as it settled. (Sozen, prep. test. foll. Tr. 10950, pp. 5-6).

Based on the testimony of Dr. Sozen, Dr. Hendron and Mr. Kane, the Board should find that the compressibility of the soils on the southern side of the DGB was a factor in the tilt of the DGB. In addition, Dr. Sozen's testimony lends support to the impingement of the building by the duct banks as another reason for the tilt.

¶92. The Staff agrees that upon release of the duct banks, there was a decrease in width of some of the existing cracks. However, that should not be taken to imply that no new cracks have formed since the surcharge. On the east wall of the DGB, the number of cracks since the

surcharge has increased from ten to sixteen. Mr. Singh describes this increase as considerable. (Sinclair Exhibit 1, p.3, Tr. 10633). While it would not be of critical importance to his evaluation, Dr. Sozen was unable to say whether the number of cracks increased or decreased under the surcharge. (Tr. 10963).

¶96 This finding implies that the classical theory of consolidation stands for the proposition that the linearity of settlement can be plotted as a function of the logarithm of time. As Dr. Peck testified, the linearity of settlement when plotted as a function of the logarithm of time is not dependent on any theory. Rather, it is an observed phenomenon. (Peck, prep. test, at 11). As this finding acknowledges, the classical theory permits the predicting of the rate of settlement over time. With this clarification, the Staff agrees with this finding.

¶100 With the following exception, the Staff does not contest this finding. We do not agree as claimed by Paragraph A of this finding, that the surcharge produced "stresses at all levels in the subsoil ro less than those that will exist and might produce settlement during the functional lifetime of the structure." (emphasis added) As Mr. Kane testified, the surcharge was not large enough to envelope settlement of the natural soils induced by dewatering (Tr. 20545-46). Indeed, approximately 1000 days after the surcharge was removed, dewatering did induce a sharp increase in settlement of the natural soils. (See Staff reply findings ¶137-137;). The surcharge did, however, take into account dewatering-induced settlement in the plant fill. (Tr. 20546). Hence, Paragraph A of this finding should state that the surcharge would produce stresses at all levels in the plant fill no

less than those that will exist and might produce settlement during the functional lifetime of the structure.

¶137 In lieu of this finding, the Staff would submit these findings ¶137a. During cross examination of Dr. Peck on December 7, 1982, the Staff questioned him about the slope of the settlement versus time curve for diesel generator building settlement marker DG-3. (Staff Exhibit 16). Although the curve was difficult to interpret, the slope of the curve for a period of time after about 1000 days after the surcharge program began appeared to exceed the average slope for the permiter markers on the DGB between Days 100 and 200, when the surcharge was still active. This observations led to the question whether settlement predictions based on linear extrapolations of the straight line protion during surcharging were sufficiently conservative (Tr. 10404-10417, 10428-10434).

¶137b Dr. Peck tentatively concluded that the period of increased settlement after Day 1000 stemmed from dewatering activities causing the natural soil underlying the plant fill to compress. (Tr. 10409-10410). It was agreed that an analysis would be taken to verify Dr. Peck's tentiative conclusion and that the results would be furnished to us and the Parties (Tr. 10406-10407, Tr. 10409 -10410).

¶137c On April 19, 1983, the Board and parties were served with a document prepared by Bechtel Associates, dated March 4, 1983, titled "Diesel Generator Building Dewatering Settlement Report," ("Settlement Report"). (Staff Exhibit 23) The Settlement Report contained the results of an analysis which addressed the concerns raised about the

period of increased settlement after Day 1000. Also included was an affidavit by Dr. Peck agreeing with the analysis.

¶137d Mr. Kane of the NRC Staff reviewed the Settlement Report. On September 20, 1983, he testified as to his evaluation.

¶137e Mr. Kane explained that the Settlement Report draws three conclusion. First, the steepened slopes occurring after Day 1000 are primarily due to settlement of the natural soils due to dewatering.*/ Second, future settlement from dewatering will be small. Third, the settlement plots, that have been used to predict future settlements are conservative. (Tr. 20535-20537).

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*/ The surcharge was not large enough to envelope settlement of the natural soils caused by dewatering. Hence, such settlements were expected. (Tr. 20544-46).

¶137f The Staff agrees with the three conclusions drawn by the settlement report. (Tr. 20,536)

¶137g. Besides being questioned about the steep increase in settlement after Day 1000, Mr. Kane was also asked about settlement that has occurred since the "steep increase." Since the "steep increase", there has been a slight heaving of soil due to a rebound in the ground water table, and then, due to another drawdown, more settlement. (Tr. 20,567. See Figure A-2, Staff Exhibit 23). That settlement has been continuing, but at a slower rate than the sharp increase in settlement that occurred shortly after Day 1000. (Tr. 20567-20568).

¶137h There has been a steeper settlement trend at marker DG-3 than Mr. Kane would have anticipated. As the actual settlement gets closer to the predicted settlement, Mr. Kane feels the need to watch to

be sure that the rate of settlement does not increase as it did after Day 1000. He wishes to be sure that the predicted settlement remains appropriately conservative. (Tr. 20569).

¶137i Mr. Kane recognizes that there are limitations to predicting future settlement. Hence, there will be technical specifications which mandate a comparison of the actual settlements to what was predicted. By so doing, the Staff will be able to assess the validity of future settlement predictions. (Tr. 20537).

¶99. The Staff adopts this proposed finding except as follows. Footnote 188 states that, with respect to surcharging, there is "no precedent for the specific combination of circumstances at the Midland DGB." Elaboration is needed. When surcharging a completed or partially completed structure, the engineering principles are no different than when surcharging any other type of structure or system. (Peck, Tr. 3463, 3464). However, placing a surcharge after, rather than before, a structure is built carries with it additional difficulties. Mr. Kane explained that surcharging before a structure is completed is an attempt to ensure that, once the structure is built, differential settlement will not harm it. Essentially, the "differential settlement" is taking place before the structure is built. (Tr. 9204). Once the structure is completed, surcharging does not prevent differential settlement and its harmful effects, i.e., warping and cracking of the reinforced concrete, stress on conduit and pipes. (Tr. 4204, 4206; SSER #2, p. 2-31). In fact, when the surcharge reached its maximum surcharge height in April, 1979, 94% of the DGB structure was completed (SSER #2, p. 2-24). Moreover, Dr. Peck testified that, while he doubts it is

unprecedented, the Midland DGB was his first experience in surcharging a substantially completed concrete reinforced structure. (Tr. 3226-3227).

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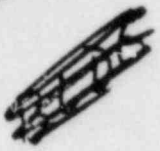

MIDLAND - DGB

Rec'd 11/16/83
J Kane

147. Except as follows, we do not contest this proposed finding. We would replace the sentence "[in] addition, Applicant presented three expert structural engineers who provided detailed analyses showing that the DGB is structurally adequate to perform its intended function over the forty year operating life of the Midland Plant, taking into account the settlement which has occurred and is predicted to occur," with the following. "In addition, Applicant presented three expert strucrural engineers who provided detailed analyses presenting CPC's position as to why the DGB is structurally adequate to perform its intended function over the forty year operating life of the Midland Plant, taking into account the settlement which has occurred and is predicted to occur."

148-151. These proposed findings are a description of the dynamic lumped-mass model and of the finite element model used to reanalyze the structural adequacy of the DGB. The Staff does not question these descriptions of the models. Therefore, we do not contest these findings.

152. The Staff has two disagreements with these proposed findings. First, the Staff does not contend that the structural reanalysis of the DGB "showed" that tensile rebar stresses and concrete compressive stresses were less than the code allowable values. This is because we take no position on the acceptability of CPC's finite element analysis. (Tr. 11,149, 11,171). Hence, the last sentence of this proposed finding should read "[f]or both sets of load combination, Bechtel's structural reanalysis of the DGB concluded that tensile rebar stresses and concrete compressive stresses were less than the code allowable values."

Second, we feel the need to qualify the statement in footnote 306 that Bechtel's analysis shows the DGB to be capable of withstanding a

seismic event 50% larger than the FSAR, SSE and remaining within code allowable stresses. CPC's counsel explained that this analysis was only done for CPC's own information and was merely "strong wind [indicating] which way things are going" with respect to the DGB. It was not something that the Board needed to review. The seismic margin review that CPC owed the Staff would be submitted later. (Tr. 10,835-10,837). In view of this, the Board should give no weight to the analysis described in footnote 306.

153-162. We do not contest these proposed findings.

163. The Staff comments as follows on CPC's claim that "[t]he NRC staff's structural reviewers had no problems with the Applicant's analysis and considered this approach to be consistent with sound engineering practice." At the hearing, a great deal of effort was made to differentiate the official Staff position from the personal views of the witnesses. (See Tr. 11,090, 11,112-11,119). Similarly, the proposed findings should also be clear as to whether the Staff position or a personal view is being discussed. In the sentence quoted above, that distinction is not made.

The official Staff positions is not that there were no problems with CPC's finite element analysis. Rather, the Staff took no position with respect to acceptability of the finite element analysis. The Staff does, however, believe that because CPC was analyzing a struture already in the field, rather under precise laboratory conditions, the approach taken was consistent with sound engineering practice. (NRC Staff Testimony on Structural Adequacy of DGB, fol. Tr. 11,086 at 6, Tr. 11,141-11,143). However, the fact that the Staff found the approach acceptable does not necessarily mean that it had no problems with the analysis.

The Staff would agree that Mr. Rinaldi, Mr. Matra and Dr. Harstead offered the following personal views. Mr. Rinaldi found nothing wrong with the way CPC used the field settlement data in its finite element analysis. Both the results and the approach were acceptable. However, Mr. Rinaldi emphasized that, in addressing the structural adequacy of the DGB, he did not rely on CPC's use of settlement data in its finite element analysis. (Tr. 11,104-11,105, 11,137-11,138, 11,143). Mr. Matra also found CPC's finite element analysis to be satisfactory. (Tr. 11,096). Dr. Harstead also personally believes CPC's finite element to be acceptable. (Tr. 11,144). However, he stressed that the finite element analysis was one of many tools used to assess the structural adequacy of the DGB and that it was important to look at all information available. (Tr. 11,092, 11,144).

164. While Mr. Kane stated that he was unsure of what happens in a finite element analysis, his and Mr. Weidner's descriptions of the process comport. Compare Kane, Tr. 11.184-11,185 with Weidner, Tr. 10,807-10,812). Also a more detailed explanation of Mr. Kane's concerns is in order. With respect to the use of an error band of 1/8 inch, Mr. Kane questioned the need for an error band of that magnitude in light of the fact that he has been given raw settlement data to a thousandth of a foot. Mr. Kane also expressed his trust in the reliability of survey data. (Tr. 11,176-11,177, 11,186).

Similarily, greater emphasis should be placed on Mr. Kane's views on the significance of the actual measured settlement values. As CPC states, Mr. Kane believes that the measured settlement data does, and the nearly straight line in the finite element analysis does not, show the effect of

discontinuities in the soil. (Tr. 11,177). It should further be noted, however, that the bottom line of his concern is that the actual measured settlement actually reflects the performance of the building while the almost straight line does not. (Id.)

Mr. Kane also explained that permanent benchmarks were being read as early as May, 1978, rather than late December, 1978 as Mr. Weidner testified. (Tr. 11,175, 10,794, 10,796-10,797).

Mr. Kane's assessment of the Staff's methodology for assessing the structural adequacy of the DGB is discussed later.

165. The Staff does not contest this proposed finding that would add the following. Mr. Singh explained that it is difficult to consider the cracks because element boundaries of every crack must be taken. (Tr. 11,201).

Like Mr. Kane, Mr. Singh's bottom line was that the finite element analysis does not reflect the actual conditions of the DGB. (Tr. 11,201).

166. In fact, Mr. Matra agreed, only for academic purposes, to run the finite element analysis using actual measured and predicted settlement values. Mr. Matra did not believe that the DGB either has undergone or will undergo the actual measured and predicted settlements. (CPC Ex. 30, p. 19). In particular, Mr. Matra offered this explanation for why actual measured and predicted settlement values could not be used in his finite element analysis. In the analysis, settlement values that occurred while the structure was partially complete were imposed on the completed structure. This led to large errors since the following factors were not taken into account. Without taking into account, (a) redistribution of loads once yield is reached, (b) relocation effects, (c) accuracy of the actual measured

settlement data, and (d) location of the measured settlement values relative to the footings. (CPC Ex. 30, Conclusion, pp. 78-79).

CPC asserts that the results of both CPC and the Naval Surface Weapons Laboratory (NSWL) were "the same". While there is record support for that claim, the Staff prefers to describe the results of the two analyses as "similar." (Tr. 11,098).

Finally, we offer this comment to CPC's assertion that "[e]ach of the concerns raised by Mr. Kane and Mr. Singh has been answered in the record." Since the Staff has taken no position on the acceptability of CPC's finite element analysis, we take no position on whether Mr. Kane and Mr. Singh's concerns have been adequately addressed. As will be discussed in more detail later, the Staff believes that in assessing the structural adequacy of the DGB, the Board should rely on the Staff's methodology, rather than CPC's.

167. The Staff takes no position on whether the survey data was sufficiently adequate for the finite element analysis. With respect to using nominal measures as predicted settlement values in the finite element analysis, we agree that in this case, it would not be done. (See ¶ 166 of CPC's proposed findings). However, the Staff had never taken the position that the rigidity of the structure that prevented the nominal measured and predicted settlements from being used in the finite elements analysis. In view of the fact that both the Staff and CPC agree on the inability of feeding, for the DGB, actual and predicted settelment values into the finite element analysis, the Board need not make a finding on whether or not rigidity make a such a direct feeding improper. The Staff does not contest the last sentence of this proposed finding.

168. There is evidence of other hard spots under the DGB besides the duct bank. Dr. Peck gave conduits, backfill concrete and possibly local zones of unusually stiff soil. (Peck, prep. test at 71, fol. Tr. 10,180). Furthermore, when examined in 1978, the cohesive soils ranged from very stuff to very stiff and the granual soils ranged from loose to very dense (SSER # 2, p. 2-24). Mr. Singh believes that there are hard spots beneath the DGB. (Tr. 10,668). Mr. Kane testified, as CPC acknowledges, that the measured settlement data reflected hard and soft spots, especially the presence of condensate lines under Bays 1 and 2. (CPC proposed findings, (¶ 164, Tr. 11,177). Finally, when Dr. Sozen and Dr. Corley testified that they found no evidence of hard spots besides the temporary duct bank impringements, they appear to be basing their testimony on their observations of cracks. (Tr. 11,058). The fact that cracks are not appearing because of hard spots is not conclusive evidence that hard spots do not exist. Rather, the crack observations are more appropriately used as evidence of stress to the building because of hard spots. In fact, the question posed to Dr. Corley and Dr. Sozen was whether the DGB was deformed, bent, or distressed because of local soft or hard spots. (Id.) Hence, the Board should not find that there are no hard spots under the DGB except for the temporary duct bank impingement, but should find that there is no distress to the DGB due to local hard spots. Otherwise, we do not contest this proposed finding.

169. To repeat, the Staff takes no position as to whether Mr. Singh's concerns about the finite element analysis have been answered.

170. This proposed finding begs the question. CPC is claiming that Mr. Singh's concern about cracks not being incorporated into the finite

element analysis is addressed by the fact that in the analysis performed by the Staff, cracks were considered. The Staff assumed all cracks on the DGB stemmed from settlement, computed stresses from the cracks, and added those stresses onto stresses derived from CPC's finite element analysis. (Staff prep. test on structural adequacy of DGB at 2, 5-6, Tr. 11,171-11,172). That is not the same as incorporating cracks into a finite element analysis. The Staff's use of cracks in its analysis does not address Mr. Singh's concerns. Similarily, the concern is not addressed by asserting that a better approach is beyond the state of the art. If flaws in the finite element analysis render it unacceptable, the fact that it is beyond the state of the art to correct the flaws does not make the finite element analysis acceptable. As to whether the inability to incorporate cracks in the finite element analysis does make the analysis unacceptable, the Staff takes no position.

171. The Staff comments as follows on this proposed finding. First, Mr. Singh is a structural engineer. (Tr. 11,188). Second, Mr. Singh did not testify that all of the structures he maintained were bridges. (Id.) Third, Mr. Singh testified that attempts to use crack widths to calculate stress in steel could lead to inaccuracies of 50% or more. (Tr. 11,189). Otherwise, we do not contest this proposed finding.

172. Dr. Corley's comments about not taking cracks into account are inappropriately applied to the Staff's analysis of the DGB. It is clear from reading Dr. Corley's testimony that when he was discussing how considering cracks leads to reduced stresses, he was talking about incorporating cracks into a finite element analysis. (Tr. 12,224-12,226). As is discussed in

the Staff's response to ¶ 170, the Staff's analysis of the DGB was different from doing a finite element analysis and incorporating cracks into it.

173. The Staff does not contest this proposed finding.

174. The Staff disagrees with CPC's characterization of the Staff's decision-making process. None of the Staff's witnesses used the term "veto" in describing the decision-making process of the Staff. Similarly, the word "compromise" was not used by any of the Staff witnesses. As CPC acknowledges, the Board should not be concerned with "jurisdictional boundries" within the Staff (¶ 176). Hence, the Board need not concern with the internal dynamics of the Staff's decision-making process, but should simply assess the technical soundness of the Staff's evaluation of the structural adequacy of the DGB.

175. Mr. Matra did testify that in his personal opinion, the adequacy of the best fit curve is a stuctural, and not a geotechnical concern. (Tr. 11,096, 11,110-11). Mr. Rinaldi, however, did not testify that he was unhappy with the Staff's decision to treat the adequacy of the best fit curve as a geotechnical question. Rather, because acceptability of the best fit curve was deemed to be a geotechnical question, Mr. Rinaldi felt it inappropriate to comment on that subject. (Tr. 11,095). Despite Mr. Matra's personal opinion, the Staff does not believe the record supports a finding that the Staff structural engineers gave "lukewarm" support to the Staff treating the acceptability of the best fit curve as a geotechnical concern.

176. The Staff does not contest this proposed finding.

177. It has been shown that the actual measured and predicted settlement values could not be directly fed into the finite element analysis of DGB. (Tr. 10,814-16, 11,121-23). However, CPC's assertion that "[t]he assignment of error bands to measured and predicted data is not an 'unnecessary

refinement' of such data; instead it is an essential element of scientific data" is too broad. First, it is not clear whether CPC is referring to settlement measurements in general, or simply to settlement measurements as used in the finite element analysis of the DGB. If the latter, the Staff takes no position. If the former, the statement is too sweeping. For instance, the record does not offer an airtight conclusion that measured settlement values could never be used in a finite element analysis. For example, Dr. Sozen testified that for the Midland DGB, settlement values would have to be accurate up to 1/10,000" of an inch to be fed directly into the finite element analysis, that such accuracy would not be required for a more flexible structure. (Tr. 10,994-95). Furthermore, Dr. Sozen did not testify that measurements with 1/10,000th inch accuracy were impossible, but that they are not easy to achieve under field conditions. (Tr. 10,956). In the absence of precise laboratory condition, the approach taken by CPC was acceptable. (Tr. 11,138-11,114) Staff prep. test on structural adequacy of DGB (fol. Tr. 10086 at 6). Furthermore, Mr. Kane testified that he has seen highly precise raw settlement data, with an accuracy of 1/1.000th inch (Tr. 11,176). The above indicates that in assessing the ability to directly feed actual measured or predicted settlement data into a finite element analysis, the Board should limit itself to the situation at hand, the diesel generator building at Midland.

If CPC's discussion of the need to apply an error band to settlement measurements is not limited to their use in finite element analyses, this proposed finding is even more objectionable. Settlement will be monitored throughout the plant, both during underpinning (SSER #2, p. 2-24) and afterwards. (SSER #2, p. 2-53). The Board should not make a finding

on whether error bands might or might not be acceptable for such settlement monitoring.

178. CPC asserts that the structural reviewers agreed that the survey data was adequate for the way CPC used it. The Staff takes no position on the acceptability of the data for use in the finite element analysis done for the DGB.

179. First, the Staff did not admit that its assessment of the structural adequacy of the DGB is "too pessimistic" or "too conservative". Of course, we believe our analysis is conservative. (Staff prep. test on structural adequacy of DGB, fol. Tr. 11,056 at pp. 4-5). However, we have not testified that we have placed a needless degree of conservatism into our analysis. Second, the Staff does not believe that its analysis is "simplistic". The Staff acknowledges that it made some simplifying assumptions; (1) all the cracks were assumed to be caused by settlement even though other phenomena may cause cracks and (2) crack patterns which produced the highest stress levels were utilized. (Staff prep. test on structural adequacy of the DGB, fol. Tr. 11086, pp. 4-5). These simplifying assumpticns do not make the analysis "simplictic". Rather, they build conservatism into the analysis. Since the Staff did not rely on CPC's finite element analysis to compute the effect of settlement loads on the structure, the Baord should view as appropriate the conservativeness built into the Staff's analysis. Furthermore, as will be shown by our responses to the next proposed finding, the Staff's analysis should not be rejected in favor of Dr. Corley or Dr. Sozen's assessment of the cracks in the DGB.

180. The Staff would replace this proposed finding with the following:

The Board finds that CPC's attempt to assess the structural adequacy of the DGB through a finite element analysis was an acceptable approach. However, the record shows a gamut of opinions on the acceptability of CPC's finite element analysis. Because of this wide range of opinions, the Board chooses not to rely on CPC's finite element analysis. It is not necessary to do so because the Staff has presented an alternative method of assessing the structural adequacy of the DGB. The Staff does not rely on the results of CPC's finite element analysis to assess the adequacy of the DGB. Rather, it makes the conservative assumption that all cracks in the DGB were due to settlement, calculates the stress such cracks would impose on the structure, and adds those stresses to stresses already calculated by CPC. Since CPC's analyses already assessed the effects of dead and settlement loads on the structure, the Staff, is to a degree, double counting the effecs of dead and settlement load. The total stress to the structure was acceptable. By assuming that all cracks stemmed from settlement and double counting dead and settlement loads, the Staff's analysis is highly conservative. The Board finds this high degree of conservatism all the more reason to accept the Staff's analysis. By accepting the Staff's analysis the Board can be assured that the effects of settlement on the structures have been considered and at the same time not rely on an analysis which has been the subject of extensive disagreement. The Board is mindful that Mr. Singh and Mr. Kane have expressed skepticism about analyzing cracks to assess stress on a structure. It is also aware that Dr. Sozen acknowledged that using crack widths to assess in the structure is a rough estimate. However, the Staff did testify that crack analysis is an acceptable method to analyze structures subjected to excessive loading. In view of the Staff's testimony on the acceptability of crack analysis and the high degree of conservatism built into that analysis, the Board accepts the Staff's assessment of the structural adequacy of the DGB and finds it to be structurally adequate to perform its intended safety function over the lifetime of the plant.*/

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*/ On October ___, 1983, the Board received a report by Brookhaven National Laboratories assessing the structural adequacy of the DGB. The Board will be determining whether this report warrants a reopening of the record. If the Board so determines, these findings on the structural adequacy of the DGB are subject to modification.

181-184. The Staff does not contest these proposed findings.

185. Except as follows, the Staff does not contest these proposed finding. The Staff has not taken the position on what effects these would be on the DGB should predicted settlements be exceeded. The Staff find predictions for future settlements to be acceptable. Also, as CPC acknowledges, long term settlement and crack monitoring programs will be in place. Hence, it is not necessary for the Board to make a finding on what would happen to the structure if predictions for future settlement were exceeded.

186-188. The Staff does not contest these proposed findings.

189. Subject to our comments, we do not contest that the proposed findings cited here by CPC adequately address the contention

190-192. The Staff does not contest these proposed findings.

193. The Staff would replace this proposed finding with the following:

> While this contention is not entirely clear, we interpret it as expressing a number of distinct concerns. The Licensing Board concludes, based on paragraphs 93-138, supra, and the Staff's responses that Dr. Peck's predictions of future differential soil settlement for the DGB are reasonable and conservative. As explained in paragraphs 122-125 and 137, supra, and the Staff's responses Dr. Peck's settlement predictions adequately take into account the effects of dewatering. For the reasons given in the Staff's substitute for paragraph 180, supra, the Licensing Board also concludes that the way in which Staff has determined that measured and predicted differential settlement has not made the DGB structurally unsound is appropriate.

194. The Staff does not contest this proposed finding except to note CPC is supporting this proposed finding by reference to ¶¶ 139-146. The Staff stands by its reply to these proposed findings.

195. For the reasons discussed in the Staff's respond to ¶ 152, the Board should not give weight to Bechtel's internal assessment that the DGB can withstand 1.5 of the FSAR earthquake. To the extent CPC relies

on its dynamic model to show that its seismic analysis of the DGB to be adequate, the Staff does not contest this proposed finding. To the extent that CPC relies upon its finite element analysis, the Staff believes the Board should rely upon the Staff's assessment of the structural adequacy of the DGB.

196-198. The Staff does not contest these proposed findings.

199. The Board should rely on the Staff's, rather than CPC's assessment of the structural adequacy of the DGB. Also, subject to our comments on CPC's proposed findings, the Staff does not contest that the paragraphs referenced in this proposed finding adequately address Ms. Sinclair's contention.

201-202. The Staff does not contest these proposed findings. See the Staff's response the ¶ 199.

203-308. The Staff does not contest these proposed findings.

209. With respect to the structural adequacy of the DGB, the Board should rely on the Staff's analysis. Subject to the Staff's comments, we do not contest that the other proposed findings cited here by CPC adequately address Ms. Warren's contention.

11/4/83 Draft from CELD

Status of J. Kane's review of CELD Findings

	Subject	Latest CELD Draft		Applicable to CES comments	Status
✓	SWPS	11/9/83	Mike Wilcove	Nos. 18 thru 23	Agreement reached with CELD 11/7/83
✓	AUXIL BLDG	11/7/83	Mike Wilcove	Nos. 7 thru 17	Agreement reached with CELD 11/10/83
✓	UNDER. PIPING	11/9/83	Mike Wilcove	Nos 36 thru 50	Agreement reached w/CELD 11/11/83
✓	LIQUEFACTION & DEWATERING	11/7/83	Wm Paton	Nos. 54 thru 59	JDK comment no. 55 is still not resolved (Revised finding on #55 given to B Paton on 11/12/83
✓	BWST	11/9/83	Wm Paton	Nos. 24 thru 35	Agreement reached w/CELD previously Draft of 11/11/83 is acceptable
✓	SLOPE STABILITY BAFFLE & PERIMETER DIKES	Not yet drafted	Wm Paton	Nos 60	See JDK comments of 11/12/83
✓	DGB	not yet drafted		Nos. 1 thru 6 Nos 61 & 62	To be addressed @ later date
✓	Duct Banks	11/11/83	Wm Paton	Nos. 51 - thru 53	See JDK comments of 11/12/83

11/12/83
1 of
J. Kane

Dr. Weeds identifies three new borings out of 16 where "more loose sand pockets were identified (Nov. 20, 1982 - Tr. 7746, 47

Dr. Weeds, is referred to Bechtel analysis on liquefaction at buried diesel fuel tanks (Tr. 7747 line 10). He indicates he is familiar with Bechtel's liquefaction analysis.

Dr. Weeds notes that one of the borings close to the diesel fuel oil tanks indicated a loose sand pocket which when analyzed for earthquake forces up to 0.19g acceleration showed only minor deformations and no danger of liquefaction (Tr. 7745 lines 1-10)

Dr. Weeds identifies the "new" borings where loose sand pockets were identified (Tr. 7762) the borings are ME-27B and MP-10 (Tr. 7762 line 4-6) Dr. Weeds in response to his testimony questioning by J. Harbour responds there are only two borings - rather than the three he previously indicated in testimony (Tr. 7763 lines 6-10)

Dr. Weeds gives the coordinates to locate the new borings
MP-10 South 4942.6 West 7.74 (Tr. 7764, line 7-8)
~~MP~~ ME-27B South 5062.35, East 524.37 (Tr. 7764, line 18-21)

Dr. Weeds in response to Ms Stamiris question (Tr. 7765 line 21-23) indicates the boring near the diesel fuel oil tanks WAS NOT ONE OF THE NEW BORINGS

Ms. Wright indicates the Staff has not ~~yet~~ evaluated Dr. Weeds recent information and when they do it will appear in the SSER (Tr 9768 line 7-9)

J. Kane indicates that the boring showing loose sand at the diesel fuel oil tank is DF-5 (Tr. 9777, line 22) and if the soil at this boring were assumed to have zero shear strength, there remains enough passive resistance in the surrounding soil to resist failure (9ECC line 8)

J Kane indicates liquefaction is not a [illegible] above El 610 at any places other than the DGB & MR area (Tr 9810 - 9811, lines 15 - 14 Tr. 9811)

For ASLB testimony on Cooling Pond
See Tr. of Aug. 7-13, 1981

11/12/83
JPK
1 of 2

Slope Stability of Baffle and Perimeter Dikes

CL
Changed against CL DD 11/14/83 version

457. We do not contest this proposed finding but would add to Footnote 769, "~~5~~ SER, Par. 2.5.6.1, Pg. 2-47, 2-48."

459. We do not contest this proposed finding but would add to Footnote 773, " SER, Par. 2.5.6.2, pg. ~~2-49~~ 2-48".

460. We do not contest this proposed finding but would add to Footnote 775, "SER, Par. 2.5.6.1, pg. 2-48".

461. We do not contest this proposed finding but would add to Footnote 776, "SER, Par. 2.5.6.5, pg. 2-49"

462. We do not contest this proposed finding but would add to Footnote 777, "SER, Par. 2.5.6.3 and Par. 2.5.6.4, Pgs. 2-48 and 2-49.

464. We do not contest this proposed finding but would add to Footnote ~~776~~ 779, "SER, Par. 2.5.6.5, pg. 2-49".

468. We do not contest this proposed finding but would ~~supplement the Applicant's findings~~ add to Footnote 784, "SER, Par. 2.5.6.6, pg. 2-50"

469. We do not contest this proposed finding but would correct the proper numbering of this paragraph to 469 instead of 460 and would add to Footnote 785, "SER Par. 2.5.6.6, pg. 2-50".

471. We do not contest this proposed finding but would add to Footnote 790, "SER, Par. 2.5.6.7, Pgs. 2-50 and 2-51".

472. We do not contest this proposed finding but would add to Footnote 791, "SER, Par. 2.5.6.7, Pg. 2-50".

473. We do not contest this proposed finding but would add to Footnote 793, "SER, Par. 2.5.6.7, Pg. 2-50."

475. We do not contest this proposed finding but would add to Footnote 797, "SER, Par. 2.5.6.7, Pg. 2-50".

484. The Applicant's Findings indicate that Mr. Singh testified the PMF should not cause dike slope stability problems and cites Tr. 4117 - 4121 as the reference. The record does not support this finding. On Tr. 4118 Mr. Singh testifies that if the PMF were to occur and cause a breach in the perimeter dike, then "The damage will be done to the perimeter dike, mainly because of the erosion from the outside".

485. We do not contest this proposed finding but would add to Footnote 820, "SER, Par. 2.5.6.7, Pg. 2-50".

486. We do not contest this proposed finding but would add to Footnote 824, "SER, Par. 2.5.6.7, Pg. 2-50".

FROM SER May 1982

benchmarks set in a rectangular array around the site continues to be monitored for surface subsidence. Surveying techniques for these benchmarks have been upgraded to a Level 1, Class 2 survey, as compared with either the Level 2 or 3 surveys used by the USGS for its topographic control in the immediate area. On the basis of the most recent surveys, the applicant reports no new evidence of subsidence as of December 1981.

Dow Chemical, in separate surveys over its operations since 1958, also reports no measurable evidence for surface subsidence in the Midland, Michigan area.

2.5.4 Stability of Subsurface Materials and Foundations

This section and Sections 2.5.5 and 2.5.6 provide the status and results of the staff's geotechnical engineering review of the Midland plant, based on the FSAR through Amendment 42, 10 CFR 50.54(f) report entitled "Responses to NRC Requests Regarding Plant Fill," and testimony presented during the hearing sessions before the Atomic Safety and Licensing Board (ASLB) on the NRC December 6, 1979 Order Modifying Construction Permits No. CPPR-81 and CPPR-82. The stability of subsurface materials and foundations (FSAR Section 2.5.4), the stability of slopes (FSAR Section 2.5.5), and embankment and dams (FSAR Section 2.5.6) are evaluated in accordance with the applicable criteria outlined in 10 CFR 50, 10 CFR 100, Appendix A of 10 CFR 100, Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants" (Revision 2), Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants," Regulatory Guide 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants," and NUREG-0800, "Standard Review Plan" (Sections 2.5.4 and 2.5.5).

The stability of subsurface materials, as exemplified by foundation problems for several of the seismic Category I structures, has been a major review area during the construction of the Midland plant. These problems were caused by inadequate compaction of the plant fill. As a result, specialized remedial treatments such as underpinning are required to improve the foundation stability of nearly completed structures. Because the above references on review criteria do not explicitly provide guidance in this specialized area of foundation engineering, the adequacy of underpinning as a remedial fix is being evaluated, with the help of consultants, to state-of-the-art conservative criteria as recommended in NUREG-0800, Section 2.5.4. Consultants who have assisted the staff in the geotechnical engineering area of review include the U.S. Army Corps of Engineers and Geotechnical Engineers, Inc.

On December 6, 1979, the NRC issued an Order Modifying Construction Permits which prohibited specified soil construction activities. On December 26, 1979, the applicant filed a request for a hearing before the ASLB. The actual ASLB hearings began in July 1981 and are nearing completion on the problems associated with plant fill. One of several reasons for the staff's issuance of the Order was whether the applicant's criteria and design details on the variously proposed remedial measures were sufficient for the staff to conclude with reasonable assurance that the affected safety-related structures would be adequately required to permit safe operation of the plant. Table 2.2 lists the seismic Category I safety-related structures and ultilities that are known to be affected by the plant fill problem. This table also identifies the foundation problems that investigations have shown to exist and the various remedial measures currently proposed by the applicant to correct those problems.

Table 2.2 Safety-related structures and utilites affected by the plant fill problem

Structures	Foundation support problem	Proposed remedial measures
Control tower	Void located beneath mudmat in fill soils	Underpin with permanent concrete wall extended to undisturbed natural soil.
Electrical penetration areas	Loose and soft fill layers	Underpin with permanent concrete wall extended to undisturbed natural soil.
Feedwater isolavalve pits	Loose and soft fill layers	Replace loose and soft fill soils with compacted granular fill.
Railroad bay	Liquefaction potential in loose fill	Eliminate problem with permanent dewatering system.
Diesel generator building	Experience large settlements	Completed surcharge program to consolidate fill and accelerate settlement.
	Liquefaction potential in loose fill	Eliminate problem with permanent dewatering system.
Service water pump structure	Loose and soft fill layers	Underpin with permanent concrete wall extended to undisturbed natural soil.
Diesel fuel oil tanks	Isolated layer of loose fill	Not required because of limited extent.
Borated water tanks	Experienced large settlements and cracking of ring beam foundations.	Completed surcharge program to consolidate fill. Plan to construct new ring beam foundations and relevel Unit 1 tank.
Underground piping	Experienced large settlements	Replace or rebed lengths of pipes most affected by settlement or liquefaction. Rely on monitoring during plant operation for other piping lengths.

Except for consideration of differential settlement that has already occurred for the DGB, the staff and the applicant have essentially reached agreement on the remedial fixes. Resolution of design details to ensure foundation stability and the implementation of adequate construction controls to safely complete this work are currently being worked out by the applicant for the variously proposed fixes. The staff's evaluation of the stability of subsurface materials and foundations for seismic Category I safety-related structures and components will be presented in a supplement to this SER. See Section 1.12 of this report.

2.5.5 Stability of Slopes

This section deals with the staff's evaluation of soil slopes for static and dynamic stability that are associated with the main power plant facilities. The dike embankments associated with the cooling pond are discussed in Section 2.5.6. FSAR Figure 2.5-46 provides a plan view of both the plant area dikes and cooling pond dikes. Typical sectional views of plant area dikes are presented in FSAR Figures 2.5-49 and 2.5-50.

The plant area dikes form the northern boundary of the main power plant complex along the Tittabawassee River. In this area, approximately 35 ft of fill had been placed and compacted in order to raise the plant grade to elevation 634 ft. On the easterly side of the plant area dikes, there is a transition into the cooling pond perimeter dike. This transition is the beginning of the boundary embankment that retains the large cooling pond (that is, the cooling pond dikes).

The materials within the plant area and cooling pond dikes were selected and placed to safely control seepage and to best utilize soil materials that were available from excavation of the cooling pond area. These materials were zoned (selectively placed) within the embankment to result in a stable slope that is capable of withstanding both static and dynamic loading.

The applicant has used results from his stability analysis on the cooling pond dikes to make conclusions on slope stability of the plant area dikes. Foundation conditions and embankment materials for the plant area dikes are similar to the cooling pond dikes. Also, the embankment materials were placed and compacted to comparable specifications. Because the applicant concluded that the more severe condition for slope stability would exist for the slightly higher cooling pond dike section, which has a lesser crest width, the applicant further concluded that the factor of safety against slope stability failure for the plant area dikes would be higher. The staff concurs that this is an acceptable method for addressing the slope stability of the plant area dikes. The staff's evaluation of the cooling pond dikes is presented as part of Section 2.5.6.

2.5.6 Embankments and Dams

2.5.6.1 General

This section presents the staff's evaluation of slope stability for the earth fill embankments and excavation slopes. As shown on FSAR Figure 2.5-46, the earth fill embankments were constructed for flood protection and for impounding cooling water that is required for normal plant operation. In addition to the perimeter dikes (cooling pond dikes) that confine the approximately 880-acre

cooling pond, there is an interior baffle dike whose function is to ensure adequate circulation between the intake and outlet areas. In the northeast corner of the cooling pond, an area designated as the emergency cooling water reservoir (ECWR) has been excavated below the original ground surface for a depth ranging from 9 to 12 ft. The stability of the excavation or cut slopes of the ECWR is considered to be seismic Category I related because the function of the ECWR is to retain sufficient water, without allowing for makeup, for 30 days' continuous cooling during plant shutdown (the ultimate heat sink). The perimeter and baffle dikes are not classified as seismic Category I structures because, in the unlikely event that these dikes would fail and permit release of the cooling pond waters, sufficient cooling water would remain available in the ECWR for plant shutdown. Although the perimeter and baffle dikes are not classified as seismic Category I, their failure has the potential to adversely affect the function of the two seismic Category I emergency discharge conduits and the ECWR. Based on guidance provided in Regulatory Guide 1.29, "Seismic Design Classification," the staff required that the design of the affected perimeter and baffle dike slopes be equal to seismic Category I requirements. The staff imposed this requirement on the applicant during the investigation of the plant fill problem; the requirement is discussed in detail in the ASLB transcripts for the August 7 and 11, 1981 hearing sessions.

2.5.6.2 Dike Section

Typical sectional views and foundation profiles of the perimeter dikes and ECWR are presented on FSAR Figures 2.5-53 through 2.5-60. Additional sectional views and subsurface information on the ECWR were provided by the applicant in the 10 CFR 50.54(f) reports in response to Question 45. The tops of the perimeter and baffle dikes were designed to be at elevation 632 ft, except at the transition sections with the plant area dikes where the top rises to elevation 634 ft. The operating level of the cooling pond water surface will be at elevation 627 ft, with most of the cooling pond bottom surface between elevations 605 and 610 ft. The bottom of the ECWR ranges between elevations 593 and 596 ft. As indicated in Section 2.4.4 of this SER, the applicant is required to address the effect on the slope stability of the ECWR should an estimated wave runup reach maximum elevation during the probable maximum flood condition.

The crest width of the perimeter and baffle dikes is 20 ft except at the northern section where it is widened to allow for railroad lines. The maximum height of the dike embankment is approximately 35 ft high. The dikes have interior slopes (pond side) of 1 vertical on 3-1/2 horizontal and outer slopes (river and property boundary side) of 1 vertical on 3 horizontal.

2.5.6.3 Dike Zoning and Materials

The baffle dike is not zoned but consists of random fill which is primarily clay with smaller amounts of silty sands. Both sides of the baffle dike slopes are protected with 18-in.-thick riprap overlying a gravel filter that extends from elevation 615 ft to top elevation 632 ft. The perimeter dikes are zoned embankments consisting of impervious and random fill sections and a clean sand chimney drain that separates the impervious and random fill zones. On the interior slopes 18-in.-thick riprap protection has been placed over a gravel filter extending from elevation 615 to 632 ft. The riverside slope is protected with 18-in.-thick riprap from original ground line up to elevation 614 ft. From elevation 614 ft to top of dike elevation 632 ft, the slope has been top-

soiled and seeded for erosion protection. The 9- to 12-ft-high excavated slopes of the ECWR are relatively flat, ranging from 1 vertical on 5 horizontal to 1 vertical on 20 horizontal. The natural soils which are exposed in the ECWR excavation include clays, silty sands, and glacial tills.

2.5.6.4 Foundation Preparation

Treatment of all dike foundations consisted of the removal of topsoil and surficial silts within the limits of the final dike section. To control seepage through the foundations of the outer perimeter and plant area dikes, cutoff trenches were excavated a minimum depth of 8 ft through the upper sand layers and 2 ft into the underlying soil of low permeability. In areas where the foundation sands were too deep or existing groundwater conditions made it impractical to fully penetrate the sands, a slurry trench cutoff was constructed to reach the lower impervious soils.

2.5.6.5 Subsurface Investigations

FSAR Figure 2.5-16 provides a plan view of the extensive number of borings or probes which were completed in the exploration program for the dike system. Most of these explorations had been completed before the dikes were constructed to define the top of the impermeable foundation layer and to permit undisturbed foundation soil samples to be recovered for laboratory testing. In June 1980, when the extent of the plant fill problem was known to be widespread, the staff and its consultant (the Corps of Engineers) recommended that seven additional borings be drilled to clearly demonstrate that the fill materials placed in the perimeter and baffle dikes in the vicinity of the ECWR had been adequately compacted. Laboratory testing of samples recovered in the embankment materials was requested to establish that shear strength properties of the fill were equal to values assumed in design at the PSAR stage. The objective of the requested borings and testing, whose results were provided to the staff in July 1981, was to obtain reasonable assurance that the slopes of the perimeter and baffle dikes in the area of the ECWR would remain stable during years of plant operation under all anticipated conditions of loading.

The results of explorations in the foundations of Midland dikes indicate that the dikes are founded on very dense glacial till deposits in the northern and eastern portions of the cooling pond. The till materials are relatively impervious and broadly graded and include gravel, sand, silt, and clays. From deeper explorations in the plant area it is known that the till materials extend from elevation 365 to 431 ft at which point the tills overlie a very dense, water-bearing, sand layer containing cobbles and boulders. Beneath the thick, very dense sand layer, the black shale of the Saginaw Formation has been encountered. Buried channels and depressions do occur on the surface of the glacial till and have been found to be filled with a uniform silty sand. Over the western and southwest portion of the site, the till is blanketed by a preconsolidated silty clay, which is referred to as a lacustrine clay. The lacustrine clay has a maximum thickness of 13 ft in the southwest corner of the pond and disappears near the middle of the pond. Over much of the cooling pond area the dikes have been founded on a uniform silty sand of varying thickness that overlies either the lacustrine clay or glacial till.

2.5.6.6 Laboratory Testing

To analyze the stability of dike slopes, the applicant initially had to establish the engineering properties of both the embankment and foundation materials by conducting laboratory testing on representative soil samples. Soil shear tests that duplicate the pore water drainage conditions that these materials could potentially experience during the years of plant operation are the most important. Such data were obtained by the applicant. The design values of soil properties adopted by the applicant for use in analyzing slope stability are presented in Table 2.5-22 of the FSAR. The later results of testing required by the staff to demonstrate that acceptable engineering properties actually had been achieved in the constructed dike embankments were provided in the applicant's report of July 27, 1981.

Based on the staff's (and its consultant's) review of the information provided by the applicant (which includes the dike's section, zoning and materials, foundation preparation measures, the results of extensive subsurface explorations, and laboratory testing to establish required engineering properties on both foundation and embankment materials), the staff concludes that the applicant has met the Commission's regulations, Regulatory Guides, and applicable SRP sections. Therefore, the staff finds this information acceptable.

2.5.6.7 Slope Stability Analysis (Response to Staffing Condition 4.B.)

The applicant analyzed the slope stability of the various dike sections by the circular arc method using soil properties acceptable to the staff. Analyses were conducted on perimeter and baffle dike sections of greatest embankment height, at locations considered to have the most unfavorable foundation conditions, and at locations with the greatest potential to impact the function of a seismic Category I structure. Stability conditions analyzed include (1) after construction, when excess pore pressures resulting from dike construction were assumed not to have dissipated, (2) long-term steady seepage condition with reservoir at pond operating elevation 627 ft, (3) rapid drawdown condition, where rapid loss of cooling pond water was assumed to occur from elevation 627 ft to elevation 604 ft, and (4) seismic loading. The conditions analyzed and the resulting factors of safety are presented on FSAR Table 2.5-20 and in the applicant's testimony of August 11, 1981 before the ASLB. The stability of the dikes under seismic loading was initially analyzed by the pseudostatic method using a maximum seismic coefficient of 0.12 g. In recognition of a potential increase in peak seismic ground acceleration that the Midland plant could be required to address, the applicant also analyzed the dynamic stability of the dike embankment slopes using the Newmark method to calculate the dynamic yield acceleration of the cooling pond dikes.

The results of the applicant's slope stability studies indicate that the calculated factors of safety are acceptable and are appropriate and conservative for the stability conditions required to be analyzed. The results of the state-of-the-art Newmark method indicate that a maximum seismic peak acceleration well in excess of 0.19 g would have to occur to develop yield accelerations which would cause the dike slopes to suffer unacceptable movement.

Based on the staff's (and its consultant's) review of the stability studies conducted by the applicant (which include conservative adoption of material properties, groundwater, and loading conditions), the staff concludes that the

studies are acceptable and the plant area dikes and the perimeter and baffle dikes in the vicinity of the ECWR will remain stable under static and SSE conditions.

2.5.6.8 Instrumentation

Piezometers were installed before the pond was filled at two sections along the perimeter dike which parallels the Tittabawassee River. The piezometers were installed to record piezometric levels that develop during various operating conditions and to check the performance of the chimney drain and the effectiveness of the impervious cutoff and slurry trenches. The applicant will be asked to provide a commitment and a monitoring plan to visually inspect the diking system and to record and evaluate the results of the piezometric readings for comparison with design expectations during years of plant operation on a regularly scheduled basis.

2.5.6.9 Conclusions

Based on the staff's (and its consultant's) review, as summarized in the preceding paragraphs, the staff concludes that the plant area dikes and the perimeter and baffle dikes in the vicinity of the ECWR are stable under static and SSE conditions and will provide a reliable water retention system to permit safe operation of the Midland plant.

2.5.7 References

Algermissen, S. T., and D. M. Perkins, "A Probabilistic Estimate of Maximum Ground Acceleration in the Contiguous United States," U.S. Geological Survey, Open-File Report 76-416, 1976.

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Barstow, N. L., and others, "An Approach to Seismic Zonation for Siting Nuclear Electric Power Generating Facilities in the Eastern United States," USNRC Report NUREG/CR-1577, May 1981.

Campbell, K. W., "A Ground Motion Model for the Central United States Based on Near-Source Acceleration Data," Proceedings of the Conference on Earthquakes and Earthquake Engineering, Knoxville, TN, 1981.

Coffman, J. L., and C. A. Von Hake, "Earthquake History of the United States," NOAA, U.S. Department of Commerce Publication 41-1, 1973.

Cross, A. T., "Review and Comments on the February 1982 Report by Weston Geophysical Corporation," Report to Consumers Power Company, Michigan State University, MI, 1982.

Eardley, A., "Structural Geology of North America," Harper and Row, NY, 1962.

Fisher, J. H., "Review of Weston Geophysical's Report (February 1982) on the Bedrock Structure in the Vicinity of the Midland Nuclear Plant." Report to Consumers Power Company, Michigan State University, MI, 1982.

J. Kane
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REMARKS

It appears the Corps of Engineers feels it is important enough to document their concern with respect to the structural adequacy of the DGB and has forwarded the unsolicited letter of Oct. 28, 1983.

It is my recommendation that the Oct 28, 1983 letter, with attachments be forwarded to DL and be made available in PDRs.

I have had discussions with H. Singh on Consumer's Findings of Fact in the past via telephone and recapt of handwritten comments. I have been attempting to incorporate his comments in our input to OELD where it is appropriate and can be based in what is presently in the hearing record. Perhaps we should meet & discuss.

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DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
BOX 1027
DETROIT, MICHIGAN 48231

REPLY TO
ATTENTION OF

28 OCT 19

Design Branch

SUBJECT: Two Memoranda Concerning the Midland Nuclear Power Plant

Mr. George Lear
U.S. Nuclear Regulatory Commission
Chief, Hydrologic and Geotechnical Engr Br
Division of Engineering
Mail Stop P-214
Washington, D. C. 20555

Dear Mr. Lear:

Attached are two memoranda providing Corps of Engineers comments regarding the recent controversy over the structural adequacy of the Diesel Generator Building (D.G.B.). These memoranda are Midland Nuclear Power Plant, Midland, Michigan dated 28 September 1983 and Applicant's Proposed Finding of Fact and Conclusions of Law on Remedial Soils Issues-Midland Nuclear Power Plant, Midland, Michigan.

Sincerely,

P. McCallister, P. E.
Chief, Engineering Division

Enclosures

[redacted]

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