




NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

September 12, 1983

Staff Exhibit 28

MEMORANDUM FOR: James G. Keppler, Regional Administrator
Region III

FROM:  Ben B. Hayes, Director
Office of Investigations

SUBJECT: MIDLAND NUCLEAR PLANT - ALLEGED VIOLATION OF ATOMIC SAFETY
AND LICENSING BOARD ORDER (3-82-061)

Enclosed is an OI supplemental report of investigation on this subject. Throughout the course of this investigation, Consumers Power Company (CPCo) continually has denied that they violated the April 30, 1982 ASLB Order requiring prior approval by the NRC Staff before commencing certain work activities at the Midland facility.

CPCo contends that the excavation beneath the deep Q duct bank was approved in a May 25, 1982 letter to Consumers Power from NRR. The NRR May 25th letter states in its Enclosure 4, "The information which provided the basis for staff review and approval was provided by CPCo's letters of ...January 6, 1982..." (Figure 7 of that January 6, 1982 letter indicated a "gap" of 6"-12" beneath the ductbank). The May 25, 1982 letter continues, "...Underground Utility Protection...the staff agrees that prior explicit concurrence for the activities listed by paragraph 1.c. (underground utility protection) of CPCo's letter, May 10, 1982, had been obtained from the staff prior to the April 30, 1982 Order...Any deviation must be reported and approved by the staff..."

The investigation revealed that on May 20, 1982, the NRC Staff, CPCo and Bechtel Power employees met at the Midland site and discussed, among other things, the protection of underground utilities. At that time Bechtel and CPCo identified their plan to excavate an additional 10'+ beneath the deep Q duct bank. A formal record of that meeting was not made, but a Bechtel supervisor recorded in his personal notes the NRC Staff's reaction to the proposal was, "We (CPCo) will proceed w/exposing utility and not proceed with excavating the pit below deep Q until NRC approval." In a second meeting on May 20, 1982, without the NRC Staff present, another Bechtel supervisor recorded in his personal notes, "no further deepening of the deep duct bank until NRR concurrence." On May 21, 1982, CPCo recorded in their minutes of a NRC exit meeting, "Dr. Landsman confirmed his understanding that this pit (deep Q duct bank) would terminate a relatively short distance below the duct, and not be to extended lower, as originally intended." While CPCo may argue that they notified the NRC of the design deviation, it is difficult to construe from the Bechtel employees' notes and the CPCo meeting minutes any type of NRC approval of excavation beneath the deep Q duct bank. The three NRC Staff members at the May 20, 1982 meeting when interviewed by OI each stated they did not approve the additional excavation beneath the deep Q duct bank.

*Jim Cook based on Schaub's input
 who or what is the basis for this statement - is it J. Schaub who refused to give an affidavit?*

CPCo claimed that NRR's Joseph Kane had given his permission on May 20, 1982 to proceed with the excavation beneath the deep Q duct bank at CPCo's "commercial risk". However, when interviewed, Kane stated he was still waiting for CPCo to submit their new plans for the duct bank to the NRC for review and approval and had no recollection of making any such statement. *no recollection is that no statement was made.*

CPCo has maintained both the excavation beneath the deep Q duct bank and the excavation to relocate the fire protection pipeline were approved through an informal understanding between the CPCo Soils Remedial Section Head and NRC Inspector Ross Landsman. The Soils Remedial Section Head for CPCo described this understanding to allow minor excavations to have been approved by Landsman after the work had begun. The Section Head stated that he spoke to Landsman during June 1982, and Landsman had then agreed to allow minor excavations to proceed with Landsman reviewing the excavation permits during a subsequent site visit. The Section Head defined major excavations as the actual underpinning of the safety related structure and minor excavations as all other soils remedial work. Landsman informed OI that he agreed, and had indeed had a conversation with the Section Head; Landsman also agreed that he had allowed CPCo to proceed with minor excavations. However, Landsman recalled the discussion with the Section Head concerned the digging of security fence postholes as his (Landsman's) definition of minor excavations, and not excavation beneath the deep Q duct bank.

It is the view of the Office of Investigations that CPCo had more than sufficient information in the form of their minutes of Landsman's May 21, 1982 meeting to at least raise the question, "has NRC approved this excavation", and the personal notes of two Bechtel supervisors in the soils remedial area, added to the May 21, 1982 exit meeting minutes, show an additional awareness that NRR had not approved the work. Further, the May 25, 1982 NRR letter, acknowledging approval of utility protection designs prior to the April 30, 1982 Order, required CPCo to report to the NRC Staff any deviations of the already approved design in order that the new design be reviewed and receive new approval. Finally, on June 23 and 30, 1982 the CPCo soils remedial Short Term Action Plans were marked "NRC Review Required" for the headings, "Complete Deep Q Duct Bank" and "Relocate Fire Protection Pipeline."

It is the opinion of the Office of Investigations that the weight of the evidence developed during the supplemental portion of this investigation supports the allegation that the CPCo violated the ASLB Order. While we cannot determine from the information developed whether this violation was done willfully, there is sufficient evidence to indicate that CPCo had been put on notice that prior NRC approval was required prior to the deep Q duct bank excavation being initiated, and that their failure to obtain that approval was at the very least due in part to a breakdown in their own organization's internal communications. It is possible that one could view CPCo's actions in this matter to be sufficiently negligent to constitute careless disregard of NRC requirements.

Neither this memorandum nor report may be released outside the NRC without the permission of the Director, OI. Internal NRC access and dissemination should be on a need and right-to-know basis.

cc: ✓ W. Dircks, EDO (w/enc. 3 copies)
E. Pawlik, OI:RIII (w/enc.)

1/Box 7

Records in folder labeled

"Midland - Findings of Facts"

Maintained by Joseph Kore.



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OCT 14 1983

MEMORANDUM FOR: William D. Paton, Attorney
Office of the Executive Legal Director

FROM: George Lear, Chief
Structural and Geotechnical Engineering Branch
Division of Engineering

SUBJECT: GEOTECHNICAL ENGINEERING REVIEW COMMENTS ON THE
APPLICANT'S PROPOSED FINDINGS OF FACT AND
CONCLUSIONS OF LAW - MIDLAND PLANT

We have enclosed the final phase of geotechnical engineering input on Midland's Finding of Fact in response to OELD request. Comments 1 through 23 were previously provided to you in my memos of September 27, 1983 and September 30, 1983. The enclosed comments cover our review of the Applicant's Findings on the Borated Water Storage Tanks, Diesel Fuel Oil Tanks, Underground Piping, Liquefaction and Dewatering, Slope Stability of Baffle and Perimeter Dikes and the Diesel Generator Building.

The enclosed comments were prepared by Joseph Kane (28153) who may be contacted if you wish to further discuss the comments.

Lyman W. Heller
for George Lear, Chief
Structural and Geotechnical
Engineering Branch
Division of Engineering

cc: w/attachment
R. Vollmer
J. Knight
T. Sullivan
E. Adensam
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H. Singh, COE

~~8310204129~~

17pp.

Final Review Comments on CPC Findings of Fact
Midland Project 50-329/330

Prepared by: Joseph Kane, NRR, DE, SGEB

Borated Water Storage Tanks

24. (Page 196, Para. 277). The hearing record is not clear and the Applicant's Findings are misleading with respect to the total amount of settlement that the BWST foundations have experienced. Dr. Hendron did testify (Tr. 7215) that in his opinion the settlements observed were not excessive and "the primary settlements on the edge of the foundations are around 1.3 inches." The settlement of 1.3 inches identified by Dr. Hendron is only a portion of the settlement history experienced by the BWST foundations and was measured only after Unit 1 tank was filled with water. Prior to this time and filling of the tanks, however, a settlement in excess of 1 inch had already been recorded at the same marker (TF-1). A question by Judge Harbour (Tr. 7217) attempted to bring out an understanding of the total settlement picture but the response by A. Boos which directed the Board to Figure BWST-8 in response to J. Harbour's question is again misleading because the settlement history on Figure BWST-8 begins with the filling of the tanks and does not provide the settlements prior to this time. As indicated in SSER No. 2, page 2-41, the total settlement history for the BWST are shown in FSAR Figures 2E.1-17, -18, -20 and -21 and the importance of addressing the total settlement history is discussed on Tr. 7451.

The significance of this comment on the Applicant's Findings is that if the entire settlement history of the plant fill were correctly recognized,

the Board would be in a better informed position to accept the Staff's position that the problem with the BWST foundations is traceable to inadequate compaction of the plant fill in this area.

DISCUS W/CELD.
NOT AFFECTED
DISCUSSED BY
CP 100-10000

25. (Page 196, Para. 278). Ms. Stamiris asked Dr. Kennedy (Tr. 7366) whether the condition of the fill soils beneath the BWST contributed to the differential settlement which he addressed in his study of the BWST. The Applicant's Findings correctly record Dr. Kennedy's response which gives his three causes for the cracking of the ring wall:

1. Pocket of softer fill material under the west end of Tank 1T.
2. Presence of valve pit which had lower bearing pressure.
3. Under-reinforcing of the ring wall. If wall had been more heavily reinforced with steel, the differential settlement would not have occurred.

The Applicant's Findings also indicate Dr. Kennedy's conclusion that cause no. 3 was the major cause.

We believe that Dr. Kennedy's testimony can and should be shown to support the Staff's position that the inadequately compacted fill contributed to the BWST problem. Presently the testimony of Dr. Kennedy and the

Applicant's Findings pass swiftly and lightly over his identified cause no. 1 - that of softer fill material and concentrates on the under-reinforcing. In actuality, however, if the fill had been properly compacted, the considerations inherent in causes nos. 2 and 3 would not be important factors. These causes only become important because of the presence of the inadequately compacted fill.

26. (Page 197, Par. 279). As indicated in SSER No. 2, page 2-34 the results of the soils investigations of the fill in the tank farm area and the results of the plate load tests are reasons in addition to the actually observed total and differential settlements for the Staff's conclusion that the problem is the inadequately compacted fill. These additional reasons should be included after the first sentence of Par. 279.

27. (Page 197, Par. 279). The Applicant's wording "Mr. Singh, while not disagreeing with Mr. Kane..." is a subtlety that attempts to lessen the Staff's position but is taking the testimony out of context. In the first sentence of this paragraph, Mr. Kane is responding to a question from Ms. Stamiris (Tr. 7451) and it is indicated that in Mr. Kane's opinion the settlement problem at the BWST was caused by the inadequately compacted fill. The question posed to Mr. Singh by Ms. Stamiris is not the same and therefore a comparison should not be made. The question posed comes from Stamiris Exhibit 33 (Tr 7477) where Mr. Singh is asked to explain the resolution (Tr. 7479) of Question 1, Section 3 of Exhibit 33. Mr. Singh in his response indicates how the tank foundation

has settled (Tr. 7482) and how the unsymmetrical foundations of the valve pits and ring foundations have an influence on the observed differential settlements. In one question we are discussing the cause of the problem and in the other question we are discussing the effects resulting from the problem. NRC Findings should correct the Applicant's Findings and clearly make the distinction.

28. (Page 197, Par. 279). Why would NRC Findings willingly endorse the Applicant's statements about Dr. Landsman? What findings or conclusions have been drawn or are to be drawn from the last two sentences of this paragraph? If these sentences are to remain, in fairness to the Board, a conclusion of full resolution of the opinion "design deficiency" should be reached.

See suggested word changes to OED Summary

29. (Page 206, Par. 290). The first sentence on Page 206 should either reference (by footnote to SSER No. 2, Section 2.5.4.4.3) the Applicant commitment to providing a Technical Specification for long-term settlement monitoring and to providing FSAR documentation on new ring beam construction and releveling operations or add this information on the commitment to Par. 290.

See suggested word changes to OED Summary

OK ✓ 30. (Page 206, Par. 292). The manner the Applicant has presented his Findings implies that Ms. Stamiris original and long outstanding Contentions were not valid. I would hope that NRC findings would correctly point out that initially many of her contentions were valid and the safety concerns

expressed in her contentions were similar to the NRC Staff's positions and which served as the basis for the December 6, 1979 Order. Our Findings should recognize that the concerns expressed in her contentions have come to be resolved but not depreciate their importance.

OK ✓ 31. (Page 210, Par. 299). The sentence beginning on sixth line implies that the Staff has approved future monitoring plans for the BWSTs. SSER No. 2, pages 2-35 and 2-52 and Table 2.8 indicate the Technical Specification details remain to be resolved for future settlement monitoring.

OK ✓ 32. (Page 210, Footnote 536). ^{Par 299} The Applicant's choices of words in stating "To begin with, staff criticized Ms. Warren's definition of backfill" is inappropriate and should not be included in NRC Findings. The Staff recognized Ms. Warren's concern but we do not expect or require that her public statements be technically accurate. In the Staff's testimony of February 1982 we attempted to indicate how a technically more accurate description of the random fill at Midland differed from her contention statement.

Diesel Fuel Oil Tanks

33. (Page 212, Par. 304, Footnote 544). The page of the transcript at the end of footnote 544 is incorrect and should be changed to Tr. 7752.

OK ✓ 34. (Page 214, Par. 309) On line 3 the paragraph numbering of six is incorrect and should be corrected to paragraph 304.

35. (Page 216) This page is missing but should be provided to complete the discussion on seismic shakedown settlement.

Underground Piping

- ✓ 36. (Page 220, Par. 318). Because the DGB does not have a mat foundation, the last two words (base mat) of the first sentence should be changed. *OK - See CELD Draft 4*
37. (Page 222, Par. 322). The footnote at the end of this paragraph is incorrectly numbered and should be 572. *CELD check not*
38. (Page 226, Par. 330). Footnote 583 references SSER No. 2 and implies that the SSER indicates we have closely spaced borings along the alignments of underground piping. This implication is not correct because we do not have closely spaced borings and SSER No. 2 does not indicate that we do. This should be corrected in NRC findings. *CELD check not to make this correction*
- ✓ 39. (Page 226, Par. 332). The Applicant's Findings conclude there is no correlation between the depth (settlement) profiles along the underground piping and the compressibility characteristics (stiffness) of the underlying fill soils. On February 19, 1982 following TR. 7902 the Staff testified that there was a correlation and on TR 7764 we indicated the soil profiles would be used to locate settlement monitoring instruments at locations of large potential differential settlements based on the subsurface information reflected on the profiles. Refer also to paragraph 375 of the Applicant's Findings. NRC findings should reflect the Staff's position on this aspect. *2 am in word in change to CELD Draft 4/19/82*

40. (Page 239, Par. 357). The Applicant's use of the terms "locally isolated from differential settlement" and "effectively suspended at the transition" are inaccurate technical descriptions. The encasement of the underground piping in Ethafoam is a construction measure that is taken to permit a more gradual transition of the differential settlements (rather than an abrupt change) at locations where differential settlements would be anticipated.

OK
See OELD
Draft of
11/9/83

To my knowledge the Affidavit of Dr. Shunmugavel (Footnote 624) has not been entered into the hearing record and has not been addressed by the Staff. Based on previous discussions with OELD it is uncertain why this affidavit can be part of the Applicant's Findings.

Discuss
w/ OELD

41. (Page 241, Par. 360) SSER No. 2, page 2-36 does not state that the K-Krete replacement fill will reduce the adverse effects of differential settlement. It is possible that the K-Krete may actually increase differential settlements but the "Ethafoam" transition length should make those settlements tolerable and acceptable. NRC Findings should not include the Applicant's statement.

See
wording
changes
in OELD
Draft of
11/9/83

42. (Page 244, Par. 366). The footnote at the end of this paragraph is incorrect and should be numbered footnote 645.

OELD chose
not to correct

43. (Page 247, Par. 373). A correction is needed to the wording in the first sentence of this paragraph.

OK

44. (Page 248, Par. 374). The testimony of J. Kane (Tr. 7764) indicates that the strain gages will not only be monitored for proper functioning but that the Applicant will be required to commit to a replacement of the gages if they were to stop functioning during years of plant operation. This commitment should be included in the Findings. Refer also to Paragraph 379 where the replacement commitment is stated to be only five years. (See Tr. 9002 - 9003). OK See
OELD
Draft
45. (Page 248, Par. 375). This paragraph does not include some of the important aspects on settlement monitoring which are covered in the first two paragraphs on page 2-52 of SSER No. 2, nor does it reference the SSER. Our findings should include this information. OK See
OELD
Draft
46. (Page 249, Par. 378). This paragraph should reference SSER No. 2, pg. 2-52 for the pertinent statements made on the Applicant's commitments to monitoring frequency. OK See
OELD
Draft
47. (Page 251, Par. 380). It is not the Staff's recollection that rattlespace monitoring of safety related piping will be limited to only those pipes which have not been rebedded or reanalyzed as indicated in the Applicant's Findings. This reduced monitoring aspect should be checked with the Mechanical Engineering Section. The Applicant's statement in Par. 380 is inconsistent with the statement in Par. 395 where it is indicated that "all pipes in the vicinity of the DGB" will be subject to conservative rattlespace monitoring. Handled
in response
to Tr. 395
See OELD
Draft to
Tr. 395

48. (Page 251, Par. 381). The discussions in this paragraph are incomplete in that it does not present the Staff's statements (Tr. 8999) with respect to what remains to be resolved in the technical specifications for laydown loads.

OK See
OELD Draft
11/11/83

49. (Page 259, Par. 395). Cutting piping such as the condensate storage lines prior to preloading, would reduce the potential magnitude of stresses that could be caused by settlement but it would not have relieved all stresses caused by past settlements.

OK
11/11/83

50. (Page 259, Par. 395 and 396). Our previous review comment no. 30 is applicable to the treatment of the intervenor's contentions in these two paragraphs of the Applicant's Findings.

Use similar statement as in response

OK -
Not addressed
by OELD.
Statement of
NRC in response
to Par. 395
this covers item

Duct Banks

51. (Page 265, Par. 406). The Applicant's statement in the last sentence of Par. 406 should be clarified to indicate that the duct bank's capacity to span voids is based on an uncracked duct bank section.

OK
See
11/11/83
draft

52. (Page 266, Par. 408). The last two sentences of Par. 382 of the Applicant's Findings is also applicable to Par. 408 and should be included in the discussions of this paragraph. The last sentence of Par. 408 should also state that the backfilling treatment of the duct bank excavations proposed by the Applicant still requires NRC staff approval (See Tr. 12016, pg. 5 of Shunmugavel testimony).

See
changes to
OELD
11/11/83
draft

53. (Page 272, Par. 419, Footnote 717). The hearing record on Tr. 12117-12118 does not support the information provided in footnote 717. The Army Corps of Engineers was not involved in the investigation of loads at the design audit that is covered in this footnote.

SEE OELD
Draft
of 11/11/83

Liquefaction and Dewatering

54. (Page 274, Par. 423). Footnote 719 refers to Dr. Wood's statement on November 20, 1982 (Tr. 9771) that liquefaction has not occurred at locations unless several acres of liquefiable materials are involved. The footnote does not clearly show, however, that Dr. Woods attempted to correct this statement on February 15, 1983 (Tr. 1151) by admitting that the technical papers in the available literature which he previously cited do not provide information with respect to the lateral extent (acreage) of liquefaction incidents. Footnote 719 should be revised to include Dr. Wood's correction of the hearing record. In addition the reasons for Mr. Kane's hesitancy in evaluating liquefaction using a minimum area approach (Tr. 9793 - 9795) should be included in NRC findings.

OK
SEE OELD
write-up
(12/28/83 - R.L.J.)

OK
SEE
OELD
Draft
of
11/9/83

55. (Page 275, Footnote 721). This footnote should be corrected for two incorrect statements. The indication of loose sand at the diesel fuel oil tanks was based on subsurface information from an older boring-not borings completed after the preparation of Dr. Wood's testimony. Secondly, it is the Staff's recollection that the impact of the loose sands discovered in the later borings was ultimately addressed in a later hearing (?Feb. 1983) by the Staff and does not require a supplement to the SER.

check
Tr. 9746
Footnote 721

check Tr. 11559 (2/15/83) where J. Kane indicated seismic hazard down had been addressed

56. (Page 275, Par. 425). The areas identified as potentially liquefiable in this paragraph are not in full agreement with the areas identified in the last full paragraph on page 2-43 of SSER No. 2.

See modified wording on OELD draft of 11/9/83

57. (Page 277, Par. 427). The words "service water piping and" should be added to the last sentence of this paragraph following the words "Category I".

OK See 11/9/83 OELD Draft

58. (Page 278. ^{Par. 428} Footnote 732). The incorrectly numbered footnote at the bottom of this page should be changed to 732.

OK See 11/9/83 draft

59. (Page 279, Footnote 737). The footnote at the end of paragraph 432 should be correctly numbered 737.

OK

Slope Stability of Baffle and Perimeter Dikes

60. (Page 292 to 307). The entire Applicant's Findings on this subject, for some unknown reason, do not draw on or reference the Staff's evaluation and conclusions provided in the May 1982 SER, Sections 2.5.5 through 2.5.6.9. The effects of this omission include:

1. The Applicant's Findings identify unresolved review concerns discussed in the hearings which have subsequently been resolved (e.g. see Par. 460).
is incorrectly typed in Applicant's Findings should be Par. 469
2. The Staff's review efforts on the acceptability of dike design and construction and final conclusions on slope stability are not fully included in the Findings either by reference to the SER or in

actual Finding discussions. Because of the above effects we feel major revisions to the Applicant's Findings are needed in order to adequately reflect the Staff's SER positions and conclusions in the NRC Findings.

Diesel Generator Building

61. (Page 134, Par. 166). In this paragraph the Applicant's Findings cite the results of the Naval Surface Weapon Center (NSWC) study which ultimately concludes that when the measured settlement values are imposed on the analytical models of the DGB, very high stresses result in areas where no cracks now exist. In response to this study conclusion, we have examined the results of the NSWC report. As indicated in the attached tables where we have compared the areas of high stress computed by the NSWC with areas of recorded cracking (visible signs of potential structural distress) our conclusions in this review indicate that in the majority of locations cracks do appear in the identified areas of high stress. Because the NSWC conclusions are so significantly different from our conclusions we feel it is necessary to resolve this difference with the NSWC. If our conclusions are correct we feel both the Applicant's Findings and the hearing record need to be corrected in order for the Board to make the proper Findings.

62. (Page 98 to Page 157). Many of our comments on the Applicant's Findings on these pages affect both geotechnical and structural engineering review concerns. It is our recommendation that SES and GES meet with OELD to discuss the best approach to be followed in responding to the Applicant's Findings.

Comparison of Computed High Stress Areas with Recorded Cracked Areas

WEST CENTER WALL

NSWC Figure	Computed High Stress Areas	Period of Measured Settlement	Observations of J. Kane in Comparison of Cracked Areas with High Stress Area			Conclusions on Comparison
			Fig. 14-2 Mapping December 1978	Figs. 28-2 and 28-3 Mapping Dec 1978; Sept 1979 to Jan 1980	Fig. 49 Mapping July 1981	
31	On south side ① below El. 650	3/28/78 to 8/15/78 (presurcharge)	*No cracks shown on 12/78 Map	Crack observed in 9/79 is recorded in this area and is identified as crack due to structural displacement	Same crack observed in 9/79 is again recorded in 7/81.	Cracks do appear in all NSWC identified areas of high stress when incremental settlements for a given time frame are imposed and the latest crack mapping (July 1981) is used.
32	On north side ② below El 650	3/28/78 to 8/15/78 (presurcharge)	*Crack shown in 12/78 Map	No cracks shown on 9/79 Map	Cracks shown in 7/81 Mapping	*If comparison is limited to available maps closest to dates of measured settlement, then cracks appear in 4 out of the 6 locations (shown by asterisks) of high stresses. The fact that cracks were observed in 12/78, not observed in 9/79 but reappear in same locations in 7/81 could mean the cracks were missed in 9/79.
33	On north side ③ above El 634.	8/78 to 1/79 (presurcharge)	*Cracks shown in 12/78 Map	No cracks shown on 9/79 Map	Cracks shown in 7/81 Mapping and slight extension of 12/78 mapped cracks.	
35	On north side ② below El 650	8/78 to 1/79 (presurcharge)	*Crack shown in 12/78 Map	No cracks shown on 9/79 Map	Cracks shown in 7/81 Mapping	
37	On north side ③ above El 634	1/79 to 8/79 (Surcharge Period)	Fig 14-2 Mapping not applicable as it pre-dates this period of settlement	*No cracks shown on 9/79 Mapp	Cracks shown in 7/81 mapping and slightly extend 12/78 mapped cracks.	
39	On south side ④ above El 634	1/79 to 8/79 (Surcharge Period)	Fig. 14-2 Mapping not applicable.	*Crack shown in 9/79 map and is identified as structural displacement crack.	Same crack observed in 9/79 is again recorded in 7/81.	

Comparison of Computed High Stress Areas with Recorded Cracked Areas

CENTER WALL

NSWC Figure	Computed High Stress Areas	Period of Measured Settlement	Observations of J. Kane in Comparison of Cracked Areas with High Stress Area			Conclusions on Comparison
			Fig. 14-2 Mapping December 1978	Figs. 28-2 and 28-3 Mapping Dec. 1978; Sept 1979 to Jan 1980	Fig. 49 Mapping July 1981	
31	On north side ① above El. 634	3/28/78 to 8/15/78 (presurcharge)	Cracks shown in 12/78 Map	Cracks shown and increase from 12/78 to 9/79	Cracks shown in 7/81 Mapping	Cracks do appear in 5 out of the 6 locations where NSWC has computed areas of high stress and on crack maps with dates closest to the periods of measured settlements.
32	On north side ② below El. 650	3/28/78 to 8/15/78 (presurcharge)	Cracks shown in 12/78 Map	Cracks shown and increase from 12/78 to 9/79.	Crack shown in 7/81 Mapping	
33	On north side ① above El. 634	8/78 to 1/79 (presurcharge)	Cracks shown in 12/78 Map	Cracks shown and increase from 12/78 to 9/79.	Cracks shown in 7/81 Mapping	
35	On north side ① above El. 634	8/78 to 1/79 (presurcharge)	Cracks shown in 12/78 Map	Cracks shown and increase from 12/78 to 9/79.	Cracks shown in 7/81 Mapping	
37	On north side ① above El. 634	1/79 to 8/79 (Surcharge Period)	Fig. 14-2 Mapping not applicable as it predates this period of settlements	Cracks shown and increase from 12/78 to 9/79	Cracks shown in 7/81 Mapping	
39	On south side ③ above El. 634	1/79 to 8/79 (Surcharge Period)	Fig. 14-2 Mapping not applicable	No cracks shown on 9/79 Map	No cracks shown on 7/81 Map	

Comparison of Computed High Stress Areas with Recorded Cracked Areas

EAST CENTER WALL

NSWC Figure	Computed High Stress Areas	Period of Measured Settlement	Observations of J. Kane in Comparison of Cracked Areas with High Stress Areas			Conclusions on Comparison
			Fig. 14-2 Mapping December 1978	Figs. 28-2 and 28-3 Mapping Dec. 1978; Sept. 1979 to Jan 1980	Fig. 49 Mapping July 1981	
31	On south side below El 663 (not reasonable since wall is built only to El 656 at this time).					Location of high stress is unreasonable for this stage of construction. No comparison therefore can be made.
32	On north side ① below El. 650	3/28/78 to 8/15/78 (presurcharge)	*Cracks shown in 12/78	No cracks shown in 9/79 Map	Cracks shown in 7/81 Mapping	Cracks do appear in all NSWC identified areas of high stress when incremental settlements for a given time frame are imposed and the latest crack mapping (July 1981) is used.
33	On north side ② above El. 634	8/78 to 1/79 (presurcharge)	*Cracks shown in 12/78 Map	No cracks shown in 9/79 Map	Cracks shown in 7/81 Mapping	
35	On south side ③ above El. 640	8/78 to 1/79 (presurcharge)	*Cracks appear very close to this location in 12/78 Map	Crack shown in 12/78 Map	Crack shown in 7/81 mapping	
37	On north side ④ above El 640	1/79 to 8/79 (surcharge period)	Fig. 14-2 Mapping not applicable as it predates this period of settlement	*No cracks shown in 9/79 Map	Cracks shown in 7/81 mapping	*If comparison is limited to available maps closest to dates of measured settlements, then cracks appear in 3 out of the 5 locations (shown by asterisks) of high stresses.
39	On south side ⑤ above El. 634	1/79 to 8/79 (Surcharge Period)	Fig. 14-2 Mapping not applicable.	*Crack shown in 12/78 Map but not in 9/79 Map	Crack shown in 7/81 Mapping	