UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
GEORGIA POWER COMPANY	)	Docket Nos. 50-424
et al.	)	50-425
	)	(OL)
(Vogtle Electric Generating Plant,	)	
Units 1 and 2)	)	

AFFIDAVIT OF GARY B. STALEY IN SUPPORT OF NRC STAFF RESPONSE TO APPLICANTS' MOTION FOR SUMMARY DISPOSITION OF CONTENTION 7 (GROUNDWATER)

I, Gary B. Staley, being duly sworn, do depose and state:

1. My name is Gary B. Staley. I am an employee of the U.S. Nuclear Regulatory Commission in Washington, DC. My present position is Hydraulic Engineer, Environmental and Hydrologic Engineering Branch, Division of Engineering, within the Office of Nuclear Reactor Regulation. My responsibilities include review and evaluation of surface water and groundwater hydrologic conditions used in the design of structures, systems and components of nuclear power plants. A statement of my professional background and qualifications is provided as an attachment to this affidavit.

2. The purpose of this affidavit is to address Applicants' Motion for Summary Disposition of Joint Intervenors' Contention 7, which states:

Applicant has not adequately addressed the value of the groundwater below the plant site and fails to provide adequate assurance that the groundwater will not be contaminated as required by 10 CFR 51.20(a), (b), and (c), 10 CFR 50.34(a)(1), and 10 CFR 100.10(c)(3).

3. I have reviewed the Applicant's Motion for Summary Disposition and all attachments thereto filed in this proceeding on July 15, 1985.

4. I have reviewed the Applicant's Statement of Material Facts and I agree with Statements numbered 1, 2, 3, 4, 5, 6, 8, 14, 16, 17, 18, 19 and 20. The other Statements are outside my area of expertise.

I. Groundwater Aquifer Systems at the Vogtle Plant Site

5. Correlation of information from several sources, including boring logs, cores and groundwater observation well data, supports the conclusion that the groundwater regime under the Vogtle site includes both unconfined (water table) and confined (artesian) aquifers[1,2,3]. An unconfined or water table aquifer is one in which groundwater possesses a free surface open to the atmosphere. A confined or artesian aquifer is one in which groundwater is confined under pressure by overlying and underlying aquitards or aquicludes and water levels in wells rise above the top of the aquifer.

6. The water table aquifer at Vogtle occurs in the Utley Limestone and Irwinton Sand Member of the Barnwell Group[1,2,3]. The aquifer is perched on the Blue Bluff marl member (aquiclude) of the Lisbon

Formation. The pre-construction water surface for the water table aquifer in the vicinity of the main plant area for Vogtle was normally between about elevations 155 to 165 feet msl[3].

7. There are two confined aquifers under the Vogtle site. The uppermost confined aquifer is of the Tertiary System and is located in the unnamed sands of the Lisbon Formation and just below the confining Blue Bluff marl aquiclude of the Lisbon Formation. This Tertiary aquifer is separated from the deeper Cretaceous aquifer by the Huber and Ellenton Formations that act as an aquitard but permit hydraulic contact between the two aquifers. The Cretaceous aquifer is in the sands of the Tuscaloosa Formation[1,2,3]. The water level (in observation wells) for the Tertiary aquifer under the main plant at Vogtle is about elevation 115 ft msl. The pressure in this aquifer is rather stable with water level fluctuations of about five feet or less. The top elevation of the unnamed Sands member of the Lisbon Formation near the power block is about 65 feet msl. This indicates there is about 50 feet (115 ft msl-65 ft msl = 50 ft) of pressure head on the Tertiary Aquifer at plant Vogtle[3]. Both confined aquifers flow toward the Savannah River, which serves as a sink for both aquifers.

II. Possible Contamination of Groundwater Aquifers as a Result of an Accidental Tank Spill at Vogtle

8. Based on my thorough review of the hydrogeology of the Vogtle site, including lengthy technical discussions with experts in geology, geotechnical engineering and hydrogeology, and the evaluation of a postulated accidental release of radioactive contaminants to groundwater beneath the Vogtle plant, I have concluded that the Vogtle site is a good site with respect to its ability to preclude possible contamination of the deep (confined) aquifers and to minimize possible contamination of the shallow (water table) aquifer.

9. Section 2.4.13 of the Vogtle SER describes the postulated rupture of the Waste Evaporation Concentrate Holdup Tank (WECHT) and subsequent migration of the radioactive contaminants through the groundwater pathway to surface water and its acceptability with respect to meeting 10 CFR Part 20 requirements for potable water supplies in an unrestricted area.

10. The accidental tank spill evaluation envelopes other possible accidental releases at the site except a core melt release[2] which is not considered a credible or design basis accident. The tank spill analysis is conservative for the following reasons:

    (1) There is no evidence to support a continuous direct pathway from the plant backfill through the Utley Limestone to one of the many springs around the periphery of the site. However, the travel time between the plant backfill and the nearest spring

(assumed to flow entirely in the Utley Limestone) was conservatively ignored.

(2) The parameters necessary to compute groundwater velocity (ultimately groundwater travel time) are permeability, effective porosity and gradient. The values for these parameters were selected from the conservative end of the range of values.

(3) As a result of radioactive decay during radionuclide travel, including the effects of retardation, from the release point to the perimeter of the plant backfill, all radionuclides except tritium will meet the 10 CFR Part 20 requirements at the nearest spring without taking any credit for dilution in ground or surface water. When dilution is considered, tritium is diluted to less than 10 CFR Part 20 requirements within the plant backfill.

11. In addition to the above conservatisms, the features of this plant would also allow the mitigation of any significant radioactive release by standard engineering methods.

12. The analysis for the tank spill assumes no flow through the marl aquiclude. In order to further document the competence of the marl to preclude contamination of the lower confined aquifers, additional analyses were made assuming flow through the marl using conservative parameters. The field permeability tests of the marl conducted by

the applicant in the main plant area all resulted in zero permeability. The applicant is performing laboratory permeability tests on the recent (June 1985) cores from the marl. These tests are not complete. A value of 10^{-7} cm/sec, a conservative textbook value for this type of material, was assumed for this analysis. The assumed effective porosity of 3% is also a conservative textbook value for this type of material. Using these values and procedures from Todd,[9] a groundwater velocity of 0.7 ft/year was calculated for downward travel through the marl. Radionuclides are reduced to innocuous levels when they decay 10 half lives or more. Therefore, if it can be shown that the radionuclides with the longer half lives and smaller retardation factors in the source terms for the tank spill decay more than 10 half lives in traveling through the marl, then by comparison all other radionuclides can also be eliminated.

13. The four most important radionuclides in the tank spill source term (and their half lives) are: Cs 137 ($t^{\frac{1}{2}}$ = 30.1 yrs); Sr 90 ($t^{\frac{1}{2}}$ = 28.2 yrs); H_3 ($t^{\frac{1}{2}}$ = 12.3 yrs) and Co 60 ($t^{\frac{1}{2}}$ = 5.3 yrs). The source term also contains Pu 239 ($t^{\frac{1}{2}}$ = 24,400 yrs) and I 129 ($t^{\frac{1}{2}}$ = 15.9×10^6 yrs) but the tank concentrations are less than 10 CFR Part 20 limits and therefore need not be considered. Except for tritium (H_3), these chemically active nuclides travel through the groundwater pathway at a much slower rate than water because of the process of sorption onto the soil and rock media. The degree of retardation is governed by the various physical properties such as bulk density, aquifer porosity and radionuclide equilibrium distribution coefficients.

Using conservative parameters, selected from the lower end of the range for clay and the 38 foot minimum depth of marl below the Auxillary Building, radionuclide travel times were computed and compared to the half lives of the elements with the following results. Cs 137 would undergo 3100 half lives of decay, Sr 90 would undergo 326 half lives of decay, H_3 would undergo 11 half lives of decay and Co 60 would undergo 86,000 half lives of decay in traveling through the marl. Based on this somewhat conservative analysis, I conclude that all of the radionuclides from a WECHT spill would be reduced to innocuous (small fractions of 10 CFR Part 20 requirements) levels before they reach the Tertiary aquifer.

III. Status of Boreholes at Vogtle and Potential as Containment Pathway

14. To address the concern about the integrity of the marl, the status of all known penetrations through it were evaluated. Section 2.4.12.4 of the Vogtle SER provides complete documentation of the status of boreholes drilled at the Vogtle site. All boreholes, except three, that are not presently being used as production or observation wells have been sealed by grouting. Boreholes number 236, 237 and 239, which are located near the river facilities, do not have any record of being grouted. However, Applicants have stated that they believe these were also grouted, since it was standard practice to do so. In any event, these boreholes are located more than 2,000 feet from the

main power block area, and should not be exposed to any possible accidental spill at the site. Even if they were exposed to contamination, no potable water supplies would be affected because the Savannah River is the sink for aquifers in this area and there are no wells between the ungrouted borehole locations and the Savannah River. All other inactive boreholes have been grouted using the "tremie method," which is performed by inserting a small diameter pipe (drill rods, 1/2 to 1-inch steel or PVC, etc.) to near the bottom of the hole and pumping cement slurry through the pipe, filling the hole from the bottom up. Grouting is continued until grout appears at the top of the hole. This method assures that the hole is completely filled and no voids are present. A similar technique was used to seal the water supply wells and observation wells in the confined aquifer. The Applicants' provisions for sealing boreholes is acceptable and will insure that boreholes at the Vogtle site will not provide a pathway for contamination of the confined aquifers.

IV. Possible Contamination of Groundwater Aquifers as a Result of a Core Melt Release of Radioactive Contaminants at Plant Vogtle

15. Section 5.9.4.5(4) of the Vogtle FES provides a comparative evaluation of the radiological consequences that might result following a large release of radionuclides from the Vogtle reactors to the local ground-water system. Such releases could occur

following a postulated, beyond design basis, core meltdown with eventual penetration of the containment basemat.

16. The analysis for the core melt release is similar to the analysis for the tank spill in that it only takes credit for the transport and radioactive decay in the plant backfill (dilution is not considered). The transmitted fractions for the more important radionuclides are compared to the transmitted fractions for the river site in the Liquid Pathway Generic Study (LPGS)[8]. The transmitted fractions for Vogtle are less than the transmitted fractions for the generic river site in LPGS and by comparison it is shown that the Vogtle site is as good or better than other river sites in the United States.

17. Regarding radionuclide travel through the marl, the WECHT analysis for the tank spill eliminated (because of travel time through the marl) most of the important radionuclides that would be released to groundwater in the event of a core melt release except Pu 239 and I 129. The concentrations of these two radionuclides in the core melt release source term are larger than the 10 CFR Part 20 limits. Pu 238[1] has a half life of 24,400 years, but is very chemically active and the radionuclide travel time through the marl is about 931,000 years or about 38 half lives of decay. I 129 has a very long half

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1 The source term for the tank spill analysis contains Pu 239 with a half life of 24,400 years. The source term for the core melt release contains Pu 238 with the same half life.

life of 15,900,000 years and is not very chemically active. The radionuclide travel time through the marl is about 540 years which would not be enough to reduce this nuclide to innocuous levels. It is therefore necessary to consider the effects of dilution for this nuclide to determine the possible contamination of the confined aquifers. There are assumed to be 2.9 curies[8] of I 129 in the core melt release source term. The initial concentration of I 129 in the sump water (3080 m^3) is $9.4 \times 10^{-4} \mu ci/ml$. Within 1,000 feet of the containment, the dilution in the marl and Tertiary aquifer would further reduce the concentration to less than $1 \times 10^{-10} \mu ci/ml$. Therefore I 129 would meet the 10 CFR Part 20 requirement of $6 \times 10^{-8} \mu ci/ml$ within 1,000 ft of the release point. The gradient of the Tertiary Aquifer is toward the Savannah River, which is a sink for this aquifer. There are no wells between the plant and the river, and thus no potable water supplies would encounter I 129 in excess of Part 20 limits.

V. Radioactive Contamination of Groundwater Aquifers Beneath the Savannah River Plant

18. A cursory review of several documents[4,5,6,7] related to the Savannah River Plant indicate at least two significant differences between the SRP and the Vogtle plant with respect to possible contamination of groundwater aquifers. One important difference is the mode of operation of the two facilities. The SRP has seepage basins and

burial grounds that could possibly provide a constant source of wastewater seepage with radioactive material to the groundwater, whereas at Vogtle normal releases of radioactivity are to surface water under conditions controlled to meet conservative environmental standards, and there are no planned releases to groundwater. Thus, any possible groundwater contamination at Vogtle would have to involve some low probability accidental release to generate a source term. Another important difference between the two sites is the geology. The SRP site covers a much larger area (300 sq mi) than the Vogtle site (5 sq mi) and therefore is subject to more geologic variation in the areal expanse than the much smaller Vogtle site. The green clay at SRP is comparable to the Blue Bluff marl at Vogtle. However, the green clay is much thinner (as little as 10 feet thick) than the Blue Bluff marl which is typically 60 to 70 feet thick at Vogtle (except under the auxiliary building where, due to excavation, it is about 38 feet thick). Additionally, the green clay is discontinuous near the northern SRP site boundary, whereas the marl under the Vogtle site is continuous.

VI. Summary

19. In summary, I conclude that it is very unlikely that any radioactive release to groundwater pathways at the Vogtle plant would contaminate the confined aquifers that lie below the Blue Bluff Marl Aquiclude. Moreover, a radioactive release to the water table aquifer would not contaminate any existing potable well water supplies and only the

core melt release could cause possible impacts for potable water supplies on the Savannah River. In the event of a major radioactive release at Vogtle, the geologic features, especially the presence of the Blue Bluff Marl, would facilitate mitigative measures that would minimize contamination of even the local water table aquifer in the immediate vicinity of the plant. It is my judgement that with respect to possible impacts upon groundwater regimes as a result of a radioactive release, the Vogtle plant site is an excellent site.

The above statements are true and correct to the best of my knowledge and belief.

Gary B. Staley

Gary B. Staley

Subscribed and sworn to before me
this 9th day of August, 1985

Eugene S. Becker Notary Public

My Commission expires: 8/9/85

References

1. U.S. Nuclear Regulatory Commission, NUREG-1137, "Safety Evaluation Report to the Operation of Vogtle Electric Generating Plant, Units 1 and 2," June 1985.

2. U.S. Nuclear Regulatory Commission, NUREG-1087, "Final Environmental Statement Related to the Operation of Vogtle Electric Generating Plant, Units 1 and 2," March 1985.

3. Georgia Power Company, "Final Safety Analysis Report for Vogtle Electric Generating Plant Units 2 and Unit 2," Docket Nos. 50-424 and 50-425, June 1983.

4. U.S. Department of Energy, DOE/EIS-0108D, "Draft Environmental Impact Statement, L-Reactor Operation Savannah River Plant," Volumes 1 and 2, September 1983.

5. Steele, J. L., "Technical Summary of the A/M Area Groundwater (AMGW) Remedial Action Program," Draft DuPont Report, March 1984.

6. Lawless, W. F., Management Appraisal Report, "Savannah River Plant (SRP) Burial Ground Building 643-G," November 1, 1982.

7. Lawless, W. F., "Savannah River Plant Offsite Radioactive Releases," Draft Report, January 15, 1985.

8. U.S. Nuclear Regulatory Commission, NUREG-0440, "Liquid Pathway Generic Study," February 1978.

9. Todd, David Keith, "Groundwater Hydrology," 1980.

PROFESSIONAL QUALIFICATIONS

GARY B. STALEY

I am employed by the U.S. Nuclear Regulatory Commission as a Hydraulic Engineer on the staff of the Environmental and Hydrologic Engineering Branch, Materials and Qualification Engineering Group, Division of Engineering.

My formal education consists of study in civil engineering at South Dakota State University, where I received a B.S.C.E. in 1960. I also completed 18 hours of graduate work in water resources engineering at the University of Nebraska in the period of 1965 to 1973.

My present employment with NRC dates from September 1974 in the areas of hydrologic engineering in the Division of Engineering for consultation on siting of materials utilization facilities and on environmental matters. My responsibility in the licensing review of nuclear facilities is in the area of flood vulnerability, adequate water supply, thermal analyses of ultimate heat sinks and surface and groundwater acceptability of effluents. In addition, I participated in the development of the technical bases for Safety Guides and Standards in the area of interest. I am also responsible for preparing safety and environmental related testimony for hydrologic related matters on facilities under my review.

From 1973 to 1974, I was a Hydraulic Engineer in the Coastal Engineering and Hydraulic Design Branch of the North Central Division of the Corps of Engineers in Chicago, Illinois. I was responsible for the hydrologic review of multi-purpose dams, navigation locks, flood control projects, and coastal engineering development. The projects included those of five districts located in the States of Minnesota, Wisconsin, Iowa, Illinois, Indiana, Ohio, New York, Pennsylvania, Michigan, and including the Great Lakes.

From 1960 to 1973 I was a Hydraulic and Civil Engineer with the Omaha District of the Corps of Engineers in Omaha, Nebraska. I worked on design of hydraulic structures, model studies and general hydrologic engineering on multipurpose dams and flood control projects. I was assigned for severl years of this time to the Missouri River Basin Comprehensive Study where I served as a Task Force Chairman and was involved with long range planning for water yield, water use and flood control.

I am a member of the American Society of Civil Engineers and Subscribe to the Journals of the Hydraulics Division and the Geotechnical Engineering Division as a means of keeping abrest of current developments in my fields of interest. I co-authored a technical paper entitled, "Radionuclide Migration from Low-Level Waste: A Generic Overview." This paper was presented at the Low-Level Waste Management Symposium in Atlanta, Georgia, May 23-27, 1977.