UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD PANEL

Before the Licensing Board:

G. Paul Bollwerk, III, Chairman
Nicholas G. Trikouros
Dr. James Jackson

In the Matter of	Docket No. 52-011-ESP
SOUTHERN NUCLEAR OPERATING CO.	ASLBP No. 07-850-01-ESP-BD01
(Early Site Permit for Vogtle ESP Site)	

PRE-FILED DIRECT TESTIMONY OF SHAWN P. YOUNG

Q1: Please state your name and current business address.

A1: My name is Shawn Paul Young, and my current business address is 103A Natural Resources Building, University of Idaho, Moscow, ID 83844.

Q2: What is your educational background?

A2: I received a B.S. degree in Environmental Studies from Northland College (Ashland, WI) in 1996. I received a M.S. degree in Aquaculture, Fisheries, and Wildlife Biology (Fisheries emphasis) from Clemson University (Clemson, SC) in 2001. I received a Ph.D. in Fisheries and Wildlife Biology (Fisheries emphasis) from Clemson University (Clemson, SC) in 2005.

Q3: For whom do you work and in what capacity?

A3: I am currently Research Faculty of Fisheries Biology at the University of Idaho (Moscow, ID). I also currently hold Adjunct Faculty status at Clemson University (Clemson, SC).

Q4: What is your professional background?

A4: A copy of my curriculum vitae has been provided to the Board and other parties previously and is attached to this testimony as JTI000042. Briefly, I have eleven years of experience researching the effects of human activities on fisheries and aquatic ecosystems, including six years of experience studying fisheries in the Savannah River Basin. In addition to the faculty positions I currently hold, I was previously a visiting Assistant Professor of Fisheries Biology at Purdue University.

Q5: Have you published or presented in the fields of fisheries and aquatic ecology?

A5: Yes; I have in publication, in press, and in review twenty-seven peer-reviewed articles relevant to fisheries and aquatic ecology. I have presented scientific presentations at numerous professional meetings, academic seminars, and citizen fishing association functions.

Q6: Have you testified as an expert previously in any jurisdiction or proceeding?

A6: Yes; I have been recognized as an expert in fisheries and aquatic ecology. I provided scientific review and affidavit opinion on the potential environmental impacts of nuclear expansion on the North Anna/Pamunkey River (VA) and Tennessee River (AL). I am currently involved in fisheries issues pertaining to the Federal Energy Regulatory Commission ("FERC") re-licensing of Tillery Dam on the Yadkin-Pee Dee River (NC). Also, I provided review on a draft petition to designate critical habitat for the endangered Goldline Darter and Blue Shiner.

Q7: Do you have a written summary of your education, employment, experience and background, and papers and presentations you have made over your career?

A7: The copy of my curriculum vitae attached as JTI000042. to this testimony supplies such a summary.

Q8: What materials have you reviewed and actions have you taken in preparation for your testimony?

A8: I am familiar with the application of Southern Nuclear Operating Company ("SNC") for an Early Site Permit ("ESP") at the Vogtle Electric Generating Plant ("VEGP") site. I have reviewed excerpts of the Final Environmental Impact Statement ("FEIS") prepared by the staff of the Nuclear Regulatory Commission ("NRC"), including those sections describing water intake, water consumption, and thermal discharge into the Savannah River associated with the proposed additional nuclear power generating units ("Units 3 and 4"), the cumulative impacts of Units 3 and 4 operation, and the subsequent potential impacts of Units 3 and 4 on the fish assemblage of the Savannah River, together with related documents submitted in this matter.

Q9: Have you given affidavits or declarations in support of or in connection with any of Joint Intervenors' contentions in this ESP proceeding?

A9: Yes, I submitted a declaration in support of the petition to intervene in December 11, 2006. (JTI0000023). I submitted an affidavit in opposition to SNC's motion for summary disposition of EC 1.2 on November 13, 2007. (JTI0000003). Also I submitted a declaration in support of admission of contention EC6.0 on September 22, 2008. (JTI000005)

Q10: What are the topics of your testimony?

A10: I will testify on three topics to a reasonable degree of scientific certainty. I will testify on the deficiencies, in data, quantitative analysis, field studies, and logic, of the FEIS conclusions regarding (1) the potential impacts of entrainment and impingement, (2) the thermal effluent discharge impacts on aquatic species, and (3) the impacts of the proposed dredging required for construction of Units 3 and 4 on the aquatic species located in the Middle, Lower, and estuarine Savannah River. My testimony will support Environmental Contention 1.2, which provides that

the FEIS fails to adequately discuss the impacts of the proposed cooling system intake on the aquatic species of the Savannah River, and Environmental Contention 6.0, which provides that the FEIS fails to adequately analyze the cumulative impacts of dredging the Savannah River federal navigation channel and water flow regulation from upstream reservoirs.

Entrainment and Impingement

Q11: Please summarize your opinion of the FEIS conclusions regarding the potential impacts of entrainment and impingement on aquatic resources.

A11: The FEIS lacks sufficient field surveys and quantitative analysis to assess baseline habitat conditions, species diversity, and species abundance in the vicinity of the VEGP site. In addition, the FEIS discussion of the direct, indirect, and cumulative impacts of entrainment and impingement is inadequate and relies on incorrect assumptions.

Q12: Does the FEIS contain sufficient data to analyze the construction and operation impacts on the fish species located in the Middle, Lower, and estuarine Savannah River?

A12: No. The FEIS does not contain sufficient data to analyze the construction and operation impacts on fish species located in the Middle, Lower, and estuarine Savannah River. In order to accurately evaluate the construction and operation impacts, the causes of the population decline must be articulated. The FEIS, on pages 2-81 through 2-91, sets forth certain information regarding the six fish species located in the Middle, Lower, and estuarine Savannah River that are experiencing population decline and considered most imperiled and/or most important to Savannah River fisheries. However, the FEIS provides very little information regarding the causes for such population decline. Also, the FEIS lacks adequate discussion of the other fish

species that may be at risk of population decline, as a result of construction and operation of Units 3 and 4.

Q13: Does the FEIS provide sufficient data to substantiate conclusions regarding the impacts of entrainment on the fish species located in the Middle, Lower, and estuarine Savannah River in the vicinity of the VEGP site?

A13: No. Although the FEIS does contain some survey data from the Academy of Natural Sciences of Philadelphia ("ANSP"), the ANSP surveys are not an adequate indicator of the construction and operation impacts on the fish species located in the Middle, Lower, and estuarine Savannah River. For example, the ANSP surveys lack detailed data of the life history stages of fish species near the Plant Vogtle site, the migration timing of each species' life history, distribution patterns in the immediate vicinity of Plant Vogtle, or population numbers. Notably, no such studies have been conducted since the mid-1990s, as is evidenced by JTI000001 (ANSP 2001) and JTI000002 (ANSP 2003). Moreover, several parts of the existing – albeit outdated – ANSP research, including ichthyoplankton surveys, were performed on a limited basis, only a few times per year, and during alternating years. For instance, the FEIS relies on portions of ANSP's research (JTI000002 (ANSP 2003)) where fish investigations were conducted once per year, during three days in September, at a limited number of sampling stations. This sampling protocol is grossly insufficient to supply information needed to draw appropriate conclusions regarding the impact of Units 3 and 4 on fish species.

Q14: When analyzing entrainment, is it important to consider the life history of the fish species that inhabit the Savannah River near Plant Vogtle or pass by Plant Vogtle as part of the drift community?

A14: Yes. Data for early life history of fish that inhabit the Savannah River near Plant Vogtle, or pass by Plant Vogtle as part of the community drift, is of paramount importance when analyzing entrainment. The early life stages of fish are the most susceptible to entrainment because they have limited capacity for avoidance. Many fish species' eggs and larvae are found in the river drift. In general, fish eggs have no mobility and larval fish have very little mobility. They utilize the inertia of flowing water for passive transport to conserve energy. Since fish eggs and larval fish have limited capacity for avoidance, they are inherently vulnerable to entrainment.

Q15: Are the larval fish that inhabit the Savannah River near Plant Vogtle or pass by Plant Vogtle as part of the drift community capable of avoiding the predicted water intake velocities?

A15: No. Not all of the larval fish that inhabit the Savannah River near Plant Vogtle or pass by Plant Vogtle as part of the drift community are capable of avoiding the predicted water intake velocities. The FEIS at 5-30 states that "species and life stages evaluated in various studies could endure a velocity of 1ft/sec." However, many of the endangered or important fish of the Savannah River cannot endure that water intake velocity. For example, the FEIS on page 2-83 notes that the larval fish of the Robust Redhorse, a state-listed endangered species, are only capable of swimming speeds that range from 3 to 5 inches/sec. Thus, the larval fish of the Robust Redhorse are not capable of swimming through the affected area, given the predicted water intake velocities.

Furthermore, the FEIS discussion is inadequate because it lumps all categories of larval fish together. Some larvae are better swimmers than others. Thus, a group conclusion regarding the swimming abilities of larvae in is vague, at best.

Q16: Is it reasonable to assume that the drift community near Plant Vogtle is uniformly distributed?

A16: No. It is not reasonable to assume that the drift community near Plant Vogtle is uniformly distributed. The FEIS makes this assumption at 5-31, even though the most widely recognized studies indicate that the drift community is not uniformly distributed. For example, JTI000006 (Wiltz (1983)) studied fish egg and larval drift, and JTI000007 (Nichols (1983)) surveyed macroinvertebrate drift distribution near Plant Vogtle during pre-operation monitoring. Both found that the drift community, including eggs and larvae of 34 fish species, were non-uniformly distributed and varied over time and space in the vicinity of Plant Vogtle. Further, JTI000004 (Paller (1995)) studied American Shad egg distribution at the Savannah River Site intakes which are near Plant Vogtle. Paller found a higher abundance of American Shad eggs along the Georgian Bank than the South Carolina bank, reaffirming that the drift community is not uniformly distributed.

Q17: Does entrainment correspond directly with the percent of flow withdrawn, when the drift community is not uniformly distributed?

A17: No. When the drift community is not uniformly distributed, entrainment will not correspond directly with the percent of flow withdrawn. Impacts due to entrainment may be greater during periods when the drift community is highly concentrated.

Q18: Does the FEIS provide sufficient data and analysis to substantiate its conclusion that the current and future operation of Units 3 and 4 will have a minor impact on the ichthyoplankton community near Plant Vogtle?

A18: No. The FEIS fails to provide any baseline data regarding species composition, abundance, and distribution to support its conclusions. The FEIS states that American shad are the most dominant ichthyoplankton in the river, but its analysis of the American shad population is limited. In addition, on page 2-82 of the FEIS, the staff illogically relies on oxbow population data, which is not relevant to its analysis of the mainstream ichthyoplankton community. Moreover, the FEIS states that American shad eggs are concentrated along the bottom of the water column, and then concludes – because of such concentrations – that the current and future operation of VEGP will result in only minor impacts. This conclusory statement is inadequate because it fails to take into consideration other factors which might affect the American shad eggs distribution and in turn, the ichthyoplankton community near Plant Vogtle. Also, it fails to take into account Paller's 1995 study of the horizontal distribution of American shad eggs in the drift near Plant Vogtle. Paller found a higher abundance of American shad eggs along the Georgian bank, and stated that the study results revealed "the importance of site specific assessments of ichthyoplankton distribution near existing or proposed water intakes using statistical designs that permit sensitive resolution of spatial patterns." (JTI000004 (Paller 1995)).

Q19: What is the most effective method to determine the composition, distribution, and vulnerability to entrainment of the ichthyoplankton species in the vicinity of the VEGP site?

A19: The most effective method to determine current ichthyoplankton species composition, distribution, and vulnerability to entrainment in the vicinity of the VEGP site is an

ichthyoplankton-net collection. Many widely recognized studies have relied upon ichthyoplankton-net collections (JTI000008 (Bilkovic et al. 2002); JTI000009 (Overton and Rulifson 2007); JTI000010 (Perez-Ruzafa 2007)). Ichthyoplankton collections should be conducted at equal intervals from riverbank to riverbank, surface to bottom, during a stratified sampling period occurring day and night several times per week during each month of the year. These collections will give a more accurate depiction of the drift community that may be entrained.

Q20: Does the FEIS provide sufficient data and analysis to support its conclusion that the fish and shellfish located in the vicinity of the VEGP site are adapted to survival in varying flow regimes and velocities?

A20: No. The FEIS lacks sufficient data and analysis to support its conclusion that the fish and shellfish located in the vicinity of the VEGP site are adapted to survival in varying flow regimes and velocities (NRC000001 (FEIS Table 2.7)). The FEIS discussion of variability fails to distinguish between natural variability and human-induced variability. While it is true that fish and shellfish can adapt to natural variability, human-induced variability produces different results. This case concerns human-induced variability, since the New Units' additional water intake produces the variability. Studies demonstrate that human-induced variability, combined with related anthropogenic stressors such as increased entrainment mortality, is the primary cause of decreased freshwater biodiversity (e.g., fish, mollusks, macroinvertebrates) in the United States. JTI000016 (Vaughn and Taylor 1999); JTI000017 (Ricardi and Rasmussen 1999); JTI000018 (Cosgrove and Hastie 2001); JTI000019 (Layzer and Scott 2006)).

Q21: Does the FEIS consider a sufficient range of flows in its analysis of water intake percentages and their affect on entrainment and impingement?

A.21: No. The FEIS fails to consider a sufficient range of flows in its analysis of water intake percentages and their affect on entrainment and impingement (NRC000001 (FEIS 7-24)). The FEIS lacks sufficient analysis of entrainment and impingement during low flows, even though low flows are reasonably likely to occur. The FEIS should, at the very least, include analysis of flows ranging from normal to Drought Level 4.

Q22: Does entrainment increase as river levels drop?

A22: Yes. There is evidence of increased entrainment as river levels drop, because when river levels drop, the concentration of eggs and larvae in the river increases. As previously discussed, the early life stages of fish are the most susceptible to entrainment because they have limited capacity for avoidance.

Q.23: Does the Hydraulic Zone Influence study conducted by SNC in support of this proceeding provide sufficient data and analysis?

A.23: No. The Hydraulic Zone Influence study lacks sufficient data and analysis because the study was conducted while operation was only at 56% capacity during a limited range of flows. In order to provide complete and accurate analysis, the modeling should also include the impact at full capacity under different flows. The modeling should include the impact at full capacity under different flows because the volume of water intake will change, depending on the percentage of facility operation capacity. For example, operation at 100% capacity will require more water withdrawal , thus increasing the zone of influence further into the river channel and increase intake velocities, than operation at 56% capacity.

Q.24: Does the FEIS consider a sufficient range of flows?

A.24: No. The FEIS fails to consider a sufficient range of flows. The FEIS considers only the following flows: average conditions (8830 cfs), Drought Level 1 (4200 cfs), Drought Level 2 (4000 cfs), and Drought Level 3 (3800 cfs). Currently, the level is below Drought Level 3, the lowest level considered. Thus, the area is experiencing extreme drought conditions not contemplated by the FEIS.

Thermal Impacts

Q.25: If the current river flow is less than the flows that were modeled, how will the discrepancy distort the results?

A.25: Lower river flow or volume means less volume to dissipate the heat from the thermal discharge. Plus, the thermal plume will constitute a larger proportion of the river volume in that area. The lower flow may also change, likely reduce, the flow velocity of the river, which may lead to a change in thermal plume dimensions.

Q.26: How does reduced flow impact aquatic species?

A.26: Reduced flow places more of the drift community at danger of thermal impacts due to river channel confinement. That is, low water levels confine organisms to a smaller habitat, concentrating the number of organisms per unit of area in the vicinity of the thermal plume. Further, low-flow reduces the river volume, and thus, the ability for the heat to be dissipated across time and space. This confinement increases the vulnerability to thermal stress and mortality.

Q.27: Does the FEIS provide sufficient data and analysis of thermal stress and mortality for the fish species located in the Middle, Lower, and estuarine Savannah River?

A.27: No. The FEIS does not provide sufficient data and analysis of thermal stress and mortality for the fish species located in the Middle, Lower, and estuarine Savannah River. The FEIS fails to consider all possible river conditions and rather, focuses on conservative river conditions. The FEIS lacks analysis under elevated temperatures. High water temperature kills the early life history stages of several highly-valued fish found near VEGP, and most likely also causes mortality in many less-studied and less-desired Savannah River fish species. For example, American shad eggs suffer mortality at 80.1ºF, and larvae suffer mortality at 87ºF (JTI000011 (Steir and Crance 1985)). Blueback herring eggs and larvae suffer mortality at 85.5ºF (JTI000012 (Pardue 1983)). The federally endangered shortnose sturgeon's eggs suffer mortality at 75ºF, and larvae suffer mortality at 85ºF (JTI000013 (Crance 1986)). Striped bass eggs suffer mortality at 75ºF, and larvae suffer mortality at 85ºF (JTI000014 (Bain and Bain 1982); JTI000015 (Fay et al. 1983)). JTI000015 (Fay et al. (1983)) also provides data and synthesis from a number of studies on the effects of thermal pollution discharge on early life stages of striped bass, "Most early striped bass life stages show significant elevated mortality when exposed to rapid changes in water temperature (such as that in a thermal discharge plume)." The studies found in JTI000015 (Fay et al. (1983)) provide evidence that striped bass larval survival is significantly affected by sudden temperature elevations of 18ºF, and mortality exceeds 50% when water temperatures reach 90°F.

Q.28: Does the FEIS provide a comprehensive analysis of potential thermal impacts on the vulnerable life history stages of fishes located in the Middle, Lower, and estuarine Savannah River?

A.28: No. The FEIS only discusses fish species and life history stages that provide a supportive argument that additional units will not affect fish species. The FEIS analysis is inadequate because it fails to adequately list, discuss, and assess potential thermal impacts on the vulnerable life history stages. Fish thermal tolerance and mobility changes across life history stages. Eggs have no mobility and reduced thermal tolerance during embryonic development. Further, no data detailing spatial distribution of ichthyoplankton drift in the vicinity of the thermal plume is presented to determine impacts.

Dredging

Q.29: Is it likely that the proposed dredging required for construction of the New Units may impact the aquatic species located in the Middle, Lower, and estuarine Savannah River?

A.29: Yes. It is likely that the proposed dredging may impact the aquatic species located in the Middle, Lower, and estuarine Savannah River.

Q.30: What are the potential impacts of the proposed dredging required for construction of the New Units on the aquatic species located in the Middle, Lower, and estuarine Savannah River?

A.30: Such dredging may (i) disrupt food web dynamics, affecting the aquatic species located in the Middle, Lower, and estuarine Savannah River, including the endangered shortnose sturgeon (JTI000026 (Shortnose Sturgeon Recovery Team 1998)) and rare robust redhorse (which are benthic feeders), and (ii) affect spawning success of some of the aquatic species located in the

Middle, Lower, and estuarine Savannah River, including the striped bass. In fact, previous dredging activities have been cited as a cause for the decline of numerous Savannah River fish (JTI000027 (Duncan et al. 2003)) such as Atlantic sturgeon (JTI000028 (Atlantic Sturgeon Review Team 2007)). Dredging may also degrade chemical aspects of water quality and re-suspend contaminants, which contaminants may then in turn be bioaccumulated by mussels and other organisms (JTI000029 (Bellas et al. 2007)). Further, previous dredging has been identified as a major cause for freshwater mussel decline (JTI000017 (Ricciardi and Rasmussen 1999)). Dredging destroys benthic habitat needed by mussels, and mussels may be killed directly by being suffocated or buried in dredging spoils. In addition, if dredging causes fish hosts of the mussels' glochidial life stage to vacate co-inhabitated areas, mussel reproduction will be negatively impacted by the disruption in the commensalistic relationship. The FEIS mentions the potential for benthic organism (i.e. the freshwater mussel) relocation, yet surprisingly provides no detail concerning this proposal. Relocations of freshwater mussels have had variable success – with some relocation attempts resulting in 100% mortality.

Q.31: Does the FEIS contain sufficient information to adequately assess and analyze the impacts of the construction of the New Units and operation of the VEGP (including the New Units) on the freshwater mussels?

A.31: No. The FEIS does not contain sufficient information to adequately assess and analyze the impacts of the construction of the New Units and operation of the VEGP (including the New Units) on these freshwater mussels. With the large-scale dredging, a thorough freshwater mussel survey for the entire affected area should be completed. The last survey conducted by the U.S. Fish and Wildlife Service in 2006 (NRC000001 (FEIS, 2-76)) was incomplete, as it failed to survey a forty-four mile segment around VEGP. Further, because each mussel species has

specific fish hosts and habitat requirements, a thorough discussion of each mussel species' life history is also required.

Q.32: Does the FEIS provide sufficient data and analysis regarding the dredging impacts on the aquatic species located in the Middle, Lower, and estuarine Savannah River?

A.32: No. Although the proposed dredging required for construction of the New Units will likely have very large and severely negative impacts on the aquatic species located in the Middle, Lower, and estuarine Savannah River, these impacts are insufficiently assessed and analyzed. For example, the FEIS lacks sufficient data and analysis of the impacts on the freshwater mussels, shortnose sturgeon, Atlantic sturgeon, striped bass, robust redhorse and other catostomids, catfish species, and numerous benthic organisms, which may be affected by the dredging.

Further, beyond the dredging, the shipping of materials up to VEGP also has potential for large impacts on fish and mussels. Navigation-induced habitat disruption has been observed to affect small sized fish and the smaller-sized early life stages of other fishes (JTI000030 (Wolter and Arlinghaus 2003)). In the Wolter and Arlinghaus (2003 (JTI000030)) study, swimming performance of juvenile freshwater fish was the major bottleneck for fish recruitment in waterways, as a result of their inability to withstand bank-directed navigation-induced physical forces.

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on January 9, 2009.

Executed in Accord with 10 C.F.R. 2.304(d)
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