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)	

REVISED PREFILED REBUTTAL TESTIMONY OF WILLIAM POWERS CONCERNING CONTENTION EC 1.3

Q1: What materials have you reviewed and what actions have you taken in preparation for your prefiled rebuttal testimony?

A1: I have reviewed Southern Nuclear Operating Company's ("SNC") application for an early site permit ("ESP") at the Vogtle Electric Generating Plant site (the "VEGP site"). I have reviewed excerpts of the Final Environmental Impact Statement (NRC000001), SNC's feasibility study on the Air Cooling Condensation ("ACC") system, attached as JTI000034, and related documents submitted in this matter. I have also reviewed the prefiled direct testimony of SNC expert James W. Cuchens and Staff experts Lance Vail, Michael T. Masnik, and Jill S. Caverly, as they pertain to the dry cooling alternative.

Q2: Mr. Vail and Ms. Caverly, in answer 8 of their prefiled testimony, stated that "[t]he effect of the humidity ... makes it easier for wet cooling systems to obtain a lower temperature of cooling water being returned to the condenser in most conditions." Mr. Vail and Ms. Caverly further stated in answer number 9 of their prefiled testimony, that as a result of this lower cooling temperature, the wet cooling system will "operate at a higher electrical generation efficiency." Based on your knowledge and experience of power generation, and cooling technology issues and implementation, is this an accurate statement? What would the actual MW differential be between a wet cooling system and a dry cooling system? (Exhibit JTIR00049)

A2: There is a small difference in the output of closed-cycle wet cooled plants and dry cooled. This difference is most significant at high ambient air temperatures. As noted in my earlier testimony, using the example of a 500 MW coal-fired power plant, the average annual efficiency penalty would be 1.5%. Using a nuclear plant example, Dominion Nuclear has proposed to build the 1,560 MW (net) North Anna 3 reactor using a combination of wet and dry cooling. The Final Environmental Impact Statement for the North Anna 3 and 4 ESP states that "*Under favorable meteorological conditions, the entire excess heat load from Unit 3 would be dissipated using closed-cycle dry cooling towers*." (Exhibit JTIR00050). The document goes on to state that *"Dominion's combination wet and dry cooling system would have an energy efficiency penalty of 1.7 to 4 percent."* (Exhibit JTIR00050). The maximum efficiency penalty identified for North Anna 3, presumably when operating with 100% dry cooling, is 4 percent. This is analogous to an automobile that achieves 25 mpg with a water-cooled engine achieving 24 mpg with an air-cooled engine. This is a relatively small change in overall plant efficiency.

Q3: Mr. Powers, in answer number 26 of Mr. Cuchens' testimony, he stated your evaluation of the thermal cycle efficiency "lacks merit." He further stated that "I do not say that the loss of efficiency at the AP1000 Nuclear Plants in Augusta, Georgia would amount to only 0.5 percent." Can you please explain how you derived a 1.5% efficiency penalty for the thermal cycle efficiency at Plant Vogtle?

A3: The standard in the industry when discussing the impacts on plant efficiency of different types of cooling systems is to the impact on heat rate. For example, if the annual average energy efficiency penalty of dry cooling is 1.5 percent on a plant with a wet tower design heat rate of 10,000 Btu/kW, the design heat rate with dry cooling would be 10,150 Btu/kW. However, a plant with a design heat of 10,000 Btu/kW only has a thermal efficiency of 34 percent (3,416 Btu/kWh/10,000 Btu/kWh). A 1.5% reduction in heat rate translates into a 0.5 percent reduction in the overall thermal efficiency of the plant [((34% x (1-0.015)) = 33.5%]. As Mr. Cuchens pointed-out, this is nothing more than semantics.

Q4: Mr. Powers, Mr. Vail, Ms. Caverly and Mr. Masnik, argued in answer number 11 of their prefiled testimony, that there are disadvantages of the dry cooling system, associated with "land use, fuel use, spent fuel transport, and spent fuel storage." The Staff argues that the cost of the implementation of the dry cooling system is prohibitive. Is dry cooling a cost effective and practical alternative to the proposed wet cooling system? (see A25, 31, 35 Powers Decl.)

A4: Yes, a dry cooling system is a cost effective and practical alternative to the proposed wet cooling system. The Staff has not performed a full evaluation of the cost and technical feasibility of implementation, as noted in answers 14 and 25 of their prefiled direct testimony. Overall, dry cooling is a practical alternative to the proposed wet cooling system, especially in light of the drought conditions in South Georgia. The potential for drought will likely compromise the availability of water necessary for a wet cooling system, especially during the summertime high demand period. This factor alone compromises the reliability of the wet cooling system, making dry cooling a more preferable system. Dominion Nuclear states that a particular advantage for a dry-cooled nuclear plant is its ability to continue to operate during periods of drought. Dominion states "*Resulting Performance – When you really need it, the system can perform – long droughts*." (Exhibit JTIR00049)

Furthermore, simpler systems tend to be more reliable systems. In this case, an air-cooled condenser (ACC) design is simpler than the standard AP1000 design based on steam turbine surface condensers and wet cooling towers. An ACC design would incorporate high backpressure steam turbines. High backpressure turbines are simpler and less expensive than the proposed, standard backpressure turbines.

Q5: Mr. Powers, Mr. Vail, Ms. Caverly and Mr. Masnik, in answer number 11 of their prefiled testimony, stated "dry cooling systems involve very large heat-exchange surface areas that would require more land area than an equivalent capacity natural-draft or mechanical-draft cooling system." Is a natural/mechanical-draft system comparable to that of a wet cooling system in the land area it will require?

A5: A dry cooling system would require more surface area than a system based on wet cooling towers. For equivalent cooling capacity, the dry cooling system would require about three times as much surface area. (Exhibit JTIR00049). However, arguments against dry cooling at the Vogtle site are based on the presumption advanced by Mr. Cuchens that the dry cooling system would be spectacularly oversized at 324 cells. In reality, the best balance between cost and performance, an ACC with an ITD of 35 oF, would consist of approximately 200 cells and require only about 60 percent of the land area necessary for the 324-cell unit.

Q6: Mr. Powers, Mr. Cuchens claims in answer 13 of his prefiled direct testimony that a dry cooling system would be impractical and uneconomical when utilized with the AP1000's current standard plant design. Specifically he stated, "while I would not say that a high backpressure turbine and/or an air-cooled system could never theoretically be used with any kind of AP1000 plant design, I would say that it cannot be used with the <u>current</u> AP1000 standard plant design, as proposed ..." Based on your expertise and familiarity with the AP1000 standard design, does Mr. Cuchens' proposal outline the only possible design that could incorporate a dry cooling system? Is it indeed possible to substitute a high backpressure turbine in the standard AP1000 design? (see A28, A31, Powers, Decl. ¶13, Testimony A23)

A6: Mr. Cuchens' standard design with standard backpressure turbines, as proposed, is definitely feasible. However, he offers a flawed analysis of the feasibility of high backpressure turbines. Cuchens stated in answer 13, "I am not aware of any turbine manufacturer that offers a triple-exhaust turbine capable of handling the steam flows that would be associated with the current AP1000 steam cycle if the reactor used dry cooling", is in error. The GE-ESBWR reactor is larger than the AP1000, 1,560 MW net versus 1,117 MW net, and GE can provide a 100% air-cooled version of the GE-ESBWR nuclear plant. The GE_ESBWR steam turbine is a triple-exhaust turbine, just like the AP1000 steam turbine (Exhibit JTI000051). The GE-ESBWR reactor has been proposed by Dominion Nuclear for the North Anna 3 plant in Virginia. The GE-ESBWR reactor is larger than the AP1000, 1,560 MW net versus, 1,154 MW net, and GE can provide a 100% air cooled version of the GE-ESBWR nuclear plant. A condition of the

NRC Early Site Permit for North Anna 3 and 4 is that North Anna 4, if built, will be 100% dry cooled at all times (Exhibit JTI000052). It is not credible that GE can design and build much larger nuclear plants using 100% dry cooling and Westinghouse can not apply air cooling on the AP1000.

Furthermore, high backpressure turbines are simpler in design, and in this case, simple means less expensive. Based on a conversation I had with Charles Jones of General Electric on July 26, 2002 regarding the adaptation of a standard backpressure turbine to a high backpressure turbine, it seems that the SNC will be able to save money on the steam turbine portion of their design if they implemented the triple-exhaust, high backpressure turbines. Finally, a high backpressure turbine can be easily substituted in the design of the AP1000, as it is shorter than the standard backpressure turbine and therefore requires less space, without constraining other engineering or financial feasibility aspects of the plant.

Q7: Mr. Powers, Mr. Cuchens stated in answer 13 of his prefiled testimony that in determining the feasibility of high back-pressure turbines, "Mr. Powers appear[s] to extrapolate from experience significantly smaller generating units." How do you respond?

A7: The fact that the 1,560 MW North Anna 3 steam turbine will be capable of operating on 100 percent air cooling negates Mr. Cuchens implication that there is a bright-line steam turbine size above which air cooling is impractical. Mr. Cuchens implies this bright-line is a steam turbine bigger than the 660 MW steam turbines at the air-cooled Matimba plant in South Africa, which have been operating on 100 percent air cooling for many years, but less than the 1,117 MW AP1000 steam turbine at Vogtle. This is wrong, as demonstrated by the NRC's Early Site Permit (ESP) for North Anna 3 and 4. Dominion Nuclear proposed to build North Anna 4 as a dry-cooled only plant. That is a condition of the NRC's ESP for North Anna 3 and 4 (Exhibit JTI000052).

Q8: Mr. Powers, in answer number 14 of Mr. Cuchens' prefiled testimony stated that you do not provide any examples of a nuclear power plant that utilizes a dry-cooling system. However, you did not provide several examples of natural-gas and coal-fired power plants that have successfully implemented dry-cooling systems. Can you please explain why, though the examples you provided were not of nuclear power plants, the comparison is still relevant?

A8: Nuclear plants, coal plants, and natural gas combined cycle plants generate heat in different ways to boil water and create steam. Yet all three types of plants direct this steam to a steam turbine connected to an electric generator to generate power. The dry cooling system would serve the steam turbine, the common element to each plant type. As is clear in the case of North Anna 3 and North Anna 4, there are no scale-up issues related to the use of dry cooling on the AP1000 steam turbine.

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 February 6, 2009.

<u>Executed in Accord with 10 C.F.R. 2.304(d)</u>
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