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September 18, 1984

United States Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Mr. George W. Knighton, Chief
Licensing Branch 3
Office of Nuclear Reactor Regulation

SUBJECT: Beaver Valley Power Station - Unit No. 2
Docket No. 50-412
Response to Draft SER Open Item 174

Gentlemen:

The response to the NRC Geotechnical Engineering Section's Draft SER Open Item No. 174 is provided in Attachment 1. The associated revisions to FSAR Section 2.5.4 are provided in Attachment 2.

DUQUESNE LIGHT COMPANY

By E.J. Woolever
E. J. Woolever
Vice President

JDO/wjs
Attachments

cc: Ms. M. Ley, Project Manager (w/a)
Mr. E. A. Licitra, Project Manager (w/a)
Mr. G. Walton, NRC Resident Inspector (w/a)

SUBSCRIBED AND SWORN TO BEFORE ME THIS
18th DAY OF September, 1984.
Anita Elaine Reiter
Notary Public

ANITA ELAINE REITER, NOTARY PUBLIC
ROBINSON TOWNSHIP, ALLEGHENY COUNTY
MY COMMISSION EXPIRES OCTOBER 20, 1986

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COMMONWEALTH OF PENNSYLVANIA)
) SS:
COUNTY OF ALLEGHENY)

On this 18th day of September, 1984, before me, a Notary Public in and for said Commonwealth and County, personally appeared E. J. Woolever, who being duly sworn, deposed and said that (1) he is Vice President of Duquesne Light, (2) he is duly authorized to execute and file the foregoing Submittal on behalf of said Company, and (3) the statements set forth in the Submittal are true and correct to the best of his knowledge.

Anita Elaine Reiter
Notary Public

ANITA ELAINE REITER, NOTARY PUBLIC
ROBINSON TOWNSHIP, ALLEGHENY COUNTY
MY COMMISSION EXPIRES OCTOBER 20, 1986

ATTACHMENT 1

Draft SER Open Item No. 174 (Sections 2.5.4.3.2 and 2.5.4.5) - Foundation data for main intake structure and revised factors of safety for bearing capacity:

Section 2.5.4.3.2

All Category I structures are founded on reinforced concrete mat foundations. FSAR Table 2.5.4.4 gives the approximate plan dimensions, the applied foundation loads, and the ultimate bearing capacity of each foundation. Table 2.5-1 of this SER gives the plan dimensions, mat elevations, and approximate bearing pressures for the foundations of major Category I structures. Since the mat foundations are embedded in dense sands and gravels, the ultimate bearing capacity is quite high, ranging from 33 ksf for the decontamination building to 129 ksf for the auxiliary building. The calculated static foundation sresses range from 2.5 ksf to 7.5 ksf - the upper value being the foundation pressure beneath the Reactor Containment Building. Therefore, the factor of safety against a bearing capacity failure is typically very high.

In response to OL question 241.9, the applicant has informally furnished a revised copy of FSAR Table 2.5.4-4 incorporating the dynamic foundation loads therein. The foundation stresses including the effects of dynamic loads range from 3.8 ksf to 12.4 ksf. The applicant has not revised the factors of safety shown in that table, although the proposed revision should not alter the above conclusions regarding the high safety factors against a bearing capacity failure. The applicant is expected to docket the revised FSAR Table 2.5.4-4 with corrected safety factors.

The information concerning the foundation dimensions and the bearing capacity of the main intake structure are not included in Table 2.5.4-4. The applicant has been requested to include the foundation data concerning the intake structure in revised FSAR Table 2.5.4-4.

Section 2.5.4.5

The major items that need to be addressed by the applicant in the forthcoming amendment of the FSAR are the following:

...6. Docket the revised FSAR Table 2.5.4-4, including therein the corrected dynamic soil pressures and factors of safety against bearing capacity failure and also incorporating the data concerning the foundation for the main intake structure; ...

Response:

Refer to revised FSAR Section 2.5.4.10.1 and revised FSAR Table 2.5.4-4 (Attachment 2). These revisions will be incorporated into FSAR Amendment 9.

2.5.4.10 Static Stability

Foundation analyses related to the static stability of Category I structures included evaluation of bearing capacity, estimate of settlement, and the development of design lateral earth pressure parameters.

2.5.4.10.1 Bearing Capacity

All Category I structures are founded on mat foundations. The design of mat foundations, particularly those on dense sands and gravels, is generally limited by a consideration of maximum tolerable settlements rather than by ultimate bearing capacity, since the factor of safety against a bearing capacity type failure is typically quite high. Estimated static settlements of plant structures are presented in Section 2.5.4.10.2. However, for completeness, the bearing capacity of the foundations of Category I structures and the factors of safety against a bearing capacity type failure have been computed for both static and dynamic loading conditions and are presented in Table 2.5.4-4.

The ultimate bearing capacity of the supporting soil is a function of the soil properties, the size and shape of the foundation, the depth of embedment and the depth to the ground-water table. The equation used for computing ultimate static bearing capacity is:

Square or rectangular footings:

$$q_{ult} = cN_c \left(1 + 0.3\frac{B}{L}\right) + \gamma DN_q + 0.4\,\gamma BN_\gamma$$

Circular footings: radius = R

$$q_{ult} = 1.3cN_c + \gamma DN_q + 0.6\gamma RN_\gamma$$

(2.5.4-11)

where:

q_{ult} = ultimate bearing capacity
c = cohesion
D = depth to base of mat foundation
γ = unit weight of soil
B = width of foundation
L = length of foundation
N_c, N_q, N_γ = bearing capacity factors

The following assumptions were made in computing the ultimate static bearing capacity:

1. Each structure was considered individually, ignoring increases in confinement due to adjacent structures.

2. Each structure was assumed to be founded on the in situ sand and gravel with the following properties:

   friction angle = 30°
   cohesion = 0
   unit weight = 125 pcf above ground-water table
   = 136 pcf below ground water table

3. The ground-water table was taken as that corresponding to probable maximum flood conditions at el 730 feet.

As discussed in Section 2.5.4.7, a portion of the safeguards area and the RWST is underlain by a layer of stiff silty clay with a top surface at approximately el 688 feet. Soil profiles depicting the conditions underlying these structures are shown on Figures 2.5.4-8 and 2.5.4-9. This stiff clay was not considered to be a concern to the stability of the structure insofar as a bearing capacity failure is concerned due to the thickness of the overlying compacted structural fill. The bearing capacities given in Table 2.5.4-4 for the safeguards area and the RWST were computed for their respective foundations on compacted fill with the preceding assumptions.

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(pg. 2.5.4-23a)

2.5.4.10.2 Settlement

This section discusses the estimation of the total static settlement of the plant structures; the estimation of dynamic settlement during a seismic event is discussed in Section 2.5.4.8.2.

A summary of the estimated total static settlements of the plant structures is provided on Figure 2.5.4-20. Differential settlement between structures was taken as the difference between the estimated total static settlement of the respective structures. Observed settlements as of January 1, 1983 are shown on Figure 2.5.4-46.

Foundation soils in the main plant area consist of compacted select granular fill and medium dense to dense in situ granular soils. The northern portions of the safeguards area and RWST are underlain by a layer of stiff silty clay as discussed in Section 2.5.4.7. Site subsurface profiles within the plant area are shown on Figures 2.5.4-2 through 2.5.4-9.

The ground-water level was assumed to coincide with normal river level at el 665 feet.

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The ultimate static bearing capacity was also used as the ultimate dynamic bearing capacity when computing the factor of safety against a bearing capacity failure for dynamic loading conditions. The ultimate dynamic bearing capacity is conservatively represented by the computed ultimate static bearing capacity. Tests reported by Vesic et al. (1965) for both dry and saturated dense sands, performed at various loading rates, showed a slight drop in bearing capacity with increased loading rate, followed by a steady slow increase. The observed minimum dynamic bearing capacities were about 30 percent lower than the static bearing capacities, which corresponds to a 2 degree decrease in the angle of internal friction. The in situ sands and gravels at the BVPS-2 site have an internal friction angle which ranges between 33 and 40 degrees (see Section 2.5.4.2), while a 30 degree value was conservatively chosen for design purposes. Since a 2 degree reduction in the actual minimum internal friction angle of the in situ soils would still be higher than the friction angle used for design, the actual dynamic bearing capacity is higher than the computed static bearing capacity shown in Table 2.5.4-4. Therefore, the ultimate dynamic bearing capacity is conservatively represented by the computed ultimate static bearing capacity.

Reference

Vesic, A.S., Banks, D.C, and Woodward, J.M., 1965. An Experimental Study of Dynamic Bearing Capacity of Footings on Sand, Proceedings, Sixth International Conference on Soil Mechanics and Foundation Engineering, Montreal, Canada, Vol. II, pp 209-213.

TABLE 2.5.4-4

BEARING CAPACITY - CATEGORY I STRUCTURES

	Approximate Dimensions of Contact Area (ft)	Approximate Foundation Depth (ft)	Ultimate Bearing Capacity (ksf)	STATIC Approximate* ~~Static~~ Load (ksf)	STATIC Factor of Safety	DYNAMIC Approximate* ~~Dynamic~~ Load (ksf)	DYNAMIC FACTOR OF SAFETY
Auxiliary building	120 × 146	32	129	5.7	32	10.6	15
Control room extension	65 × 81	32	~~[illegible]~~ 97	3.5	~~[illegible]~~ 54	5.6	25
Decontamination building	33 × 33	5.5	33	6.3	~~[illegible]~~ 5	11.5	3
Demineralized water tank** e	38 × 40	~~3.5~~ 4.7	~~32~~ 35	3.4	~~7~~ 10	10.9	3
Diesel generator building	81 × 83	22	90	3.1	45	5.9	19
Emergency outfall structure	22 ~~[illegible]~~ × 30	~~[illegible]~~ 25	~~[illegible]~~ 60	7.1	10	8.0	9
Fuel building	44 × 110	17.7	61	6.3	11	11.5	6
Main steam and cable vault	90 × 135	22.5	~~[illegible]~~ 74	3.7	28	7.1	12
Reactor containment	142 dia.	54	157	7.5	36	12.4	17
Refueling water storage tank	55 ~~hexagon~~ ×55	~~[illegible]~~ 4.7	~~[illegible]~~ 45	3.5	~~[illegible]~~ 13	8.8	5
Safeguards area	60 × 96	20.5	76	3.2	35	4.7	21
Service building	55 × 186	9.5	54	4.0	15	4.6	13
Valve pit	23 × 35	18.8	50	2.5	31	3.8	17
MAIN INTAKE STRUCTURE	84 × 89	39.5	115	6.0**	19	6.7	24

NOTES:

*Foundation load does not include buoyant effect of water. Bearing capacity calculated assuming ground-water level at el 730 feet corresponding to PMF condition.

**Preliminary data, structures not fully designated. e

** Includes buoyancy