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Docket Nos.: STN 50-456
and STN 50-457

Mr. Louis O. DelGeorge
Director of Nuclear Licensing
Commonwealth Edison Company
Post Office Box 767
Chicago, Illinois 60690

Dear Mr. DelGeorge:

Subject: Staff Comments on Applicant's Response to Questions on Geotechnical Engineering for Braidwood Station, Units 1 and 2

A request for additional information dated May 7, 1981 was sent to the Commonwealth Edison Company in order to enable us to complete our review of the Braidwood Station FSAR. The applicant responded in Amendment No. 33 to the FSAR dated October 1981. The applicant's response to two questions (Q362.4 and 362.5) was not satisfactory and additional clarification is required. The questions relate to the volume of water seeping out of the Essential Services Cooling Pond during a 30-day emergency shutdown cooling period.

The enclosure details the staff's comments on these two items and the requirements necessary to complete the review. Your response is required by March 11, 1983 so that these items may be discussed and resolved during a forthcoming site meeting later in March. For further information or clarification, please contact the Braidwood Project Manager, Janice A. Stevens, (301)492-7144.

Sincerely,

Original signed by:
B. J. Youngblood

B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing

Enclosure:
As stated

cc w/encl.: See next page

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Staff Comments on Applicant's Response
to Questions 362.4 and 362.5 - Geotechnical Engineering
Braidwood Station, Units 1 & 2 Docket Nos.: 50-456 and 50-457

Prepared by: Banad N. Jagannath, HGEB, DE

1. QUESTION 362.4

"The coefficient of permeability, K, parameter of the fine sand stratum was determined by laboratory tests on reconstituted specimens. These tests do not simulate the in situ flow condition as in the case of a field pumping test. Why didn't you perform field permeability tests?"

"Geologic Section 23 (Figure 2.5-50) and many borings drilled within the limits of the project (presented in FSAR Section 2.5.4) reveal the presence of coarse grained material in the bottom 2 feet to 4 feet portion of the fine sand stratum. The gradation of the sand is from fine to coarse size; fine gravel and cobbles are also present. The cut face in the strip mining area, in the immediate vicinity of the project, revealed the presence of relatively more permeable material and showed marks to suspect that water is seeping in the bottom 2 to 4 feet zone of the fine sand stratum. It is feasible that the water from the Essential Service Cooling Pond (ESCP) may seep down to the more permeable zone beneath and travel horizontally. Does your seepage analysis cover this case? If so, submit the details of your analysis. If not, justify the rationality of your assumption that this seepage path does not exist and present your plan to confirm that this seepage path will not be operable."

APPLICANT'S RESPONSE

Laboratory permeability tests were performed on samples from the Equality Formation using the constant head permeability test in accordance with ASTM D-2434. The Equality Formation is composed primarily of fine- to medium-grained sands with some silt layers. In some borings and mapped sections, a 1 to 4 foot thick layer of coarse gravel, cobbles, and boulders in a fine- to medium-grained sand matrix occurs directly above the clay till of the Wedron Formation. Table 2.5-24 provides a summary of permeability tests performed on samples of SP and SM material from the Equality Formation. A total of 31 samples of the Equality Formation were tested using the constant head permeability test. The permeabilities for the SP and SM material ranged from $7.37 \times 10^{-2}$ cm/sec to $3.658 \times 10^{-4}$ cm/sec with an average permeability of approximately $6.7 \times 10^{-3}$ cm/sec. Comparing these values with published data on coefficients of permeability for sands and gravels indicates that the coefficients of permeability determined through laboratory testing were within the range of the published data. Therefore, it was concluded that any further field testing could only provide a slight improvement of the laboratory values and that a field pumping test would not be required.

The fine-sand stratum referred to is the Pleistocene-age Equality Formation. The upper few feet of the deposit is a fine sand, generally containing less than 15% silt, and having a consistency ranging from loose to medium dense. Below a depth of approximately 15 feet, the sand generally contains less than 5% silt, and has consistency ranging from medium dense to dense. Locally, coarse gravels, cobbles, and boulders in a fine sand matrix occur in a 1 to 4 foot thick layer overlying the Pleistocene-age Wedron Formation. A review of 354 boring logs and 31 mapped geologic sections indicates that the basal lag gravel is not continuous over the entire site area. The coefficient of permeability, K, of the Equality Formation, as determined by laboratory constant head permeability tests ranges from 3.658 x $10^{-4}$ cm/sec to 7.37 x $10^{-2}$ cm/sec with an average K value of approximately 6.7 x $10^{-3}$ cm/sec. Even though the basal 1 to 4 feet of the Equality Formation contains coarser material than the upper part of unit, the coefficient of permeability of the lower few feet will be near the average K value as the fine sand matrix is controlling the coefficient of permeability. In an unconsolidated deposit, the permeability will decrease for a given diameter as the standard deviation of particle size increases. The increase in standard deviation indicates a more poorly sorted sample, so that the finer material can fill the voids between the larger fragments.

The discussion of Equality Formation exposures along a vertical strip-mining cut (Subsection 2.5.1.2.4.1.1.2) does not mention the presence of materials that is more permeable than the average Equality Formation sands. The groundwater found in the Equality Formation is under watertable conditions meaning that water infiltrates downward through a permeable unit due to gravity. This groundwater continues its downward movement until it encounters a less permeable unit. Once it encounters a less permeable unit, it will move downgradient to a discharge point. In the case of the seeps observed at the base of the Equality Formation, in the strip-mine cut, groundwater is infiltrating downward through the sands of Equality Formation until it reaches the aquiclude formed by the less permeable Wedron Formation clay till. The groundwater is then discharged as seeps along the cut face of the strip mine.

As stated above, the coefficient of permeability, K, of the Equality Formation averages approximately $6.7 \times 10^{-3}$ cm/sec. Due to the sand matrix of the coarser basal material, the permeability of the lower part of the Equality Formation is near the average value. This, combined with the fact that the basal lag gravel is not a continuous deposit, indicates that the basal lag gravel is not a continuous deposit, indicates that the basal lag gravel does not exist as a seepage path of higher permeability than the remainder of the Equality Formation. Therefore, the methods of seepage analyses and analysis conditions discussed in Subsections 2.5.6.6.1 and 2.5.6.6.2 are valid as this seepage path does not exist.

STAFF COMMENTS

The applicant's response is not satisfactory to the staff because:

- The applicant has not presented valid bases for not performing a field pumping test. Also, the applicant has not demonstrated that the magnitude of the coefficient of permeability used in the seepage analysis is conservative enough to provide an adequate safety margin for use in computing the seepage loss from the Essential Services Cooling Pond.

- The applicant's assessment of the lag-gravel layer, as it effects the seepage analysis, is not conservative.

The applicant should consider the following comments in a revised response.

1. <u>Selection of the design value of the coefficient of permeability parameter</u>

The coefficient of permeability (k) is a very sensitive parameter for sands and a minor change in the structure and/or grain size of the soil will result in a correspondingly major change in the magnitude of the k parameter. This is evident from the range of k reported in Table 2.5-24 of Braidwood FSAR. The Equality Formation (sand stratum at the project site) is a lacustrine deposit and for such soils the coefficient of permeability in the horizontal direction is greater than that in the vertical direction. The reconstituted samples, used in the laboratory permeability tests (ASTM D2434) do not simulate the in situ structure of the sand deposit. Also, the laboratory test simulates flow in the vertical direction whereas an in situ test (ex. field pumping test) would simulate actual flow conditions in the field. Hence, it is a common practice for important water retaining structures to establish the design value of the permeability parameter by performing field pumping tests and supplemented by laboratory tests.

The applicant's response stated that the k values from the Braidwood project's laboratory tests were within the range of published data for similar soils. Therefore, the applicant had concluded that any further field testing could only provide a slight improvement of the laboratory values and that a field pumping test was not required. However, most of the published data is from laboratory tests and agreement with such published data does not confirm or support that the k value used in the design is representative for the in situ conditions at this project site. The staff does not agree with the applicant's reasoning for not performing a field pumping test. If this project's laboratory test results were compared with any published field pumping test results, then the applicant should provide complete details of those field tests so that the staff can independently assess the applicability of that data for this site.

The magnitude of the k parameter presented in table 2.5-24 of the FSAR ranges from $3.65 \times 10^{-4}$ cm/sec to $7.37 \times 10^{-2}$ cm/sec and the applicant has used the average value ($6.7 \times 10^{-3}$ cm/sec) as a controlling design parameter. This is not a conservative approach, especially when used for computing the seepage loss from a seismic Category I water retaining structure (Essential Services Cooling Pond or Ultimate Heat Sink). The staff does not agree with the use of average value of the K parameter (determined from laboratory tests only) as a controlling design parameter in computing the seepage from the Essential Services Cooling Pond.

2. <u>Interpretation of the basal lag-gravel in the seepage analysis</u>

The applicant's response states that the basal lag-gravel occurring at the bottom of the sand stratum is not continuous at the site. During the foundation excavation stage, 31 sections were geologically mapped. Only 8 out of the 31 sections mapped the sand-till interface zone and all 8 mappings (Sections S-23, S-28, S-31, S-33, S-36, PL-1, SH-1 and SH-2) show presence of the lag-gravel at the bottom of the sand stratum. In the borings, the soil was sampled at approximately 5-foot intervals and the material occurring between the samples was interpreted. A review of the boring logs reveal that in a majority of the borings, where a soil sample was obtained from the vicinity of the sand-till interface, the descriptions in the boring logs indicate that gravel and/or cobble with the coarse sand is present at the sand-till interface. Hence, there is enough information to conclude that there is a good possibility that this basal lag-gravel is present throughout the site. There is not enough evidence to conclude definitively that this layer is not continuous at this site. Besides, neglecting this gravel stratum to be continuous might result in an unconservative design.

The applicant's response states that the matrix of this lag-gravel is a fine sand and that the results from the laboratory permeability tests on fine sand samples (obtained from the upper zone of the sand stratum at the site) are applicable to this lag-gravel. The mappings do not provide any detailed description of the matrix of this gravel layer, and the description in the boring logs indicate that the matrix is a coarse to medium sand. There is no stated basis for the applicant's assessment of the matrix of this lag-gravel layer.

The staff does not agree with the applicant's assessment of this gravel deposit in the seepage analysis.

2. QUESTION 362.5

"In your analysis, the critical condition for maximum seepage from the ESCP assumes that the level of water in the pond is at elevation 590.0 feet and the level of water outside the pond is at elevation 580.0 feet. However, the lowest water level recorded in piezometer LW-2, close to ESCP, is at elevation 577.5 feet (Figure 2.4-45). Using this as the level of water outside ESCP, the differential head causing seepage is 12.5 feet rather than the 10.0 feet used in your analysis. What is the rationale for using ten feet differential head in your seepage analysis?"

APPLICANT'S RESPONSE

The median groundwater level for the period from July 1973 through May 1977 for LW-2 is 580.1 feet, MSL, which supports the head differential of 10 feet used in ESCP seepage analysis.

STAFF COMMENTS

The staff does not agree with the applicant's response that the median ground water level, elevation 580.0 feet, is the water level to be used in the seepage computations. The Essential Services Cooling Pond (ESCP) is a seismic Category I structure and the seepage loss should be computed for the worst critical combination of water levels i.e. water inside the pond at elevation 590.0 feet and outside the pond at the lowest ground water level measured in the vicinity of ESCP, which is at elevation 577.5 feet. The applicant should submit detailed justification as to why the median ground water level and not the lowest measured ground water level should be used in computing the seepage loss from the ESCP.

3. STAFF REQUIREMENT

The staff requires the following additional information from the applicant to complete the review:

1. Provide dry density, relative density and grain size distribution data for all the test specimens listed in Table 2.5-24 of the Braidwood FSAR.

2. Provide justification, in the light of the staff comments, for:

   - the coefficient of permeability used in the seepage analysis

   - the differential head used in the seepage analysis.

   - assessment of the lag-gravel layer in the seepage analysis.

3. Provide a seepage analysis that utilizes the highest permeability anticipated from the most permeable material encountered in the ESCP. The value selected should consider known differences in vertical and horizontal permeability values as well as differences normally

obtained between laboratory and field test procedures. Submit detailed information on the method of selection of the permeability value. The analysis should also use the lowest groundwater level measured from the piezometer (LW-2) in the vicinity of the ESCP. Provide the 30-day volumes for seepage and evaporation (worst case), and also volume of silt accumulation assumed in the design.

Also, discuss the degree of conservatism in the analysis. If the analysis shows that there is less than a 30-day supply, then the applicant should propose solutions for resolving this issue.

4. If the applicant elects to perform any field tests to demonstrate that the permeability parameters for both sand and gravel strata used in the analysis were conservative, then the staff would like an opportunity to review and comment on the scope of the test before it is performed.

5. If the applicant elects to line the pond with a relatively impermeable membrane, the staff considers this as a positive solution to the problem.

The staff suggests that these items may be discussed during the forthcoming staff site visit.