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January 28, 1982
Project 81907
File 2.0
Ref: 81907-1

Mr. Joseph Kane
Project Officer
U. S. Regulatory Commission
Division of Engineering, M/S P-214
Washington, D.C. 20555

Subject: Information Desired at Audit of February 1-5, 1982
For License Condition 5
Bechtel Offices, Ann Arbor, MI
Midland Plant Underpinning
Contract No. NRC-03-82-092

Dear Mr. Kane:

Based on our telephone discussion with Mr. Hari Singh on January 27, 1982 and on my review of the documents regarding underpinning of the Auxiliary Building, I suggest that the following information be requested of the applicant as part of License Conditions 5a through 5e.

5a. See 5c.

5b. See 5c.

5c. For conditions (a) during underpinning and (b) after completion of underpinning provide the following:

(1) The locations in the structure and on the bearing layer which will be most critically stressed.

(2) The magnitude of the stresses in (1).

(3) Measurements and frequency of readings to be made at the critical locations to monitor behavior during and after completion of underpinning.

(4) The allowable movements, strains or stresses at the monitoring points. Show calculations to provide a basis for the allowable movements that are selected.

(5) The limits of measured movement or stress that will be the basis for re-evaluation and for stopping underpinning. Provide the estimated time interval between the observation of critical movements and follow-up.

(6) The stages during underpinning when the critical bearing pressure and the critical structural stress will occur.

5d. Comment: The stresses imposed by the post-tensioning system should be taken into account when evaluating the most critically stressed locations.

5e. S. J. Poulos will comment as necessary after a site visit on January 28, 1982 with Mr. Reuben Samuels.

Sincerely yours,

GEOTECHNICAL ENGINEERS INC.

Steve J. Poulos
Principal

SJP:mm

The cracking observed in the electrical penetration wings and the control tower does not seem to be extensive. The rigidity of the structure and the complicated connection between these two elements and the auxiliary building make it difficult to relate the cracking to possible settlement of the fill. This correlation should be developed if it has not been done already. It is possible that the fill could settle away from the EPA and the CT to form planar voids beneath them. Consideration should be given to exploring this possibility and the effect of such void planes on the underpinning procedure.

The cracks in the service water pump structure are both diagonal and vertical. The diagonal cracks are oriented in a manner consistent with downward rotation of the SWPS relative to the intake structure.

A system for monitoring cracks should be established which will be effective for measuring changes in width as small as 0.001 in. See the text for a description of the suggested method of monitoring.

2. HARD CLAY BEARING STRATUM

Several samples of the natural hard clay bearing stratum, taken from the CON borings, were visually inspected by us.

The samples of the bearing stratum were slightly brownish-gray, hard silty clay of low plasticity. (Since these jar samples were partially dried, the hard consistency may be misleading, although strength data provided in the documents for this project indicate a hard consistency.) The silty clay contains slight color variations that appear to represent horizontal stratification. One or two partings of a tan fine sandy silt were found in each sample inspected. Occasional rounded 1/8 in. to 1/4 in. gravel particles were found in one sample. The clay showed no gloss when rubbed with a jackknife or the fingernail.

During our visit a sample was taken at the bottom of a permanent benchmark that was being installed through the west Feedwater Isolation Valve Pit. This sample was taken close to El 425 and had a standard penetration resistance of 100+ blows/ft. (The first 4 in. gave 50 blows and the next 4 in. gave 80 blows.) It is a hard, slightly brownish-gray silty clay of low toughness and low plasticity. Its natural water content was perhaps 1 or 2% above the plastic limit. It contained occasional rounded gravel particles of 1/4-in. size. Barely discernible color variations were observed, but no partings of silt were found in this sample.

At the bottom of the benchmark sample there was a 2-in.-long layer of a brownish-gray clayey fine sand. Based on borings provided in the FSAR, one would expect to find a sandy layer of higher blowcount at about El 400 to 420. It appears that this layer had just been reached at the bottom of the borehole.

In the FSAR it was indicated that the hard silty clay bearing stratum is a lacustrine deposit that has been overridden by a glacier. The stratification is still evident in the clay and, although the partings showed some distortion, there was no complete remolding that is typical of a basal till. It appears, therefore, that this stratum is best described as a hard silty clay that has been heavily overconsolidated by the weight of a glacier.

3. FILL MATERIAL

About five excavations with depths of 4 to 10 ft were observed during our visit. These excavations were near various utilities and apparently had been made for exploration purposes to ensure that they would not be struck during the ongoing drilling for dewatering wells and freeze-wall pipes. The deepest excavation was located northeast of the east containment (No. 2) where two service water pipes had been exposed for pipe profiling.

The fill materials were either brownish-gray silty clay or tan silty sand. The two materials were present in most of the excavations. The boundaries between them generally were horizontal. Whether one or the other material was used in the fill apparently was dependent on its immediate availability during construction. Thus, one can expect to find either material in the underpinning drifts and pits.

The silty clay that was exposed was partially dried out in the walls of the excavations. Shallow cuts into the walls revealed a chunky structure. The silty clay exists as relatively undisturbed chunks, in the size range of a few inches, which seem to have been pushed together during compaction. No obvious void spaces were evident between chunks. The partial drying of the excavation walls revealed the boundaries of the chunks fairly clearly. No relict evidence of sheepsfoot-roller feet was observed in the one deep excavation in the silty clay.

In some locations layers of the silty sand from one inch to two feet thick were found within the silty clay fill.

Some of the excavations were almost entirely in silty sand fill. This material appeared relatively widely graded. Perhaps the coefficient of uniformity lies in the range of 6 to 15. Layering was evident, but no specific observations of their thicknesses were made.

The silty clay in these excavations was stiff or hard, and the silty sand was dense enough to stand well in an open cut. None of the excavations extended below the water table.

4. COMMENTS ON UNDERPINNING PITS IN FILL

The presence of sand layers below the water table within the silty clay fill could cause troublesome flows into the excavations. The silty sand has a relatively wide gradation and may not "run" too easily. However, south of the auxiliary building there is a natural silty fine sand layer several feet thick overlying the natural hard silty clay. This material may have a tendency to run. Thus, dewatering in advance of pit construction is important to minimize potential movements of the structures during underpinning. It is for this reason that numerous wells and a freeze wall are being planned by Bechtel.

The wells that are currently in place are relatively far from the auxiliary building, in locations where the fill is shallower than at the auxiliary building. It may be prudent to install a pit early during the underpinning process within the deep fill and to use this pit for dewatering. The other pits may then be installed with less likelihood of running sand. A pattern of pits for pumping and pits for bearing may be safer than dewatering within the pits used for bearing.

During underpinning there will be periods when the open face or the bottom of the pit may be left open. If this period is more than one shift, special precautions should be taken to support the face securely during such time intervals to prevent movement of the adjacent soils.

5. FEEDWATER ISOLATION VALVE PIT (FIVP)

The two large pipes that pass through the FIVP were inspected to gain insight into possible effects of differential settlement between the FIVP and the containment structure. Only the west FIVP was inspected.

The FIVP currently is supported from the top by a grid of steel beams that bear on the buttress access shaft wall and on the turbine building.

The two large pipes have been installed and connected to the containment wall and to the southerly wall of the FIVP. The pipe supports at the top of the loops within the FIVP are not in place. The opening in the turbine building wall through which the pipes pass has a clearance all around of about 6 in. or more. Also, the pipes are supported on spring-loaded mounts within the turbine building near the FIVP wall. Both pipes make a 90° bend just after they enter the turbine building.

To evaluate the allowable differential settlement of the FIVP, the effect on stresses in these pipes should be checked due to (a) movement of the FIVP vertically relative to the containment and (b) movement of the FIVP vertically relative to the turbine building. (Note: Stresses induced for case (b) would be on the turbine building side of the isolation valves and, therefore, may not be safety-related.) The differential settlement stresses should be considered as normal operating stresses, i.e., present at all times, unless the pipes are disconnected, adjusted, and reconnected after any settlement has occurred. The differential settlement that would cause stress is the sum of all differential settlement that has occurred, or will occur, after the pipes were secured in position.

A check was made to observe whether any cracks exist on the inside walls of the FIVP opposite the locations where the Williams rock anchors were installed for temporary support of the structure. These anchors penetrate a few feet into the top of the outside walls. Cracks might be expected at these locations because expansion loads may have been applied during installation of the anchors. No cracks were found.

A check was made to observe any cracks inside the FIVP between the top slab and the top of the outside walls. This junction could crack due to differential loading between the rock anchors in the wall and the tie bolts that penetrate the top slab. It appeared that a caulking compound had been placed at this joint, but due to the small (2 in.) space, it was not possible to make a satisfactory observation.

The joint between the FIVP wall and the containment is filled with semi-rigid foam. The joint was tight and no movements between the foam and the two adjacent concrete walls was apparent, although any differential movement would be difficult to observe due to the deformability of the foam.

The joint between the FIVP wall and the buttress access shaft also was filled with semi-rigid foam. No evidence of differential movement was observed and the joint was tight.

The wall of the buttress access shaft abuts the containment and can be observed from within the FIVP. This joint is narrow (1/8 in. to 1/4 in. wide) and is patched with a grout. Evidence of downward movement of the buttress access shaft relative to the containment was observed. The grout in the joint had parted and measurement of the vertical width of the parting indicated a relative movement of 1/16 in. to 1/8 in. No horizontal relative movement was apparent. This movement could have occurred when the load from the FIVP was placed on the wall of the buttress access shaft.

6. ELECTRICAL PENETRATION AREAS (EPA)

The east and west EPA's were toured briefly to gain visual insight into the nature of the documented cracking. The most obvious cracking was found in the floors of both EPA's on two or three of the levels above the lowest level. These cracks were narrow, probably about 0.005 in. wide, generally extended in a north-south direction, and were located at or near the narrowest dimension of the EPA's. On each floor observed there appeared to be about one to three such cracks.

7. CONTROL TOWER (CT)

The CT was toured to gain visual insight into the nature of the documented cracking. The impression one gains is that most of the cracks are vertical, although one or two diagonal cracks were observed in the north-south shear walls at the lowest level. Due to the complicated nature of the connection between the CT and the auxiliary building, it is difficult to understand the correlation between the cracking and the possible differential movements between these two elements.

8. SERVICE WATER PUMP STRUCTURE (SWPS)

An inspection was made of the SWPS to gain insight into the cracking that has occurred to date.

The building is tied to the intake structure with steel rods that are stressed in tension at the roof level to compress the structures. Thus, the SWPS on fill was tied to the intake structure, which is founded on natural soils.

The shear walls of the SWPS contain diagonal cracks that start near the intake structure and grow upward at an angle away from the intake structure. The orientation of these cracks seems to be consistent with downward rotation of the SWPS relative to the intake structure. The observed cracks were narrow - 0.005 to 0.020 in. wide. It was not determined whether any of the diagonal cracks penetrated the entire thickness of the walls. One vertical crack was observed in an interior shear wall. This crack had been cored with a 1-in.- or 1.5-in.-dia. hole. The crack passed entirely through the wall.

All cracks in the SWPS are now being recorded on a drawing by Bechtel personnel. The crack monitoring program of the SWPS consists of periodic checking of the crack width together with observations of extension of cracks. A crack must be at least 0.005 in. wide to be considered in the monitoring program.

Consideration should be given to the following approach for monitoring cracks in underpinned structures:

1. Map all cracks 0.005 in. or wider for record purposes. Any crack that is 0.005 in. or wider should be mapped from beginning to end, i.e., between the points where the crack is no longer visible.

2. Select two or three "telltale" cracks. These should be significant cracks that are in highly stressed zones. They should be cracks that are most likely to change during and after underpinning.

3. Using epoxy, attach two washers on each side of the telltale cracks. The washers should be only one or two inches apart and spaced on a square pattern. They should be accessible, but not in danger of damage.

4. Select monitoring frequency for the telltale cracks based on (a) construction activity on the building and in the vicinity, (b) unusual events, and (c) ambient temperature variations. Biweekly readings should be the minimum frequency, unless the accumulated data indicate otherwise.

5. Measure the distance in a direction perpendicular to each telltale crack and in the two diagonal directions. Use a caliper that is accurate to 0.001 in. Record the inside and outside temperature, the date and the time of each reading. Record the end points of each crack, i.e., the point at which each crack is no longer visible.

6. Plaster of Paris or a nonshrink glue could be placed in the telltale cracks to provide a quick visual indication of future movements.

7. Plot each measurement for each crack. Plot time on the abscissa and distance on the ordinate. Plot temperatures on the ordinate also. Make one plot for each telltale crack.

The above procedure of carefully monitoring only a few "telltale" cracks should be considerably less costly but more reflective of changes in the structure during underpinning events than the present mapping system. Upon completion of the underpinning, a map of the cracks may be desirable for record purposes.

Memorandum of Telephone Conversation

Date of Conversation: April 20, 1982

Subject: Discussion of Letter Dated March 31, 1982 from Consumers Power to NRC concerning responses to NRC questions on Phases II and III for AUX and FIVP underpinning

Parties Represented:

Consumers Power - John Schaub
Bechtel Corp. - Neil Swanberg
Al Boos
Mergentime Corp.- Charles Gould
Nuclear Regulatory Commission - Joseph Kane
Steve Poulos (GEI)
Reuben Samuels (Crimmins)

Memorandum prepared by: Reuben Samuels and Steve Poulos

Phase II - Review Comment 7

> "Submittal of measures to be required during periods of work shutdowns to support faces of drifts and bottom of pits [illegible]."

In response to a request for more specific information than was provided in Consumers Power letter of March 10, 1982 (Cook to Denton, Serial 16069), Mr. Gould described the face support system. He indicated that the face will be breasted with the ends of the breast boards reacting on the longitudinal lagging behind the flanges of the steel and butting to provide reaction for the breast boards. In addition, a soldier beam/[illegible] will be set at the center of the face breast boards and wedged to clamp on the longitudinal lagging. The backpacking material will be a well-graded granular material (with some clay sizes permitted) which will be placed promptly.

In response to a question, Mr. Gould stated that dewatering during construction is the responsibility of Mergentime.

The discussion moved from support of the face during shutdown to contingency plans to be used if the face "unravels" during excavation. Mr. Gould indicated that contingency plans would be implemented if the face unravels. Action would be taken in two stages. First, grouting of the unstable soil would be carried out. The required equipment, materials, and labor for grouting would be prepared in advance and available at the site so that within a few hours after the unravelling is noticed, grouting could commence. Second, if required, spiling or forepoling would be used as the sheeting system instead of horizontal lagging.

Encl. 4

Phase 2A - Review Concern 11

> "A contingency plan for grouting of voids under the Turbine Building."

After considerable discussion it was concluded that Consumers Power would consider further methods for detecting potential planar openings under the Turbine Building and criteria for judging whether action should be taken during construction to control their effects. Consumers Power will provide information on this point at a later date.

During the discussion of planar openings, Steve Poulos expressed concern that the bulkhead on the Control Tower side of the northerly drift for the first set of needle beams should be designed for high earth pressures to reduce the zone under the EPA that is relieved of stress due to the drift. He suggested that the design should be for stresses as high as three times active pressure. Reuben Samuels suggested an alternate to the lagging and soldiers proposed by Consumers Power, namely that horizontal spiling be used to minimize loss of soil and the necessity for backpacking. It was agreed by Consumers Power that an increase of design pressure, a stiffer wall, and the horizontal spiling would be considered and that they would discuss this item with NRC at a later date.

Consumers Power agreed to mail an index of the approximately 30 construction procedures that have been submitted by Mergentine to Consumers Power.

cc: Mr. Joseph Kane
Mr. Hari Singh
Mr. Reuben Samuels

Response to Letter Dated April 22, 1982
J. W. Cook (Consumers) to H. R. Denton (NRC)

on

Geotechnical-Related Issues for Underpinning the Service Water Pump Structure - Needed Information

Geotechnical Engineers Inc. | Project 81907 | May 12, 1982

Items are listed by Confirmatory Issue No. in letter of April 22, 1982.

1 Basis for stresses

By others

2 Justify 4000 kcf

In our opinion, it is not appropriate to use a k-value of 4000 kcf to compute stresses due to jacking load. Jacking should cause curvature of the lower mat. The structural group should review this item.

3 Acceptance criteria

5/16-in. extension in a gage length of 20 ft implies a very high stress in the steel and cracking during underpinning. Control should be on vertical differential settlement. The criterion should be consistent with that used for the Control Tower. The criterion should be small enough so that corrective action can be taken in advance of severe stressing of the structure.

4 Tendon anchor

By others

5 Dowels/rock bolts

By others

6 Sliding calculations

Provide calculations and assumptions used for soil properties and interface friction.

7 Empty forebay

By others