UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of	)	
Georgia Power Company, et al.	)	Docket Nos. 50-424 (OL)
(Vogtle Electric Generating Plant,	)	50-425 (OL)
Units 1 and 2)	)	

PARTIAL INITIAL DECISION

INTERVENORS' PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW ON TECHNICAL AND ENVIRONMENTAL CONTENTIONS

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OPINION

This Partial Initial Decision addresses a contention proposed by Intervenors (Campaign for a Prosperous Georgia and Georgians Against Nuclear Energy) for consideration by this licensing Board in connection with Georgia Power Company et al.'s (Applicants') application to operate Plant Vogtle (VEGP). VEGP is located alongside the Savannah River east of Augusta and north of Waynesboro, GA, near the Department of Energy nuclear weapon materials production facility, the Savannah River Plant located in South Carolina across the Savannah River and adjacent to the VEGP site. Intervenors alleged that Applicants have not adequately protected the important Tuscaloosa aquifer from the potential for groundwater contamination due to operation of the VEGP facility. Specifically, this contention alleges that the Applicants have not adequately assured that the groundwater will not become contaminated, and that the important Tuscaloosa aquifer underneath the groundwater aquifer will not in turn become contaminated.

The complete record not only supports Intervenors, but quite surprising to Intervenors, also demonstrates that Applicants have seriously damaged the primary protection of the Tuscaloosa aquifer, the strategic blue marl underlying the VEGP facility, and that such damage has in certain areas compromised the integrity of the marl and in other locations has already defeated the integrity of the marl. The complete record includes the findings and conclusions proposed by Applicants (Applicants' proposal, dated April 14, 1986). Although the NRC Staff has supported the Applicants' position that Applicants' geological and hydrological exploration has been adequate, with possible exception being the methodology used by Applicants (Tr. 786), the record indicates otherwise. The Board concludes that Applicants cannot assure that potable water sources will not become contaminated, and that operation of Plant Vogtle will be inimical to the public health and safety.

Introduction

In accordance with 10 CFR 2.754 and the Atomic Safety and Licensing Board's (ASLB) directive (Tr. 824), Intervenors submit their proposed findings of fact and conclusions of law on the groundwater contention, Contention 7, one of the contentions remaining at issue in the Plant Vogtle operating license proceeding (Contentions 10.1 and 10.5 have been forwarded from Atlanta under separate cover). The groundwater contention was heard before the ASLB Board in Waynesboro, GA, March 11-14, 1986, and based on the record, should be resolved in Intervenors' favor. Intervenors therefore propose that the Board make the following findings of fact and conclusions of law in a partial initial decision.

PROPOSED FINDINGS OF FACT

I. Jurisdiction and Parties

1. This initial decision involves the application filed in September, 1983, by Georgia Power Company, et al. (Applicants), for licenses to operate the Vogtle Electric Generating Plant, Units 1 and 2 (VEGP). 48 Fed. Reg. 46,670 (1983) Receipt of Application for Facility Operating License. VEGP comprises two pressurized water nuclear reactors located in Burke County, GA, 26 air miles south southeast of Augusta and 15 air miles east northeast of Waynesboro, GA. Each unit is designed to operate at a steady-state power level of 3411 megawatts thermal, with an equivalent net electrical output of approximately 1160 megawatts. Id.; 48 Fed. Reg. 57,183 (1983).

2. On December 28, 1983, the Nuclear Regulatory Commission (NRC) published a Federal Register Notice of Opportunity for Hearing. 48 Fed. Reg. 57,183 (1983). Petitions for leave to in-

tervene and requests for hearing were subsequently filed by Caimpaign for a Prosperous Georgia (CPG) and Georgians Against Nuclear Energy (GANE). Accordirgly, on January 31, 1984, the ASLB Board was established to rule on these and other relavant petitions and to intervene and preside over the proceedings in the event a hearing was ordered. 49 Fed. Reg. 4,570 (1984).

3. On April 11, 1984, the two intervenors CPG and GANE submitted proposed contentions, subsequently consolidated as Joint Intervenors' contentions. Memorandum and Order dated November 5, 1984.

4. On May 30, 1984, the Board conducted a prehearing conference to address proposed contentions. Thereafter, by Memorandum and Order dated September 5, 1984, the Board admitted for adjudication the groundwater contention, Contention 7. This issue addresses whether Applicants have assured that releases of radioactive contamination or radioactively contaminated water onsite would not result in contamination of the aquifers underlying the VEGP site, particularly the important Tuscaloosa aquifer, already contaminated from mixed wastes (radioactive and chemical) by the Department of Energy (DOE) underneath its Savannah River Plant (SRP) facility located northward and adjacent to the VEGP site (1). Each site is separated from the other by the Savannah River.

5. Discovery was permitted and was partly successful but was not completed until after Applicants were compelled to respond by the Board's June 4, 1985 Memorandum and Order. Applicants then moved for summary disposition of the groundwater contention, supported by the NRC staff. Intervenors responded to the motion.

6. With respect to Contention 7, the Board granted in part and denied in part Applicants' motion for summary disposition, and the Board identified particular issues to be heard at the hearing. Memorandum and Order, dated November 12, 1985; reconsideration denied, Memorandum and Order, dated January 7, 1986. (During the hearing, the Board reconsidered and then admitted specific issues denied in its November 12, 1985 Memorandum and Order. See Tr. 712-21 for the Board ruling and their designation of admitted prefiled testimony from Intervenors.)

7. By Orders dated January 14, 1986 and January 23, 1986, the hearing on Contentions 7 and 10.1 and 10.5 was scheduled to commence on March 11, 1986, and the prefiling of testimony was directed. A notice of hearing was published in the Federal Register. 51 Fed. Reg. 4,548 (1986). In response to the Board's Orders, Applicants prefiled testimony (Crosby et al.; and Papadopulos, Tr. 253) , the NRC staff prefiled testimony (Heller et al., Tr. 764), and Intervenors prefiled testimony with an attachment (Lawless, Tr. 720).

8. An evidentiary hearing on Contention 7 (and others) was conducted from March 11 to March 14, 1986. At the beginning of the hearing, CPG withdrew from the hearing (Tr. 229-240, 246-247). GANE remained as the intervenor for Contention 7, 10.1, and 10.5.

9. At the conclusion of the hearing, the Board directed that all parties file proposed findings of fact and conclusions of law according to the schedule set forth in 10 CFR 2.754 (Tr. 824). Upon consideration of the proposed findings that were submitted and of the entire record, the Board makes the following findings resolving Contention 7 in Intervenors' favor. All proposed findings of fact and conclusions of law submitted by the parties that are not incorporated in this initial decision are not necessary to the rendering of this partial initial decision. This partial initial decision terminates the Board's jurisdiction over this contention.

II. Contention 7. Groundwater

10. The gravamen of Contention 7 is that releases of radioactive water or radioactive contamination onsite could result in radioactive contamination of the shallow unconfined groundwater aquifer under and alongside VEGP surface and subsur-

face facilities, and the deeper confined aquifer under Plant Vogtle. With respect to this contention, the Board allowed five issues to be heard, initially resolving all other groundwater issues in Applicants' favor. Intervenors had not responded to the Applicants' motion to strike or their motion for summary disposition of August 26, 1985, desiring instead to resolve all of the groundwater issues at the hearing. The five issues admitted by the Board were:

1) Adequacy of Geological/ Hydrological Exploration
2) Data on Marl Thickness and Permeability
3) Data on Marl Continuity
4) Direction of Groundwater Flow
5) Groundwater Travel Time

In addition, as a result of the hearing of Applicants' motion to strike the testimony of Intervenors' witness W.F.Lawless, the Board allowed the following:

6) Inferential treatment of hydrological data (Tr. 720, Lawless, p. 1)
7) Settlement of the marl (Ibid., pp. 3; attachment p.9)
8) Surface runoff (Ibid., p. 3)

A. Adequacy of Geological/Hydrological Exploration

11. Applicants have conducted numerous surveys of the geology and hydrology at and in the vicinity of the plant. Whereas the studies may indicate an adequacy of data for plant construction, the Applicants appear to have treated the protection of the groundwater as a secondary consideration (Tr. 253, Crosby, Figure 4; Tr. 271-273, 281-280).

12. Applicants considered the number of exploratory holes and the 60,000 drilled feet of hole to be evidence of a satisfactory exploration of the VEGP site (Tr. 253, Crosby at 5; Tr. 663). However, Applicants did not provide evidence that the quantity of hole or the exploratory holes drilled ipso facto leads to a superior hydrogeologic site investigation. Applicants' conclusion that these quantities are sufficient are based on speculation moderated by experience (Tr. 274), not scientific fact.

13. Based on the record, the Applicants' witnesses' experience seems at times to confound the uncertainty in the findings presented by Applicants, not reduce it. Part of that confounding may be due to the admitted lack of qualifications in nuclear engineering matters by Applicants' witnesses (Tr. 631), but part is due to the uneven treatment of the VEGP data by Applicants.

14. For example, the data from "core holes provide accurate definition..." (Tr. 253, Crosby at 7) contrasts with the later attempt by Applicants to discredit core samples used to measure permeability (Tr. 451-453).

15. On another occasion, Applicants stated that permeability was based on field exploration that did not include a south by easterly direction from the power block area (Tr. 283). Later the characteristics of the marl were stated to be "consistent" yet anisotropic in permeability (Tr. 470-471); and again that the marl was adequately defined "in the directions of groundwater flow" (Tr. 273), suggesting that in other directions this definition may be less than adequate.

16. On another occasion, Applicants stated that groundwater flow would not occur in a southwesterly direction (Tr. 591). Yet this clearly contradicts the meaning of what groundwater divides are, and testimony offered by Applicants (Tr. 253, Crosby at Figures 10, 15, 16; Tr. 403). Groundwater flows away from a divide on both sides of a divide (Tr. 781; 253, Crosby at 10 and Figure 10).

17. The penetration tests conducted by VEGP in the summer of 1985 for further geotechnical verification work may unwittingly have added additional pathways into the marl, compromising this important barrier to the downward flow of potential contamination

(Tr. 253, Crosby at 7-8; Tr. 720, Lawless at 6).

18. Applicants obtained laboratory measurements of the cation exchange properties of the backfill (Tr. 253, Crosby at 7-8). However, Applicants failed to account for cation exchange saturation, known as breakthrough, a likely situation that can occur and leads to the speedup of contamination migration through soil (Tr. Id.; see also Ref. 2).

19. Applicants recently performed slug tests in four observation wells in the power block area to determine the permeability of the backfill material (Id. at 9; Ref. 3). This data was then used to calculate a new, much slower permeability of 1220 ft/y. However, the slug test performed by Applicants resulted in a hydraulic conductivity K of 2.475 ft/day with a standard deviation of 0.826, in excess of the 20% criteria cited by Bouwer (4). Bouwer states that 10 to 20 replicate point measurements may be required to produce standard deviations less than 20% of the mean (p. 132). Applicants obtained their data from only 4 points. (Tr. 253, Crosby at 9).

20. One stream does not surround the VEGP site, the unnamed branch of Beaverdam Creek (Tr. 302). This creek is much closer to the power block area than other streams and also is down gradient from VEGP. Whereas a groundwater divide presently separates the subsurface pathway to the creek, this separation would be an ef-

fective barrier only for slow releases not accompanied by a head, or those releases without concentration gradients. Releases of radioactive contamination are often accompanied by the former and always by the latter. The groundwater divide is not an impediment to contamination flow (particularly with a release head or concentration gradient), but instead represents where groundwater flow direction is divided, and where the flow velocity is typically the slowest (Tr. 781). Applicants attest that groundwater flow is away from the interfluve toward the bodering streams (Tr. 253, Crosby at 10 and Fig. 10).

21. Although the VEGP groundwater well drilling and characterization program seemed haphazard early on, in recent years, Applicants have increased their groundwater staff and their attention to groundwater issues (Tr. 257, 298-299), reflecting an increased concern about the potential for contamination of the groundwater.

B. Data on Marl Thickness and Permeability

22. The thickness of the marl under the VEGP power block has been reduced to as low as 38 ft under the Auxiliary Building (Tr. 273, Crosby at 12-13).

23. Laboratory permeability tests of the marl were conducted

and reported by Applicants (Tr. 253, Crosby at 14; Tr. 387-393). Applicants calculated a harmonic mean of this marl test data for flow in the vertical direction (Tr. 585). Yet, competent authority, cited by Applicants themselves, states clearly that the harmonic mean is to be used in a system with the predominant flow in the vertical direction (4, p.132), usually for alluvial groundwater flow systems, with appropriate checks on the standard deviations of the collected data (4, 56). Applicants provided no data to show that flow within the marl is primarily vertical, or that the marl should be treated as a layered system of permeabilities for each layer. The Applicants' data does not fit that check: their standard deviation of their data exceeds 20% of the means of their data (4, p.132). At first, Applicants used the lab permeability data to support their belief that the marl permeability was 1 E-7 cm/s (Tr. 253, Crocby at 20), but in an apparent later contradiction, Applicants then stated that the lab data used to calculate the marl permeability was to be disregarded (Tr. 392). Applicants appeared confused on the significance of their use of the harmonic mean, stating at the outset that their data was skewed to the high end (1E-9) of the distribution of their permeability data, when just the opposite was the case (Tr. 389-392). The arithmetic mean of Applicants' data was 1.72 E-6 cm/s with a standard deviation of ±2.42 E-6 cm/s, a standard deviation that is larger than their mean (Tr. 444-446).

24. Applicants attested to the importance of the integrity of the marl to protect the important Tuscaloosa aquifer below (Tr. 293-294).

25. Applicants changed their description of their testimony when describing the permeability of the marl from "effectively impermeable" to a "very low permeability" (Tr. 295-297).

26. Although given the opportunity to state otherwise, Applicants stated that they believe that contaminant flow through the marl will only be by convection or dispersion (Tr. 305-309).

27. Applicants admitted that the reduction in thickness of the marl under the power block reduced the effectiveness of the marl (Tr. 384-385) to protect the Tuscaloosa aquifer below.

28. Applicants consider the higher head in the unconfined aquifer as an asset to the protection of the underlying Tuscaloosa aquifer (Tr. 397; 253, Crosby at 16), when in fact, the higer head above will drive contamination through any penetrations that exist or may eventuate in the marl. It is a large and predominant higher nead in the lower aquifer that is considered a protection of the underlying Tuscaloosa aquifer (1, p. 5-18). On the other hand the consisten*ly large head in the unconfined aquifer above at the VEGP site indicates that the unconfined aquifer serves as a source of recharge to the aquifers below (5,

p. 6-9). The greater head differential in the confined aquifer increases the importance of a marl with an integrity not compromised or defeated.

29. Applicants estimate that the recharge to the water table aquifer is 15 inches per year, and that a marl permeability of 1 E-7 cm/s results in a maximum flow through the marl of 1.5 to 2 inches downward per year, with a best estimated upper bound of 1.8 inches downward per year (Tr. 450-451, 586). Applicants state that a permeability in the marl of 1 E-6 cm/s would result in a downward recharge of the confined aquifer of 20 inches per year (not observed) (Tr. 477).

30. Applicants state that the harmonic means is to be calculated for data from a layered medium; that the marl is not alluvium; and that there is no relationship between the geologic origin of a material and the determination of a harmonic mean for the effective permeability through layered material (Tr. 585). One of the hydrogeology authorities referenced by Applicants was Bouwer (Tr. 253, Crosby at 20; cf. 4). In sharp contrast to the testimony of Applicants, Bouwer presents the use of the harmonic means under Anisotropy (4, p.56), where anisotropy is the rule for flow in alluvium, through many different layers, where the conductivity K_n represents each layer n with different thicknesses and with different K values (p.57), such as the flow

through sand and gravel layers (p.60). Applicants did not provide evidence that the permeabilities presented in testimony rerresented unique permeabilities from different layers of the marl (Tr. 253, Crosby at 14; Tr. 387-390). The Applicants did state "Assuming the 10 laboratory tests are a representative sample of the layers present in the marl (each sample represents an equal proportion of the total marl thickness)..." (Tr. 253 Crosby at 20; Tr. 594). However, there is no assurance in this assumption. It is only an assumption. There was no data presented by Applicants that there are 10 layers in the marl nor that the collected samples were representative. Bouwer states, "...the locations and depths of K measurements and the mumber of replications must be carefully selected. This requires detailed knowledge of the various soils, soil layers, and stratigraphy of the area so that each layer or soil type will be adequately covered by the measurements." (4, p. 131). The data presented by the Applicants did not fit the requirements specified by their authority.

31. Bouwer states, "If the flow is mainly vertical, the harmonic means should be taken." (Tr. 587). Yet Applicants make the opposite assertion, that whenever flow is through any vertical layered system, regardless of the type system, the harmonic means is to be used. (Tr. 587; 589). Applicants further attest that flow is primarily horizontal (Tr. 587). The authority for

Applicants clearly states that when the flow is mainly horizontal, in a medium, K normal to streamlines will be closer to the arithmetic mean (4, p. 132). Later on, on another occasion, Applicants assert that flow within the marl itself is primarily vertical (Tr. 591; 657); however, no evidence or data for this assertion was offered, i.e., no data on the three dimensional nature of streamlines within the marl was presented.

32. Applicants have not bound the permeabilities of the marl, except to the extent of recharge of the unconfined aquifer and estimated flow through the marl, and by calculating the harmonic mean of permeabilities from lab samples.(Tr. 253 Crosby at 20; e.g., Tr. 586). For instance, a simple variance within one order of magnitude in the permeability for the marl would not be unreasonable. With a permeability of 0.5 ft/y the maximum flow through the marl would still be less than 9 inches per year, and less than the recharge.

33. Using a hydraulic gradient of 1.447, and a permeability for the marl of 0.5 ft/y, with a porosity of 47.5%, and Darcy's Law, travel time across a 38 foot section of the marl would take about 25 years, much less than calculated by Applicants. This travel time would be a concern not only for a spill or release of tritium, but for strontium-90. Strontium-90 has been found to move considerable distances with groundwater under the imputus of

a head differential (1,5). Retardation factors are not a consideration for strontium-90 to the extent that they are a factor for cesium-137. Strontium-90 has been found to cover a distance of about about 500 ft in 7 years and 1500 ft in 12 years (1, p. F-84; 5, 6-152, 6-156). At those rates, strontium-90 has traveled at a greater rate through a ground and groundwater system, not unlike that found at VEGP, than Applicants calculate for the rate of flow of ground water at VEGP.

C. Direction of Groundwater Flow

34. Applicants testified that the groundwater flow from under VEGP will be only northward. (Tr. 253, Crosby at 22-23). However, Applicants' testimony also shows the nearness of groundwater divides to the power block (Ibid. Figures 10, 15), and that the power block is located on a ridge so that Beaverdam Creek southward is downgradient (Ibid, Figure 9). The issue is not only the precise locations of the groundwater divides in relation to the power block, but, for example, what interactions with the soil enroute downward, how fast the rate of flow downward of a release, the physical size of a release, how wetted the vadose zone at the time of a release, the added head gradient provided by the release, the concentration gradient established by the

release, and whether channels exist in the backfill at the time of release. The literature has established that each of these are an important consideration in the direction of flow not only of groundwater carrying the releases, but in the migration of releases in the unexpected direction. It is not unusual for contaminants to migrate upgradient (e.g., 1, pp. F-86-96). The literature has established that it would be relatively easy for migration to cross a groundwater ridge where the groundwater velocities are negligible. All that is needed is a head and a concentration gradient, both of which will be provided by the release itself. Additionally, the facility provides migration pathways alternative to the expected flow of groundwater, through channels opened by parts of the facility itself, such as piping beds (e.g., 6, p. 2.4-31, Supplement 1), or damaged structures (e.g., 6, p. 2.4-35, Supplement 1). (Tr. 400-403).

35. The must recent data provided by Applicants depicts the groundwater divide under the power block area (Tr. 253, Crosby at Figure 16). In an apparent contradiction, Applicants state that the groundwater divide is no closer than 700 feet to the power block backfill area (Tr. 402). Testimony by Applicants show otherwise (Tr. 253, Crosby at Figure 16; Tr. 673-677).

36. Applicants have ignored the possibility of alternative pathways through the backfill in their testimony. However, con-

duits are a likely possibility, and have defeated soil barriers in the past at other and similar facilities (Tr. 740-744; 6).

D. Groundwater Travel Time

37. The permeability of the backfill has been changed in testimony by Applicants from 2260 ft/y (Testimony Crosby et al. July 1985) to 1220 ft/y from field tests (Tr. 253, Crosby at 25). However, the standard deviation of the field test data indicates unacceptable variation in the data (3, p. 3). A more conservative approach would have been to bound the calculations using lab and field data.

38. Applicants state that retardation factors due to adsorption are sufficient to reduce the concentration of all radionuclides except for tritium (Tr. 253, Crosby at 26-27). However, as stated above, strontium-90 has been found to move through the environment much faster than has been found to be the expected case (1). If strontium-90 were to migrate through the marl, its half-life would make it a viable concern for about 300 years (i.e., 10 half-lives). Applicants use a laboratory method, the batch method, to calculate the retardation coefficients for strontium-90 (Tr. 495-498); however, this particular method has been found not to correlate very well with actual

field conditions and does not account for the large difference between predicted migration rates for strontium-90 versus actual rates (1,7).

39. Applicants assert that a three dimensional model would lead to longer travel times than would a one-dimensional model (Tr. 253, Papadopulos at 8-12); that the one-dimensional approach is therefore more conservative because the flow path is longer (Tr. 253, Pap. at 3-4); and that the one dimensional model over-estimates average velocity (Ibid., at 5-8). (Tr. 646-652) Whereas Applicants are more correct to assert that flow path is shorter in a one versus a three-dimensional model, it does not then follow that the one dimensional model is more conservative. To make it appear that their one-dimensional model was more conservative, Applicants increased the calculated velocity to 117 ft/year in order to compare their model with one used by the Savannah River Plant that used a velocity of 40 ft/yr (Tr. 253, Pap. at 10-11; 7). Real-world flow modeled in one dimension must be approximated, and the error based on added assumptions increased. For example, when calculating horizontal flow components, if flow is vertical flow only, then the one-dimensional horizontal velocity is zero, and so is its average. Three dimensional computer-assisted calculations have the advantage in being able to more closely approximate the real world. The flow used in most one

dimensional models is unrealistic because flow is presumed to occur on the surface of the groundwater forced only by the gradient. Three dimensional flow includes the head within the plume and the head of the source point, an important distinction. This accounts for the more rapid movement than expected through many groundwater systems (e.g., 1,6), and for the increase in velocity of the center of a discharge's plume.

40. The important point to be made about the Savannah River Plant updated modeling effort on their calculation of groundwater velocity, was that groundwater calculations using average velocities and one-dimensional flow analyses are inherently flawed and unrealistic (8). Numerical modeling allows the calculation of groundwater movement in complex systems using sophisticated treatments of Darcy's Law over extended distances to calculate what releases may do in the real environment using data developed for the entire region of flow, with the model adjusting for the location of the release plume and interactions with structures and different parts of the groundwater system as migration progresses.

41. Applicants offered little in the way of model validation for their release model (Tr. 602-603), citing only one reference of a study of the DOE INEL facility in Idaho. The study cited was of little value because INEL is a desert facility, dis-

similar to VEGP, and because the validation study was unsuccessful (Tr. 603), and therefore irrelevant for testing the validity of the VEGP groundwater modeling calculation completed by Applicants. The VEGP groundwater model is a simple one-dimensional linear model that can be worked by hand calculation in minutes, not a very sophisticated model in comparison to the numerical models that have been available for a number of years (e.g., 8). The VEGP model is untested, uncalibrated, and not validated, all important to the assurance of a correct calculation of groundwater flow rates, the migration of contaminants and dose to the public.

42. Applicants only considered physical factors in their calculation rate of strontium-90 through the environment (Tr. 623-625). Applicants have not considered the interaction of the release with chemical factors that may be present in the waste medium itself or in the release environment at the time of release (Tr. 625-631). Such factors make a difference in whether adsorption can be a factor or not for not only strontium-90 but also cesium-137 (1,7,9). Under certain conditions cesium-137 will migrate and not be adsorbed, similar to strontium-90 (9). Applicants state that chemical effects have little to no influence on the migration rate of radionuclides under consideration (Tr. 628-629). The nuclear waste management literature concludes the

opposite, that chemical effects often control the migration rate (e.g.,4, p. 436-439; 9, p. 16,21,25; Maher, at Tr. 671).

E. <u>Settlement of the Marl</u>

42. Applicants testified that the marl was more rigid than the grouted columns under the power block (Tr. 792). Applicants did not offer data to support their testimony, although Applicants did provide data that the marl is elastic, having heaved about 4 inches after excavation and recompressed 3 inches after backfill plus facility construction (Tr. 815-816). However, in an earlier but conflicting statement comparing the marl and the grouted wells, Applicants stated that the marl and grout had roughly the same physical properties (Tr. 462). Finally, in comparing the marl and the grouted columns under the power block and in and through the marl, Applicants became confused and were unable to clarify how rigid or elastic either were (Tr. 803).

43. Applicants testified that there would be no slip between the grouted columns and the marl because of friction (Tr. 793). Applicants testified that slip could not occur because of the bond between grout and marl (Tr. 793-794). Then Applicants stated that after slip occurred, the elastic marl would close around the grout and seal off the grout (Tr. 794, 796-797, 803).

Applicants confused static with dynamic friction and could not tell the difference between static and dynamic friction (Tr. 796-799). Then Applicants expert witnesses stated that they were not expert on the settlement issue (Tr. 799, 805). Applicants did not present an expert on the settlement issue in their testimony.

44. Testimony by Applicants differed on groundwater flow through the marl. At the end of oral testimony, Applicants testified that there is no exchange of groundwater between the two aquifers (Tr. 795). However, Applicants also stated that the marl was not impermeable (Tr. 296), that the flow through the marl was about 1.5 to 2 inches per year (Tr. 451), and that the flow through the marl was no more than 1.8 inches per year (Tr. 586). (In addition, the recharge provided by Applicants for the unconfined aquifer was 15 inches per year (Tr. 451).) Further, the flow rate through the marl can be calculated with data presented or assumed by Applicants: porosity 47.5%, gradient 1.447, and an assumed vertical permeability of 0.1 ft/yr (Tr. 253, Crosby at 20). The calculation equals 3.66 inches per year (0.305 ft/year).

45. Applicants stated that the marl's properties were such that the marl would close any openings if slippage between the marl and grouted wells under the power block did occur (Tr. 794). During oral testimony , Applicants stated that this was an elastic property, but transcript corrections submitted by Applicants

requested that the word "elastic" pressure be changed to "lateral" pressure; however, this request was made for only one location (Tr. 794) and the request compares with the other times that Applicants referred to the elastic nature of the marl during settlement (Tr. 796,L-13; 797,L-4; 803,L-5, 11, 23). The Applicants had become confused (Tr. 803). To further confound their testimony, in response to a question from the Board, Applicants affirmed that the openings caused by slippage would be closed by plastic deformation of the marl (Tr. 814). Elastic limit is the greatest stress that can be applied on a material without plastic deformation remaining after the release of the stress; with plastic deformation, accommodation is lost; rigidity is the resistance of a material to deformation when stress is applied to it (10). Testimony by Applicants was unable to discriminate between these terms.

46. Applicants have stated that settlement is nearly complete (Tr. 794), but this was stated by non-experts (Tr. 814). The question of additional settlement then becomes an open issue, and may depend not only on the additional overburden being added (backfill is 95% complete) (Tr. 794), but also on long-term pumpage from the confined aquifer below which may be impacting the Tertiary/ Tuscaloosa aquifers (Tr. 464-465), or on other factors not yet identified by VEGP hydrogeologists who are experts

in the matter- testimony was void of Applicants' testimony by expert witness on this important issue.

47. The possible issue of uneven settlement was raised in testimony (Tr. 236, 814), but was left as an open issue and unresolved (Tr. 814). There are many potential questions that need to be addressed on uneven settlement, e.g., the different horizontal and vertical stress loadings on the marl and backfill, and grouted holes/wells underlying the power block, impact on three-dimensional groundwater flow patterns, etc.

48. Uneven settlement may also affect hydrologic characteristics differentially (Tr.720, Lawless at 6). The porosity for the marl is 47.5% and for the backfill 34% (Tr. 253, Crosby at 20, 26). Settlement of the power block may lead to plastic deformation of the backfill that may result in shear and slippage zones in the backfill if the settlement is not uniform across, under, or through the power block area (Tr. 720, Lawless at 6).

49. Grouted wells/holes are under the power block area and under settling, heavy facilities that may be settling at differential rates (Tr. 789-793). Settlement may lead to the compromise of the integrity of the marl which has been shown to be the primary protection protection of the underlying Tuscaloosa aquifer (Tr. 720, Lawless at 6, Attachment at 8).

50. Some of the grouted columns are directly overlain by

heavy structures above them, whereas others are not (Tr. 812-813). Those grouted columns not directly covered by a structure may rise and fall with the marl movement, however those with structures atop them may move differently. This remains an open question. The grouted columns under the structures passed completely through the marl into the aquifer systems below (Tr. 815, 817-818).

F. <u>Conclusion</u>

51. Based on the findings above, the Board concludes that Applicants' geological and hydrological exploration has been inadequate, including their gathering of data pertaining to marl thickness, permeability, and continuity. The Board further concludes that Applicants have not adequately determined the direction that contaminants will follow in their migration patterns after release above and into the confined groundwater aquifer, and that Applicants have not conservatively computed the time for contamination to reach Mathes pond or Beaverdam creek. Because of this, because the integrity of the marl has been significantly reduced and may have been compromised endangering the important Tuscaloosa aquifer beneath the plant, and because channels may develop downward or outward from the release point, Board con-

cludes that uncertainty exists for the offsite concentrations of radionuclides released at VEGP from the power block. Having also found serious issues open and remaining as a result of the presentation on power block settlement by Applicants, the Board concludes that Applicants have not adequately assured that potable water sources will not be contaminated and that operation of Plant Vogtle will not be inimical to the public health and safety.

Proposed Conclusions of Law

Based on the entire record in this proceeding, and pursuant to 10 CFR 2.760a, the Board concludes as follows:

1. With respect to those matters encompassed by Contention 7, there is a lack of reasonable assurance that the activities authorized by the operating license cannot be conducted without endangering the health abd safety of the public and that such activities may not be conducted in compliance with the Commission's regulations.

2. With respect to these matters, issuance of the license may be inimical to the common defense and security or to the health and safety of the public.

Order

WHEREFORE IT IS ORDERED in accordance with 10 CFR 2.760, 2.762, 2.763, 2.785, and 2.786 of the Commission's Rules of Practice, that this Partial Initial Decision shall become effective immediately and shall constitute with respect to the matters decided therein the final action of the Commission forty-five (45) days after the date of issuance hereof, subject to any review pursuant to the Commission's Rules of Practice.

A notice of appeal may be filed by any party within ten (10) days after service of this Partial Initial Decision. Within thirty (30) days after service of a notice of appeal (forty (40) days in the case of the Staff), any party filing a notice of appeal shall file a brief in support thereof. Within thirty (30) days of service of the brief of the appellant (forty (40) days in the case of Staff), any other party may file a brief in support of, or in opposition to, the appeal.

IT IS SO ORDERED.

THE ATOMIC SAFETY AND LICENSING BOARD

Judge Morton B. Margulies, Chairman

Judge Gustave A. Linenberger, Jr.

Judge Oscar H. Paris

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