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SOUTHERN COMPANY

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Southern Nuclear Operating Company
Vogtle Electric Generating Plant Units 3 and 4 Combined License Application
Response to Request for Additional Information Letter No. 048
Control Room Habitability Analyses

Ladies and Gentlemen:

By letter dated March 28, 2008, Southern Nuclear Operating Company (SNC) submitted an application for combined licenses (COLs) for proposed Vogtle Electric Generating Plant (VEGP) Units 3 and 4 to the U.S. Nuclear Regulatory Commission (NRC) for two Westinghouse AP1000 reactor plants, in accordance with 10 CFR Part 52. During the NRC's detailed review of this application, the NRC identified a need for additional information, involving control room habitability analyses, required to complete their review of the COL application's Final Safety Analysis Report (FSAR) Section 6.4, "Habitability Systems." By letter received February 5, 2010, the NRC provided SNC with Request for Additional Information (RAI) Letter No. 048 concerning this information need. This RAI letter contains two RAI questions, numbered 06.04-02 and 06.04-03. The enclosure to this letter provides the SNC response to these questions.

This letter identifies changes that will be made to a future revision of the VEGP Units 3 and 4 combined license application (COLA).

If you have any questions regarding this letter, please contact Mr. Wes Sparkman at (205) 992-5061.

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NRO

Mr. B. L. (Pete) Ivey states he is a Vice President of Southern Nuclear Operating Company, is authorized to execute this oath on behalf of Southern Nuclear Operating Company and to the best of his knowledge and belief, the facts set forth in this letter are true.

Respectfully submitted,

SOUTHERN NUCLEAR OPERATING COMPANY

Brian L. (Pete) Ivey

Sworn to and subscribed before me this 5th *day of* March, *2010*

Notary Public: Dana M. Williams

My commission expires: 12/29/2010

BLI/BJS/dmw

Enclosure: Response to NRC RAI Letter No. 048 on the VEGP Units 3 & 4 COL Application Involving Control Room Habitability Analyses

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Southern Nuclear Operating Company

ND-10-0459

Enclosure

Response to NRC RAI Letter No. 048

on the

VEGP Units 3 & 4 COL Application

Involving the

Control Room Habitability Analyses

NOTE: The enclosed document is nine (9) pages in length.

FSARSection 6.4, Habitability Systems

eRAI Tracking No. 4281

NRC RAI Number 06.04-02:

1. Provide data to facilitate the staff's confirmatory analysis.

   To assure the control room habitability per GDC 19 during a hypothetical accidental release of methoxypropylamine and ammonium bisulfite, the staff requests the following chemical data for confirmatory analysis with respect to these two chemicals (the applicant has specified these two chemicals as 60% aqueous solution):

   Vapor Pressure, Boiling Point, Critical Pressure, Critical Temperature, Density (gas), Flash Point, Freezing Point, Heat Capacity (gas, constant pressure), Heat Capacity (liquid, constant pressure), Molecular Weight, Specific Gravity, Heat of Vaporization

   Provide references or bases (e.g. chemical specification from vendor, formula, etc.) to support the above chemical data and the 60% aqueous solution assumption.

SNC Response:

The requested data (where available) is provided below.

The lack of certain available chemical data prevented the use of the ALOHA model to determine control room toxicity effects for both methoxypropylamine (MPA) and ammonium bisulfite. Although a direct release scenario is feasible for both chemicals, based on the available data, it is an inappropriate conceptual model based on the type of chemicals (i.e., atmospheric liquids) and storage conditions of the chemicals (e.g., tank surrounded by a berm). This dictated our use of the proprietary program TOXDISP, which is a dispersion program based on the methodology presented in NUREG-0570, for the calculation of control room toxicity effects for the release of both chemicals.

Unlike in ALOHA, where evaporation of normal boiling point liquids is driven by the temperature of the puddle and the temperature of the atmosphere, TOXDISP calculates evaporation of normal boiling point liquids based on diffusion into the atmosphere due to the vapor pressure between the liquid's surface and the atmosphere. In order for ALOHA to calculate evaporation rates, several chemical properties, such as heat capacity, heat of vaporization, and critical temperature and pressure, must be known. All that is required in TOXDISP is a mass transfer coefficient, which can be calculated based on the diffusion coefficient for a given chemical. Diffusion coefficients are calculated based on molecular weights and volumes. Therefore, due to the lack of appropriate chemical properties needed for an ALOHA analysis, TOXDISP is the most suitable program for these calculations.

The tables below provide the chemical data for methoxypropylamine (MPA) and ammonium bisulfite which are used in the TOXDISP calculation, along with the additional data specifically requested by the NRC which was not used in TOXDISP. As noted, this data was obtained from several manufacturers' Material Safety Data Sheets (MSDSs).

Methoxypropylamine (MPA):

Chemical Property	Value	Source
Properties Used in TOXDISP		
Vapor Pressure:	20 mmHg @ 30°C	NALCO Company MSDS (NALCO 94UF193)
Boiling Point:	116°C	NALCO Company MSDS (NALCO 94UF193)
Liquid Density	0.99 g/cm^3	NALCO Company MSDS (NALCO 94UF193)
Solution Molecular Weight	34.54 g/mol	Calculated based on ARKEMA Inc MSDS (3-methoxypropylamine)
Binary Diffusion Coefficient	0.163 cm^2/s	Calculated
Additional Properties Requested in RAI		
Critical Pressure:	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Critical Temperature:	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Density (gas):	3.7 kg/m^3 @ 20°C	ARKEMA Inc MSDS (3-methoxypropylamine)[1]
Flash Point:	>93°C	NALCO Company MSDS (NALCO 94UF193)
Freezing Point:	-75.7°C	ARKEMA Inc MSDS (3-methoxypropylamine)[1]
Heat Capacity (gas, constant pressure):	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Heat Capacity (liquid, constant pressure):	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Molecular Weight:	89.14 g/mol	ARKEMA Inc MSDS (3-methoxypropylamine)[1]
Specific Gravity:	0.97-0.99 @ 25°C	NALCO Company MSDS (NALCO 94UF193)
Heat of Vaporization:	Not available from vendor(s) MSDS sheet(s)	Not Applicable

[1]These chemical properties are for pure MPA.

Ammonium Bisulfite:

Chemical Property	Value	Source
Properties Used in TOXDISP		
Vapor Pressure:	17.25 mmHg @ 20°C	ScienceLab.com MSDS[1]
Boiling Point:	100°C	ScienceLab.com MSDS[1]
Liquid Density	1.32 g/cm^3	NALCO Company MSDS (NALCO 7905)
Solution Molecular Weight	35.36 g/mol	Calculated based on Chemical Hazards Response Information System MSDS
Binary Diffusion Coefficient	0.185 cm^2/s	Calculated
Additional Properties Requested in RAI		
Critical Pressure:	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Critical Temperature:	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Density (gas):	0.75 kg/m^3 @ 20°C	ScienceLab.com MSDS[1]
Flash Point:	Non-flammable	NALCO Company MSDS (NALCO 7905)
Freezing Point:	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Heat Capacity (gas, constant pressure):	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Heat Capacity (liquid, constant pressure):	Not available from vendor(s) MSDS sheet(s)	Not Applicable
Molecular Weight:	99.10 g/mol	Chemical Hazards Response Information System[2]
Specific Gravity:	1.32 @ 25°C	NALCO Company MSDS (NALCO 7905)
Heat of Vaporization:	Not available from vendor(s) MSDS sheet(s)	Not Applicable

[1]These chemical properties are for a 45% solution of ammonium bisulfite and water.
[2]This chemical property is for pure ammonium bisulfite.

The assumption that the chemicals are in 60% aqueous solution is taken from the NALCO Company MSDS for each chemical (NALCO 94UF193 and NALCO 7905).

This response is PLANT-SPECIFIC for VEGP.

Associated VEGP COL Application Revisions:

None.

eRAI Tracking No. 4281

NRC RAI Number 06.04-03:

1. Justify analysis methodology and information.

   The applicant used the ALOHA and TOXDISP methodologies to perform the chemical release analysis. Provide the following for review:

   a. Information and data that links ALOHA and TOXDISP from chemical evaporation to concentration in control room,
   b. Justification of the TOXDISP results of 10E-37 for stability class F, which the staff estimates to be greater when HABIT is used,
   c. The cross-sectional area of the building structure projected on a plane perpendicular to the wind direction,
   d. Justification of the "Urban or Forest" assumption for ground roughness as input in ALOHA (such as by reference to design features described in the FSAR).

2. Justify the data of air exchange per hour used in the analysis and correct it in the FSAR.

   The data for air exchange per hour used in the analysis are not the same as the data shown in the FSAR (e.g. 0.391 in Section 2.2.3). Provide:

   a. Calculation details for the analysis data,
   b. Revision of the data shown in the FSAR, so that it is consistent with the analysis data.

<u>SNC Response:</u>

1. a. There is no link between ALOHA and TOXDISP. They are two independent programs that provide results to similar scenarios using different inputs. (See the response to RAI 06.04-2 above for additional discussion of the differences between the two models.)

   b. The TOXDISP results for stability class "F" for both chemicals are low due to the stability class and the air intake height. Class "F" stability is the most stable of the atmospheric stability classes, causing limited vertical mixing of a chemical plume. At ground level, "F" stability causes the highest chemical plume concentrations. However, at the height of the control room air intake, the concentrations would be much lower due to the lack of this vertical mixing.

   Therefore, subsequent to the original calculation, a sensitivity study was performed in order to determine the worst-case conditions for the elevated control room air intake. This revised calculation shows that stability class "A," along with a wind speed of 1.5 m/s and an ambient temperature of 95.1°F, is the worst-case scenario, resulting in maximum indoor (i.e., main control room) concentrations of 1.94 ppm and 2.07 ppm for the ammonium bisulfite and MPA, respectively. Essentially, the stability class "A" allows for more vertical mixing and, thus, higher concentrations at the raised intake.

These revised calculational results supersede those reported to the NRC in SNC's response to NRC RAI Letter No. 019, dated January 9, 2009. However, although the control room concentrations of ammonium bisulfite and MPA increased due to the use of stability class "A," they remain well below the limits that would pose a toxic hazard to control room operators. Therefore, no further analysis is required, and the conclusions of FSAR Subsection 2.2.3.2.3.2 remain valid.

c. The cross-sectional area of the building structure projected on a plane perpendicular to the wind direction is not a required input parameter to the TOXDISP program unless the conceptual model accounts for building wake. Because building wake would decrease the concentration of the cloud, it is, conservatively, not considered in this calculation.

d. Due to the site layout, as shown in the FSAR, and the location of the chemicals, "Urban or Forest" ground roughness was selected as most representative of the site conditions. This selection is appropriate because releases at the storage locations would require that the formed vapor cloud travel between the structures related to Units 1 and 2. The "Urban or Forest" ground roughness is used, in ALOHA, to describe "an area with many friction-generating roughness elements, such as trees or small buildings."

2. a. Westinghouse has made significant airflow changes to the AP1000 main control room because of design development. As a result, the control room air exchange rate used in the VEGP Units 3 and 4 onsite chemical hazards analysis has been revised from 0.391 exchanges per hour to 0.95 exchanges per hour. The basis, as provided by Westinghouse, is a control room makeup air flow rate of 1500 cfm and an approximate control room volume served by the air handling unit of 105,000 cu. ft. With a 10% margin, the control room air exchange rate thus becomes 0.95 exchanges per hour.

   This change, along with the associated FSAR chemical hazards analysis descriptions, will be addressed in a future VEGP COLA revision.

   b. FSAR Subsection 2.2.3.2.3.1 will be revised to reflect the revised control room air exchange rate and associated chemical hazards analysis changes.

This response is PLANT-SPECIFIC for VEGP.

Associated VEGP COL Application Revision:

VEGP COLA Part 2, FSAR Subsection 2.2.3.2.3.1, will be revised as follows:

2.2.3.2.3.1 Hydrazine Hazard from Onsite Storage Tanks

Impact on safety related structures and control room habitability for Units 3 and 4 due to accidental releases from or explosion in the 6,644 gallon Units 1 and 2 hydrazine tank was not evaluated in the ESPA SSAR, but is evaluated below.

The Areal Locations of Hazardous Atmospheres (ALOHA) code (Reference 202) and the TNT equivalency method is used to determine the minimum safe distances for hydrazine that is stored onsite at VEGP. These minimum safe distances for Unit 3 control room are then compared to the distances from where hydrazine is stored to Unit 3. Since the Unit 4 control room is further west of Unit 3, the evaluation is based on Unit 3 only and then the results are applied to Unit 4. The four scenarios evaluated are: toxicity of a vapor cloud, flammability of a vapor cloud, explosive vapor cloud, and a tank explosion.

The assumptions for the three vapor cloud scenarios include the following:

• Hydrazine is a 35% hydrazine solution.

• Atmospheric air flow is turbulent in only one direction (no cross flow) such that the released gases spread downstream in a Gaussian manner.

• Total quantity of hydrazine is released and forms an evaporating puddle with a depth of 1 cm (NUREG-0570). This provides a significant surface area to maximize evaporation and the formation of a vapor cloud.

• Ambient temperature is 95.1°F for daytime releases and 70.1°F for nighttime releases, the relative humidity is 50%, and the atmospheric pressure is 1 atmosphere (40 CFR 68.22).

• A sensitivity study was performed to determine the worst-case meteorological conditions (wind speed and stability class). The worst-case scenario is a wind speed of 2 m/s and stability class "F".

• Ground roughness is "Urban or Forest" which most accurately represents site conditions.

• Cloud cover selected is based on the appropriate stability class and wind speed (Reference 202).

• Time of accidental release is 12:00 pm on July 21, 2008 for daytime releases and 5:00 a.m. on July 21, 2008 for nighttime releases. The date was selected because it coincides with the highest daily maximum temperature, and 12:00 p.m. was selected because solar radiation is highest during midday. Higher solar radiation leads to a higher evaporation rate and thus a larger vapor cloud. Five o'clock (5:00) a.m. on July 21, 2008 was selected to provide a realistic meteorological condition for the more stable stability classes. ALOHA requires manual override if 12:00 p.m. is used with stability classes "E" and "F", or "D" with a wind speed of 3 m/s (Reference 202).

• Wind input height is 10 meters. ALOHA calculates a wind profile based on where the meteorological data is taken. ALOHA assumes that the MET station is at a height of 10 meters. The National Weather Service usually reports wind speeds from the height of 10 meters.

• There is no temperature inversion.

• It is not known how long after a release ignition occurs for vapor cloud explosions. Therefore, the "unknown" time of vapor cloud ignition option was selected for this case. ALOHA will run explosion scenarios for a range of ignition times that encompass all of the possible ignition times for a scenario. ALOHA takes the results from all of these scenarios and combines them on a single Threat Zone plot.

• Type of vapor cloud ignition is "ignited by detonation." This is the worst case scenario for an accidental explosion.

The assumptions for the tank explosion (TNT mass equivalency) scenario include the following:

• Vapor space is assumed to be the tank volume at the upper flammability limit of hydrazine.

• Air temperature is 32.2°F, the lowest mean daily minimum temperature, which corresponds to an air density of 0.081 lb/ft^3.

• Detonation occurs inside the tank.

• Vapor explosion is treated as if it is completely confined. Thus, a yield factor of 100% is used for the confined vapor explosion (NUREG-1805).

Toxicity of a Hydrazine Vapor Cloud

For assessing the toxicity of a vapor cloud from hydrazine release, it is necessary to determine the maximum distance at which the Immediately Dangerous to Life or Health (IDLH) value exists (RG 1.78). This distance represents the minimum safe distance from the hydrazine storage area that a nuclear power plant can operate. The distance depends on the prevailing meteorological conditions, wind speed, relative humidity, atmospheric pressure, ambient temperature, toxicity and the quantity of hydrazine released. It is also necessary to determine the resulting concentration of hydrazine inside the control room to ascertain the effects of a toxic vapor on the operators. ALOHA calculated both the inside and outside concentrations of the control room over time (0 to 1 hour). For this evaluation, a release of 6,644 gallons of 35% hydrazine solution is assumed.

The hydrazine tank is located east of the Unit 1 Turbine Building, 2,200 feet from the Unit 3 control room. The evaluation considers a control room air exchange rate of 0.95 exchanges per hour, and an IDLH for hydrazine of 50 ppm. The maximum vapor cloud distance to the IDLH is calculated to be 927 feet (the resulting maximum concentration at the control room air intake is 15.4 ppm). The maximum concentration of hydrazine inside the control room is calculated to be

7.76 ppm. The resulting hydrazine concentrations inside the Units 3 and 4 control rooms are within the IDLH limit value of 50 ppm.

Results indicate that operators in the Units 3 and 4 control rooms are not impacted by the potential toxicity from a hydrazine vapor cloud.

Flammability of a Hydrazine Vapor Cloud

For assessing the flammability of a vapor cloud from a hydrazine release, the ALOHA air dispersion model is used to determine the distances where the vapor cloud may exist between the upper flammability limit (UFL) and lower flammability limit (LFL) (40 CFR 68.22). Once the concentration of the hydrazine vapor cloud is above the UFL or below the LFL, the vapor is no longer flammable.

For this evaluation, a release of 6,644 gallons of 35% hydrazine solution is analyzed for potential flammable hydrazine vapor threats.

Hydrazine has an LFL of 4.7% and a UFL of 99.9%. The distance from the leak source to the LFL is 54 feet. Though ALOHA does report a distance to the LFL, the vapor cloud does not ever exceed the LFL for any scenario. The distance that is reported is the same for every situation due to near field patchiness. It is further shown that the LFL is never exceeded because, as shown below, no explosions occur, even though a detonation was chosen in every instance.

The distance from the hydrazine storage tank to where the hydrazine vapor cloud exists between the UFL and the LFL is less than the distance from the storage tank to the Units 3 and 4 control rooms. Therefore, results indicate that there is no potential flammable, hydrazine vapor cloud reaching safety related structures or the operators in the Units 3 and 4 control rooms.

Explosive Hydrazine Vapor Cloud

For assessing the explosion from a vapor cloud due to hydrazine release, it is necessary to determine the "safe distance", the minimum distance required for an explosion to have less than or equal to 1 psi peak incident pressure (RG 1.91). This is the minimum safe distance for no impacts from an explosion of a hydrazine vapor cloud. A peak overpressure of 1 psi will shatter glass but not significantly cause structural damage to buildings (RG 1.91). The peak overpressure to the Unit 3 control room is also established. For this evaluation, a release of 6,644 gallons of 35% hydrazine solution is analyzed for potential explosive vapor threats.

The ALOHA analysis indicates that the vapor cloud does not reach the LFL and, therefore, does not explode. Since there is no explosion, the safety related structures and operators working in the Units 3 and 4 control rooms are not impacted.

Hazard from a Tank Explosion

The methodology presented below is for a confined explosion occurring within some form of a storage container (i.e. tank). Since only vapor will burn or explode, the methodology employed

considers the maximum vapor within the hydrazine storage tank as explosive (equivalent TNT). For atmospheric liquid storage, this maximum vapor would involve the container to be completely empty of liquid and filled only with air and chemical vapor at UFL conditions (NUREG-1805). Due to complete confinement and the use of only the UFL vapor mass, a 100% yield factor is attributed to the explosion (NUREG-1805). The equivalent mass of TNT is calculated by taking into account the product of the vapor mass (within the flammable range), heat of combustion, and the explosion yield factor. Once the equivalent mass of TNT is calculated, a radial distance generating a 1 psi peak incident pressure ("safe distance") is calculated by taking the product of the factor 45 and the cube root of the equivalent mass of TNT (RG 1.91).

The evaluation is based on a vapor-filled 6,644 gallon hydrazine tank. For the assumed atmospheric conditions, a heat of combustion of 8,345 Btu/lb, and a vapor specific gravity of 1.1, the mass of flammable hydrazine in the tank is 79 pounds. The resulting equivalent mass of TNT is calculated to be 330 pounds, and the resulting "safe distance" is 311 feet.

Results from the TNT equivalency method indicate that there are no potential explosive vapor threats from hydrazine storage tanks to safety related structures or operators in the Units 3 and 4 control rooms.