COMMENTS BY RALPH B. PECK

(Reconstructed from notes prepared 17 & 18 July 1979)

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The investigations at the Diesel Generator Building rather quickly showed that the seat of settlement was in the clay fill underlying the structure. They also showed that the clay fill was extremely variable with respect to its density, its water content, and even its composition. Furthermore, the investigations showed that it would be feasible to surcharge the area in such a way as to stress the subsoil of the structure to levels exceeding the final stresses that would exist under operating conditions.

After consideration of a number of alternatives, it was decided to prestress the subsoil by means of a surcharge. In my view, this procedure had several important advantages. One of these is the opportunity to provide instrumentation, principally piezometers and subsurface settlement gages, that could furnish data permitting a reliable upper-bound settlement forecast. Furthermore, the procedure automatically proof-tested the subsoil with respect to its future settlement behavior. Therefore there would be no need, in determining the acceptability of the foundation, to depend on the results of additional borings, samples, compaction tests, or other similar activities. Such tests would be likely to prove inconclusive on account of the heterogeneity of the fill material, but they would also be irrelevant in view of the knowledge of the actual behavior.

The results of the preload procedure have been convincing. The observed pore pressures were small, smaller than actually anticipated, and they dissipated rapidly. Hence, primary consolidation was accomplished quickly and the curve of settlement as a function of the logarithm of time became linear shortly after the completion of placement of the fill. Therefore, it is possible to forecast the settlement that

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would occur at any future time by simple extrapolation, on the assumption that the surcharge will remain in place. Even this amount of settlement would be acceptable. However, the projected settlement determined on this basis is an upper bound, because the surcharge will be removed and the real settlements will certainly be smaller. In my judgment, the foregoing circumstances eliminate any uncertainties concerning the settlement behavior of the Diesel Generator Building resulting from the underlying clay fill.

The investigation at the Diesel Generator Building also showed, however, the presence of zones of sand, including some portions that were loose. This finding indicated a potential for liquefaction under severe earthquakes, and the possibility of settlement originating in the sands due to shakedown under seismic conditions. The surcharge would, of course, be ineffective to remedy this condition.

Of the various possible remedial measures, grouting, probably using chemicals, would, in my judgment, be feasible. Nevertheless, it would be difficult to be assured that all injected materials had been successfully treated, or that all loose zones had actually been injected. Thus, chemical grouting would at best be a piecemeal solution. It would be

difficult to give a positive answer to the question whether all significant zones that might liquefy had been identified and treated.

The chosen alternative to grouting is general permanent dewatering of a large portion of the plant site. This solution has the advantage of being a positive solution to the liquefaction problem. Therefore, it provides positive answers to such questions as those just mentioned. The solution has the further advantage that it can be monitored effectively by simple procedures, primarily by the use of piezometers. In my view, one of the greatest advantages of general dewatering is the margin of safety inherent in the time lag that would be required for recharge of the dewatered zone if the pumps should cease to operate. That is, the beneficial effects of the dewatering would persist for a period on the order of weeks after pumping might be interrupted. Failure of the pumping system because of an earthquake would, therefore, not destroy the protection achieved by the dewatering.

In addition to being a positive solution to the liquefaction problem, wherever any such problem might exist in the dewatered area of the plant site, the drainage will reduce substantially any settlements that might be induced by compaction

of the sands during an earthquake. The present methods of estimating settlements due to seismic shakedown are overconservative, because they are based on the results of laboratory tests on dry sands. Even the settlements estimated on this basis would be acceptable. However the presence of capillary moisture in the soil would greatly reduce the freedom of the sand grains to assume a denser position during vibration. Therefore, I consider that dewatering will essentially eliminate any potential problems of seismic shakedown.

The continuing investigations of the plant area indicated other potential trouble areas. In my view, these potential trouble zones have now been adequately defined by the boring program and other investigations. One such area is the location of the Borated Water Tanks. Beneath these tanks the investigations have indicated better and more consistent subsurface conditions than beneath the Diesel Generator Building. It is proposed to fill the tanks with water as a test load. The filling will constitute full-scale proof tests with respect to the bearing capacity of the subsoil. It is anticipated that the tanks will settle under the test load, and this settlement will increase the bearing capacity. Furthermore, by making settlement observations at various depths in the

subsoil during and after the test loading and by combining this information with stress calculations and theory, it will be possible to make reasonable settlement predictions that take into account the actual subsurface conditions under realistic loadings.

The Electrical Penetration Structures extending from the Auxiliary Building, and the adjacent Valve Pits, are to be underpinned. This is a positive solution that will lead to satisfactory and predictable results irrespective of the nature of the fill materials that may presently underlie these structures. The operations are expedient, in the sense that they are compatible with the general construction schedule. The nine caissons under each of the Electrical Penetration wings will be tested individually to 150 percent of the anticipated loading, and collectively to 100 percent of the anticipated working load. The latter procedure, in which all nine caissons are loaded simultaneously, constitutes a proof loading that will eliminate any doubts concerning the ability of the underpinning to support the structure without significant settlement.

The Diesel Fuel Tanks are buried structures that have already been subjected to a full-scale loading by filling them

with water. The settlements under these test conditions were minimal. Whatever settlement of the tanks may occur will be associated primarily with settlement of the underlying and surrounding fill under its own weight. Since the tanks will be settling with the fill, the differential movements between the tanks and the surrounding soil and piping will be minimal, and the connections can be expected to settle approximately equally with the tanks. Therefore, I do not consider that any unusual conditions exist with respect to the Diesel Fuel Tanks, and that attention to details providing reasonable flexibility will satisfy all requirements.

The Service Water Structure lies outside the area of planned permanent dewatering. Therefore the wing presently supported by fill will be picked up by a system of piles. The proposed procedure provides positive support. The piles are to be designed to carry the structural loads at their buckling strength and will therefore be effective even in the event of liquefaction of the surrounding soil. Since these piles are not clustered in such a way as to stress highly a large mass of the bearing material, as in the case of the caissons proposed for the Electrical Penetrations of the Auxiliary Building, they are not to be proof loaded as a group, but will

be loaded individually to 150 percent of the anticipated working load. This procedure is conservative.

In summary, my overall impressions and conclusions concerning the proposed remedial measures are as follows: The investigation has proceeded in a progressive fashion. Like most investigations of this kind, it has not always proceeded in a straightforward way, but has appropriately pursued various approaches. Although it is still continuing in some respects, I consider that it has now disclosed the significant conditions and potential problems associated with the foundation conditions of the site. As a result of the studies, a variety of solutions has evolved. Each solution is suited to the specific conditions and problems of a particular part of the facility. However, the potential for liquefaction has been eliminated once and for all, and many potential uncertainties have been eliminated by full-scale loading or proof testing where such procedures have been found advantageous. In my judgment, this is a strong advantage of the procedures adopted.

Finally, the proposed solutions do not require unreasonable maintenance or monitoring during the lifetime of the plant, and can therefore be adopted with confidence.

Agenda
Item 7.0

7.0 CAUSE INVESTIGATION

The investigation into the cause of insufficient compaction of plant area fill was made by Bechtel using a problem analysis ~~approach~~ technique approach. This ~~technique~~ involved the following steps:

(1) Identify deviation, in this case insufficiently compacted plant area fill.

(2) Develop criteria for determining in which plant area fill the deviation exists.

(3) Identify distinctions and changes which might have caused the deviation considering the subject of the deviation, where it occurred, time factors, and the extent.

(4) Develop list of possible causes using all distinctions and changes.

(5) Test possible causes for most probable causes.

It was noted that although all areas were included in the investigation where deviations were identified by the soils investigation, some deviations were thought to be insufficient to require corrective actions. Two examples of such areas are the borated water tank area and the auxiliary building railroad bay. In these areas the compacted fill is adequate despite some indications of localized insufficiently compacted material.

Seventeen distinctions or changes were found to have occurred which could have been possible causes and these have all been evaluated. Specifications, first identified as a possible cause, were not included in the most probable cause list because it was felt upon evaluation that variances from the PSAR and FSAR and the various relatively minor inconsistencies could not have been a cause of the problem under investigation.

It was stated that investigation is still under way into soils testing methods, equipment, results, retests, reviews, and evaluations, but that these were found to have contributed to the cause.

Five most probable causes remained after evaluating the possible causes. They are, not necessarily in order of importance:

(1) Lift thickness/compactive effort. Recent tests have shown that lift thicknesses in some cases exceeded the capability of equipment being used, verifying that equipment was never adequately qualified.

(2) Compaction equipment/qualification. Same comments as for (1) apply.

(3) Test procedures and results. This included representativeness of tests, procedures for comparison with standard proctor specimens, procedures for taking soil tests within a lift, calculation of relative density, use of nuclear densometer.

(4) Inspection procedures. This included the use of a surveillance type program for at least part of the time, and the almost total reliance of inspection procedures on test results.

(5) Reliance on test results. This included construction's total reliance on test results for qualification of equipment during the work and for acceptance of the work by Construction and Quality Control personnel.

Personnel were not included as a most probable cause because a review of qualifications and experience of both Bechtel and U. S. Testing personnel had shown presence of sufficient education, experience, and training to carry out the tasks assigned.

PAM/pp

To File

From TCCooke

Date December 11, 1979

Subject MIDLAND PROJECT GWO 7020 -
ADDITIONAL 50.54(f) SOILS QUESTIONS
File: 0485.16 UFI: 71*01 Serial: CSC-4660
12-5-80 MEETING @ SITE

Consumers Power Company

INTERNAL CORRESPONDENCE

cc Attendees
Midland P&T (2)

Attendees:

Consumers Power Company	Bechtel Power Corporation
RMWheeler	MORothwell
GSKeeley	BDhar
CAHunt	GTuveson
TCCooke	WCParis (Geotech)
DESibbald	JHook
DBMiller	JRutgers
	JOWanzeck
	CRussell

I. General Review

A review was held covering the 50.55(e) report, 50.54(f) report, miscellaneous questions from the July 18, 1979 presentation to the NRC in Washington, D.C., the consultants meeting date and the draft schedule. The following was noted:

A. Cut off date for interim report 9 to MCAR 24 will be mid-January. This report is due in mid-February.

B. Since the Geotech report indicates the soil to be satisfactory in the tank farm we will note that we are deleting the load test of the borated water storage tank. If ever needed, six feet of sand could be added around the tank filled with water for the load test.

C. Dewatering should be discussed in the February report, however, the computer modeling which may be required could delay this discussion.

D. The guard pipe on the borated water storage tank line has been closed in an earlier report.

E. Responses to questions 4 and 14 will not be out until January 15, 1980. GSKeeley is to notify D. Hood. Draft responses will be submitted to Consumers Power Company on January 2, 1980.

F. Rixford will have a matrix out by December 21, 1979 which should provide locations of answers to D. Hood's memo on the July 18 meeting and informal

questions noted by TCCooke. All open items on the MCAR should be closed by February 1980.

G. John Rutgers took an action item to respond as to whether or not a full time man will be employed to collect or locate all documentation for the ~~50.54(f)~~ SP.SE report closure items.

H. Bechtel is to advise the date of the consultants meeting this afternoon. It was noted that it would be December 10 or 11 in Ann Arbor. (Note: cancelled after NRC order of December 6) At that time the formal final report will be discussed. The total picture should be completed by discussion of individual subjects. All signatures of consultants should be obtained. Calculations or review should also be discussed at this meeting.

I. Al Boos noted that the resolutions of underground pipe and utilities question was significant to the construction schedule.

J. Draft Schedule - During the review of the draft schedules provided by RMWheeler, it was noted that the more detailed schedules should be completed by Bechtel in the near future. Discussions with Mergentine will have to be held to determine which unit will be done first on the underpinning contract. It was also noted that the dewatering spec should be completed by the middle of March. Jim Wanzeck or Bechtel Ann Arbor will advise TCCooke on the 138 kV poles and bore holes in the dike. This should be added as a line activity to the dewatering schedule. The Diesel Generator pedestal vibration tests will not take place until 1981. However, the consultants will be questioned as to whether some other means can be used to vibrate the pedestals. Bechtel is to comment on the draft schedule and check Mergentine on vibratory application.

II. New 50.54(f) Questions (24 - 34)

Discussion was held on individual questions and methods of response. A Bechtel meeting on November 30, 1979 initiated responsibilities for answers to questions and the schedule for same. It was noted that an outline should be prepared by December 7, 1979 and that a draft response should be prepared by December 21, 1979. This should be coordinated with Consumers Power Company by January 4, 1980. Allowing two weeks for review and two weeks for contingency, the final response should be ready by February 1, 1980. This schedule is tight and realistically it should be noted that probably mid-February would be the earliest date that it could be submitted to the NRC. GSKeeley will advise D. Hood that we should be able to submit our responses by March 1 and that we will know more about it in January of 1980. It was also noted in passing, that the dewatering will be made to elevation 600' with 0.2G acceleration utilized as the new criteria.

III. Since 0.12g appears to be a realistic acceleration value for the seismic event it was noted that a separate meeting would probably have to be held on questions 25 and 26. Additional checks will be made with Karl Weidner on these subjects. These questions and other new 50.54(f) questions will be handled in the same manner as they were handled on the old Diesel Generator task force.

IV. Underpinning Contract

It was noted by both Consumers Power Company and Bechtel that after having reviewed the award procedures, the complaint from the second low bidder had no basis in fact. It was also noted that Bechtel and Consumers Power Company attorneys have differing opinions on the Michigan PE licensing question. This question will be raised during the pre-award in Ann Arbor on December 6, 1979 and the low bidder will be requested to respond.

Attachment
SHOWS AGENDA FOR DEC 5 MEETING

MIDLAND PROJECT - FOUNDATION PROBLEMS

Meeting with Soil Consultants at Denver Colo

June 28 1974

1. F Montcrief, K Wiedner and T Cooke had informal meeting with the Consultants (Drs Peck, Hendron and Davisson) on the evening of June 27 1974. to brief the Consultants on the project situation and to learn the concerns of the Consultants.
F Montcrief summarized the proceedings of the evening discussion which is as follows:

   1. Soil borings may not tell the whole story. While the "male silt" (marginal situation) found in some borings may not liquify under SSE of 0.12g, the increase of acceleration to say 0.25g would definitely cause liquefaction. Furthermore, assuming NRC + intervenors that sand in areas away from the borings are as good or better than that found in borings would be very difficult. Therefore, politically "total plant permanent dewatering" is a more attractive solution and it completely wipes out the concern of liquefaction.

   2. The temporary dewatering system that will be used for underpinning the Aux. Bldg. Penetr. Area, will provide valuable information towards designing a permanent dewatering system.

   3. Consultants need more information regarding Aux. Bldg. Electrical Penetration Area foundation design to arrive at a viable fix. They urged a parametric type of study for the ground and structural conditions.

This study would enable to narrow down the choices, such as whether to put caissons, obtain lateral support by attaching the floor to containment and turbine building Mat, attaching the slab to valve pit structure or the use of 'raking' caissons.
They suggested that instead of underpinning the valve pit structure, the structure can be replaced with another one with better foundation or with lean concrete fill extending down to till.

4. Bechtels Cost Estimate of 3 million is too low for underpinning operations and 20 million for permanent dewatering too high.

5. Consultants made a commitment that they will put their recommendations in writing this time.

6. Concerning attending meeting with NRC Dr. Hardies will be able to make it. There is a good probability the remaining two can attend the meeting.

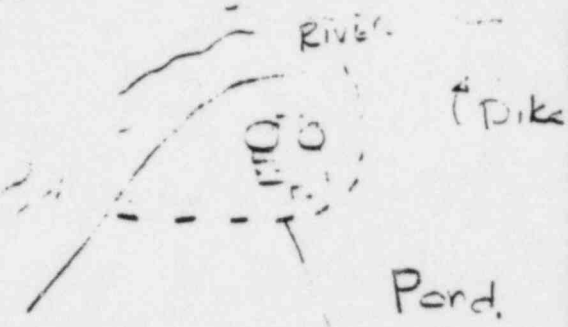
7. Consultants stated that choice of a fix be made on feasibility and licensability and give less weightage to schedule delay which when put in dollars will outshadow the task force.

2. Agenda for the meeting is attached. A new item, No. 7 was added. This concerned with structural sand back-fill around the edges of structures.

3. Item 7 of the Agenda was taken up first.

2. Liquefaction Potential.

1. Permanent Dewatering System design would be independent of surrounding features such as Tidal basin, river, pond and dikes.



2. Temporary dewatering system for underpinning purposes will establish the criteria for the design of the permanent dewatering system. In otherwords, the temporary system around the exist. building penetration zone would serve as a major test program and could be very well used for justification of the continued 40 year functionability of the permanent dewatering system.

3. No need to have an alternate redundant system. Required redundancy is achieved by providing additional units (wells) in the system. This can be justified by the fact it would take anywhere from one to two weeks after stopping of pumping operations to completely recharge the soil mass with water. This time period can be established and documented by performing a test once the dewatering system is installed and is functional.

4. The system should be designed so as to preclude loss of fines during pumping operations. This design criterion is very important and as an additional safety margin, no wells should be located within 50 ft. of any structure

5. System description (Conceptual)

   1. The system will comprise of a series of wells completely encircling the power block area including any additional area

of cemetery. It is estimated to cover a perimeter of about 2000 ft. The wells will be placed 10 to 12 ft apart, resulting in a total number of wells between 250 to 200 wells. Within the perimeter 40 to 50 wells will be placed to lower and control the water table at the cremation. The wells will be sunk to the level of till and will penetrate into the till about 2ft. Temporary drains will be done within the perimeter to remove any perched water in sand lenses, and small diameter gravel drains will be provided to drain the water accumulation of precipitation to the till.
The submerged pumps will be 1/4 to 1/2 hp. type. Well casings will be made from plastic so that there will be no maintenance problems. Life of pumps will be in the order of 5 years. It should be expected that 20 to 30

7. Structural Sand Backfill around the edges of Class I Structures

Specification C-211 required that around class I structures a minimum of 3ft width sand back be placed. Due to labor union contracts this thickness was increased to 5ft. Functionally this backfill was placed to the compaction requirements in Spec. C-211, there are few tests to show that the requirements have been met. So the concern was raised as to what would happen if this sand undergoes liquefaction.

Liquefaction would induce additional lateral load on structures, such as containment. All class I structures are conservatively designed to withstand this additional load. Furthermore, even if liquefaction of this sand occurs it will be local and will not affect adjoining structures.

Conclusion: No need to be concerned about the sand back fill.