NRC Staff Responses to Licensing Board's Questions Regarding Safety Matters

<u>**Note**</u>: Citations to the "ASER" refer to the Advanced Safety Evaluation Report with no Open Items (Nov. 2008) unless otherwise noted. Citations to the Site Safety Analysis Report ("SSAR") in the Vogtle Early Site Permit application refer to Revision 4 of the SSAR submitted by Southern Nuclear Operating Co. ("Southern," "SNC," or "applicant").

Question No. 1, ASER Sections 2.1.2.1 2.1.2.3, Pages 2-4, 2-6: *What measures will be in place, other than posting No Trespassing signs, to monitor and control access into the Exclusion Area?*

Response No. 1 (Tammara): The guidance provided in Section 2.1.2 of Review Standard RS-002, "Processing Applications for Early Site Permits" (May 3, 2004), and also in SRP Section 2.1.2, "Exclusion Area Authority and Control," of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," ("SRP") states that the applicant's legal authority and control to determine all activities within the designated exclusion area for the proposed ESP site should be reviewed. In accordance with the regulatory requirements of 10 CFR 100.3, the reactor licensee should have the authority and control to determine all activities within the designated exclusion area including the exclusion or removal of personnel and property. In ESP SSAR Section 2.1.2, the applicant stated that it has the ownership of the entire plant exclusion area, including complete authority to regulate any and all access and activity within the entire plant exclusion area. The applicant also stated that the perimeter of the Vogtle Electric Generating Plant ("VEGP") exclusion area boundary ("EAB") is adequately posted with "No Trespassing" signs on land as well as with signs along the Savannah River that indicate the actions to be taken in the event of emergency conditions at the plant. In addition, the applicant stated that there are no state or county roads, railways, or waterways traversing the VEGP exclusion area. The only facilities within the EAB which are unrelated to nuclear plant operations (the visitors' center and Plant Wilson) have been authorized by and are controlled by the applicant. No specific measures other than posting "No Trespassing" signs, to monitor and control access into the EAB are addressed by the applicant.

On the basis of the applicant's information provided in the VEGP ESP application SSAR, the Staff finds that the applicant has the complete authority and control of entire plant EAB. Accordingly, and as the EAB is not a considered a Restricted/Secured Area, additional specific measures to monitor and control access into the EAB are neither required by NRC's regulations nor is such monitoring warranted by the potential for intrusion. Moreover, the EAB is the same for the operating Units 1 and 2, which would have physical security measures and procedures in place that may provide additional assurance from intrusion and trespassing activities.

Question No. 2, ASER Sections 2.2.1.3, 2.2.2.3, Pages 2-15, 2-22: *Will there be any ongoing monitoring to ensure that the level of hazard from barge, rail, and highway shipments does not increase in the future?*

Response No. 2 (Tammara): No ongoing NRC monitoring of these levels of hazard is anticipated. However, as explained below, changes in these hazard levels might need to be evaluated pursuant to 10 CFR 52.39.

The guidance provided in Section 2.2.1-2.2.2 of Review Standard RS-002, and in SRP Section 2.2.1-2.2.2, "Identification of Potential Hazards In Site Vicinity," of NUREG-0800 calls for adequate descriptions of the nature and extent of activities conducted at the site and nearby facilities, including the products and materials likely to be processed, stored, used, or transported, to be provided to permit identification of possible hazards. Pursuant to this guidance, all identified facilities and activities within 8 kilometers (5 miles) of the plant should be reviewed. Facilities and activities at greater distances should be considered if they otherwise have the potential to affect safety-related features of the nuclear power plant(s) that might be constructed on the proposed site. For sites with existing plants, nearby industrial, military and transportation facilities and transportation routes will be reviewed for any changes or additions which may affect the safe operation of the nuclear power plant(s) that might be constructed on the proposed site. If these changes alter the data or assumptions used in previous evaluations or demonstrate the need for new ones, appropriate evaluations will be performed.

In ESP SSAR Section 2.2.2, the applicant provided descriptions of roads, railroads, and waterways and performed analyses to evaluate the impact on the proposed ESP Units for potential accidents resulting in an explosion, flammable vapor cloud explosion, or toxic chemical releases due to these transportation routes. Since the Savannah River above the VEGP site is primarily used for recreational purposes, and because of the lack of commercial facilities and barge slips/docks, there is no current or projected barge traffic of hazardous chemicals on the Savannah River past the VEGP site; therefore, barge transport hazards are not evaluated. The nearest highway with commercial traffic is Georgia State highway 23. The primary commercial traffic on this highway consists of transport of timber and wood products. Based on a traffic corridor evaluation, the applicant concluded that the only hazardous chemicals transported by truck on this highway are gasoline and diesel/fuel oil. The potential hazards due to these chemicals are evaluated for the ESP application. Based on the most recent information obtained from CSX railroad, cyclohexane, anhydrous ammonia, carbon monoxide, and elevated temperature material liquids (“ETMLs”) were considered and evaluated for the ESP application.

No ongoing monitoring is proposed for hazardous chemical shipments by barge, road or rail.

On the basis of the information in the FSAR and the Staff's consultation with the local and state government officials during the site visit, the Staff finds that nearby industrial growth potential is expected to be minimal, and potential increases of hazardous shipments via barge, road and rail are not anticipated. Therefore the Staff considers that specific provisions for monitoring of hazardous shipments is neither required nor warranted for approval of the ESP. However, should there be new chemical facilities constructed in the future or should there be any significant increases in hazardous shipments, new evaluations would be performed in accordance with 10 CFR 52.39.

Question No. 3, ASER Section 2.3.1.3.1, Table 2.3.1-1, Pages 2-28, 2-29, 2-43: *Why was the meteorological data recorded by the existing Vogtle plant meteorological tower not used as a data source?*

Response No. 3 (Harvey): The Vogtle Units 1 & 2 onsite meteorological tower was not listed in ASER Table 2.3.1-1 as a climatic data source because the submitted 5-year period of record is not long enough to define climatic extremes for the Vogtle ESP site. ASER Table 2.3.1-1 identifies the nearby weather stations used by the applicant, in addition to those used by the Staff, to review the regional climatology of the proposed Vogtle ESP site. ASER Section 2.3.1.3.1 states that the weather stations listed in ASER Table 2.3.1-1 are within 50 miles of the site and have periods of record greater than 10 years.

The applicant submitted 5-years (1998-2002) of onsite meteorological data; the selection and use of this period meets criteria set forth in Regulatory Guide 1.23, Revision 1, "Meteorological

Monitoring Programs for Nuclear Power Plants," for an early site permit:

> The minimum amount of onsite meteorological data to be provided at the time of application … for an early site permit … is a consecutive 24-month period of data that is defendable, representative and complete, but not older than 10 years from the date of the application. However, 3 or more years of data are preferable and, if available, should be submitted with the application.

Although the applicant's data met the criteria in this guidance, this 5-year period of record is not long enough to define climatic extremes for the Vogtle ESP site. Section 2.3.1, "Regional Climatology," of Attachment 2 to Review Standard RS-002 states that data on severe weather phenomena should be based on standard meteorological records from nearby representative National Weather Service ("NWS"), military, or other stations recognized as standard installations which have long periods of record. Accordingly, the applicant used long-term temperature and atmospheric moisture data from the National Weather Service station in Augusta, GA to determine the ambient air temperature and humidity site characteristics presented in SSAR Section 2.3.1.

The Staff compared the onsite meteorological data with offsite sources to determine the appropriateness of the Augusta climatic data to be used for design considerations. ASER Section 2.3.3.3.2 discusses a comparison of hourly data from the Vogtle application with concurrent data from the Augusta NWS. Because the Staff found a reasonable correlation between the Augusta data and the Vogtle onsite data, the Staff concludes that the long-term temperature and atmospheric moisture data from Augusta are appropriate for determining the ambient air temperature and humidity site characteristics for the Vogtle ESP site.

Question No. 4, ASER Section 2.3.1.3.4, Page 2-36: *The ASER states that "[t]he applicant stated that the [passive cooling system (PCS)] is not significantly influenced by local weather conditions." This statement does not appear to be independently verified in the ASER. Is there a reference to the AP1000 design certification document (DCD), SER, or some other document that would provide independent verification of this conclusion?*

Response No. 4 (Harvey): Many plants use a cooling tower as an Ultimate Heat Sink (UHS) to dissipate residual heat after an accident. Instead of using a cooling tower to release heat to the atmosphere, the AP1000 design uses a passive containment cooling system (PCS) to provide the safety-related UHS. The applicant describes the AP1000 PCS design in SSAR Section 2.3.1.4 and contends that the use of the PCS in the AP1000 design is not significantly influenced by local weather conditions as compared to the use of a cooling tower.

Details regarding the description, design basis, and operation of the AP1000 PCS are provided in AP1000 DCD Tier 2 Section 6.2.2. Section 6.2.2.1 states that the PCS is designed to withstand the effects of natural phenomena such as ambient temperature extremes. Revision 15 of DCD Tier 2 Section 6.2.2.3 further states that the containment pressure analyses are based on an ambient air temperature of 115 °F dry bulb and 80 °F coincident wet bulb; these are the maximum safety air temperature site parameter values listed in Revision 15 of DCD Tier 1 Table 5.0-1 and DCD Tier 2 Table 2-1.

Therefore, regardless of whether the PCS is significantly influenced by local weather conditions, the PCS is designed to withstand the maximum safety dry bulb and coincident wet bulb air temperature site parameters specified in the AP1000 DCD. Pursuant to 10 CFR 52.79(b)(1), the COL applicant referencing the Vogtle ESP will need to demonstrate that the air temperature site parameter values specified in the design of the facility ultimately selected bound the corresponding air temperature site characteristics specified in the ESP.

Question No. 5, ASER Section 2.3.1.3.5, Pages 2-36 to 2-39: *Site Safety Analysis Report (SSAR) Table 1-1 (at 1-12 to 1-13) provides data for the maximum dry bulb (DB), minimum DB, maximum wet bulb (WB), and site temperature basis for the AP1000. Why are the AP1000 limits below the limits specified for the site? What are the implications of this? If there is a coincidence limit (i.e., maximum DB and coincident WB) required for the AP1000, why is this not specified for the site as well in Table 1-1?*

Response No. 5 (Harvey): All the ambient air temperature site characteristic values presented by the applicant in SSAR Table 1-1, including the "site temperature basis for AP1000" values, are *site characteristic values* that are applicable to the Vogtle ESP site. These values were derived by the applicant using meteorological data from Augusta, GA. The "site temperature basis for AP1000" values listed in SSAR Table 1-1 are intended to directly correspond to the air temperature site parameters listed in AP1000 DCD Revision 15 Tier 1 Table 5.0-1 and DCD Tier 2 Table 2.1. Pursuant to 10 CFR 52.79(b)(1), the COL applicant referencing the Vogtle ESP will need to demonstrate that the design of the facility ultimately selected falls within the site characteristics and design parameters specified in the ESP. If the COL final safety analysis report does not demonstrate that the design of the facility falls within the site characteristics, the COL application needs to include a request for a variance from the ESP that complies with the requirements of 10 CFR 52.39 and 10 CFR 52.93.

Some of the "site temperature basis for AP1000" site characteristics values are different from the "maximum DB" and "maximum WB" site characteristic values. These differences may occur for one of two reasons:

- The two sets of site characteristic values are based on different exceedance levels. For example, the maximum normal “site temperature basis for AP1000” site characteristic values are 1% exceedance frequencies whereas the “maximum DB” and “maximum WB” site characteristic values are based on different exceedance frequencies (e.g., 2%, 0.4%) as listed in SSAR Table 1-1.

- The two sets of site characteristic values are based on different averaging times. For example, the maximum safety non-coincident WB “site temperature basis for AP1000” site characteristic value is intended to be a historical value which excludes peaks of less than 2 hours duration whereas the 100-year return period “maximum WB” site characteristic value is based on a maximum recorded value.

AP1000 DCD Tier 1 Table 5.0-1 and DCD Tier 2 Table 2-1 do specify maximum DB and coincident WB air temperature site parameter values. The applicant has specified corresponding maximum DB and coincident WB “site temperature basis for AP1000” site characteristic values in SSAR Table 1-1 in order to enable comparison with the DCD air temperature site parameter values at the COL stage.

Question No. 6, ASER Section 2.3.1.3.5, Pages 2-38, 2-39: *What is the relationship between the AP1000-specific and the site-specific temperature characteristics? What is the limiting factor in determining the AP1000-specific temperature and humidity limits, if it is not the ultimate heat sink (UHS) performance?*

Response No. 6 (Harvey): The applicant provided site-specific (i.e., maximum dry bulb, minimum dry bulb, maximum wet bulb) air temperature characteristics that are meant to encompass many potential designs and corresponding site parameters. Since the applicant expressed an interest in the AP1000 design, the applicant also identified site-specific “site temperature basis for AP1000” air temperature characteristics that directly correspond to the air temperature site parameters presented in the AP1000 DCD. Some of the AP1000-specific air temperature characteristics differ from the other site-specific air temperature characteristics because they are based on different exceedance levels or averaging times, as discussed in the Staff's response to Question #5 above. However, all of the applicant's air temperature site characteristics are based on data from nearby Augusta, GA. Pursuant to 10 CFR 52.79(b)(1), the COL applicant referencing the Vogtle ESP will need to demonstrate that the design of the facility ultimately selected falls within the site characteristics and design parameters specified in the ESP. This means that should the COL applicant select the AP1000 design, the COL applicant would need to show that the air temperature site parameters presented in the AP1000 DCD bound the "site temperature basis for AP1000" air temperature site characteristics specified in the ESP.

The Staff does not know what the limiting factors are in determining the AP1000 DCD air temperature site parameters. However, the Staff notes that the AP1000 DCD air temperature site parameters are used in the safety system design basis for a number of AP1000 systems. For example, Westinghouse has increased the AP1000 maximum safety wet bulb temperature site parameters in DCD Revision 17 from 80 °F to 86.1 °F (coincident) and from 85.5 °F to 86.1 °F (non-coincident). Westinghouse performed evaluations for the various systems that were impacted by this change to demonstrate that these proposed changes to the DCD are acceptable; these changes are presently under Staff review as part of the AP1000 design certification amendment proceeding. The results of Westinghouse's evaluations are presented in the AP1000 DCD Impact Document Submittal of APP-GW-GLE-036 (ADAMS Accession No. ML081830146). The systems that Westinghouse reviewed included:

- passive containment cooling system
- normal residual heat removal system – in-containment refueling water storage tank cooling
- spent fuel pool cooling – partial core shuffle and full core off-load
- service water system – plant cooldown/shutdown
- component cooling water – normal operation, normal plant cooldown, and refueling

- central chilled water system – normal operation
- nuclear island non-radioactive ventilation system

The Staff does not know which of these evaluations was the limiting factor in determining the AP1000 DCD air temperature site parameter values. Regardless of which of these evaluations is considered "limiting," the AP1000 design will be acceptable for the Vogtle ESP site if the COL applicant can demonstrate that the air temperature site parameters presented in the AP1000 DCD bound the "site temperature basis for AP1000" air temperature site characteristics specified in the ESP.

Question No. 7, ASER Section 2.3.4.3.1, Page 2-68: *The staff states relative to atmospheric dispersion estimates that it used the PAVAN input model provided by SNC. Did the staff perform an independent review of the entire input deck before using it, or did it review only the key assumptions discussed in the ASER?*

Response No. 7 (Harvey): The applicant provided a copy of the PAVAN input file used to compute the short-term X/Q values in response to RAI 2.3.4-5. The Staff qualitatively reviewed all the inputs to the PAVAN model (e.g., wind speed, wind direction, and atmospheric stability joint frequency distribution; release height; building wake dimensions; distances to the exclusion area boundary and outer boundary of the low population zone) and found the inputs to be consistent with the site configuration and guidance provided in Regulatory Guide 1.145, Revision 1, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants." For example, the distances to the exclusion area boundary and outer boundary of the low population zone were consistent with those described in the SSAR and met the criteria specified in Regulatory Guide 1.145.

Question No. 8, ASER Section 2.3.5.3.4, Table 2.3.5-2, Pages 2-79, 2-80: *Is the staff comfortable with the comparative differences between the current analysis results and the Vogtle Units 1 & 2 results? Please explain why or why not?*

Response No. 8 (Harvey): The Staff is comfortable with the comparative differences between the proposed Vogtle ESP long-term atmospheric dispersion site characteristic values presented in ASER Table 2.3.5-2 and the corresponding values for Vogtle Units 1 & 2 as discussed below.

ASER Table 2.3.5-2 presents the maximum long-term atmospheric dispersion (χ/Q) and deposition (D/Q) factors for the dose calculation Exclusion Area Boundary (EAB) and receptors-of-interest (i.e., resident, meat animal, and vegetable garden). The applicant used these data in SSAR Section 11.3.3 to calculate doses to the maximally exposed individual (MEI) due to routine gaseous releases to the environment from normal plant operation. Atmospheric dispersion and deposition factors for similar purposes are presented in Vogtle Units 1 & 2 FSAR Section 2.3.5 and Vogtle Units 1 & 2 Offsite Dose Calculation Manual (ODCM) Sections 3.3 and 3.4.

The Vogtle Units 1 & 2 FSAR and ODCM and the Vogtle Units 3 & 4 SSAR all derived their long-term χ/Q and D/Q values using the methodology outlined in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors." Nonetheless, the SSAR site boundary and receptors-of-interest χ/Q and D/Q values are higher (more conservative) than the corresponding FSAR and ODCM χ/Q and D/Q values. The Staff is comfortable with these differences because of differences in release pathway and receptor location assumptions. For example:

- The FSAR and ODCM present χ/Q and D/Q values for two release pathways: the plant vent and the turbine building vent. The plant vent is treated as a mixed-mode release (e.g., part-time ground and part-time elevated) and the turbine building vent is treated as a ground-level release. Mixed-mode releases generally have lower (less conservative) χ/Q and D/Q values at relatively flat terrain sites such as the Vogtle ESP site. By contrast, the SSAR presents only one conservative set of χ/Q and D/Q values for a ground-level release pathway.

- The FSAR and ODCM site boundary receptor locations are based on distances from the midpoint between the Unit 1 and Unit 2 reactors and vary as a function of direction sector from 1097 meters to 2240 meters. By contrast, the SSAR site boundary (dose calculation EAB) receptor locations are conservatively set at 800 meters downwind for all direction sectors.

- The FSAR and ODCM locations for the receptors-of-interest are based on land use census results. For example, the FSAR identified residences in only 8 out of 16 direction sectors at distances ranging from 1931 meters to 7483 meters. By contrast, the SSAR distances to all of the receptors-of-interest are based on the distance to the nearest resident in any of the 16 direction sectors (1071 meters); that is, 1071 meters was conservatively used in all direction sectors for all the receptors-of-interest.

Accordingly, for the reasons discussed above, the Staff is comfortable with the comparative differences between the proposed Vogtle ESP long-term atmospheric dispersion site characteristic values presented in ASER Table 2.3.5-2 and the corresponding values for Vogtle Units 1 & 2.

Question No. 9, ASER Section 2.4.2.4, Page 2-92: *What is the significance of differentiating between "flooding causal mechanisms" and "the controlling flooding mechanism"? Also, for the purpose of the flooding evaluation, how is "in the vicinity of the site and site regions" defined?*

Response No. 9 (Ahn, Prasad): “Flooding causal mechanisms” refer to the set of those hydrometeorological, geoseismic, or structural failure phenomena that can produce a flood at or near a site. The “controlling flooding mechanism” is one among the various “flooding causal mechanisms” that results in the most severe flooding hazard to the site. This most severe flood is also called the design basis flood since all safety-related SSCs should be designed to withstand hazards from this flood.

The term “in the vicinity of the site and site regions” refers to the geographical area which is relevant in determination of flooding hazard at the site. The extent of the vicinity of the site and site regions that must be considered for the determination of flooding hazard is also dependent on these causal phenomena. For both rainfall-induced river flooding and dam break flooding at the Vogtle site, the vicinity that was considered covers about 7,900 square miles within the drainage basin of the Savannah River upstream from the Vogtle ESP site. The downstream portion of the drainage basin extending from the site to the Atlantic coast, covering approximately 2,700 square miles, was considered as the vicinity of hurricane storm surge and tsunami runup flooding. The Atlantic Ocean and the Caribbean Sea including coastal areas on their rims were considered as the vicinity for tsunami generation and propagation. Causal mechanisms active in these geographical areas may produce a flood that propagates to or near the site and therefore need to be considered for the determination of the controlling flooding mechanism.

The Staff reviews the flood anticipated to be produced by each of the relevant causal phenomena for a given site. The Staff guidance in RS-002 and guidance from the American Nuclear Society (ANS 1992), as well as relevant hydrometeorological reports produced by the National Oceanic and Atmospheric Administration’s National Weather Service and engineering manuals and hydrologic modeling software of the U.S. Army Corps of Engineers, are followed and used during this review to determine the controlling flooding mechanism and the design basis flood. The Staff also considered the floods caused by combined effects by superimposing different but concurrent flood causal mechanisms, antecedent conditions, and the action of coincident wind waves.

Reference:

American Nuclear Society, 1992. ANSI/ANS-2.8-1992: Determining Design Basis Flooding at Power Reactor Sites. American Nuclear Society Standards Committee Working Group ANS-2.8. La Grange Park, Illinois.

***Question* No. 10, ASER Section 2.4.2.4, Page 2-92:** *Expand on how historical data were used to determine the key hydrological parameters such as the Probable Maximum Flood, Design Basis Flood, and flooding causal and controlling mechanisms. Review the basis for judging that the added margins were sufficient to account for the uncertainty of the historical record of measurements.*

Response No. 10 (Ahn, Prasad): An inspection of historical data may reveal the flooding causal mechanisms that should be considered for a site. For example, an inspection of air temperature data may suggest potential for formation of ice jams or dams, the subsequent collapse of which may generate a flood. More relevant are an inspection of the hydrology, topography, morphology, and geology and the presence of any water control structures in the vicinity of the site (e.g., a site located on the banks of a river should be investigated for the probable maximum flood ("PMF") in the river; a site that has several upstream dams should be analyzed for floods from cascading dam failure).

The Staff used both of these approaches to determine the flooding causal mechanisms for the Vogtle site and concluded that the following mechanisms should be considered: (1) flooding at the immediate plant site due to local intense precipitation, (2) PMF in the Savannah River near the Vogtle site, (3) flooding due to cascading dam failures upstream of the site, (4) flooding induced by hurricane storm surges in the Savannah River estuary, (5) flooding from tsunamis in the Atlantic Ocean and the Caribbean Sea, (6) flooding induced by ice events, and (7) flooding due to the Savannah River diverting towards the Vogtle site. For the first three mechanisms listed above, an inspection of the hydrology and the presence of upstream dams were used to determine their relevance to flooding at and near the Vogtle site.

Both the applicant and the Staff used historical data to estimate flooding levels for the flood causal mechanisms considered or to cross-check the estimated hypothetical flooding levels for those mechanisms. The PMF is a hypothetical flood estimated from the probable maximum precipitation ("PMP"). The PMP is defined as the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year (Hydrometeorological Report (HMR)-51, 1978). The National Oceanic and Atmospheric Administration's National Weather Service published many HMR reports for different geographical regions in the U.S.A., in which they used historical extreme precipitation data along with theoretical methods for moisture maximization, transposition, and envelopment to estimate generalized PMP. The PMP therefore has sufficient margin to account for the historically-observed extreme precipitation events. The method for estimating the PMP for a given drainage basin is outlined in the relevant HMR reports. The applicant and the Staff estimated the PMP in the Savannah River Basin using the method described in HMR-51 (1978). The Staff estimated the PMF from the estimated PMP using very conservative hydrological conditions (no precipitation loss and instantaneous translation of runoff to the stream network) that favor maximization of flooding. The margins inherent in the PMP coupled with the conservative conditions for runoff generation would sufficiently account for any floods observed in the Savannah River near the Vogtle site. As explained below, however, the PMF was not the controlling flooding mechanism for the Vogtle site and therefore did not result in the design basis flood.

Historical hurricane track data were used to determine if hurricane storm surges should be considered for the Vogtle site. Historical tsunami data were used to determine the likelihood of a tsunami event near the Savannah River estuary. Historical air temperature data from nine stations near the Vogtle site were used to assess the likelihood of ice formation. Historical and current topographic, morphologic, and hydrologic information near the Vogtle site was used to determine the likelihood of flooding caused by river diversions in the drainage basin.

The Staff determined that a cascading dam failure scenario upstream of the site would produce the design basis flood because the dam failure flooding generates the highest flooding level among all considered flooding causal mechanisms. For the dam failure flooding analysis, both the applicant and the Staff used the dam failure parameters, including width and height of dam breaches, which were estimated by the empirical equations (USBR, 1996) derived from the historically-recorded dam failures in the United States. Then, the hypothetical cascading dam failure scenario was selected based on the maximum flood volume that would be generated upstream of the site and subsequently would be propagated to the Vogtle site.

Finally, historical flood elevations in the Savannah River were compared with the flood elevations corresponding to the design basis flood in order to determine that the most extreme historical flood, plus a margin based on the uncertainty in the historical record of measurement, would not result in a flood more severe than the design basis flood. The applicant estimated, based on the historically-recorded data at the USGS gauging stations near the site, that the historical maximum stage of the Savannah River at the Vogtle site is 136.6 feet MSL. Based on the historical records, the applicant estimated the peak discharge at the site as approximately 2.3 million cubic feet per second (cfs) with a combined effects flood water surface elevation of

178.1 ft MSL. The Staff estimated a more conservative flood water surface elevation of 189.1 ft MSL with a corresponding discharge of approximately 2.5 million cfs at the site (SER Section 2.4.4.3.2); the value estimated by the Staff was higher because the Staff used the same dam failure scenario but with significantly (50%) more conservative breach parameters that would result in quicker release of the water stored behind the dam, thus increasing the severity of the flood. Therefore, the Staff concluded that the Vogtle site would remain dry in the event of the postulated bounding flood and that the applicant's estimate of 178.1 ft MSL as the maximum flood elevation was acceptable since it is based on the breach parameters estimated from the historical data-based empirical equations (USBR, 1996) that are currently accepted in engineering practice. The Staff's more conservative analysis serves as a sensitivity study.

The difference in flood water surface elevation estimated as the design basis, 178.1 ft MSL, and the maximum historically observed water surface elevation in the Savannah River near the site, 136.6 ft MSL, is more than 40 ft. Because the difference between the two is so significant and the estimated corresponding peak discharge during the hypothetical cascading dam failure being approximately 6.6 times greater than the historical peak flood discharge near the Vogtle site, the Staff concluded that the flood estimation procedures followed by the applicant and the Staff have sufficient margins to account for uncertainty in the historical flood records.

<u>References</u>:

(HMR-51) U.S. Department of Commerce, 1978, "Hydrometeorological Report No. 51, Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 51, Washington, D.C. (ADAMS Accession No. ML090150038)

U.S. Bureau of Reclamation, 1996, "Prediction of Embankment Dam Breach Parameters: Literature Review and Needs Assessment," Prepared by T.L. Wahl, USBR, Water Resources Research Laboratory, PAP-735, Denver, CO. (ADAMS Accession No. ML090150051)

Question No. 11, ASER Section 2.4.7.3.2, Page 2-131: *What is the basis for using 18° F as a baseline figure in the evaluation of the freezing hazard?*

Response No. 11 (Ahn, Prasad): The Staff used the manual published by the U.S. Army Corps of Engineers (USACE, 2002) for estimation of ice formation and effects of this ice on safety-related SSCs of nuclear power plants. The manual states that frazil ice in general is formed in turbulent, supercooled water, and that supercooled water is at a temperature below its equilibrium freezing point; for pure water the freezing point is, by definition, 32°F at atmospheric pressure. The supercooling takes place in lakes and rivers in turbulent, open-water areas when the air temperature is significantly less than 32°F. The manual states that usually an air temperature of 18°F or lower is required to form frazil ice. The above manual forms the basis for the Staff's use of 18°F as a necessary condition for the formation of frazil ice in open and turbulent waters.

<u>Reference</u>:

U.S. Army Corps of Engineers, 2002. "Engineering and Design - Ice Engineering," EM 1110-2-1612, U.S. Army Corps of Engineers, Washington, DC. (ADAMS Accession No. ML090150033)

Question No. 12, ASER Section 2.4.13.3.2, Page 2-172: *Is there evidence of chelating agents actually being present at the VEGP site? If not, what is the basis for the staff's conclusion that the possibility of their presence should be considered in evaluating contaminant transport?*

Response No. 12 (Ahn, Kincaid): The Staff is not aware of any data suggesting chelating agents are at the operating plants or in the environment around them; however, based (1) on the fact that Southern Nuclear Operating Company (SNC) stated that chelating agents had been used in the past and (2) the limited water chemistry monitoring data around the plants, the Staff can not preclude the possibility of chelating agents actually being present at the site currently. The basis for the Staff's determination to evaluate chelating agents with respect to contaminant transport is that SNC has not precluded the use of chelating agents in the future.

During the Safety Site Audit in January of 2007, the Staff asked the applicant about the presence or absence of chelating agents at the Vogtle site, and the potential for their mixing with the radiological liquid effluent that could be released into the environment. Southern Nuclear Operating Company (SNC) indicated that they thought chelating agents had been used in the past, but that they were no longer used at the Vogtle site. Subsequently, Staff submitted RAI 2.4.13-2 (NRC, March 15 2007) requesting that SNC discuss the process used to evaluate the potential for and the impact of the mixing of chelating agents (e.g., organic acids) with radiological liquid effluents at the Vogtle site.

The full RAI 2.4.13-2 request is as follows:

> Discuss the process used to evaluate the potential for and the impact of chelation and complexation agents (e.g., organic acids) to mix with radiological liquid effluents either within the facility or along the transport pathway in the environment outside the facility. In this discussion, make a clear statement regarding whether or not it is possible for any chelation agents to be mixed with radiological liquid effluents within the ESP facility.

In its response, SNC (SNC, April 16, 2007) stated:

> In the past, Vogtle has used chelating agents to enhance the treatment of wastewaters containing small amounts of radiological material. This routine practice was stopped a number of years ago, primarily because disposal facilities placed strict limits for certain agents on wastes being disposed in the low level radiological waste landfills. The site does not prohibit the use of chelants, but rather requires a comprehensive evaluation prior to use. Vogtle has a Chemical Control procedure that requires evaluation of any chemicals used on or in plant systems and approval before use. For example, a chelating agent (EDTA) was recently used in the Vogtle steam generator chemical cleaning project. This project required a detailed evaluation of all chemical use including waste disposal.
>
> Vogtle is [sic] strictly controls the use of chemicals, including chelating

> agents, to ensure the use or disposal of wastes resulting from use does not adversely impact plant systems or the environment. Any future use of chelating agents at Vogtle will be tightly controlled. It is not anticipated that chelating agents would be used in applications where they could come in contact with radiological materials, due to the problems that could result from the presence of chelating agents in waste requiring disposal. There is no provision in place at Vogtle for use of chelating agents to mitigate a spill containing radiologically contaminated liquids, and the possibility of inadvertent mixing of spilled radiological material with chelating agents is extremely remote.
>
> In summary, it would be extremely unlikely that a release of radiologically contaminated liquids could come in contact with chelating agents in a manner that would negatively alter the rate of transport for the spill and increase the time of travel to the nearest receptor.

Based on the SNC response, the Staff concluded that while chelating agents were previously used on site, their routine use has been discontinued; however, the response indicated that chelating agents could be used in the future. For that reason, as well as because the use of chelating agents has led to enhanced mobility and transport in groundwater at several DOE sites, the Staff felt that their presence should be considered in evaluating contaminant transport.

References:

Nuclear Regulatory Commission (NRC). March 15, 2007. Request for Additional Information Letter Number 6 – Southern Nuclear Operating Company Early Site Permit (ESP) Application for the Vogtle ESP Site, Site Safety Analysis Report (SSAR) Sections 2.4 and 2.5. Nuclear Regulatory Commission, Rockville, Maryland. (ADAMS Accession No. ML070660266)

Southern Nuclear Operating Company, Inc., (SNC). April 16, 2007. Southern Nuclear Operating Company Vogtle Early Site Permit Application Response to Requests for Additional Information Letter No. 6 Involving Hydrology, Southern Nuclear Operating Company, Inc., Birmingham, Alabama. (ADAMS Accession Nos. ML071080503 and ML071090098)

Question No. 13, ASER Section 3.5.1.6.3, Pages 3-2, 3-3: *The aircraft hazard associated with the Augusta Airport was based on the number of operations projected through 2025. Why wasn't a projection used that runs through the expected life of the new Vogtle units?*

Response No. 13 (Tammara): The applicant followed the guidance provided in Section 3.5.1.6 of Review Standard RS-002, and SRP Section 3.5.1.6, "Aircraft Hazards," of NUREG-0800, for the distance threshold for evaluating aircraft hazards due to nearby airports. The acceptance criteria for aircraft hazards are based on meeting the relevant requirements of 10 CFR § 52.17 and 10 CFR Part 100. RS-002, Section 3.5.1.6, specifies that these requirements are met if the probability of aircraft accidents having the potential for radiological consequences greater than the 10 CFR Part 100 exposure guidelines is less than about 10^{-7} per year. The probability is considered to be less than about 10^{-7} per year by inspection if the distance from the site meets all of the following criteria:

> 1. the site-to-airport distance (D) is between 5 and 10 statute miles and the projected annual number of operations is less than 500 D^2, or the site-to-airport distance (D) is greater than 10 statute miles, and the projected annual number of operations is less than 1000 D^2,
>
> 2. the site is at least 5 statute miles from the edge of military training routes, including low-level training routes, except for those associated with usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation, and
>
> 3. the site is at least 2 statute miles beyond the nearest edge of a Federal Airway, holding pattern, or approach pattern.

The applicant identified that the closest commercial airport is Augusta Regional Airport at Bush Field, which is located approximately 17 miles north-northwest of the VEGP site. Based on information obtained from the Federal Aviation Administration (FAA) for the projected number of operations up to year 2025, the applicant concluded that the total number of projected aircraft operations of 35,945 is substantially less than the threshold value of 289,000 determined from

1000 D^2. However, based on FAA data up to the year 2025, the Staff independently estimated the projected number of aircraft operations up to the life of plant operation period year 2070 (assuming a start year of 2030) as 63,405. This is also much less than the threshold value of 1000 D^2, confirming the acceptability of the Staff's conclusion.

In Section 2.2.2.6.2 of the SSAR, the applicant also identified airways within the vicinity of the proposed reactors. The Staff independently confirmed the locations of these airways. Airway V417 is about 12 miles northeast of the VEGP site, and Airway V70 is approximately 20 miles south of the VEGP site. However, the centerline of Airway V185 is approximately 1.5 miles west of the VEGP site.

Because, with respect to Airway V185, the VEGP site is within the two-mile limit specified in Section 3.5.1.6 of RS-002, the applicant performed a more detailed review of aircraft hazards associated with air traffic along the V185 Airway; and this analysis was presented in Section 3.5.1.6 of the SSAR. Due to the unavailability of traffic data for Airway V185, the applicant used the acceptable probability of 1×10^{-7} per year and back-calculated to determine the number of flights travelling along the airway that would give that acceptable probability, applying the guidance provided in Section 3.5.1.6 of RS-002 and NUREG-0800 for the determination of the aircraft hazard probability. The estimated number of flights along V185 was higher compared to the total number of flights that originated from Bush Field, and the applicant thereby concluded that Airway V185 is not a safety concern. To confirm that conclusion, the Staff obtained flight operations data from the FAA for Airway V185 for the years 2003 through 2006. From this data, the Staff found that approximately 10 percent of yearly flights to Airway V185 originated from Bush Field Airport (about 3000 flights per year). Assuming that 10 percent of the flights from the Bush Field Airport projected to the end of life of the plant (6341) travel along Airway V185, the estimated aircraft hazard probability due to Airway V185 would be 1.24 x 10^{-8} per year and would not pose a safety concern at the VEGP site. The Staff's analysis confirmed that the acceptable probability would not be exceeded by operations through the year 2070, the expected operational life of the new units.

Question No. 14, ASER Section 11.3.2, Page 11-5: *As referenced by the staff, in Table 11.2-1 of the SSAR (at 11.2-3), (a) what is the basis for using 0.1 hour as the transit time for the maximally exposed individual (MEI); (b) why is the 16-hour transit time for the average population reasonable; and (c) are the population numbers conservatively projected?*

Response No. 14 (Schaffer): SSAR Table 11.2-1 lists the transit time for liquid effluent releases in the Savannah River for both the maximally exposed individual (MEI) and the average population. The applicant used a short transit time (0.1 hour) for the MEI calculation to simulate a conservative scenario where the maximally exposed individual uses the river near the plant. By using this short transit time, the applicant simulated river concentrations just downstream from the plant discharge where there is little time for radiological decay to take place and reduce radionuclide concentrations significantly. By doing this, the applicant conservatively included short-lived radionuclides and higher radionuclide concentrations in its dose estimation.

The applicant used the 16-hour transit time for the population dose estimation to account for the fact that the average population considered extends 50 miles downstream from the plant and that some radiological decay will take place during the 50-mile transit. The applicant describes the basis for this transit time in the footnote to SSAR Table 11.2-1. Sixteen (16) hours is the amount of time required for effluent to travel half the 50-mile distance, resulting in a radiological decay time that is central for the entire population along the river. Estimating a decay time that is central to the entire population is a good approach for calculating population doses. The Staff agrees that this approach reasonably represents the liquid effluent concentrations for both individuals closer to and farther from the plant.

With respect to population projections, SSAR Table 11.2-1 also lists the population usage values for fish consumption and other recreational uses of the river. The applicant obtained these parameters from DOE's 2005 Savannah River Site Environmental Report. To test whether these values reasonably represent the usage for the area surrounding the site, the Staff estimated the entire population living in the various compass sectors on either side of the river out 50 miles from the site and multiplied this population by the usage values for the maximum individual in Regulatory Guide 1.109. The results were similar to the values used by the applicant (roughly within a factor of 6). In other words, if the entire 50-mile population living near the river used the river at the maximum rates, this usage would not be very different than that assumed by the applicant. Based on the test, the Staff believes that the population usage values in SSAR Table 11.2-1 are conservative, because only a small portion of the population will use the river at the maximum usage rates.

<u>Reference</u>:

U.S. Department of Energy, 2005 *Savannah River Site Environmental Report for 2005,* Washington Savannah River Company, 2006. Accessed from http://www.srs.gov/general/pubs/ERsum/er06/liqdos_05.htm, April 18, 2007.

Question No. 15, ASER Section 11.3.2, Page 11-5: *As referenced by the ASER, in Table 11.2-3 of the SSAR (at 11.2-5) why are the radioactive Iodine and Cesium isotope releases (and consequently the collective doses) so much higher for Units 3 and 4, as opposed to Units 1 and 2?*

Response No. 15 (Schaffer): The applicant derived radioactive iodine and cesium effluent concentrations for the existing units (Units 1 and 2) from actual annual releases measured during operations and documented in the annual effluent reports. For the proposed units (Units 3 and 4) the applicant obtained the iodine and cesium effluent releases from the AP1000 Design Control Document, in which Westinghouse used the GALE computer code, a predictive licensing model, to derive effluent releases. For reasons explained below, this code tends to over-estimate actual iodine and cesium releases, thereby providing a margin of safety for isotopes of these elements.

The GALE code applies conservative parameters that tend to artificially increase the concentration of radioactive iodine and cesium in the primary coolant and reduce the effectiveness of process and effluent treatment systems. In contrast, the concentrations of radioactive iodine and cesium in the primary coolant and the effectiveness of process and effluent treatment for Units 1 and 2 are based on operating data, which reflect actual reactor coolant chemistry and treatment system performance.

Question No. 16, ASER Section 11.3.2, Page 11-6: *Are the river flow rates used in the liquid pathway analysis, Table 11.3-1, still reasonable lower bounds in light of recent drought conditions in the area?*

Response No. 16 (Schaffer): Yes, the Staff found that the river flow rates listed in ASER Table 11.3-1 are reasonable and appropriate. These flows are the long-term average of the yearly river flows measured over many years, including drought years, by the USGS. The NRC's predictive dose models simulate radionuclide buildup from effluent discharges over many years. The long-term annual average flow is the most appropriate value to use in this case. Using drought flow is inappropriate for our modeling because we would be assuming long-term radionuclide buildup based upon short-term drought conditions.

Question No. 17, ASER Section 13.3: *Other than having a protected area boundary that surrounds all four reactor units, and full emergency response organization paging to handle multi-site accidents, is the staff treating each reactor on the site as an independent entity with respect to radiation releases and emergency response, or has the staff considered any other multiple unit emergency planning issues/responses relative to this four-unit site?*

Response No. 17 (Musico): In general, an onsite emergency plan applies to the entire reactor site, irrespective of the number of reactors. In regard to emergency response, the proposed onsite emergency plan for the Vogtle Units 3 and 4 is also applicable to the existing Units 1 and 2. The Staff's review and findings in the Advanced Safety Evaluation Report (ASER) apply to the proposed Units 3 and 4, and reflect the extension of elements of the existing Vogtle site emergency plan for Units 1 and 2 to the proposed new reactor units. As with other multiple unit sites, the Vogtle onsite emergency plan treats the Vogtle Electric Generating Plant (VEGP) as a single entity (or site). Various unit-specific reactor design and plant conditions are identified in the onsite plan, in regard to how events associated with a specific unit would lead to emergency response actions for the entire site.

For example, ASER Section 13.3.3.2.4, "Emergency Classification System" (at pages 13-33 through 13-38) describes the standard emergency classification and action level scheme for Units 1 and 2, versus Units 3 and 4. Initiating Conditions (ICs) represent a predetermined subset of (specific) plant conditions, which serve to initiate the emergency classification process for the affected unit. The ASER describes the detailed IC matrices that are shown in the tables in Annex V1, Section D.2, “Classification Process,” for Vogtle Units 1 and 2, and in Annex V2, Section D.2, “Emergency Class Description and Resources,” for Units 3 and 4. In addition, Table V2A2-1, “VEGP Units 3 and 4 SSAR Transient Table,” provides FSAR postulated transients (accidents) for various systems and identifies the corresponding emergency levels.

As such, each reactor on the site is treated by the onsite emergency plan (and by the Staff) as a subpart of the common VEGP emergency plan, with respect to how the unit-specific features (e.g., reactor systems, associated balance of plant, available staff) would affect actions that would be taken by both the affected and unaffected unit(s) during an emergency. In Part 5, “Emergency Plan,” of the Vogtle early site permit (ESP) application, the applicant states (on page V2-ii) the following:

> The VEGP Emergency Plan is designed to accommodate the unique features of the two unit designs used at the Site. A common VEGP Emergency Plan is supported by Annex V1 which contains the parts of the Emergency Plan that are unique to existing Units 1 and 2, and Annex V2 which contains the parts of the Emergency Plan that are unique to new Units 3 and 4 (i.e., the proposed Westinghouse Electric Company, LLC, AP1000 standard reactor plants). Each segment of the Emergency Plan is supported by Appendices that contain supporting information for each segment of the plan.

In regard to radiation releases, each reactor on a site is treated as an independent entity for emergency planning purposes. The affected (damaged) reactor unit would serve as the source of the radiation release, which would be used to perform an assessment of the potential or actual corresponding radiation exposures from the release. (*See also* Response Nos. 27 and 28.)

<u>Other Multiple Unit Issues</u>

The Staff has not considered any other multiple unit emergency planning issues or responses relative to the four-unit Vogtle site, beyond that which is described above and in Section 13.3, “Emergency Planning,” of the ASER. In regard to multiple unit sites, which would include the VEGP site, Appendix A to 10 CFR Part 50, entitled “General Design Criteria for Nuclear Power Plants,” Criterion 5, “Sharing of structures, systems, and components,” states the following:

> Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

Relative to consideration of multiple unit issues, and as part of the NRC’s preparation of an environmental impact statement (EIS) to support the Exelon ESP site, the Staff responded to public comments received during the EIS scoping process, including the following January 9, 2004, comment from Paul Gunter of the Nuclear Information and Resource Service, et al. (ADAMS Accession No. ML040230487):

> Comment: 8. All impacts arising from the simultaneous operation of the existing and aging Clinton power reactor in close proximity to any new proposed advanced reactor design, including the possibility of multiple, simultaneous accidents, whether related (e.g. by fire or natural disaster) or unrelated (EGCESP-S-51-8).
>
> Response: *Existing requirements provide assurance that the probability of simultaneous accidents at multiple units would be substantially less (e.g., over an order of magnitude) than the probability of accidents involving a single unit. For example, 10 CFR Part 50, General Design Criterion 5, “Sharing of structures, systems, and components,” requires that structures, systems, and components important to safety not be shared unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units. Also, a plant- and site-specific probabilistic risk assessment (PRA) will be required prior to operation of any future plant pursuant to 10 CFR 50.34(f)(1)(i). This PRA will determine whether the risk from the as-built units will be low and will account for any inter-unit dependencies. In contrast, the consequences associated with an accident involving multiple units (e.g., a multi-unit core-melt accident) could reasonably be expected to be only marginally greater than for a single unit event. For example, given the same accident release characteristics for both units, the total releases from two reactor cores (and the associated accident consequences) would, as a first-order-of-magnitude approximation, be about twice that for a single unit. The substantially lower frequency of a multiple-unit accident would more than offset the potentially greater consequences of the multiple-unit accident. Thus, the risk associated with multiple, simultaneous accidents would be a negligible contributor to the overall*

> *risk from all units on the site. Accordingly, the staff does not plan to address multi-unit accidents as part of the ESP review.*

(Emphasis added.) See NUREG-1815, Vol. 2 (July 2006), “Environmental Impact Statement for an Early Site Permit (ESP) at the Exelon ESP Site,” Final Report, Appendix D, “Scoping Meeting Comments and Responses,” Section D.1.11, “Comments Concerning Postulated Accidents,” Comment No. 8 and Response (at D-27, -28) (ADAMS Accession No. ML061930275).

This was true for the Staff’s review of the “major features” emergency plan that Exelon submitted as part of its ESP application for the Clinton site. Similarly, the Staff’s ESP application review of the complete and integrated emergency plan for the Vogtle Units 3 and 4 does not address multi-unit accidents. For both the Vogtle and Clinton ESP applications, the Staff only considered the presence of multiple units on a common site – as reflected in the proposed emergency plans – and not multi-unit accidents. Multiple unit emergency planning issues are also addressed in Response Nos. 19, 21, 22, and 27.

Scope of Review

The scope of the Staff’s ESP (emergency planning) review in the ASER is consistent with that contained in the applicable regulations and associated guidance, which is identified in the ASER subsections, entitled “Regulatory Basis.” Of note is the following guidance from Section 13.3, “Emergency Planning,” of the Standard Review Plan (SRP) (NUREG-0800) (at page 13.3-3, first paragraph[1]), which specifically addresses the limitation of the Staff’s review of a combined

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[1] Southern Nuclear Operating Company submitted the initial Vogtle ESP application by letter dated August 14, 2006. The updated Standard Review Plan (SRP) (NUREG-0800), Revision 3, was issued in March 2007, and reflects the previous (May 3, 2004) guidance in NRC Review Standard (RS)-002, “Processing Applications for Early Site Permits” (ADAMS ML040700094), Section 4.5, “Use of Existing Information from Nearby Facilities for ESP Applications” (at page 15 of 20).

license (COL) application for an additional reactor(s) at an existing operating reactor site.

> In general, if an application is for an additional reactor at an operating reactor site, and the application proposes to incorporate and extend elements of the existing emergency planning program to the new reactor (including by reference), those existing elements should be considered acceptable and adequate. The reviewer will generally focus the review on the extension of the existing program to the new reactor, and will determine whether the incorporated emergency planning program information from the existing reactor site (1) is applicable to the proposed reactor, (2) is up-to-date when the application is submitted, and (3) reflects use of the site for construction of a new reactor (or reactors) and appropriately incorporates the new reactor(s) into the existing plan.

(Emphasis added.) The basic intent is to have the applicant take advantage of previously filed information that is applicable to the proposed ESP location, for which prior regulatory findings have been made. An ESP applicant referencing such information needs to demonstrate that it is applicable to, and appropriate for, an ESP for its proposed site. The Staff's evaluation findings should support the Staff's conclusions as to whether the applicable regulations have been met. (See Section 4.5, "Use of Existing Information from Nearby Facilities for ESP Applications," of RS-002, at page 13 of 20.)

Question No. 18, ASER Section 13.3.1.2, Page 13-5: *The staff makes reference in the second paragraph on page 13-5 to an April 2006 evacuation time estimate (ETE) included as Enclosure 10 to the SNC application. Is this the same as the ETE report by Innovative Emergency Management (IEM), which is referenced in SSAR section 13.3.4 (at 13.3-4)? If not, please explain the difference between the April 2006 report and the IEM report and indicate whether the staff has reviewed the IEM report and what conclusions it reached based on that review. Also, please provide a reference that would allow the Board to access the IEM ETE report.*

Response No. 18 (Musico): Yes, the reference to the IEM ETE report (IEM 2006) in Section 13.3.4, "Evacuation Time Estimate," of SSAR Part 2, Revision 4, March 2008 (at 13.3-4) (see Reference Emergency Planning ("EP") 1 below), is the same ETE report referenced in the ASER on page 13-5, and well as elsewhere in Section 13.3, "Emergency Planning," of the ASER; e.g., Section 13.3.3.2.10, "Protective Response" (at 13-78 and 13-79) (see IEM ETE Report, Reference EP2).

The NRC contracted with Pacific Northwest National Laboratory (PNNL) to conduct a comprehensive technical evaluation of the IEM April 2006 ETE report, in support of the Staff's review of the Vogtle ESP application. As part of its ESP application, SNC included a copy of the ETE report in Enclosure 10, "Evacuation Time Estimate for the Vogtle Electric Generating Plant" (SNC reference AR-06-1721). A one-page discussion of the ETE report was included in ESP application Part 5, "Emergency Plan," Appendix 6, "Evacuation Time Estimate for the Vogtle Electric Generating Plant Plume Exposure Pathway Emergency Planning Zone" (see Reference EP3).

After consideration of the PNNL evaluation, the Staff sent SNC numerous requests for additional information (RAIs) in RAI Letter No. 5, dated March 15, 2007 (see Reference EP4). SNC responded by letter (AR-07-0656) dated April 16, 2007 (see Reference EP5). Subsequent to this response, the NRC issued the SER with Open Items (dated August 30, 2007) on September 14, 2007 (ADAMS Accession ML071970283), which addressed various unsettled ETE-related issues (in SER Open Items 13.3-7 through 13.3-11) that SNC's responses to RAIs failed to fully address. On October 15, 2007, SNC provided its "Response to Safety Evaluation Report Open Items" (SNC reference AR-07-1773), which adequately addressed all of the ETE-related open items. These open items and their resolution are described in the ASER Section

13.3.3.2.10 (at 13-78 and 13-79) and Section 13.3.3.2.13 (at 13-99).

The criteria for preparing and judging the acceptability of the ETE are set forth in Appendix 4 of NUREG-0654/FEMA-REP-1, and in various other related guidance documents. The purpose of an ETE in emergency planning is to provide a representative time frame for evacuation so that emergency officials can incorporate input on evacuation characteristics and traffic flows at the time of an actual emergency, and make well-informed, realistic decisions about protective action options. ETEs are intended to be representative and reasonable so that any protective action decision based on them will reflect realistic conditions – an overly conservative estimate could result in an inappropriate decision. On the other hand, an ETE should be as realistic as is reasonably achievable, and take into account a wide range of seasonal, weather, and other conditions. An ETE study does not attempt to predict exact conditions during an evacuation. Rather, it attempts to indicate the sensitivity of the analysis to a number of commonly occurring events. Finally, neither NRC regulations nor NUREG-0654/FEMA-REP-1 establishes a given time within which evacuation must be completed.

If the Licensing Board anticipates that it will be asking questions relating to the ETE, including the PNNL evaluation, the Staff respectfully requests that the Licensing Board provide sufficient advance notice for the Staff to arrange for PNNL Richland, Washington staff to prepare for and attend the hearing. Further, the descriptions of State and local emergency plans in the ASER present the results of FEMA's findings and determinations, pursuant to 10 CFR 50.47(a)(2). Therefore, if the Licensing Board anticipates that it will be asking questions relating to the review of the offsite (i.e., State and local government) emergency plans – which were evaluated by the Federal Emergency Management Agency (FEMA) – the Staff respectfully requests that the Licensing Board also provide sufficient advance notice for the Staff to arrange for FEMA staff to prepare for and attend the hearing.

References

EP1 VEGP ESP application (ESPA) Part 2 (SSAR), Section 13.3.4, "Evacuation Time Estimates" (at 13.3-4, -5) (ADAMS Accession No. ML081020209). (Package ADAMS Accession No. ML081020073)

EP2 VEGP ESPA Enclosure 10, "Evacuation Time Estimates for the Vogtle Electric Generating Plant" (SNC reference AR-06-1721) (ADAMS Accession No. ML090020383)

EP3 VEGP ESPA Part 5 (Emergency Plan), Appendix 6, "Evacuation Time Estimates for the Vogtle Electric Generating Plant Plume Exposure Pathway Emergency Planning Zone" (at A6-1) (ADAMS Accession No. ML081020226) (Package ADAMS Accession No. ML081020073)

EP4. NRC letter dated March 15, 2007, Subject: Request for Additional Information Letter No. 5 – Southern Nuclear Operating Company Early Site Permit (ESP) Application for the Vogtle ESP Site (ADAMS Accession No. ML070650577)

EP5 SNC letter, dated April 16, 2007 (AR-07-0656), "Response to Requests for Additional Information Letter No. 5 Involving Emergency Planning" (ADAMS Accession No. ML071100324)

Question No. 19, ASER Section 13.3.3.2.4, General: *ITAAC 1.1 for both units states that "the parameters specified in Table Annex V2H-1, Post Accident Monitoring Variables, are retrievable in the control room, TSC and [emergency operations facility (EOF)]." Will each control room have displays that provide data for all four units, or is the data in a given control room limited to that particular unit?*

Response No. 19 (Musico): The Staff did not determine whether each control room will have displays that provide data for the other units on the same VEGP site, since that determination is not within the applicable scope of the Staff's review of the onsite emergency plan. The applicable requirements associated with the availability of data, in support of assessing and responding to an emergency, are 10 CFR 50.47(b)(8) and (b)(9). Related Staff review guidance is contained in Planning Standards H, "Emergency Facilities and Equipment," and I, "Accident

Assessment," of NUREG-0654/FEMA-REP-1; Section 1.2, "Control Room," of NUREG-0696, "Functional Criteria for Emergency Response Facilities;" and Standard Review Plan (SRP) (NUREG-0800) Section 13.3, "Emergency Planning," and Section 14.3.10, "Emergency Planning – Inspections, Tests, Analyses, and Acceptance Criteria." Neither the regulations nor guidance address the need for displays in a control room that provide data for other units on the same site.

In Advanced Safety Evaluation Report (ASER) Section 13.3.3.2.4, "Emergency Classification System," the Staff referred to the Qualified Data Processing System (QDPS) (at 13-35), in regard to data displays in the control room. The applicant provided a description of the QDPS in Section V2H.4.3, "Process Monitoring," of the ESP application emergency plan (Part 5), which states that the monitoring of process variables is performed through the QDPS. The QDPS is a subsystem of the Protection and Monitoring System (PMS), and the QDPS subsystems are a redundant configuration consisting of sensors, QDPS hardware, and qualified displays. The QDPS provides safety-related display of selected parameters in the control room, including to the real-time data network for use by other systems in the plant, and to the plant computer and emergency response facilities. The Units 3 and 4 Safety Parameter Display System (SPDS) functions are integrated into the QDPS, and the QDPS feeds the Emergency Response Data System (ERDS) (see Response No. 22).

While the Staff's ESP review has verified that the VEGP site has numerous data acquisition and display capabilities and systems for Units 1 and 2, the Staff is unaware of the extent that the data displays for an affected unit are (or will be) available in the control rooms of the unaffected units; including for Units 1 and 2, as well as Units 3 and 4. The description provided above represents the extent of the Staff's review of the control room display systems, as reflected in the ESP application and consistent with the scope of the Staff's review pursuant to the applicable regulations and guidance. If appropriate, the applicant may be able to provide additional information regarding the control room display capabilities, availabilities and limitations, including those associated with Units 1 and 2.

Question No. 20, ASER Section 13.3.3.2.4, General: *How, and by whom, is the decision for event downgrading or termination made?*

Response No. 20 (Musico): The Emergency Director, in coordination with the VEGP emergency response organization and offsite authorities, will either determine when the recovery phase begins, or terminate the emergency. When appropriate, the Emergency Director will terminate the emergency and initiate the recovery phase. Downgrading of the emergency event – e.g., from a Site Area Emergency to an Alert classification – is not an option under the emergency plan; and therefore, the emergency will not be downgraded by the Emergency Director or anyone else. (Plant and corporate personnel that may be designated as Emergency Directors are listed in Table B-1 of the onsite emergency plan.) The process is described in ASER Section 13.3.3.2.13, "Recovery and Reentry Planning and Post-accident Operations" (at 13-98), and states the following in the third paragraph:

> [M.1] In ESP Plan Section M.1, "Commencement of Recovery Phase," the applicant stated that the emergency director will determine when the recovery phase begins. Before terminating the emergency, the director will observe the various guidelines (or conditions) listed in that section. The staff reviewed these general conditions, which include consideration of the reactor stability, plant radiation levels, and releases of radioactive material to the environment, and finds that they are reasonable and generally include the most significant aspects of the plant's condition that should be considered before ending the formal emergency phase. For example, the staff reviewed the condition associated with a site area emergency or general emergency. For these two classifications, before terminating the emergency and beginning the recovery phase, the emergency director would discuss the situation with plant management; applicable members of the VEGP ERO; and offsite authorities, including the NRC, Georgia EMA, Burke County EMA director, South Carolina EMD director,

and SRS emergency staff.

The responsibilities and processes used by the State and local (county) governments – to coordinate the decision for event downgrading or termination – are described in the agencies' respective subsections in ASER Section 13.3.3.2.13. For example, Subsection 13.3.3.2.13.b, "Burke County, Georgia" (at 13-101), states in part that "reentry and recovery operations will be initiated only when plant officials verify that the emergency situation has been eliminated, and State officials, acting on their field data, ascertain that there is no longer a threat to the health and safety of persons living nearby."

Question No. 21, ASER Section 13.3.3.2.6, Page 13-47 [F.1.a-e]: *What is the formal communication between the unaffected control rooms and the emergency response locations, including the affected control room, during an emergency? Does this include a dedicated data line and, if not, why not?*

Response No. 21 (Musico): The basic requirements for communication capabilities are contained in 10 CFR 50.47(b)(6) and Section IV.E.9 of Appendix E to 10 CFR Part 50. ASER Section 13.3.3.2.6 describes the applicant's capabilities, as part of the Staff's evaluation of emergency communications in support of Vogtle Units 3 and 4. Section F.5, "Communications among VEGP Emergency Response Facilities," of the ESP application (Part 5, Emergency Plan) states that communications among the control room, technical support center (TSC), Operations Support Center (OSC), and emergency operations facility (EOF) will be completed using dedicated telephone circuits, normal plant telephones, and radio (using the plant network). Communications between the unaffected control rooms and the emergency response locations (including the affected control room) are not addressed in a Staff emergency planning review. However, Section F.5 lists the communications that are available at each emergency response facility, including the following for the Control Room.

- Dedicated telephone circuits to the TSC, EOF, and OSC (one for each location)
- Emergency Notification System (ENS)
- NRC ENS
- Normal plant phones
- In-plant radio console
- Sound-powered phones
- Plant page system
- Southern Company Communications
- Facsimile

The qualified data processing system (QDPS), and other related data systems described in Response No. 19, are dedicated data systems and lines in support of Vogtle Units 3 and 4. Any interconnections – including those for both communication capabilities and dedicated data lines – between (among) individual reactor units on a common site, are also addressed in Response No. 19. (See also, Response No. 22, regarding the Emergency Response Data System (ERDS), and Response No. 23, regarding cell phones and communication sources.)

If appropriate, the applicant may be able to provide the Licensing Board with additional information regarding communications associated with the unaffected control rooms.

Question No. 22, ASER Section 13.3.3.2.6, Page 13-47 [F.1.f]: *This paragraph states that "the emergency response data system (ERDS), will allow for transmission of plant parameter information to the NRC." Is there a similar connection among all of the units on the site?*

Response No. 22 (Musico): Every individual commercial reactor licensed by the NRC, including all reactors on a multiple unit site such as the VEGP, is required by Section VI, "Emergency Response Data System" (ERDS), of Appendix E to 10 CFR Part 50, to have a unit-specific ERDS that provides for the automated transmission of a limited data set of selected parameters to the NRC Operations Center. Section V2H.4.4, “Emergency Response Data System (ERDS),” of the ESP application (Part 5, Emergency Plan) states that ERDS transmits critical plant variables from the onsite computer system to the NRC Operations Center over a dedicated telecommunications circuit (link).

ASER Section 13.3.3.2.6 describes ERDS for Vogtle Units 3 and 4 (at 13-47). In addition, Response No. 19 states that the Units 3 and 4 Safety Parameter Display System (SPDS) functions are integrated into the Qualified Data Processing System (QDPS), and the QDPS feeds the ERDS. However, plant parameter information (including ERDS) from one reactor unit on the Vogtle site is not available in the control rooms of the other units. If appropriate, the applicant may be able to provide the Licensing Board with additional information regarding the availability or limitations of information (including ERDS) among the control rooms.

Question No. 23, ASER Section 13.3.3.2.6, General: *Cell phones are not mentioned as a backup communication source or as a continuous communication source onsite. Cell phones were not prevalent when NUREG-0654 was developed. Should cell phones be included in the Emergency Plan (EP)?*

Response No. 23 (Musico): Cell phones should be included in an emergency plan if they are depended upon to support emergency preparedness and response – either as primary or backup communications capabilities. The basic requirement regarding emergency communications is 10 CFR 50.47(b)(6), which states that “[p]rovisions exist for prompt communications among principal response organizations to emergency personnel and to the public.” Other related requirements, such as 10 CFR 50.47(b)(8) and (b)(9), address the need for adequate equipment – which would include communications equipment – to support and carry out various emergency response functions.

The ESP applicant did not specifically mention “cellular” or “cell” phones in its application, including the emergency plan. The *Southern Company Communications*, listed in Subsection F.5.1, “Control Room,” of the emergency plan (see Response No. 21), include a cellular-based radio system (i.e., Southern LINC), which is a combination radio and telephone system. Southern LINC provides direct-connect service for all locations on a common platform that is company owned and maintained, and Southern LINC Radios have been provided to all VEGP risk counties. Commercial telephones and the Southern Company Communications in Atlanta, Georgia provide backup for the dedicated telephone circuits. If appropriate, the applicant may be able to provide the Licensing Board with additional information regarding the Southern Company Communications.

In Part 5 Emergency Plan Section F.5, “Communications among VEGP Emergency Response Facilities” (at F-3), the applicant stated that “[c]ommunications among the Control Room, TSC, OSC, and EOF will be completed using dedicated telephone circuits, normal plant telephones, and radio, using the plant network. The radio system will also be used for communications with the radiological monitoring teams.” The plan goes on to list the specific (and numerous) means for communications that are available at each emergency response facility – including Southern Company Communications (Southern LINC Radios) – which provide communication capabilities that are redundant, dedicated, and diversified.

Finally, on December 3, 2008, the Staff (Bruce Musico) participated in a presentation to the NRC Advisory Committee on Reactor Safeguards (ACRS) Early Site Permits Subcommittee. The Staff’s presentation, and associated discussion with ACRS members, addressed Section 13.3, “Emergency Planning,” of the November 2008 Advanced Safety Evaluation Report

(ASER) (see ACRS Transcript at 156-190, Reference EP6). During that presentation, the Staff responded to questions about cell phone use (Tr. 172-177). The focus of the discussion was on the use of cell phones to support communications between the TSC and control room, in relation to the location of the TSC farther than two minutes from the control room(s).

The Staff did not address whether cell phones should be included in the emergency plan, or used in support of Vogtle Units 3 and 4; only that the existence of cell phones was a redundant form (i.e., another layer) of available communications that could support communications between the TSC and the control room (Tr. 174-175). The Staff's point in referencing cell phones was merely to explain how communications technology had substantially improved since 1981, when NUREG-0696 was published. Section 2.2 of NUREG-0696 addresses TSC location and the 2-minute travel time between the TSC and control room (discussed in detail in Response No. 24).

Reference

EP6 Advisory Committee on Reactor Safeguards (ACRS) Early Site Permit Subcommittee, December 3, 2008, Transcript (partial) (ADAMS Accession No. ML083530593)

Question No. 24, ASER Section 13.3.3.2.8, Page 13-59: *It is the Board's understanding that the Vogtle site TSC is not near any of the control rooms, and is reached by walking outside of an enclosed structure. NUREG-0696, section 2.2 stresses the face-to-face communication requirement between the TSC and the control room. The proposed TSC location seemingly makes face-to-face communication problematic, especially during periods of severe weather. Why is the important decision regarding TSC location being put off until the COL stage in the form of a permit condition (Permit Condition No. 8)?*

Response No. 24 (Musico): The decision regarding the location of a common TSC for the Vogtle Electric Generating Plant (VEGP) site is not being put off until the COL stage in the form of a permit condition. As explained in more detail below, the Staff was faced with a first-of-a-kind review under the 10 CFR Part 52 licensing process. This review required the Staff to recognize, and account for, two ongoing and potentially relevant NRC licensing actions; i.e., relating to the TSC location in the AP1000 Design Control Document (DCD), and AP1000 DCD emergency action levels (EALs).

Specifically, in regard to the TSC location, the Staff had to address the incomplete nature of the ongoing AP1000 DCD rulemaking, associated with the changing characterization by Westinghouse of the TSC location from DCD Tier 1 (ITAAC) to Tier 2* information. While the ESP application proposes a common TSC and identifies the AP1000 for Units 3 and 4, it does not reconcile the clear difference in TSC location between the application and certified design (i.e., a common TSC located between Units 2 and 3 versus a separate TSC in each Unit 3 and 4 Annex Building); hence, the need for Permit Condition 8 (see below).

The Staff's evaluation and findings as to the acceptability of the common TSC – in lieu of a TSC located in each of the Annex Buildings for the Units 3 and 4 AP1000 reactor designs – are necessarily limited in scope at the ESP stage. The Staff's review at the ESP stage focused on the support and functional characteristics of a common TSC that is located greater than two minutes from the Units 3 and 4 control rooms. While the applicant identified that the AP1000 had been chosen for Units 3 and 4, the AP1000 DCD was not part of the ESP application; and therefore, was not within the scope of the Staff's review.

That is, the Staff was aware of the chosen design, but recognized that its review of the TSC location for the ESP application could be affected by developments in the AP1000 DCD because the AP1000 certified design was (1) undergoing separate rulemaking relating to the TSC location characterization in the DCD, and (2) not a formal part of the licensing review of the ESP application. The final AP1000 DCD and Vogtle Units 3 and 4 ESP will be incorporated by reference into a COL application for the Vogtle site, at which time the Staff will confirm its review of the TSC location, including with respect to applicable portions of the certified design.

The ESP review identified specific TSC ITAAC that reflect various applicable TSC requirements from NUREG-0696 (e.g., ITAAC 5.1, at 13-123). (TSC location requirements from NUREG-0696 are discussed below in more detail.) As part of the initial review, the Staff identified the conflict in the TSC location between the ESP application and AP1000 DCD, and provided for the resolution of the conflict at the COL stage through the following (ESP) Permit Condition 8 (ASER at 13-59 and 13-121).

> An applicant for a combined license (COL) referencing this early site permit shall resolve the difference between the VEGP Units 3 and 4 common Technical Support Center (TSC), and the TSC location specified in the AP1000 certified design.

The Staff's review of the TSC location at the COL stage will focus on the COL applicant's resolution of the conflict in the TSC location between the ESP application and the AP1000 DCD, as required by Permit Condition 8. The TSC location is a defined, integral part of the AP1000 DCD, and as such, the final evaluation of its location – as reflected in the ESP – is more appropriately conducted at the COL stage. In addition to Permit Condition 8, any TSC-related ITAAC (from the ESP) that are not completed (i.e., acceptance criteria "met") at the COL application stage would carry forward into the COL.

The Staff determined that this approach to the ESP evaluation was appropriate, as well as necessary. First, the regulatory structure of 10 CFR Part 52 allows for a proposed complete and integrated emergency plan at the ESP stage (see 10 CFR 52.17(b)(2)(ii)), followed by its incorporation by reference into the COL application (see 10 CFR 52.79(b)). Second, the scope of review at the ESP stage appropriately accounts for the potential significance of the ongoing rulemaking proceeding associated with the AP1000 DCD. The Staff is currently conducting a technical review of various proposed amendments to the AP1000 DCD (by Westinghouse Electric Company) under docket number 52-006. This is a parallel licensing action that will impact the Staff's final evaluation of the common TSC location for the Vogtle site – for both the Vogtle ESP and COL application reviews. Separate from the ESP application review, the Staff is currently conducting a technical review of the Vogtle COL application – which references both the Vogtle ESP SSAR and the AP1000 DCD – under docket numbers 52-025 (Unit 3) and 52-026 (Unit 4).

The proposed amendments to the AP1000 DCD include a change in the information characteristic of the TSC's location designation in the AP1000 DCD, from *Tier 1* to *Tier 2** information. (Tier 1 and Tier 2* are defined in 10 CFR Part 52, Appendix D, "Design Certification Rule for the AP1000 Design.) The significance of this change – which has yet to be finalized in the rulemaking proceeding – is that a change to a Tier 1 (AP1000 DCD) TSC location would require a COL applicant to submit an *exemption request*. In contrast, a change in a Tier 2* TSC location would only require prior NRC approval, in the form of a request for a *departure* in the COL application. See related October 16, 2007, Safety Evaluation Input, ADAMS Accession No. ML072750515 (reference: Westinghouse Electric Company "AP1000 COL Standard Technical Report Submittal of APP-GW-GLR-107, Revision 1, TR 107," submitted June 14, 2007, Westinghouse Project Number 740, NRC reference DCP/NRC1940).

Therefore, as discussed above, Permit Condition 8 is necessary to account for the outcome of the AP1000 rulemaking, and to ensure that the COL applicant will explain how the ESP-stage finding (regarding the acceptability of the common TSC) is consistent with any COL-stage request for an exemption or departure from the DCD. Accordingly, the permit condition accomplishes the goal of reconciling the TSC location in the ESP application, with the final AP1000 rulemaking.

NUREG-0696 – Re: 2-minute walking time between the TSC and control room

In ASER Section 13.3.3.2.8 (at 13-60), the Staff considered various factors relating to whether the common TSC location is appropriate and acceptable, in relation to the guidance in Section 2.2, "[TSC] Location," of NUREG-0696, "Functional Criteria for Emergency Response Facilities," which identifies the need for face-to-face communications between the TSC and control room, with a walking time from the TSC to the control room not to exceed 2 minutes.

As stated in Section 2.2, the reason for face-to-face communications and the 2-minute walking time is to "[effectively provide] all of the necessary management interaction and technical information exchange." That is, quick and direct communications would make up for ineffective "telephone communications between the facilities." Further, the TSC "proximity will also provide access to information in the control room that is not available in the TSC data system." Therefore, the two factors that drove the 2-minute walking distance – which does not specify how fast someone should walk – between the TSC and control room are the need (1) for necessary management interaction and technical information exchange, and (2) to provide TSC access to control room information.

The Staff's evaluation (at 13-60, and footnote 28) referenced the Staff's previous consideration of relaxing the 2-minute walking time, in the context of the Staff's development of emergency planning inspections, tests, analyses, and acceptance criteria (ITAAC); which are reflected in NRC document SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria" (October 28, 2005). The Staff recognized that since the publication of NUREG-0696 in 1981, there had been technical advances in both communication and data system capabilities. Therefore, the Staff stated in ITAAC acceptance criteria 8.1.2 that "[a]dvanced communication capabilities may be used to satisfy the two minute travel time."

As cited above in Response No. 23, the Staff's presentation to the ACRS Early Site Permits Subcommittee on December 3, 2008, included a discussion of the proposed TSC location, (starting at Tr. 168). The Staff addressed some of the bases for relaxing the 2-minute walking time between the TSC and control room (as discussed above), and identified the Staff's prior evaluations of the 2-minute time in SECY 05-0197 and Technical Report (TR) 107 to the Westinghouse AP1000 DCD Revision 16 (ADAMS Accession ML072750515). In addition, the Staff indicated – when asked about establishing precedence – that the relaxation of the 2-minute was not precedent setting, in that the NRC had previously approved a TSC location that was 15 minutes from the control room (at Tr. 170). The Staff subsequently identified this previous approval, during the December 4, 2008, ACRS Full Committee meeting, as that associated with the Clinton Power Station on January 19, 2007 (ADAMS Accession ML070110425).

Consistent with ITAAC 8.1.2 (discussed above), an applicant would be allowed to identify, and take credit for, technological advancements in communications and data capabilities since

1981, and demonstrate the effectiveness of necessary management interaction and technical information exchange between the TSC and control room, and TSC access to control room information. See ASER ITAAC 5.1 (at 13-123), and ITAAC Acceptance Criterion 8.1.1.D (at 13-130, -131). (See also, Response Nos. 19, 21, 22, and 23.)

Finally, movement of personnel between the TSC and control room under emergency conditions – including during periods of severe weather – is addressed in Response No. 26.

Question No. 25, ASER Section 13.3.3.2.8, Page 13-60: *The ASER states in the last sentence on the page that "[t]he TSC structure and ventilation system will be designed to ensure that the TSC personnel are protected from radiological hazards." What about non-radiological hazards?*

Response No. 25 (Musico): ASER Permit Condition 8 states that "[a]n applicant for a combined license (COL) referencing this early site permit shall resolve the difference between the VEGP Units 3 and 4 common Technical Support Center (TSC), and the TSC location specified in the AP1000 certified design" (at 13-59).

In Section 13.3, "Emergency Planning," of the September 2004 "Final Safety Evaluation Report Relating to Certification of the AP1000 Standard Design (NUREG-1793)" (AP1000 FSER), the Staff evaluated the adequacy of the TSC habitability – for both radiological and non-radiological hazards (see Reference EP7). Non-radiological factors associated with TSC habitability included facility cooling, heating, humidity, electrical power, smoke, ventilation and air filtration.

ASER Section 13.3.3.2.8, "Emergency Facilities and Equipment," addresses primarily radiological protection associated with the proposed common TSC. During the Staff's review of a COL application that references the Vogtle ESP, as part of verifying the resolution of Permit Condition 8, the Staff will determine the ability of the TSC to protect TSC personnel from non-radiological hazards. The verification that Permit Condition 8 has been met will include confirmation that the COL applicant has resolved the difference between the VEGP Units 3 and 4 common TSC and the TSC location specified in the AP1000 certified design.

If the TSC location had been maintained in the Control Support Area (CSA) of the AP1000 annex building – reflected in Revision 16 of the AP1000 Design Control Document (DCD) – then its habitability would not be an issue. This is because the structural design and ventilation system have already been examined and found acceptable, as part of the NRC's design certification process. However, since the ESP application identifies a common TSC in a separate building on the Vogtle site – a TSC location that is not part of the AP1000 certified design – design matters including the habitability (both radiological and non-radiological) of this common TSC will need to be re-evaluated as part of the Staff's review of the COL application, and without credit for previously approved design certification features. AP1000 certified design features that support TSC habitability (e.g., the TSC ventilation system in the annex building CSA) will not apply to a TSC that is not located in the CSA.

In Response No. 24, the Staff identified the need for confirmation associated with its review of the proposed common TSC for Vogtle Units 3 and 4. At the COL application review stage, the Staff will confirm the acceptability of the common TSC location, in relation to its non-CSA location, confirmation which is consistent with Permit Condition 8. While Permit Condition 8 does not specifically address TSC design features associated with personnel protection, the applicable NRC TSC habitability requirements and guidance would still apply. As discussed above, the finality associated with the AP1000 design certification review of the TSC (CSA) habitability features will not apply to the common TSC. Staff review of design matters including the common TSC's structure and ventilation system will be required at the COL application stage to ensure adequate personnel protection – both radiological and non-radiological.

In addition to Permit Condition 8, the ASER includes inspections, tests, analyses, and acceptance criteria (ITAAC) No. 5.1 (at 13-123), which states that "[a]n inspection of the as-built TSC and OSC will be performed, including a test of the capabilities." Acceptance criterion 5.1.6 further states that "[t]he TSC ventilation system includes a high-efficiency particulate air (HEPA) and charcoal filter, and radiation monitors are installed." Further, ITAAC No. 8.1 (at 13-126 through 13-135) states that "[a] full participation exercise (test) will be conducted within the specified time periods of 10 CFR Part 50, Appendix E." The associated Acceptance Criterion D.2 (at 13-130) states that the full participation exercise will "[d]emonstrate the adequacy of equipment, security provisions, and <u>habitability precautions for the TSC</u>, OSC, EOF, and emergency news center (ENC), as appropriate" (emphasis added). The ITAAC-required demonstration of the adequacy of habitability precautions for the TSC would include protection of TSC personnel from both radiological and non-radiological hazards. (See also Response No. 24.)

<u>Reference:</u>

EP7 Section 13.3, "Emergency Planning," of the September 2004 "Final Safety Evaluation Report Relating to Certification of the AP1000 Standard Design (NUREG-1793)" (ADAMS Accession No. ML043450284)

Question No. 26, ASER Section 13.3.3.2.8, Page 13-61: *The last sentence in the paragraph at the top of the page indicates that "[p]ortable radiation monitors will be available for personnel in transit from the TSC to other areas, and portable air breathing apparatus and anticontamination clothing will also be provided in the TSC." What about people initially traveling from the control room to the TSC? What about those having to make such trips in severe weather conditions?*

Response No. 26 (Musico): This issue is addressed by the following basic regulations and associated NUREG-0654/FEMA-REP-1 planning standards:

- 10 CFR 50.47(b)(8) – Planning Standard H, "Emergency Facilities and Equipment"
- 10 CFR 50.47(b)(10) – Planning Standard J, "Protective Response"
- 10 CFR 50.47(b)(11) – Planning Standard K, " Radiological Exposure Control"
- 10 CFR 50.47(b)(14) – Planning Standard N, "Exercises and Drills"

In addition, Section IV.E, "Emergency Facilities and Equipment," of Appendix E to 10 CFR Part 50 requires that "[a]dequate provisions shall be made and described for emergency facilities and equipment, including: 1. Equipment at the site for personnel monitoring; . . .."

The relevant guidance for the protection of people initially traveling from the control room to the TSC – including in severe weather conditions – is provided in Section 2.2, "[TSC] Location," of NUREG-0696, "Functional Criteria for Emergency Response Facilities" (February 1981)(Reference EP8). Section 2.2 states in part that "[p]rovisions shall be made for the safe and timely movement of personnel between the TSC and the control room under emergency conditions" (emphasis added). NUREG-0696 also addresses the operations support center (OSC), stating in Section 3, "Operational Support Center" (at 15) that the OSC is an onsite area separate from the control room and the TSC, where licensee operations support personnel will assemble in an emergency. No specific habitability criteria are established for the OSC.

In Part 5, Emergency Plan Section H.1.2 of Annex V2 (applicable to Units 3 and 4 only) (at V2H-1), the applicant describes the OSCs, stating that "[t]he OCSs are located on the second floor of the Annex building adjacent to the Unit 3 and 4 Control Rooms. The OSC is where operational support personnel . . . assemble to aid in the response to an emergency. . . . Emergency kits containing radiation monitoring equipment, first aid supplies, decontamination supplies, breathing apparatus, portable lighting, and hand-held radios are stored in the OSC. Emergency kit contents are listed in Appendix [4]." The applicant goes on to describe how emergency implementing procedures describe the method for the movement of personnel [between] facilities; in the context of OSC evacuation/ relocation.

Emergency Plan Appendix 4, "Emergency Equipment List" (at A4-1 through A4-7) provides detailed lists of specific emergency equipment that is located in the various emergency response facilities, including the Control Room, TSC, OSC, EOF, Main Control Point or Health Physics (HP) Room. A comprehensive variety of emergency equipment, including portable radiation monitors, portable air breathing apparatus, and anti-contamination clothing is available to both the TSC and Control Room. Further, because of the close proximity of the OSC to the Control Room (see above), OSC emergency equipment would provide an optional capability to supplement Control Room equipment, if needed; including supporting people traveling from the Control Room to the TSC.

NUREG-0654/FEMA-REP-1 evaluation criteria N.1.a and N.1.b state that an exercise shall be conducted that tests the integrated capability and a major portion of the basic elements existing within emergency preparedness plans and organizations. In addition, exercises should be conducted under various weather conditions. ASER ITAAC 8.1 requires a full participation exercise (Unit 3, at 13-126) and limited participation exercise (Unit 4, at 13-140), with acceptance criterion 8.1.1.D.2 for Units 3 and 4 (at 13-130 and 13-143, respectively) addressing demonstration of the adequacy of equipment in the emergency response facilities; including availability and general consistency with emergency implementing procedures (EIPs).

Such demonstrations would include procedures entitled “Emergency Equipment and Supplies,” and “Inventory and Testing of Emergency Preparedness Materials/Equipment which are not Part of the Emergency Kits” (see V2 Appendix 1, “Index of Procedures,” of Part 5 Emergency Plan, at V2A1-1). The submission of procedures is addressed in ITAAC 9.1, which states that ‘[t]he [COL] licensee has submitted detailed emergency implementing procedures (EIPs) for the onsite emergency plan no less than 180 days prior to fuel load” (Unit 3 at 13-135, and Unit 4 at 13-147) (see also, Response No. 29).

Additional, related descriptions of how people would be protected – including when they travel between emergency facilities (e.g., Control Room to the TSC) – are provided in the ASER Sections that address Planning Standards H, J, K and N (identified above). Respectively, ASER Section 13.3.3.2.8 describes the adequacy of emergency facilities and equipment to support the emergency response; Section 13.3.3.2.10 describes protection for onsite individuals; Section 13.3.3.2.11 describes personnel radiological protection; and Section 13.3.3.2.14 describes exercises and drills that will test and evaluate the adequacy of facilities, equipment and procedures, in support of protection for onsite emergency workers. Finally, various ITAAC for these Planning Standards are included in ASER Section 13.3.5, “VEGP Unit 3 ITAAC” (at 13-122 through 13-135), and Section 13.3.6, “VEGP Unit 4 ITAAC” (at 13-136 through 13-147).

Reference:

EP8 Section 2.2, “[TSC] Location,” of NUREG-0696, “Functional Criteria for Emergency Response Facilities” (February 1981). (ADAMS Accession No.: ML051390358)

Question No. 27, ASER Section 13.3.3.2.9, Page 13-69: *As referenced by the ASER, EP section 1 (at 1-2) discusses the use of the MIDRAC code (a version of the MIDAS code) to calculate the downwind dispersion of radioactive releases. How are releases from more than one unit, separated in time and magnitude, considered? Does the MIDRAC code have this capability?*

Response No. 27 (Musico): The reference in ASER Section 13.3.3.2.9, “Accident Assessment,” should be to ESP Plan Section I.4, “Dose Assessment System” (at I-2), rather than Section 1.4 (at 1-2).

In ESP Plan (Part 5 Emergency Plan) Section I.4, the applicant provided information regarding the Meteorological Information and Dose Assessment (MIDAS) code, including its origin and specific capabilities, stating that a VEGP-specific version of the MIDAS code (developed by Pickard, Lowe, and Garrick, Inc.) is referred to as MIDRAC. The basic functions of MIDRAC are the calculation of dispersion of the released material as it travels downwind, and the estimation of the resulting concentrations of this material. It calculates total effective dose equivalent (TEDE), thyroid doses, and skin doses at various fixed downwind distances. Source term information is derived from plant effluent monitors, reactor coolant system or containment samples, field monitoring teams, or default accident scenario (i.e., a predetermined hypothetical accident, with associated radioactive source term characteristics).

The Staff is familiar with the MIDAS code, but not with the MIDRAC code. In general, for multiple unit sites, the MIDAS User would first select the affected reactor unit. This is necessary to set up site- and unit-specific configuration files needed by the software, and there are separate configuration files for each reactor unit (e.g., radiation monitoring system calibration data, release point location and height, and distance to site boundary). If there were releases from more than one unit, the User would need to perform an assessment for each reactor separately, and then manually add the results for each unit together; depending upon the specific release characteristic (e.g., release location and height) and the location of the receptor of interest.

The description of the MIDRAC code in the Emergency Plan addresses 10 CFR 50.47(b)(9), which requires that "[a]dequate methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use." In addition, Section IV.B, "Assessment Actions," of Appendix E to 10 CFR Part 50 states in part that "[t]he means to be used for determining the magnitude of, and for continually assessing the impact of, the release of radioactive materials shall be described, … ." Related guidance in evaluation criterion I.4 of NUREG-0654/FEMA-REP-1 states that "[e]ach licensee shall establish the relationship between effluent monitor readings and onsite and offsite exposures and contamination for various meteorological conditions."

Licensees are not required to consider releases from more than one unit, separated in time and magnitude, for multiple unit sites. However, the capability to perform assessments on each unit separately through multiple code runs, and then combining the results (described above), could achieve that result. In regard to how such releases would be considered, including the specific capabilities of the MIDRAC code, the applicant may be able to provide the Board with additional information as to whether the MIDRAC code has the capability to handle multiple radioactive release points from the same unit, and for the same accident.

In Part 5 Emergency Plan, Annex V2, Appendix 1, “Index of Procedures” (at V2A1-1), the applicant referenced a future (unnumbered) procedure for Units 3 and 4, entitled “Estimating Offsite [Dose].” The comparable (existing) procedure for Units 1 and 2 is Procedure No. 91304-C, “Estimating Offsite [Dose],” which is listed in the Annex V1 of the Part 5 Emergency Plan (at V1A1-2). To the extent Procedure No. 91304-C may address Question No. 27 more directly, the applicant may be able to describe it to the Board.

The Staff did not review Procedure No. 91304-C, because it is not applicable to Units 3 and 4. Further, the submission of detailed implementing procedures (in support of Units 3 and 4) – which are dependent upon the as-built plant, and are only required 180 days before the scheduled date for initial loading of fuel (pursuant to Section V of Appendix E to 10 CFR Part 50) – is not required at the ESP application stage and, therefore, it is not within the scope of the Staff’s review at this time. (See ITAAC 9.1 for Units 3 and 4 at 13-135 and 13-147, respectively.) A discussion regarding the submission of detailed emergency implementing procedures for Units 3 and 4 is provided in ASER Section 13.3.3.2.1, “Assignment of Responsibility – Organization Control” (at 13-11). (See also, Response No. 17, regarding multiple release sources, and the scope of the Staff’s review, and Response Nos. 28 and 29.)

Question No. 28, ASER Section 13.3.3.2.9, Page 13-70 [I.8]: *The ASER states that “[w]hen precipitation is predicted or occurring in the area of the plume, the potential for significantly increased rates of radioactivity deposition will be considered by increasing the scope of environmental sampling, as required to quantify the effects of this potentially increased* *deposition." Please provide a fuller explanation of how the effects of precipitation will be* measured*, incorporated into the analyses, and considered in the emergency response decision making. In this regard, the current Vogtle offsite dose calculation manual does not appear to account for the effects of precipitation.*

Response No. 28 (Musico): Precipitation has the effect of increasing the washout of particulate material from a radioactive plume, and depositing the material on the ground. Subsequent surveys by field monitoring teams would detect an increased radiation level from the deposited material. The effect of washout can be increased radiation levels closer to the affected reactor due to increased ground contamination, and decreased plume concentration of radioactive material – with resultant decreased radiation levels – farther away from the affected reactor. Field teams would gather environmental samples that are appropriate to the radioactive release and meteorological conditions, including precipitation.

The specific details associated with how the effects of precipitation would be measured, incorporated into the analyses, and considered in decision making will be provided in the emergency implementing procedures (EIPs). As discussed in Response Nos. 23, 27 and 29, the submission of EIPs is not within the scope of the Staff's review, because they are only required 180 days before the scheduled date for initial loading of fuel (pursuant to Section V of Appendix E to 10 CFR Part 50), and are not required at the ESP application stage. If appropriate, the applicant may be able to provide the Board with additional information regarding this issue, including whether MIDRAC has a wet deposition component that handles precipitation events (*see also* Response No. 27).

Offsite Dose Calculation Model (ODCM)

In Units 3 and 4 ITAAC 6.6 (at 13-126 and 13-139, respectively), the applicant states in the Acceptance Criteria that the EIPs and ODCM will estimate an integrated dose. The Inspections, Tests, and Analyses column states that an analysis of the methodology contained in the EIPs and ODCM, for estimating dose and preparing protective action recommendations (PARs), will be performed to verify the ability to estimate an integrated dose from projected and actual dose rates.

An ODCM is used for calculating releases of reactor effluents, consistent with NRC Regulatory Guide (RG) 1.109, Revision 1, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I" (October 1977) (see Reference EP9). RG 1.109 describes basic features of (Staff developed) calculation models and suggested parameters for the estimation of radiation doses to man from effluent releases. While the methods used in RG 1.109 are general approaches that the Staff has developed for use in lieu of specific parameters for individual sites, the use of site-specific values by an applicant is encouraged (RG 1.109 at 1.109-1).

In general, an ODCM is used for assessing *routine* radioactive releases, rather than *accidental* releases (which are the subject of emergency planning). Routine releases are based on annual averaged meteorology for a specific site. RG 1.109 provides deposition and dose conversion factors, for use in calculating the dose from routine plant effluent releases, using annual average effluent depositions. The annual average routine effluent calculations are based upon multiple years of meteorological data – not actual conditions present on the day of an accident. As such, an accidental release cannot be directly compared with a routine release. An accident event is handled by a dose assessment team, which uses all available information. The team is generally directed from the emergency operations facility (EOF), and follows applicable implementing procedures. For example, see Vogtle Units 1 and 2 emergency plan implementing procedure (EPIP) No. 91303, "Field Sampling and Survey," listed in Section V1 Appendix 1, "Index of Procedures," of the ESP application (Part 5 Emergency Plan, at V1A1-1).

The Staff did not review how the ODCM would be used to estimate an integrated dose for Vogtle Units 3 and 4 (per ITAAC 6.6), or the capability of the current Vogtle (Units 1 and 2) ODCM to account for the effects of precipitation, as these are procedure-level details and not within the scope of the Staff's ESP application review for Units 3 and 4. If appropriate, the applicant may be able to provide the Board with additional information regarding the ODCM, including any role it plays in emergency response for accidental releases.

<u>Reference</u>:

EP9 NRC Regulatory Guide (RG) 1.109, Revision 1, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I" (October 1977). (ADAMS Accession No.: ML003740384)

Question No. 29, ASER Section 13, General: *Some positions in the EOF are designated as being site-specific. Since the VEGP site will have different reactor types at the same site, will the Emergency Plan Implementing Procedures for VEGP be modified to address this?*

Response No. 29 (Musico): Yes. In NRC's March 15, 2007, Request for Additional Information (RAI) Letter No. 5, RAI 13.3-5.e (see Response No. 18, Reference EP4), the Staff asked the ESP applicant to provide a list, by title, of procedures – comparable to the list provided in Annex V1, Appendix 1, "Index of Procedures," for VEGP Units 1 and 2 – that are applicable to Units 3 and 4, and that will be required to implement the emergency plan. In its

April 16, 2007, Response to RAI Letter No. 5 (RAI 13.3-5.e) (see Response No. 18, Reference EP5), the applicant stated in response to RAI 13.3-5.e that "SNC intends to modify the existing Emergency Implementing Procedures to include elements associated with Units 3 and 4." In addition, the applicant stated in it's response to RAI 13.3-6.c that "SNC expects to revise the existing corporate [EIPs] and EOF procedures to include provisions for an additional two units at the VEGP site."

The review of detailed emergency implementing procedures (EIPs) in support of Units 3 and 4 is not within the scope of the Staff's ESP application review. The submission of EIPs for Units 3 and 4 are addressed in the following (ITAAC) Acceptance Criteria 9.1 (Unit 3 at 13-135, and Unit 4 at 13-147):

> The licensee has submitted detailed emergency implementing procedures (EIPs) for the onsite emergency plan no less than 180 days prior to fuel load.

The development of EIPs for Vogtle Units 3 and 4 is dependent upon various as-built features associated with the individual units. As such, an ITAAC allows specific procedure development following issuance of an early site permit (ESP) or combined license (COL); e.g., as the reactor is being built. Further, the submission of the detailed EIPs to the NRC 180 days prior to fuel load – for 10 CFR Part 52 reactor licensing – is intended to *generally* parallel the submission of detailed EIPs under the 10 CFR Part 50 licensing process (see Section V, "Implementing Procedures," of Appendix E to 10 CFR Part 50).

Under Part 50, the EIPs shall be submitted 180 days before the scheduled issuance of an operating license or a license to possess nuclear material. The NRC revised Appendix E in 2007 to include the requirement (for a Part 52 COL) that the EIPs shall be submitted 180 days before the scheduled date for initial loading of fuel for a combined license under 10 CFR Part

52. (*See* NRC Final Rule, entitled "Licenses, Certifications, and Approvals for Nuclear Power Plants," published August 28, 2007, 72 Fed. Reg. 49352, 49401-02. *See also* 72 Fed. Reg. 49359, 49374-75, 49382, and 49597.)

The applicant's inclusion of this ITAAC in the Vogtle Units 3 and 4 ESP application is consistent with this (Part 52) requirement for EIP submission (at the COL stage), because the application includes a complete and integrated emergency plan – which is required in a COL application. ITAAC proposed in an ESP application, if not addressed (resolved or "met") when the COL application is submitted to the NRC, may carry forward into the COL (see 10 CFR 52.80(a)(1) and (a)(3)). The Staff will review the EIPs when they are submitted (at least) 180 days prior to the scheduled date for initial fuel load respective to Units 3 and 4.

At the Vogtle ESP application stage, the scope of the Staff's review for EIPs is limited to evaluating the adequacy of (Units 3 and 4) ITAAC 9.1. This approach is consistent with the applicable NRC review guidance in Section 13.3, "Emergency Planning," and Section 14.3.10, "Emergency Planning – Inspections, Tests, Analyses, and Acceptance Criteria," of the Standard Review Plan (SRP) (NUREG-0800).

(See also Response No. 17, regarding a common VEGP emergency plan, with Annexes V1 and V2 addressing the different reactor types at the same site, and Response Nos. 18 and 27.)

Question No. 30, ASER Section 15.0.3.1, Page 15-1: *The calculated design basis accident (DBA) doses were scaled from results in the AP-1000 DCD. Do the results come from a version of the DCD that has received final certification from the NRC?*

Response No. 30 (Hart): Yes, results come from a version of the DCD which has received final certification. The SSAR used the results from the AP1000 DCD, Rev. 15. The final rule certifying the AP1000 Rev. 15 design was issued on January 27, 2006.

Question No. 31, ASER Section 15.0.3.1, Page 15-1: *As referenced in the ASER, in SSAR Table 15-2 (at 15-5), is it assumed that the isotopes are release[d] at a constant rate over the specified time periods? If yes, is this assumption always conservative?*

Response No. 31 (Hart): The rate of release over the specified time periods is not a direct consideration in the analysis that results in the estimated design basis accident doses in the SSAR. Although the release rate may be variable during the sequence of an actual event or for the accidents modeled in AP1000 DCD Rev. 15, information on the release rate is not included as part of the activity release information presented in SSAR Table 15-2 or the other accident release information presented in SSAR Tables 15-3 through 15-10. Rather, the activity release values given in SSAR Table 15-2 are the amount of radioactivity (Ci) released for each isotope, integrated over the stated time period at the head of the column in the table. The activity releases and integrated dose per time period for the design, which are given in the SSAR Chapter 15 reference to AP1000 Document No. LTR-CRA-06-21, "AP1000 Accident Releases and Doses as Function of Time" (Westinghouse 2006b), are an interim output of the design basis accident radiological consequences analyses discussed in AP1000 DCD Rev. 15. Although the design certification did not specifically approve accident-specific release rates in the format used in the SSAR, the overall dose analyses that result in the accident-specific release rates were reviewed and approved in the DCD rulemaking.

The SSAR used the integrated dose from each time period as the basis for the site-specific dose estimates. The only other factor in the analysis that may vary over time is the atmospheric dispersion factor (χ/Q). The χ/Q values are averaged over the same activity release time periods given in SSAR Tables 15-2 through 15.-10. The design basis accident radiological consequences analyses use 5^{th} percentile χ/Q values; i.e., χ/Q values that are not expected to be exceeded more than 5% of the time during each time interval. This is a conservative assumption and conforms to Staff guidance in RG 1.145, RG 1.183, and SRP 15.0.1, all of which are referenced in RS-002, "Processing Applications for Early Site Permits."

Question No. 32, ASER Section 15.0.3.4, 2.3.4.4, Pages 15-5, 2-71: *The staff concludes there is reasonable assurance that the radiological consequences of DBAs will be within the regulatory evaluation factors. The staff also concludes that the atmospheric dispersion factors used by SNC are acceptable. Tables 15-12, 15-21, and 15-22 in the SSAR (section 15.4, at 15-17, 15-22) show that the calculated exclusion area boundary doses for pipe break and fuel handling accidents are within about 40 percent of the regulatory limits. Please expand on the basis for assuring that the atmospheric dispersion factors used in these calculations (Table 15-11, at 15-16, in the SSAR) are sufficiently conservative to support the conclusions.*

Response No. 32 (Harvey): The Staff believes the applicant's atmospheric dispersion factors used in the design-basis accident radiological analyses are sufficiently conservative for the following reasons:

- The applicant used the guidance provided in Regulatory Guide (RG) 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," to generate these χ/Q values as described in SSAR Section 2.3.4. The RG 1.145 methodology is intended to produce conservative χ/Q values that are not exceeded more than 5% of the time.

- The applicant chose to implement the RG 1.145 methodology assuming a ground-level release which usually results in higher ground-level concentrations at downwind receptors at relatively flat terrain sites such as the Vogtle ESP site. The applicant also conservatively chose short downwind distances to the exclusion area boundary (EAB) because shorter distances for ground-level releases result in higher (more conservative) χ/Q values. For example, the applicant defined a “dose calculation” EAB as a circle that extends 0.5 mile beyond the power block area, where the power block area is defined as being within a 775-foot-radius circle centered on a point between the two proposed AP1000 units. The dose calculation EAB is completely within the actual plant EAB as shown in SSAR Figure 1.4. The applicant conservatively used the dose calculation EAB distance of 0.5 mile (800 meters) in each downwind sector to calculate the χ/Q values for the EAB.

According, for the reasons discussed above, the Staff believes the applicant’s atmospheric dispersion factors used in the design-basis accident radiological analyses are sufficiently conservative and support the conclusion that there is reasonable assurance that the radiological consequences of DBAs will be within the regulatory evaluation factors.

ATTACHMENT B

Reviewer Affidavits and Statements of Professional Qualifications

January 16, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF HOSUNG AHN CONCERNING
THE NRC STAFF RESPONSE TO THE LICENSING BOARD'S
QUESTIONS REGARDING SAFETY MATTERS

I, Hosung Ahn, do hereby state as follows:

1. I am employed as a Hydrologist in the Division of Site and Environmental Reviews in the U.S. Nuclear Regulatory Commission's ("NRC") Office of New Reactors. A statement of my professional qualifications is attached.

2. As part of the NRC staff's safety review of the Vogtle Early Site Permit ("ESP") application, documented in the "Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site," November 2008, I reviewed the aspects of the application that concerned hydrology issues.

3. I am responsible for those responses to Licensing Board questions (or portions of questions) in Attachment A to the "NRC Staff Response to the Licensing Board's Questions Regarding Safety Matters" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

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

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Hosung Ahn

Hosung Ahn
Statement of Professional Qualifications

CURRENT POSITION

Hydrologist
Hydrologic Engineering Branch
Division of Site and Environmental Reviews
Office of New Reactors
U.S. Nuclear Regulatory Commission
Washington, D.C

EDUCATION

Ph.D., Hydrology, Colorado State University
M.S., Hydrology, Colorado State University
B.S., Civil Engineering, Hanyang University, Korea

PROFESSIONAL

American Geophysical Union, Member
American Water Resource Association, Member
Professional Engineer, registered in Florida
Reactor Technical Reviewer Qualification, NRC, 2008

QUALIFICATIONS

Dr. Ahn is a hydrologist with over 24 years of work experience at various federal and state governments. He has been working on the areas of water resources managements, ecosystem restorations, power plant siting, and reactor licensing. He received a bachelor degree in Civil Engineering from Hangyang University in Korea, and Master's and Doctoral degrees from Colorado State University specializing in hydrology and water resources. His expert areas include hydrology, hydrogeology, hydraulics, statistical hydrology, numerical hydrologic modeling, and risk, safety, and uncertainty analyses.

Now as a hydrologist for the Nuclear Regulatory Commission, he is responsible for reviewing new reactor license applications, especially the plant site safety analyses from extreme hydrologic hazards, such as flood, drought, dam break, tsunami, and subsurface radionuclide contamination. He has been working on three ESP applications (Clinton, North Anna, Vogtle) and 6 COL applications (South Texas, Nine Mile Point, V.C. Summer, Calvert Cliffs, Turkey Point). He is responsible for performing evaluations of hydrology-related issues in support of new reactor licensing, updating and improving reactor licensing regulatory rules and technical guides and criteria, and managing technical assistance contracts, and developing research plans and user need requests.

Prior to his current position, Dr. Ahn was assigned (2003~2006) to the National Park Service Miami Office which provides technical services for the restoration of the Everglades ecosystem. As a Research Hydrologist, Dr. Ahn performed modeling and assessment of the Everglades hydrology in support of many critical water management and ecosystem restoration projects. His responsibilities at the Park included formulating and evaluating restoration plan alternatives, assessing the impacts and benefits of water management and ecosystem restoration projects, defending the Park's positions against other federal and state agencies' agendas, and writing NEPA and EIS reports for these projects.

From 1990 to 2003, Dr. Ahn worked for the South Florida Water Management District, where he served as a technical leader for various water management and ecosystem restoration projects. Major responsibilities included developing, planning, and conducting research and assessment projects, as well as developing and applying regional hydrologic models. He acted as a technical representative for the agency on various Everglades restoration committees and teams that consisted of staff from federal and local government agencies such as USGS, USFWS, USCOE, EPA, etc.

Prior to his graduate study, Dr. Ahn worked for the Korea Electric Power Company in Korea, where he worked as a Civil Engineer. For the first two years Dr. Ahn served as a Construction Inspector at the Yongwol Gas-Turbine Power Plant Construction Office, responsible for inspecting and cost estimating of power plant facility constructions including retaining walls, dam and intake, piping systems, roads, and out-door fire protection system; and then for the remaining four years as a Civil Engineer at the Headquarter in Seoul, responsible for evaluating technical and economic feasibilities of new power plant sites which include 2 thermal plant sites, 3 nuclear sites, and 8 hydroelectric power plant sites.

Dr. Ahn has written over 45 technical reports, published 15 papers in high-rated, peer-reviewed journals mostly as a senior author, and made over 20 presentations to professional conferences and workshops.

January 15, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF MICHELLE L. HART CONCERNING
THE NRC STAFF RESPONSE TO THE LICENSING BOARD'S
QUESTIONS REGARDING SAFETY MATTERS

I, Michelle L. Hart, do hereby state as follows:

1. I am employed as a Senior Reactor Engineer in the Division of Site and Environmental Reviews in the U.S. Nuclear Regulatory Commission's ("NRC") Office of New Reactors. A statement of my professional qualifications is attached.

2. As part of the NRC staff's safety review of the Vogtle Early Site Permit ("ESP") application, documented in the "Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site," November 2008, I reviewed the aspects of the application that concerned radiological consequences of design basis accidents.

3. I am responsible for those responses to Licensing Board questions (or portions of questions) in Attachment A to the "NRC Staff Response to the Licensing Board's Questions Regarding Safety Matters" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

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

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Michelle L. Hart

Michelle L. Hart
STATEMENT OF PROFESSIONAL QUALIFICATIONS
UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, DC

CURRENT POSITION

Senior Reactor Engineer
Division of Site and Environmental Reviews
Office of New Reactors
U.S. Nuclear Regulatory Commission

EDUCATION

M.S. Nuclear Engineering, Ohio State University, Columbus, OH, 1994
B.S. Physics, Muskingum College, New Concord, OH, 1991

QUALIFICATIONS

Ms. Hart is a nuclear engineer and health physicist with over 12 years of experience in performing licensing reviews of design basis accident radiological consequences analyses for nuclear power reactors. Ms. Hart's experience includes performing dose assessments for reactor design, siting and control room habitability, performing shielding analyses, and assessing the modeling assumptions for power reactor accident progression, radiation source terms, radiation transport and removal in the context of design basis accident applications. Ms. Hart has also performed power reactor emergency response dose assessments. Ms. Hart joined the NRC in 1996. As a senior member of the staff she is responsible for understanding and assessing the control room radiological habitability and offsite radiological consequences of postulated design basis accidents for commercial nuclear power reactor design and siting, both for safety and environmental review.

NRC Experience

Design Basis Accident Radiological Consequence Analysis Safety Reviews for New Plant Applications.

Ms. Hart's duties include performing licensing safety and environmental reviews with respect to the design basis accident radiological consequences analyses for new reactor design certification, early site permits, and combined license applications. Ms. Hart's responsibilities include preparing the associated Safety Evaluation Report (SER) sections related to design basis radiological consequence analyses, source terms, fission product removal systems and structures, and control room radiological habitability. Her current assignments include performing the safety review of the control room radiological habitability and radiological consequences analyses for the AREVA EPR and MHI US-APWR design certifications, the Lee, Shearon Harris Units 2 and 3, Summer Units 2 and 3, Vogtle Units 3 and 4, Levy, Calvert Cliffs Unit 3, Callaway Unit 2, Bell Bend, Nine Mile Point Unit 3 and Comanche Peak Units 3 and 4 combined license applications and the Vogtle early site permit. She also provides technical oversight on the environmental impact of design basis accidents to the development of the environmental impact statements for the Lee, Shearon Harris Units 2 and 3, Summer Units 2 and 3, Vogtle Units 3 and 4, Levy, Calvert Cliffs Unit 3, Callaway Unit 2, Bell Bend, Nine Mile

Point Unit 3 and Comanche Peak Units 3 and 4 combined license applications and the Vogtle early site permit.

Ms. Hart was the lead safety reviewer for the control room radiological habitability, fission product removal in containment, source terms and design basis accident radiological consequences analyses for the previously certified AP1000, Revision 15, design.

Revision 3 to NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants." The Standard Review Plan (SRP) provides guidance to NRC staff in performing safety reviews of early site permit (ESP), design certification (DC), and combined license (COL) applications under 10 CFR Part 52. Ms. Hart was the technical lead in the development of SRP section 15.0.3, "Design Basis Accident Radiological Consequence Analyses for Advanced Light Water Reactors."

Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)." Regulatory Guide (RG) 1.206 is based on a revision of RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition). Ms. Hart was the technical lead in the development of sections C.I.11.1, "Source Terms," and C.I.15.6.5, "Radiological Consequences."

Design Basis Accident Radiological Consequence Analysis Safety Reviews for Alternative Source Term Implementation and Other License Amendments for Currently Operating Reactors. Ms. Hart reviewed design basis accident radiological consequences analyses submitted in support of eighteen license amendment requests related to implementation of the Alternative Source Term (AST) pursuant to 10 CFR 50.67. Ms. Hart has also reviewed the design basis accident radiological consequences analyses submitted in support of over 100 other licensing actions.

NEI Control Room Habitability Task Force. Ms. Hart participated as an NRC staff member assessing the development of the original (June 2001) version of NEI 99-03, "Control Room Habitability Assessment Guidance," particularly Appendix C, "CRH Dose Analysis: Regulatory Enhancements"

Technical Lead on Safety Issues Involving Design Basis Accident Dose Analysis. Ms. Hart was the technical lead closing out PWR reactor coolant iodine spiking issues for the Steam Generator Action Plan, which addressed a differing professional opinion on the staff's methodology for performing PWR design basis accident dose analyses. Until she transferred to NRO in November 2007, Ms. Hart was the technical lead addressing the design basis accident source term aspects for generic safety issue GSI-191 on PWR sump performance.

Member of NRC's Incident Response Organization. Ms. Hart is assigned as a Radiological Assessment Assistant Director on the protective measures team (PMT) for responding to reactor incidents. Ms. Hart previously was assigned as a dose analyst to the PMT for reactor incidents. She has been assigned to the team since 1998.

January 15, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF BRAD HAVEY CONCERNING
THE NRC STAFF RESPONSE TO THE LICENSING BOARD'S
QUESTIONS REGARDING SAFETY MATTERS

I, Brad Harvey, do hereby state as follows:

1. I am employed as a Senior Physical Scientist (Meteorologist) in the Division of Site and Environmental Reviews in the U.S. Nuclear Regulatory Commission's ("NRC") Office of New Reactors. A statement of my professional qualifications is attached.

2. As part of the NRC staff's safety review of the Vogtle Early Site Permit ("ESP") application, documented in the "Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site," November 2008, I reviewed the aspects of the application that concerned meteorology.

3. I am responsible for those responses to Licensing Board questions (or portions of questions) in Attachment A to the "NRC Staff Response to the Licensing Board's Questions Regarding Safety Matters" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

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

____
Brad Harvey

STATEMENT OF PROFESSIONAL QUALIFICATIONS OF BRAD HARVEY

CURRENT POSITION

Senior Physical Scientist (Meteorology)
Division of Site and Environmental Reviews
Office of New Reactors
U.S. Nuclear Regulatory Commission

EDUCATION

M.S. Atmospheric Science, University of Michigan, Ann Arbor, MI, 1976
B.S. Physics, Rensselaer Polytechnic Institute, Troy, NY, 1975

PROFESSIONAL AFFILIATIONS

American Meteorological Society
American Nuclear Society
Nuclear Utility Meteorological Data Users Group

CERTIFICATIONS

Certified Consulting Meteorologist, American Meteorological Society, Active since 1992

INDUSTRY COMMITTEE ACTIVITIES

ANS-2.3 Working Group. One of the reviewers for an upcoming revision to ANSI/ANS-2.3, "Standard for Estimating Tornado, Hurricane and Extreme Straight Wind Characteristics at Nuclear Facility Sites"

ANS-3.11 Working Group. One of the primary authors for ANSI/ANS-3.11-2005, "Determining Meteorological Information at Nuclear Facilities"

NEI Control Room Habitability Task Force. Participated as an industry member coordinating and authoring Appendix D, "Atmospheric Dispersion," and Appendix G, "Toxic Gas Assessments," to the original (June 2001) version of NEI 99-03, "Control Room Habitability Assessment Guidance"

QUALIFICATIONS

Mr. Harvey is a Certified Consulting Meteorologist with over 30 years of experience in performing and reviewing meteorological monitoring, atmospheric dispersion modeling, climatic evaluations, and air quality licensing analyses for the nuclear power industry. Mr. Harvey's experience includes performing atmospheric dispersion analyses and dose assessments for nuclear plant routine release and design basis accident applications. Mr. Harvey has also participated in developing emergency response dose assessment models and in performing toxic gas analyses for control room habitability evaluations. In addition, he has assisted nuclear plants in completing air emission inventories and air quality licensing documents. Mr. Harvey has been active on industry committees concerned with control room habitability and meteorological monitoring.

Mr. Harvey joined the NRC in 2003. Prior to joining the NRC, Mr. Harvey was employed by an NRC licensee (Yankee Atomic Electric Company) and several consultants (Sargent & Lundy, Duke Engineering and Services, and Framatome-ANP (now AREVA)).

<u>NRC Experience</u>

Meteorological Site Safety Reviews for New Plant Applications. Mr. Harvey supported the review of the Site Safety Analysis Report (SSAR) submittals supporting the Clinton, Grand Gulf, and North Anna Early Site Permit (ESP) applications pursuant to 10 CFR Part 52, Subpart A. Mr. Harvey's responsibilities included preparing the associated Safety Evaluation Report (SER) sections related to climatology, meteorological monitoring, and design-basis accident and routine release atmospheric dispersion modeling. These reviews established (1) site climatic characteristics to ensure potential threats from severe weather will pose no undue risk to the type of facility proposed to be located at the site, and (2) site atmospheric dispersion characteristics to ensure radiological effluent release limits associated with normal operation and radiological dose consequences associated with postulated accidents can meet regulatory criteria.

Mr. Harvey is currently the lead meteorological reviewer for the 10 CFR Part 52, Subpart B Standard Design Certification (DC) submittals for the GE Hitachi Nuclear Energy ESBWR, Mitsubishi Heavy Industries US-APWR, and AREVA U.S. EPR reactor designs. These reviews ensure appropriate climatic and atmospheric dispersion site parameters have been established in the Design Certification Document (DCD) for the reactor design and these postulated site parameter values are representative of a reasonable number of sites that have been or may be considered for a Combined License (COL) application.

Mr. Harvey is also currently the lead meteorological reviewer for the 10 CFR Part 52, Subpart C Combined License (COL) submittals for the South Texas, North Anna, and Grand Gulf sites. These reviews ensure the applicants have appropriately identified (1) regional meteorological phenomena and extreme climatic conditions that could affect the safe design and operation of the plant and (2) site-specific atmospheric dispersion characteristics for evaluating the radiological consequences of design-basis accident and routine release airborne effluents.

Revision 3 to NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants." The Standard Review Plan (SRP) provides guidance to NRC staff in performing safety reviews of early site permit (ESP), design certification (DC), and combined license (COL) applications under 10 CFR Part 52. Mr. Harvey was the technical lead in the development of SRP sections 2.3.1, "Regional Climatology," 2.3.2, "Local Meteorology," 2.3.3, "Onsite Meteorological Measurements Programs," 2.3.4, "Short-Term Atmospheric Dispersion Estimates for Accident Releases," and 2.3.5, "Long-Term Atmospheric Dispersion Estimates for Routine Releases."

Revision 1 to Regulatory Guide 1.23, "Onsite Meteorological Programs." Mr. Harvey was the technical lead in the development of Revision 1 of Regulatory Guide 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants." This regulatory guide describes a suitable onsite meteorological monitoring program for collecting the basic meteorological data needed to support new reactor licensing and operating plant needs. The draft regulatory guide revision updates the discussion of applicable regulations and references to associated regulatory guides, provides new guidance to reflect current meteorological monitoring equipment and practices, and clarifies monitoring criteria for supporting emergency planning requirements.

Revision 1 to Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants." Mr. Harvey served as project manager coordinating the development of Revision 1 of Regulatory Guide 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants." This regulatory guide provided new guidance for use in selecting the design-basis tornado and design-basis tornado-generated missiles that a nuclear plant should be designed to withstand. The new guidance is based on a more extensive set of historical tornado data and improved methods for estimating the frequency of exceedance of tornado wind speeds. Mr. Harvey's associated activities included (1) co-authoring SECY-04-0200, "A Risk-Informed Approach to Defining the Design Basis Tornado for New Reactor Licensing," and (2) serving as co-program monitor for Revision 1 to NUREG/CR-4461, "Tornado Climatology of the Contiguous United States."

Meteorological License Amendment Reviews for Alternative Source Term Implementation. Mr. Harvey reviewed onsite meteorological data sets and control room and offsite atmospheric dispersion analyses submitted in support of nine license amendment requests related to implementation of the Alternative Source Term (AST) pursuant to 10 CFR 50.67.

Member of NRC's Incident Response Organization. Mr. Harvey is assigned as a weather and dispersion analyst on the protective measures team (PMT) for responding to reactor, fuel cycle, and material transportation incidents.

Private Sector Experience

Supervisor, Radiological Engineering. Mr. Harvey directed the technical, administrative, and business development activities of more than 20 radiological engineering professionals. He managed many functions including radiological design engineering (activation analysis, shielding, equipment qualification, accident analysis, source term), effluent and environmental monitoring (RETS/REMP, waste management, pathway dose), and meteorological services (database management, dispersion analyses). Clients included operational commercial power reactors, facilities undergoing decommissioning, a fuel enrichment facility application, and other firms requiring radiological support (e.g., biotech).

Onsite Meteorological Monitoring Support. Mr. Harvey developed nuclear plant meteorological monitoring system design basis documents, instrumentation specifications, and data collection algorithms. He wrote procedures for the review and validation of onsite meteorological data and supervised meteorological data reduction and validation activities for the Yankee Rowe, Vermont Yankee, Maine Yankee, and Seabrook nuclear plants. He developed a Program Manual for the Millstone Station meteorological monitoring program that identified and coordinated the resolution of over 200 regulatory and guidance document criteria that were applicable to the monitoring program.

Meteorological Sections of Safety Analysis Reports and Environmental Reports. Mr. Harvey prepared the meteorological sections of the Safety Analysis Reports and Environmental Reports supporting the operating license applications for the Byron, Braidwood, and Seabrook nuclear plants, addressing such topics as climatology, onsite meteorological monitoring, and atmospheric dispersion modeling.

Atmospheric Dispersion Analyses for Nuclear Power Plant Applications. Mr. Harvey managed the development of a software code, AEOLUS-2, for calculating atmospheric dispersion factors for routine gaseous releases from nuclear plants, and he generated atmospheric dispersion factors for use in nuclear plant offsite dose calculation manuals (ODCMs). He calculated offsite dose estimates resulting from routine liquid and gaseous effluent releases for the Annual Radioactive Effluent Release Reports for the Yankee Rowe and Seabrook nuclear stations. He generated atmospheric dispersion analyses to evaluate control room habitability for potential accident radiological and toxic gas releases for several nuclear plants.

Emergency Response Dose Assessment Support. Mr. Harvey developed near real-time atmospheric dispersion modeling tools for use during radiological emergencies at several nuclear plants, including a variable-trajectory plume-segment atmospheric dispersion model called METPAC, which handled the site-specific topographic features of flat terrain (e.g., Maine Yankee), river valley (e.g., Yankee Rowe, Vermont Yankee), and coastal (e.g., Seabrook) sites. He trained nuclear plant emergency response personnel in atmospheric dispersion modeling techniques and provided meteorological support during nuclear plant radiological emergency response drills and exercises for the Yankee Rowe, Vermont Yankee, Maine Yankee, and Seabrook nuclear plants.

Consequence Analysis for Domestic Licensing of Special Nuclear Material. Mr. Harvey developed and implemented the consequence analysis methodology (e.g., estimating and classifying worker and public exposures to potential accident UF_6 releases) in support of the Louisiana Energy Services (LES) Gas Centrifuge Facility Integrated Safety Analysis (ISA) in accordance with Subpart H of 10 CFR 70 and NUREG-1520, "Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility."

SELECTED PRESENTATIONS AND PROCEEDINGS

"Revision 1 to Regulatory Guide 1.23 Meteorological Monitoring Programs for Nuclear Power Plants," presented at the 12th Nuclear Utility Meteorological Data Users Group Meeting, Charlotte, NC, June 2008

"Meteorological Monitoring and Modeling for New Power Plants," presented at the DOE Meteorological Coordinating Council Meeting, Reston, VA, May 2008.

"Draft Regulatory Guide DG-1164: Meteorological Monitoring Programs for Nuclear Power Plants," presented at the 11th Nuclear Utility Meteorological Data Users Group Meeting, St. Louis, MO, October 2006.

"ANSI/ANS-3.11-2005: American National Standard for Determining Meteorological Information at Nuclear Facilities," presented at the 16th Annual RETS/REMP Workshop, Mashantucket, CT, June 2006.

"Climatic Site Characteristics for Early Site Permits," presented at the 2005 ANS Annual Meeting, San Diego, CA, June 2005.

"The ARCON96 Atmospheric Dispersion Model," presented at the 2004 ANS Winter Meeting, Embedded Topical Meeting: 2004 Operating Nuclear Facility Safety (2004 ONFS), Washington, DC, November 2004.

"Using ARCON96 for Control Room Radiological Habitability Assessments," co-authors Steve LaVie and Leta Brown, presented at the Ninth Nuclear Utility Meteorological Data Users Group Meeting, Chattanooga, TN, October 2003.

"Atmospheric Dispersion Factors: What Are They and Why Do We Use Them," co-author Ted A Messier, presented at the 2002 RETS/REMP workshop, Atlantic City, NJ, June 2002.

"Meteorological Data Processing for Commercial Nuclear Power Plants," co-author Ted A Messier, presented at the 2002 RETS/REMP workshop, Atlantic City, NJ, June 2002.

"NEI 99-03 Appendix D, Atmospheric Dispersion, and Appendix G, Toxic Gas Assessments," presented at the NEI Control Room Habitability Workshop, Clearwater Beach, FL, August 2001.

"Ongoing Developments in Atmospheric Dispersion Analyses for Control Room Habitability Evaluations," presented at the 2001 ANS Annual Meeting, Milwaukee, WI, June 2001.

"NEI 99-03: Control Room Habitability Assessment Guidance," presented at the Seventh Nuclear Utility Meteorological Data Users Group Meeting, Las Vegas, NV, October 2000.

"Millstone Station Meteorological Monitoring Program Manual," co-authors Gary W Johnson and John Leavitt, presented at the Seventh Nuclear Utility Meteorological Data Users Group Meeting, Las Vegas, NV, October 2000.

"Time-Dependent Atmospheric Dispersion Factors for Use in Offsite Dose Calculation Manuals," co-author M. S. Strum, presented at the 2000 RETS/REMP Workshop, Falmouth, Mass., June 2000.

"A Methodology for Calculating Meteorological Channel Accuracies," presented at the Sixth Nuclear Utility Meteorological Data Users Group Meeting, Syracuse, N.Y., May 1999.

"A Review of the NRC Emergency Response Code RASCAL Version 2.1," presented at the Fourth Nuclear Utility Meteorological Data Users Group Meeting, San Francisco, Calif., April 1996.

"Atmospheric Dispersion Modeling Applications in the Nuclear Power Industry," presented at the ASTM 1995 Johnson Conference on Performance Evaluation of Atmospheric Dispersion Models, Johnson, Vt., July 1995.

"Meteorological Aspects of Emergency Action Level Schemes: NUREG-0654 Versus NUMARC-007," presented at the Third Nuclear Utility Meteorological Data Users Group Meeting, Charlotte, N.C., October 1994.

"Experience in Implementing a 10m Backup Meteorological Tower," co-author T. A. Messier, presented at the Second Nuclear Utility Meteorological Data Users Group Meeting, Boston, Mass., April 1993.

"Regional Weekly Background Variations in REMP-Reported Airborne Gross-Beta Activity: Influence of Meteorological Factors," co-author S. Farber, presented at the 1992 RETS/REMP Workshop, Concord, Mass., June 1992.

"Technical Specification and Off-Site Dose Calculation Manual Meteorological Requirements," presented at the First Nuclear Utility Meteorological Data Users Group Meeting, Chattanooga, Tenn., November 1991.

January 16, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF CHARLES T. KINCAID CONCERNING
THE NRC STAFF RESPONSE TO THE LICENSING BOARD'S
QUESTIONS REGARDING SAFETY MATTERS

I, Charles T. Kincaid, do hereby state as follows:

1. I am employed as a Staff Scientist V at Pacific Northwest National Laboratory, operated by Battelle Memorial Institute. I am providing responses to the Licensing Board's questions under a technical assistance contract with the staff of the U.S. Nuclear Regulatory Commission ("NRC"). A statement of my professional qualifications is attached.

2. As part of the NRC staff's safety review of the Vogtle Early Site Permit ("ESP") application, documented in the "Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site," November 2008, I assisted the NRC staff in its review and analysis of aspects of the application that concerned groundwater hydrology and the migration of radioactive liquid effluents.

3. I am responsible for those responses to Licensing Board questions (or portions of questions) in Attachment A to the "NRC Staff Response to the Licensing Board's Questions Regarding Safety Matters" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

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

____
Charles T. Kincaid

CHARLES T. KINCAID

Staff Scientist
Energy and Environment Directorate
Pacific Northwest National Laboratory

EDUCATION

B.S.	Civil Engineering, Humboldt State College	1970
Ph.D.	Engineering (Hydraulics), Utah State University	1979

EXPERIENCE

Since joining Pacific Northwest National Laboratory (PNNL) in 1979, Dr. Kincaid has devoted his attention to soil physics and ground-water studies including technical contributions, project and task management, and line management roles. He has specialized in the area of computational fluid mechanics of environmental systems. He has experience in both finite difference and finite element numerical methods and their application to surface and subsurface flows. He has collaborated in studies involving 1) mathematical models of physical processes and chemical reactions, 2) analytical and numerical code developments, and 3) site-specific applications of models/codes. Dr. Kincaid has played a leadership role in the production of the performance assessments for low-level radioactive waste defense wastes (LLW) in grout and glass waste forms at Hanford, an environmental impact statement for a weapons testing facility at Los Alamos National Laboratory, and a composite analysis of radioactive wastes to remain in the central plateau at the Hanford Site after site closure. Dr. Kincaid is a former member of the DOE headquarters Peer Review Panel (PRP) that reviewed all LLW performance assessments from the DOE complex. Dr. Kincaid was the technical leader for development and application of a stochastic System Assessment Capability designed to assess the risk and impact associated with radioactive and chemical wastes to remain at the Department of Energy's Hanford Site in Washington. He currently contributes to reviews conducted by the Laboratory on behalf of the U.S. Nuclear Regulatory Commission.

Early in his tenure at PNNL, Dr. Kincaid collaborated in the development of codes and their subsequent application to the problem of thermal energy storage in the ground-water environment. He has collaborated in the development and improvement of a multi-dimensional ground-water flow and transport code. Dr. Kincaid has managed work for government and industrial clients including a major two-part project involving (1) an evaluation of codes available for the modeling of solute leaching from electric utility solid waste disposal facilities, and (2) the subsequent design, development and testing of a code that coupled subsurface transport and mechanistic geochemistry. Transport processes considered are advection, longitudinal dispersion, and diffusion. Chemical speciation, precipitation/dissolution, and adsorption/desorption reactions are included in the geochemical component.

To compliment his code development work, Dr. Kincaid has been a contributor to site-specific applications of models for the purpose of assessing the long-term performance of a variety of wastes at the Hanford Site. He was a key contributor in preparation of the Hanford Defense Waste Environmental Impact Statement published in December 1987. He directed completion of the performance assessment for grouted low-level radioactive wastes proposed for disposal in the shallow-land deposits on the 200 Area plateau of the Hanford Site. He directed completion of the geology, soils and water resources sections of the environmental consequences chapter of the EIS for the Dual Axis Radiographic Hydrodynamic Test Facility at Los Alamos. Dr. Kincaid provided technical leadership for the design and completion of the 1998 composite analysis for radioactive waste disposed on Hanford's central plateau.

On three occasions Dr. Kincaid has been a Visiting Lecturer at Whitman College in Walla Walla, Washington. He has taught an undergraduate groundwater hydrology course within the geology curriculum at the college.

PROFESSIONAL AFFILIATION

American Geophysical Union
Registered Hydrogeologist, State of Washington

CONTRIBUTIONS TO BOOKS

Kincaid, C. T. and G. W. Gee. 1993. "Estimating Infiltration at Waste Sites: Methodology Development." Chapter 14 in Water Flow and Solute Transport in Soils: Developments and Applications, eds. D. Russo and G. Dagan, pp. 246-261. Springer-Verlag, Berlin.

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Kincaid, CT, RW Bryce and JW Buck. 2004. Technical Scope and Approach for the 2004 Composite Analysis of Low-Level Waste Disposal at the Hanford Site. PNNL-14372. Pacific Northwest National Laboratory, Richland, Washington.

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Cameron, J. T., C. T. Kincaid, and G. Z. Watters. 1980. "Stratified Bidirectional Seepage Flow Through an Earthen Embankment." Third International Conference on Finite Elements in Water Resources, pp. 2.127-2.136. May 19-21, 1980, Oxford, Massachusetts.

Kincaid, C. T., G. Z. Watters, and D. S. Watkins. 1980. "Application of Mixed Interpolation Elements to Three-Dimensional Free Surface Flows." Third International Conference on Finite Elements in Flow Problems, Volume 2, pp. 33-42. June 10-13, 1980, Banff, Canada.

PANELS AND COMMITTEES

With E.L. Wilhite (chairman), W.R. Hansen, D.W. Layton, G.J. Shott, D.W. Lee, R.L. Nitschke and S.M. Neuder. Department of Energy Performance Assessment Peer Review Panel. 1995 to 1997.

With D. P. Lettenmaier (chairman), D. H. Rinds, R. E. Dickinson, R. J. Gurney, S. Manabe, P. C. Milly, J. C. Schaake, Jr. D. Wollock and E. F. Wood. Organizing and program committees for the Chapman Conference on "Hydrologic Aspects of Global Change," June 12-14, 1990, Campbell's Resort in Lake Chelan, Washington.

With F. W. Schwartz (chairman), C. B. Andrews, D. L. Freyberg, L. F. Konikow, C. R. McKee, D. B. McLaughlin, J. W. Mercer, E. J. Quinn, P. S. C. Rao, B. E. Rittmann, D. D. Runnells, P. K. M. van der Heijde, and W. J. Walsh. National Research Council, Water Science and Technology Board, Committee on Ground Water Modeling Assessment 1987-1989.

With P. Columbo, M. Fuhrmann, G. W. Gee, D. Halford, E. A. Jenne, D. Kocher, F. Kornegay, D. A. Myers, and C-F. Tsang. March 24-25 and June 30-July 1, 1986. Technical Review Committee for the National Low-Level Waste Program's Pathway and Dose-to-Man Performance Assessment.

With A. L. Gutjahr, J. W. Mercer, I. P. Murarka, M. D. Siegel, and P. J. Wierenga. June 18-19, 1986. Workshop on Solute Transport in Porous Media. (Presented papers, transcript, and panel summary published as eds. Springer, E.P.,and H. R. Fuents. 1987. Modeling Study of Solute Transport in the Unsaturated Zone. NUREG/CR-4615, Volume 2, U.S. Nuclear Regulatory Commission, Washington, D.C.

January 15, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF BRUCE J. MUSICO CONCERNING
THE NRC STAFF RESPONSE TO THE LICENSING BOARD'S
QUESTIONS REGARDING SAFETY MATTERS

I, Bruce J. Musico, do hereby state as follows:

1. I am employed as a Senior Emergency Preparedness Specialist in the Division of Preparedness and Response in the U.S. Nuclear Regulatory Commission's ("NRC") Office of Nuclear Security and Incident Response. A statement of my professional qualifications is attached.

2. As part of the NRC staff's safety review of the Vogtle Early Site Permit ("ESP") application, documented in the "Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site," November 2008, I reviewed the aspects of the application that concerned emergency planning and preparedness issues.

3. I am responsible for those responses to Licensing Board questions (or portions of questions) in Attachment A to the "NRC Staff Response to the Licensing Board's Questions Regarding Safety Matters" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

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

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Bruce J. Musico

STATEMENT OF PROFESSIONAL QUALIFICATIONS OF BRUCE J. MUSICO

Current Position

Sr. Emergency Preparedness Specialist
Division of Preparedness and Response
Office of Nuclear Security and Incident Response
U.S. Nuclear Regulatory Commission

Education

J.D., Franklin Pierce Law Center, Concord, NH 1992
B.S., Nuclear Engineering, University of Michigan, Ann Arbor, MI 1976

Professional Affiliations

American Nuclear Society
Bar Admission – Pennsylvania & Washington, D.C.

Qualifications

Mr. Musico is a nuclear engineer with over 25 years experience in the commercial nuclear power and related industry, including approximately 20 years relating to nuclear reactor emergency planning (EP). This EP experience included work in virtually all facets of reactor emergency preparedness and response; including substantial experience performing a variety of EP work for nuclear utilities, local, State and Federal governments, and Canadian nuclear licensing work. Prior to joining the NRC in 2002, Mr. Musico had a private consulting and law practice providing counsel to governmental agencies and legislators in the area of nuclear power operation, regulation, and decommissioning.

<u>NRC Experience</u>

Combined Licenses (COLs) – Principal staff reviewer for the emergency planning information submitted in the Vogtle COL and North Anna COL applications.

Early Site Permits (ESPs) – Principal staff reviewer for the emergency planning information submitted in the North Anna ESP application, and author of Section 13.3, “Emergency Planning,” of the associated Safety Evaluation Report (SER) (NUREG-1835, September 2005). Principal staff reviewer for the emergency planning information submitted in the Vogtle ESP application.

Standard Review Plan (SRP) – Author of Section 13.3, “Emergency Planning,” of the March 2007 update to the Standard Review Plan (NUREG-0800). Creator of the emergency planning Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC), contained in SRP Section 14.3.10, “Emergency Planning – Inspections, Tests, Analyses, and Acceptance Criteria.”

Regulatory Guide (RG) 1.206 – Author of Section 13.3, “Emergency Planning,” and related guidance in RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition).”

ESP Review Standard (RS)-002 – Author of Section 13.3, “Emergency Planning,” of NRC RS-002, “Processing Applications for Early Site Permits.”

New Reactor Licensing Final Rule (10 CFR Part 52) – Principal author of various revisions to emergency planning regulations associated with new reactor licensing under 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants.”

NRC Incident Response Organization – Member of the NRC Headquarters Protective Measures Team, associated with NRC response in support of nuclear reactor emergencies.

Non-NRC Experience

Counsel – New Hampshire Nuclear Decommissioning Financing Committee

Reactor Licensing Engineer – Ontario Power Generation, Toronto & Pickering Nuclear Station

Reactor Licensing Engineer – Commonwealth Edison Co., Zion Nuclear Station

Counsel – Maryland NRC Agreement State Nuclear Materials Licensee

Emergency Planning Consultant – Impell Corporation

Emergency Planning Manager – Illinois Department of Nuclear Safety

Radwaste System Designer – Sargent & Lundy Engineers

Reactor Startup and Operations Engineer – VEPCO, North Anna Unit 1

Publications

“Getting It Right–New Hampshire’s State-of-the-Art Nuclear Decommissioning Law,” (principal author) *Radwaste Solutions*, Nov/Dec 2001

January 16, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF RAJIV PRASAD CONCERNING
THE NRC STAFF RESPONSE TO THE LICENSING BOARD'S
QUESTIONS REGARDING SAFETY MATTERS

I, Rajiv Prasad, do hereby state as follows:

1. I am employed as a Scientist III at Pacific Northwest National Laboratory, operated by Battelle Memorial Institute. I am providing responses to the Licensing Board's questions under a technical assistance contract with the staff of the U.S. Nuclear Regulatory Commission ("NRC"). A statement of my professional qualifications is attached.

2. As part of the NRC staff's safety review of the Vogtle Early Site Permit ("ESP") application, documented in the "Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site," November 2008, I assisted the NRC staff in its review and analysis of aspects of the application that concerned surface water hydrology.

3. I am responsible for those responses to Licensing Board questions (or portions of questions) in Attachment A to the "NRC Staff Response to the Licensing Board's Questions Regarding Safety Matters" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

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

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Rajiv Prasad

RESUME

(April 2007)

RAJIV PRASAD

Senior Research Scientist, Surface Water Hydrology, Hydrology Group
Pacific Northwest National Laboratory, Richland, Washington 99352
(509) 375-2096 (Voice)
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EDUCATION

Doctor of Philosophy in Civil and Environmental Engineering
Utah State University, Logan, Utah (2001)
Master of Technology in Civil Engineering
Indian Institute of Technology, Madras, India (1992)
Bachelor of Engineering in Civil Engineering
Regional Engineering College, Durgapur, India (1990)

JOB EXPERIENCE

Scientist, Surface Water Hydrology, Hydrology Group
Pacific Northwest National Laboratory, Richland, Washington (September 2004 onwards)

Postdoctoral Research Associate, Hydrology Group
Pacific Northwest National Laboratory, Richland, Washington (February 2002 – August 2004)

Postmasters Research Associate, Hydrology Group
Pacific Northwest National Laboratory, Richland, Washington (October 2001 – January 2002)

Postdoctoral Research Associate, Associated Western Universities, Richland, Washington (August 2000 – September 2001)

Graduate Research Assistant, Water Division, Utah Water Research Laboratory, Utah State University, Logan, Utah (September 1993 – August 2000)

AWARDS AND HONORS

Outstanding Performance Award, Pacific Northwest National Laboratory (2005)
Dean's Merit List, Utah State University (1994)
Graduate Student Scholar, Indian Institute of Technology, Madras, India (1990-1992)

Gold Medalist, Civil Engineering, University of Burdwan, India (1990)
Merit Scholarship, Regional Engineering College, Durgapur, India (1986-1990)

RESEARCH INTERESTS

Distributed hydrologic modeling
Scaling in hydrology
Multi-scale modeling of hydrologic systems
Ensemble streamflow forecasting
Climate change diagnosis
Impacts of climate change on water resources systems
Integrated operations of water and energy systems
Evaluation of flooding hazards at nuclear power plant sites
Evaluation of tsunami hazards at nuclear power plant sites

AFFILIATIONS

Member, American Geophysical Union
Member, American Water Resources Association

PROFESSIONAL EXPERIENCE

Early Site Permit reviews (safety and environmental issues) for the U.S. Nuclear Regulatory Commission

During the last two years, I have helped carry out three concurrent **early site permit (ESP) reviews** for safety as well as environmental reviews for the U.S. Nuclear Regulatory Commission (USNRC). These reviews are being carried for the first time under new USNRC regulations as described in Title 10 of Code of Federal Regulations. This work involved hydrologic site assessment including hazards from external flooding events such as probable maximum precipitation (PMP), local intense precipitation, dam failures including cascading dam failures, and icing. Water availability was evaluated under current and post-plant conditions to determine water-use impacts including natural variability, plant-induced water use, channel migration, and blockages due to icing.

I have helped establish critical technical expertise at PNNL to support ESP and Combined Operating License reviews for the USNRC. The insights gained during this work have led to the recognition that some of the existing USNRC regulatory guidance needs revision to reflect state-of-the-science.

Updating Standard Review Plans for the U.S. Nuclear Regulatory Commission

There is renewed concern in the public regarding tsunamis and recognition at the USNRC that guidelines related to assessment of flooding hazard due to tsunamis at nuclear power plant sites located at or near a coastline are outdated. I presented the current technical approach for site assessment for flooding hazard at nuclear power plant sites in the United States at an International Atomic Energy

Agency (IAEA) workshop. This workshop was organized by the IAEA in the aftermath of the December 26, 2004 Indian Ocean earthquake and subsequent tsunami that devastated coastlines in southeastern Asia. I am leading the effort to put together a technical team to revise review criteria and guidance related to **flooding hazards due to tsunamis**. This effort will conclude with a thorough review and update of the Standard Review Plan (SRP) for coastal nuclear power plant sites and produce a NUREG/CR document that will provide technical guidance for review of tsunami hazards at nuclear power plant sites. A follow-up workshop to discuss tsunami-related guidance of the IAEA was held at the International Center for Theoretical Physics (ICTP) in Trieste, Italy in May 2006. I presented a review of the then current tsunami review methodology followed by the USNRC at this meeting. I am also invited to attend another follow-up meeting at ICTP in Trieste, Italy in May 2007.

Water-Energy Nexus

Although there is abundant hydroelectric power available in the Pacific Northwest, the energy system and the water resources system have traditionally been optimized decoupled from each other. I am a co-Principal Investigator on a Laboratory Directed Research and Development (LDRD) funded project that will demonstrate the advantages of water and energy integrated resources systems optimization approach. This project will leverage **ensemble streamflow forecasting** techniques and **multi-scale modeling** approaches that I helped develop at PNNL to implement a water resources module for the Integrated Energy Operations Center (IEOC). The IEOC is envisioned as a central control and operations center for system-wide information gathering, processing, optimization, and scheduling. The water resources module will be integrated into the IEOC framework to provide simultaneous optimization of the water resources and the energy systems for more efficient use of hydropower resources while meeting the aquatic and instream flow demands.

Ensemble streamflow forecasting

Ensemble streamflow forecasting capability was developed over the last two years. The **PNNL Streamflow Ensemble Generation System (PNNL-SEGS)** is a control program that drives the PNNL Watershed Model (PWM) to generate a set of possible future streamflow scenarios starting from a common initial condition but corresponding to alternate meteorologies. The alternate meteorologies may be specified from historical observations where a sequence of meteorological conditions over a given time period during all available water years on record are considered equally probable. Another approach may involve specifying alternate meteorologies under changed climate scenarios generated from regional climate models such as MM5. Each alternate meteorology produces a single streamflow trace or hydrograph. The complete set of these streamflow traces represents the streamflow ensemble, with explicit characterization of uncertainty in streamflow forecasts. This streamflow ensemble can then be used for optimal operation of the water resources system.

DHSVM-MASS2 linkage

An example of multi-scale modeling is the linkage between Distributed Hydrology Soil-Vegetation Model (DHSVM) and Modular Aquatic Simulation System 2D (MASS2) model. DHSVM is a watershed hydrologic model that simulates physical hydrological processes including solar radiation, interception of precipitation by canopy, throughfall, snow accumulation and melt, infiltration of water into a soil column, and surface and subsurface runoff on a regular rectangular grid. MASS2 is a depth-averaged hydrodynamic and water quality model that operates at the stream reach scale using detailed hydrographic representation of the stream channel profile. The Bonneville Power Administration research project targeting the Grays River watershed in southern Washington is aimed at learning how Chum Salmon spawning habitat has been affected due to logging in the watershed and what remedial actions may be required. DHSVM-predicted runoff under several land cover scenarios at several points on the channel network were provided to MASS2 to specify inflow, outflow, and lateral inflow boundary conditions for steady-state simulation of discharges corresponding to several percentiles during the spawning season for Chum Salmon. These simulations are expected to help in evaluation of impacts of changes at the watershed scale to habitat conditions at the "fish" scale.

Snowmelt modeling

Utah Energy Budget (UEB) model from Utah State University, which is an energy-budget based point snowmelt model, was used in a mountainous terrain (Reynolds Creek Experimental Watershed (RCEW) in Idaho), driven by spatially-distributed inputs to develop a simpler parameterization of snow drifting and snowmelt in a small catchment (Upper Sheep Creek (USC) within RCEW). The simpler model, called **Pseudo-Distributed Index-Based Model for Snowmelt (PDIMS)**, was developed along with a drift factor map calibrated for USC using measured SWE data on a 30-m grid. This approach to snow drift and snowmelt modeling assumes that all of the drift occurs during winter and most of the snowmelt occurs during spring.

Snowdrift modeling

Results from SnowTran-3D, a three-dimensional mass-transport model from Colorado State University that runs on a grid over complex terrain were used to help parameterize spatially-distributed snowmelt in mountainous terrain affected by wind-blown snowdrifts. This approach helped **estimate drift factors** for Tollgate a subwatershed within RCEW, where SWE measurements were not feasible due to its size. SnowTran-3D estimated drift factors were then used with PDIMS to estimates spatially distributed surface water input for Tollgate, a larger subwatershed within RCEW.

Hydrologic modeling

A lumped hydrologic model called **Dominant-Zone Hydrologic Model (DZHM)** was developed to capture the within-watershed variability of dynamics of hydrologic processes. The concept of dominant zones allows the model to remain simple, yet capture the major sources of variability in hydrologic response within the catchment. Dominant zones must be developed from the understanding of hydrology within a given catchment, for example, in RCEW most of the variability in hydrologic response can be attributed to highly spatially-variable surface water input. This variability can be parameterized in terms of drift factors in RCEW. The DZHM representation for USC and Tollgate used drift factor zones. The modeling results were compared using observed aggregated streamflow (point comparison) and observed snow cover maps (spatial pattern comparison).

I have helped test and improve Distributed Hydrology Soil-Vegetation Model (DHSVM) and PNNL Watershed Model (PWM) during my post-doctoral appointment. I have applied automated calibration techniques implemented in the open source statistical software R to both models. Modeling results from these endeavors were used in research projects funded by NASA, NOAA, and EPA, among other state and federal agencies.

Most of this work involves recognition of and accounting for the landscape properties, especially the spatial heterogeneity related impacts, in hydrologic modeling.

Hydrologic design

A criterion for inclusion of rain-on-snow events in **probable maximum flood (PMF)** estimation was developed using SNOTEL and snowcourse data in Utah. The “probable maximum rain-on-snow event” was conceptualized as an existing “high” snowpack that is subjected to a “high” precipitation event (not the PMP event), in presence of “relatively high” sequence of air temperatures. Statistical analysis of historical SNOTEL and snowcourse data was performed to determine “high” snowpacks likely to occur during spring. Statistical analysis of precipitation and temperature data was performed to prescribe a 72-hour high precipitation/high temperature sequence. US Army Corps of Engineers HEC-1 model was used to compute the event hydrograph from this “**probable maximum rain-on-snow event**”. This inflow hydrograph was used further to analyze dam risk in terms of failure and overtopping to recommend appropriate action for risk mitigation.

Watershed characterization

I was involved in watershed characterization work for the Corps of Engineers’ Seattle Office, Grays Harbor County, and Washington Department of Fish and

Wildlife, and Washington Department of Ecology for the Chehalis watershed located in southwestern Washington. The goal of the project is to provide information for decision-making to improve flood control and restoration of degraded ecosystem functions. The watershed was delineated automatically from digital terrain data, and PWM was calibrated using historical meteorologic and streamflow datasets. Streamflow for all subbasins on a spatial resolution approximately equal to that of level 6 hydrologic unit codes (HUC) were modeled. A sediment generation model, the Hillslope Erosion Model (HEM) was adapted to estimate steady state sediment delivery to the stream network from the subbasins. A simple stream temperature model was also developed to help predict stream temperature. Results from these models were used to estimate environmental indicators based on the Ecosystem Diagnosis and Treatment (EDT) approach. These indicators are expected to help characterize habitat suitability for fish in these watersheds under undisturbed and current conditions for restoration.

A similar project was also carried out in the Snohomish watershed. Initial delineation of the watershed and setup of PWM is complete. PWM was modified during this phase to include a snow component. GIS data layers are being built in to help improve hydrologic characterization of the watershed.

Watershed delineation quality control

Watershed characterization for acid total maximum daily load (TMDL) work was also performed for more than 140 forest preserve lakes in New York as part of work for the EPA. The objective was to evaluate the levels of pH, aluminum, and acid neutralizing capacity in these lakes in response to atmospheric deposition. This work involved adapting terrain analysis and hydrologic algorithms implemented in ESRI Arc/Info geographic information system (GIS) software to help delineate watersheds that contribute surface and subsurface flow to these alpine lakes.

Special care was needed for developing these procedures because of two concerns: (1) limitations of digital terrain data even at the finest available resolution (10 m) because of the small size of these watersheds, and (2) presence of special cases like closed drainages (watersheds draining to lakes without an outlet), multiple outlet lakes (lakes that had more than one stream existing at different locations), and nested lakes. In addition to these issues with the automated delineation procedures, it was required that the delineated watersheds be accurate at 1:24,000 scale as per requirements of Federal Geographic Data Committee draft proposal that lays out standards for delineation of HUCs. This requirement translated into a ground accuracy of 12 m for all watershed and lake boundaries. In order to address this requirement, a protocol was developed that used manual checking of all boundaries on USGS digital raster graphs (DRG) of 1:24,000 and 1:25,000 scale topographic maps. The automatically generated watershed and lake boundaries were overlaid on the DRGs. Each boundary was manually checked to ensure that it was consistent with topographic contours.

Where needed, the points constituting the polygon representing the boundaries were moved to follow topographic ridges.

PROGRAMMING AND SOFTWARE DEVELOPMENT EXPERIENCE

Computing Languages

FORTRAN, C, C++, Perl, S, R, Java

Software Development

Most of my programming is carried out in C, C++, FORTRAN, R, and Perl in order to develop algorithms for data processing and hydrologic modeling. This includes data analysis including the USGS DEMs, streamflow, river reach files, HUCs, interpretation of results of GAP analysis, interpretation of STATSGO and SSURGO soils data for input to hydrologic models. I use terrain processing algorithms to automatically delineate subbasins and generate the corresponding stream network. Postprocessing of terrain analysis results is used to automatically set up watersheds for hydrologic modeling using DHSVM.

RESEARCH PUBLICATIONS

JOURNAL PAPERS

Prasad, R., D. G. Tarboton, G. E. Liston, C. H. Luce, and M. S. Seyfried, "Testing a blowing snow model against distributed snow measurements at Upper Sheep Creek, Idaho, United States of America," *Water Resour. Res.*, *37*(5), 1341-1356, 2001.

Prasad, R. and M. S. Wigmosta, "Evaluating the performance of a semi-distributed hydrologic model in the Yakima River Basin," manuscript under preparation, 2005.

Prasad, R., D. G. Tarboton, G. N. Flerchinger, K. R. Cooley, and C. H. Luce, "Understanding the Hydrologic Behavior of a Small Semi-Arid Mountainous Watershed in Idaho, United States of America," manuscript under preparation, 2005.

CONFERENCE PRESENTATIONS

Prasad, R., D. G. Tarboton, and C. H. Luce, "Application of a Spatially Distributed Hydrologic Model to Semi-Arid Mountainous Watersheds," 17th Annual AGU Hydrology Days, Fort Collins, Colorado, April 14-18, 1997.

Prasad, R., D. G. Tarboton, G. N. Flerchinger, K. R. Cooley, and C. H. Luce, "Understanding the hydrologic behavior of a small semi-arid mountainous

watershed," *Eos Trans. AGU*, Fall Meet. Suppl., *80*(46), Abstract H21B-19, 1999.

Prasad, R., D. G. Tarboton, G. E. Liston, C. H. Luce, and M. S. Seyfried, "Testing a Blowing Snow Model Against Distributed Snow Measurements at Upper Sheep Creek," *Eos Trans. AGU*, Fall Meet. Suppl., *80*(46), Abstract H11E-07, 1999.

Prasad, R. and M. S. Wigmosta, "Scalability issues in process-based hydrologic modeling," *Eos Trans. AGU*, Fall Meet. Suppl., *82*(47), Abstract H12C-0312, 2001.

Jain, S., J. Eischeid, and R. Prasad, "Tailored hydroclimatic information for water resources management in the western United States," Proceedings of the EWRI World Water and Environmental Resources Congress, Philadelphia, Pennsylvania, June 23-26, 2003.

Prasad, R., L. W. Vail, C. B. Cook, and G. Bagchi, "Establishment of Safety-Related Site Characteristics Based on Consideration of External Sources of Flooding at Nuclear Power Plant Sites in the United States of America," in upcoming Proceedings of the International Workshop on External Flooding Hazards (tentative title), August 29 – September 2, Kalpakkam, India, International Atomic Energy Agency, Vienna, Austria, 2005.

Bagchi, G., E. V. Imbro, K. Manoly, and R. Prasad, "U.S. Nuclear Regulatory Criteria on Nuclear Power Plant Protection against External Flooding," in upcoming Proceedings of the International Workshop on External Flooding Hazards (tentative title), August 29 – September 2, Kalpakkam, India, International Atomic Energy Agency, Vienna, Austria, 2005.

Prasad, R., "Evaluation of External Flooding Hazard at Nuclear Power Plant Sites in the United States of America," Presentation at the Topical Consultancy on Tsunamis and Other External Flooding Hazards at Nuclear Power Plant Sites jointly organized by International Center for Theoretical Physics and International Atomic Energy Agency, May 8 – 12, Trieste, Italy, 2006.

PNNL REPORTS

Vail, L. W., M. S. Wigmosta, and R. Prasad, "Impact of Climate on Aquatic Habitat in the Yakima River," PNNL-SA-35194, Pacific Northwest National Laboratory, Richland, WA, 2001.

Vail, L. W., M. S. Wigmosta, R. Prasad, and C. K. Knudson, "Accelerated Climate Prediction Initiative," PNNL-SA-36759, Pacific Northwest National Laboratory, Richland, WA, 2002.

Scott M. J., L. W. Vail, C. O. Stockle, A. Kemanian, K. M. Branch, R. Prasad, M. S. Wigmosta, and J. A. Jaksch. "Adapting Irrigated Agriculture to Climate Variability and Change," PNWD-SA-6848, Battelle—Pacific Northwest Division, Richland, WA, 2005.

Scott M. J., L. W. Vail, C. O. Stockle, A. Kemanian, K. M. Branch, R. Prasad, M. S. Wigmosta, and J. A. Jaksch. "Benefits and Costs of Options to Mitigate the Uncertain Effects of Climate Change on Irrigated Agriculture in the Yakima Basin. What Matters? What Doesn't?" PNWD-SA-6980, Battelle—Pacific Northwest Division, Richland, WA, 2005.

Scott M. J., L. W. Vail, and R. Prasad. "Managing Water for Irrigated Agriculture Under Extended Climate-Related Drought." Presented by Michael J. Scott (Invited Speaker) at American Water Reopurces Association 2005 Annual Conference, Seattle, WA on November 8, 2005.

BOOK CHAPTERS

Wigmosta, M. S. and R. Prasad, "Upscaling and Downscaling – Models," Contributed Chapter to upcoming Encyclopedia of Hydrological Sciences, John Wiley and Sons, 2004.

January 15, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF STEVEN A. SCHAFFER CONCERNING
THE NRC STAFF RESPONSE TO THE LICENSING BOARD'S
QUESTIONS REGARDING SAFETY MATTERS

I, Steven A. Schaffer, do hereby state as follows:

1. I am employed as a Health Physicist in the Division of Construction Inspection and Operational Programs in the U.S. Nuclear Regulatory Commission's ("NRC") Office of New Reactors. A statement of my professional qualifications is attached.

2. As part of the NRC staff's safety review of the Vogtle Early Site Permit ("ESP") application, documented in the "Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site," November 2008, I reviewed the aspects of the application that addressed doses from liquid and gaseous effluents.

3. I am responsible for those responses to Licensing Board questions (or portions of questions) in Attachment A to the "NRC Staff Response to the Licensing Board's Questions Regarding Safety Matters" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

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

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Steven A. Schaffer

STEVEN A. SCHAFFER

Education

Ph.D. Biology/Environmental Health Science, New York University, 1982
M.S. Aquatic Biology, New York State University, 1978
B.S. Biology, State University of New York, Oneonta, 1973

Professional Experience

2006 – present, U.S. Nuclear Regulatory Commission, Mail Stop T-6D23, 11555 Rockville Pike, Rockville, MD 20852

Health Physicist. Dr Schaffer is responsible for various health physics activities including the review of applications under 10 CFR 52 that include design certifications, early site permits and combined operating license. In addition he supports various rulemaking efforts, regulatory guidance review and updates and the preparation of construction and inspection procedures for new reactors.

1993 - 2006 SC&A, INC. 6858 Old Dominion Dr., McLean, VA 22101

Senior Project Manager. Dr. Schaffer was a senior scientist responsible for a wide variety of ecological, health and regulatory activities and has lead responsibilities for the company's chemical risk assessment business. This activity resulted in new chemical risk assessment work from the U.S. DOJ and U.S. EPA OSWER. He served as overall project manager for SC&A's radiation support contract to EPA ORIA. This contract yielded more than 30 individual work assignments a year and almost 2 million dollars in annual revenue. Dr. Schaffer managed a project which produced the Environmental Impact Statement and Regulatory Analysis which supported NRC's decommissioning residual radioactivity rulemaking. He also managed a large regulatory support project for the EPA which produced a Background Information Document and Regulatory Analysis for the Land Disposal of Low-Level Radioactive Mixed-Waste. He is also responsible for SC&A's technical training business which offers seminars to industry and government concerning risk assessment, environmental chemistry, and quality control. Dr. Schaffer also performed several studies for the EPA concerning the risks and hazards of both chemical and radiological agents in waste. He also supports the Department of Justice Environmental Defense Section as an expert witness in ecological and health risk assessment, and environmental chemistry for Navy Superfund sites.

1988 - 1993 HITTMAN EBASCO ASSOCIATES, INC., 9151 Rumsey Road, Columbia, MD 21045

President. Dr. Schaffer was responsible for Ebasco's environmental chemistry laboratory subsidiary company, which was one of the nations largest (ranked in the top 5% in annual revenue - $4.0 Million/y, 50 employees). Several sales/marketing, customer service, safety and health, quality assurance, and employee motivational programs were set in place. This reduced analysis turnaround times by 400%, and QC failure rates to 0.003, and increased profitability significantly, with a 40% increase in revenues and a corresponding cost increase of only 1%. Seven additional federal and state government laboratory certifications were added to increase the laboratory's technical expertise. Dr. Schaffer personally obtained and managed several EPA and Army COE laboratory support contracts totaling almost $2.5 Million per year.

1985 - 1988 EBASCO SERVICES, INC., Lyndhurst, NJ

Director, Environmental and Health Sciences. As Ebasco's Senior Environmental Scientist in the northeastern operation, Dr. Schaffer managed a group of 30 upper level chemists, biologists, ecologists, toxicologists, policy analysts, industrial hygienists, and statisticians whose responsibilities included the design of health and safety, field sampling and laboratory analytical programs for all of Ebasco's hazardous waste site work; the coordination, review and validation of all analytical laboratory support; the performance of health and ecological risk analyses and impact analyses for all Superfund, utility and other industry-related activities; and company occupational safety issues which included program development and performance of site safety inspections, employee medical/exposure/training history tracking, and company safety training programs according to 29 CFR 1910.120 requirements. As director, Dr Schaffer was responsible for developing and maintaining a standalone private client risk assessment business which averaged $100,000 per year.

1981 - 1985 EBASCO SERVICES, INC. 2 WTC, New York, New York

As part of the Radiological Assessment department of Ebasco, Dr Schaffer conducted numerous safety analyses in support of nuclear power plants. He designed environmental monitoring programs for several nuclear utilities and developed a course in environmental monitoring. Dr. Schaffer also performed and supervised numerous health and ecological risk assessments and was the chemist for many Superfund projects. In addition, he was responsible for all analytical support for Region II in Ebasco's REM III program with the EPA. He also authored several papers and made presentations on applying risk assessment techniques to help manage the problems posed by waste sites.

1973-1981 NEW YORK UNIVERSITY, INSTITUTE OF ENVIRONMENTAL MEDICINE, Long Meadow Road, Tuxedo, NY

Research staff. Member of a research group which examined human impacts on estuarine ecosystems including nuclear power reactors. He had evaluated physical and chemical stressors on algae, invertebrate and fish populations within the Hudson River, and authored several scientific papers on the effects of sampling gear on striped bass, chemical composition of Hudson River water, and the effects of alpha radiation and PCBs on the energy metabolism of algae.

Selected Accomplishments

Managed a project which produced the Environmental Impact Statement (NUREG-1496) and Regulatory Analysis for NRC's residual radioactivity standards for decommissioning. This work analyzed the risks/impacts and cost of four different regulatory approaches which included no action and standards based on risk, best available clean-up technology and background radiation levels. Decommissioning costs and risks were developed and analyzed for cleanup of buildings and soils for the entire spectrum of sites regulated by the NRC and agreement states. Work on this project required a detailed knowledge of NRC's DandD code.

Assisted in the development and teaching of the multi-agency training course on MARSSIM. Prepared training modules, instructor and student manuals, feedback forms, and acted as a backup instructor.

Critically reviewed numerous decommissioning plans for the EPA. These plans were reviewed for technical completeness, calculation of DCGLs, ease of implementation, and adherence to MARSSIM and other technical and regulatory guidance.

Critically reviewed and summarized the progress of decommissioning at all NRC SDMP sites. This work required the review of the entire decommissioning docket for each licensee and interviews with responsible managers. The review and summary included information on the types of remedial options, the levels of cleanup for buildings and soil (DCGLs), the techniques used to calculate DCGLs, the use of MARSSIM type surveys, the depth of the Quality Assurance, potential worker and public exposure, and impediments to progress.

Provided technical and field support for two radiologically contaminated sites in Maryland and New Jersey. This support included field work, survey measurements, data validation, dose reconstruction, risk assessment, the calculation of DCGLs using RESRAD and RES-BUILD, the identification of decommissioning engineering alternatives, and ALARA analysis.

Managed a project which produced the Background Technical Information Document and Regulatory Impact Analysis for EPA's rulemaking on mixed radiological and chemical waste disposal. This work analyzed the risks and costs from disposing mixed waste in four different land disposal options. Led the effort that quantitatively evaluated the dose and risk to workers and the general public. Provided stochastic modeling of results for worker exposure using MICROSHIELD and NRC's De Minimis code, and public exposure from groundwater transport of buried waste using PRESTO.

Developed RESRAD parameter distributions for quantitative uncertainty analysis for a project assessing safe levels in soil. Parameter distributions were for radionuclide dependent transfer and uptake.

Developed for the EPA a hazard index for the disposal of mixed radiological and chemical waste. This index quantitatively characterized the risks from disposing wastes containing chemical and radiological carcinogens and other non-carcinogenic hazardous substances. This Hazard Index was based on modeling exposures and risk from radionuclides buried at hazardous waste sites.

Performed a study for the EPA and the NRC which evaluated the synergistic action of radiation and chemical carcinogens.

Evaluated the radiological and chemical toxicities of uranium in support of EPA's rulemaking on residual radioactivity.

Carried out and subsequently published the results of laboratory experiments dealing with the effects of high LET radiation on the survival and energy metabolism of algae.

Designed a radiological environmental monitoring program for a nuclear client nuclear utility. This program included field sampling and laboratory analysis of air, water and aquatic biota.

Managed and performed a study for EPA OSWER that applied radiation population risk assessment techniques to Superfund sites. The study showed, using two real case study sites, that population risks can be quantified using the information supplied in most RI/FS.

Provided written and oral expert witness testimony to the Atomic Safety Licensing Board (ASLB) for client utility on the subjects of inhalation dosimetry, atmospheric particulate matter and environmental transport modeling.

Acted for five years as the Radiation Safety Officer for Hittman Ebasco Laboratory. Responsibilities includes obtaining the state radiation material license, developing the radiation safety program for the lab, writing Standard Operating Procedures for radiation material handling, monitoring, shipping and waste disposal, and performing routine inspections and audits of the program.

Evaluated the radiological impacts of nuclear power plant operation for five client utilities. Prepared postulated source terms and subsequent doses to surrounding areas for Safety Analysis and Environmental Reports.

Developed uncertainty distributions for environmental pathway model parameters that were utilized by the EPA and DOE in an uncertainty analysis of the environmental risks of high-level waste.

Assisted in the preparation and implementation of an environmental monitoring program for a nuclear power plant.

Provided technical and regulatory support to the DOE concerning the proposed EPA standard on high-level waste (40 CFR 191). This support included:

- Co-authoring a report submitted by the DOE to the EPA Science Advisory Board. This work quantified the uncertainty (using stochastic modeling techniques) in the EPA health risk estimates used as the basis of the proposed regulation.

- Critically evaluating the REPRISK methodology used by the EPA for determining the risk from high-level waste.

- Acting as a technical liaison between DOE and EPA especially in the area of environmental transport modeling.

Aided in the preparation of expert witness testimony for the Atomic Safety Licensing Board (ASLB) hearings on the synergistic action of radiation and chemical carcinogens.

Performed the health risk assessment for an onsite incinerator designed for the cleanup of PCBs at a New Jersey Superfund site. This effort involved the estimation of stack and water releases, atmospheric and exposure modeling, risk characterization and compliance reporting.

Designed a risk assessment screening model for incinerator siting for the state of California. This model was also developed to perform both stochastic and deterministic assessments.

Provided expert witness testimony for a private client siting of a municipal solid waste incinerator. This including performing a health risk assessment of incinerator emissions, providing testimony and participating in public meetings.

Developed and initiated the performance of the Quality Assurance Program for Hittman Ebasco Laboratory. This included writing the Quality Assurance Plan, and setting in place the needed personnel and resources to perform the program.

Managed the development of several GC, HPLC and GC/MS laboratory detection methods for army agents and agent degradation products for the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA).

Evaluated field screening techniques for army agents for the protection of hazardous waste site workers at Rocky Mountain Arsenal.

Selected Publications

Schaffer, S.A. 2000. "Using Radiation Population Risk Assessment Techniques for Chemically Contaminated Superfund Sites". Invited Speaker for the Annual Meeting of the Society of Risk Analysis, December 5, 2000, Arlington, VA.

Schaffer, S.A. 1999. The Combined Action of Radiation and Chemical Carcinogens@. In Proceedings of the Second International Symposium on Ionizing Radiation. May 10-14, 1999, Ottawa, Ontario, Canada.

Schaffer, S.A., T. McLaughlin, N. Numark, M. Boyd. 1997. The Safety of Various Waste Disposal Options for Soil From the Cleanup of Federal Facilities.@ In proceedings of Waste Management 97, Tucson, Arizona.

Rish, W.R., S.A. Schaffer, M. Marchlik and M. Amdurer, 1985. "A risk analysis approach to 'How clean is clean?' Proceedings of the National Conference on Hazardous Wastes and Environmental Emergencies, May 1985, Cincinnati, Ohio, pp. 333-339.

Rish, W.R., J.J. Mauro, S.A. Schaffer, 1983. "Uncertainties in EPA Modeling Used to Develop Draft Standard 40 CFR 191." Proceedings of the American Nuclear Society, Winter 1983.

Schaffer, S.A., 1985. "Environmental transfer and loss parameters for four selected priority pollutants."
Proceedings of the National Conference on Hazardous Wastes and Environmental Emergencies, May 1985, Cincinnati, Ohio, pp. 145-149.

Schaffer, S.A., 1985. "The use of risk assessment for coal tar sites." Proceedings of the 8th Annual Conference on Environmental Requirements Affecting Electric Utilities.

Schaffer, S.A., 1985. "The bioenergetic response of Chlorella Vulgaris to alpha radiation." Environmental and Experimental Botany, 25(1):1-6.

Steinhausler, F., S.A. Schaffer, N. Cohen, C.C. Lee, J.M. O'Connor, and M.E. Wrenn, 1980. "Effects of High LET Radiation on Intracellular ATP Content of Prokaryotic and Eukaryotic Algae." Abstracts of the 26th Annual Meetings of Radiation Research Society, Toronto, Canada, May 1978. Radiation Research, 74:591-92.

O'Connor, J.M., and S.A. Schaffer, 1977. "The Effects of Sampling Gear on the Survival of Striped Bass Icthyoplankton." Chesapeake Science 18:312-315.

Schaffer, S.A., and C.C. Lee. "Organic Carbon and Protein Concentrations of Hudson River Water in the Vicinity of Indian Point." (Abstract) American Society of Limnology

January 16, 2009

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF SESHAGIRI RAO TAMMARA CONCERNING
THE NRC STAFF RESPONSE TO THE LICENSING BOARD'S
QUESTIONS REGARDING SAFETY MATTERS

I, Seshagiri Rao Tammara, do hereby state as follows:

1. I am employed as a Physical Scientist in the Division of Site and Environmental Reviews in the U.S. Nuclear Regulatory Commission's ("NRC") Office of New Reactors. A statement of my professional qualifications is attached.

2. As part of the NRC staff's safety review of the Vogtle Early Site Permit ("ESP") application, documented in the "Safety Evaluation of the Early Site Permit Application in the Matter of Southern Nuclear Operating Company, for the Vogtle Early Site Permit Site," November 2008, I reviewed the aspects of the application that concerned Site Description (EAB), Demography, Description of Nearby Facilities and Evaluation of potential External Hazards, and Evaluation of Site Proximity Missiles and Aircraft Hazards.

3. I am responsible for those responses to Licensing Board questions (or portions of questions) in Attachment A to the "NRC Staff Response to the Licensing Board's Questions Regarding Safety Matters" for which I am listed as the author.

4. I attest to the accuracy of those statements, support them as my own, and endorse their introduction into the record of this proceeding. I declare under penalty of perjury that those statements, and my statements in this affidavit, are true and correct to the best of my knowledge, information, and belief.

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

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Seshagiri Rao Tammara

SESHAGIRIRAO TAMMARA
NRO/RSAC

M.S., Environmental Engineering (Pollution Control), University of Maryland, 1976
M.S., Chemical/Nuclear Engineering, University of Maryland, 1970
M. Tech (M.S.), Chemical Engineering, Plant Design, Osmania University, India, 1968
B. Tech (B.S.), Chemical Engineering, Osmania University, India, 1966
B. Sci (B.S.), Mathematics, Physics and Chemistry, Osmania University, India, 1961

Serves presently, as a Physical Scientist in conducting reviews and evaluations pertaining to site criteria and site suitability, potential external hazards, and aircraft hazards as a part of Safety Evaluation Reports (SERs) for the new proposed nuclear reactors.

Mr. Tammara has more than 38 years of professional experience in multi-disciplinary environmental impact assessments and evaluations of air pollutants and chemicals from power plants and other facilities; demographic analysis for the determination of population distribution and density; and radiological impact analyses of nuclear power plants and other nuclear facilities. Activities include radiological dose assessments and health effects due to normal operations and facility accidents, concentration impacts and health risk assessments due to chemical accidents, traffic and radioactive material transportation impacts, chemical and air quality impact assessments, thermal performance evaluations, cooling tower analyses, emergency cooling pond analyses, health risk assessments due to hazardous and carcinogenic substances, and remedial actions to control waste releases for corrective actions and mitigation measures.

Mr. Tammara is experienced in risk assessment and retrieval methodologies of radioactive thermoelectric generators used in space systems. He has also worked to generate radionuclide inventories for plutonium fuel used in Radioisotope Thermoelectric Generators (RTGs) using ORIGEN2 computer model. He has experience in evaluating risks due to potential accidents of space missions carrying on board RTGs, using TtNUS developed EMERGE computer model. Mr. Tammara also has processed and prepared meteorological data sets required in analyzing environmental and potential health risk impacts due to space missions.

Mr. Tammara has experience in preparing sections required for Environmental Reports and Safety Analysis Reports as well as experience in NEPA process and in preparing sections for EISs. He has been involved in calculating facility accident impacts using MACCS computer code, and has computer modeling experience utilizing various industry-wide computer models such as GASPAR, LADTAP, GENII, AIRDOS, RADTRAN IV, MACCS, ORIGEN2, CAP88PC2, ALOHA, MEPAS, SLAB, DEGADIS, CHEMSPLUS, PATHRAE, MESOPUFF, SACTI Cooling Tower Plume Dispersion model, and other pertinent meteorological models like XOQDOQ, PAVAN and ARCON96 for determining atmospheric dispersion parameters(X/Q values).