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SCE&G®
A SCANA COMPANY

February 23, 2009
NND-09-0041

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

ATTN: Document Control Desk

Subject: Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3 Combined License Application (COLA) - Docket Numbers 52-027 and 52-028
Response to NRC Request for Additional Information (RAI) Letter No. 024

Reference: Letter from Ravindra G. Joshi (NRC) to Alfred M. Paglia (SCE&G), Request for Additional Information Letter No. 024 Related to SRP Section 6.4 for the Virgil C. Summer Nuclear Station Units 2 and 3 Combined License Application, dated January 22, 2009.

The enclosure to this letter provides the South Carolina Electric & Gas Company (SCE&G) response to the RAI items included in the above referenced letter. The enclosure also identifies any associated changes that will be incorporated in a future revision of the VCSNS Units 2 and 3 COLA.

Should you have any questions, please contact Mr. Al Paglia by telephone at (803) 345-4191, or by email at apaglia@scana.com.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 23rd day of February, 2009.

Sincerely,

Ronald B Clary

Ronald B. Clary
General Manager
New Nuclear Deployment

JMG/RBC/jg

Enclosure

D083
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NRC RAI Letter No. 024 Dated January 22, 2009

SRP Section: 06.04- Control Room Habitability

Question from Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

NRC RAI Number: 06.04-1

1. Justify the use of ALOHA in Subsections 2.2.3.1.3.1 and 2.2.3.1.3.3.

Regulatory Guide 1.78 describes the use of HABIT code for calculating design basis toxic chemical dispersion. The Summer design basis utilizes ALOHA. Justify the use of ALOHA as an acceptable approach for calculating design basis toxic chemical dispersion. Include a description of how ALOHA is being used to ensure acceptable results.

VCSNS RESPONSE:

The Areal Locations of Hazardous Atmospheres (ALOHA) computer program developed by the US Environmental Protection Agency (EPA) and National Oceanic Atmospheric Administration (NOAA) was utilized to calculate airborne toxic chemical concentrations both at the closest control room air intake and inside the closest Unit 2 or Unit 3 control room. ALOHA was chosen over other similar models for its computational similarity to the EXTRAN and CHEM codes within HABIT, especially regarding the capabilities described by Regulatory Guide 1.78. In addition, as discussed below, ALOHA provides a higher level of flexibility due to its expanded modeling capabilities and its output capabilities that HABIT is unable to provide, thus making it the preferred model for the analysis at V.C. Summer.

ALOHA has been in constant development and improvement since the early 1990's. The NRC staff has accepted ALOHA for use on other projects such as the American Centrifuge Plant in Ohio where the staff stated, "The ALOHA code is a well known code for this purpose and acceptable to the staff" (NUREG-1851, 2006).

Regulatory Guide 1.78 recommends the use of "a dispersion or diffusion model that permits temporal as well as spatial variations in release terms and concentrations" and then discusses the NRC's use of HABIT for this. EXTRAN (the dispersion model within HABIT) is described as "a Gaussian plume or puff dispersion model, [that] allows longitudinal, lateral, and vertical dispersions", as well as "the effect of wakes and for additional dispersion in the vertical direction when the distance between the release point and the control room is small." Regulatory Guide 1.78 goes on to explain that other "atmospheric dispersion models (e.g., ARCON96) with similar capabilities may be used for dispersion calculations." ALOHA conforms to these requirements.

ALOHA utilizes a Gaussian plume model very similar to the one used by HABIT as well as a dense gas model to simulate the longitudinal and lateral dispersion of toxic gases. Like HABIT, ALOHA is able to model different sources, such as evaporating puddles or gases released from pressurized tanks, which account for temporal and spatial variations due to the dynamic conditions of the source. ALOHA does have a limited ability to account for turbulence effects by altering the ground roughness, however it does not possess the specific capability to account for building wake effects. Nevertheless, since building wake effects normally serve to lower concentrations downwind and generally affect close proximity receptors, it is more conservative to not take the building wake effects into consideration for the V.C. Summer analyses.

ALOHA only plots concentration at the ground level, and both sources and receptors are assumed to be ground level. ALOHA does not take into account buoyancy of gases (Reynolds 1992). Gases in ALOHA are either neutrally buoyant or denser than air. Making the source and receptor of equal heights adds to the conservatism of ALOHA. A known limitation of ALOHA is that it cannot accurately predict near field concentrations (<10 meters) (Reynolds 1992), therefore ALOHA is not used for any analysis where the receptor is within 10 meters of the source. This is not a concern for its use for VC Summer Units 2 and 3.

The dense gas model used in ALOHA is similar to DEGADIS, which is an accepted model in industry due to its extensive testing (Reynolds 1992). ALOHA will automatically choose whether to use the neutral or dense gas model dependant on the density of the chemical. Utilizing a dense gas model rather than Gaussian for denser chemicals such as chlorine allows for much more realistic modeling of the plumes. ALOHA's source modeling allows for the consideration of several release scenarios including spills and gas releases from pressurized tanks, which are normally considered to be the worst case scenarios for releases. While ALOHA's methods and assumptions are different than HABIT's, where comparative analyses have been completed, the calculated release rates are similar and give conservative results.

For the analyses conducted for the V.C. Summer site, the goal was to determine if concentrations of toxic chemicals exceed the Immediately Dangerous to Life and Health (IDLH) or similar limit within the control rooms. The HABIT software was designed to "determine the maximum concentration reaching the control room within 2 minutes after the arrival of the leading edge of the plume" (NUREG/CR-6210 1996). HABIT cuts off its output, often before the chemicals have reached their maximum concentration. This precludes the use of HABIT for the desired analysis at V.C. Summer. ALOHA provides output up to an hour after the initial release which provides much more data than HABIT. By using the data from ALOHA, a more conservative analysis can be performed which produces much more acceptable results than what HABIT could have provided.

References to the Response:

(Reynolds 1992) Reynolds, R. Michael. *ALOHA™ (Areal Locations of Hazardous Atmospheres) 5.0 Theoretical Description DRAFT,* NOAA Technical Memorandum NOS ORCA-65, August 1992.

(NUREG/CR-6210 1996) NUREG/CR-6210. *Computer Codes for Evaluation of Control Room Habitability (HABIT).* U.S. Nuclear Regulatory Commission, June 1996.

(Regulatory Guide 1.78 2001) U.S. Nuclear Regulatory Commission Regulatory Guide 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," Revision 1, December 2001.

(NUREG-1851, 2006) NUREG-1851, Safety Evaluation Report for the American Centrifuge Plant in Piketon, Ohio; U.S. Nuclear Regulatory Commission, 2006.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

None

ASSOCIATED ATTACHMENTS:

None

NRC RAI Letter No. 024 Dated January 22, 2009

SRP Section: 06.04- Control Room Habitability

Question from Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

NRC RAI Number: 06.04-2

a. Provide an explanation for the impact of potential onsite and offsite chemicals on the control room habitability for Units 2 and 3.

Chapter 2 identifies onsite and offsite hazards (ammonium hydroxide and cyclohexylamine); however, no design features are included in sections 6.4 and 9.4 to protect the control room operators. Provide an explanation why the operators remain protected. Specifically, for these chemicals that exceed the IDLH at the control room intake explain why the operators remain protected. If manual or automatic actuations are necessary, explain and justify. Explain the operation of the ventilation system during the toxic gas transient and include the assumed flow rates as well as the mode of operation.

b. Provide details of the ALOHA analyses that support Subsections 2.2.3.1.3.1 and 2.2.3.1.3.3.

Provide details of the analyses that support Subsections 2.2.3.1.3.1 and 2.2.3.1.3.3, including input conditions and assumptions to permit independent confirmatory analysis. These details should include the size of spill, wind conditions (speed and direction), dilution of the chemicals, air intake flow rate of the ventilation system, size of the control room, and the control room in-leakage rate etc.

c. Provide evaluation for the impact of chemical releases on both Units 2 and 3 control rooms.

Tables 2.2.207 to 209 lists the distances to either the unit 2 or 3 control rooms. Why do they not list values for both? Specifically, it is not known if the impact of cyclohexylamine on Unit 2 control room habitability, or 28% ammonium hydroxide on Unit 3 control room habitability, has been evaluated.

d. Provide information for the impact of potential onsite (Units 2 and 3) chemicals on the control room habitability for Units 2 and 3.

Both Tables 2.2-202 and 2.2-205 of FSAR Sec. 2.2.3.1.3 are titled with "Unit 1". There is no other similar FSAR section or table dealing with any potential onsite chemicals for Units 2 and 3. Information for this situation is required in order to review the impact of potential onsite chemicals on the control room habitability for Units 2 and 3.

VCSNS RESPONSE:

RESPONSE TO PART a:

The control room operators are protected by the normal operation of the ventilation system. All toxic chemical events are assumed to take place during normal operation in which the Nuclear Island Non-Radioactive Ventilation System (VBS) provides air to the Main Control Room (MCR) HVAC. The MCR air handling unit supplies 20,530 scfm through the system. Of this, 3210 scfm is supplied into the MCR envelope. Approximately 3015 scfm is returned to the air handling unit from the MCR area (with about 190 scfm exhausted through the MCR toilet area and 5 scfm lost through leakage). 1500 scfm from the outside atmosphere is supplied to the air handling unit. The control room area volume is 36,000 ft^3.

The ALOHA code uses air exchange rates to model the behavior of the ventilation system. The VBS outside air exchange rate was calculated from the information above to be 0.391 air changes per hour. This means that in 1 hour 39.1% of the air in the control room will be changed out with air from the outside. Though the concentrations at the control room intake may go above the IDLH limits, the air exchange rate during normal operation keeps the concentrations inside the control room from exceeding the IDLH limits. This is shown in FSAR Table 2.2-209. Therefore, no manual or automated actuations are necessary. However, these actions would serve to further protect the control room operators.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS PART a:

The following paragraph will be added after the last paragraph of FSAR Section 2.2.3.1.3:

In addition to the assumptions listed, ALOHA takes into account the control room ventilation rate to determine the maximum control room concentrations during the first hour after a release. All toxic chemical events are assumed to take place during normal plant operation. ALOHA uses air exchange rates to model the behavior of the ventilation system. Based on the normal ventilation flow rates and the volume of the control room, the outside air exchange rate was calculated to be 0.391 air changes per hour.

The fourth paragraph of FSAR Section 2.2.3.1.3.1 will be revised as follows:

In addition to the assumptions listed, ALOHA takes into account the control room ventilation rate to determine the control room concentrations during the first hour. The outside air exchange rate used in the model was 0.391 air changes per hour. This dispersion model does not report values after one hour because it assumes that the

weather conditions or other release circumstances surrounding the toxic cloud are likely to change one hour after accidental release (FSAR Table 2.2-209).

The sixth paragraph of FSAR Section 2.2.3.1.3.3 will be revised as follows:

In addition to the assumptions listed, ALOHA takes into account the control room ventilation rate to determine the control room concentrations during the first hour. The outside air exchange rate used in the model was 0.391 air changes per hour. This dispersion model does not report values after one hour because it assumes that the weather conditions or other release circumstances surrounding the toxic cloud are likely to change one hour after accidental release (FSAR Table 2.2-209).

FSAR Table 2.2-209 will be revised as shown in the response to Part c.

ASSOCIATED ATTACHMENTS PART a:

See response to Part c

RESPONSE TO PART b:

The following table provides the assumptions and inputs for the ALOHA analysis for the various chemicals addressed in Subsections 2.2.3.1.3.1 and 2.2.3.1.3.3:

Menu	Parameter	Input	Basis
Site Data	Location	Lexington, SC	This is the geographically closest station to the VC Summer nuclear facility, located near Peak, SC, that is listed in ALOHA. ALOHA uses the latitude, longitude, elevation, and time zone of the location of a chemical release in some of its computations—sun angle or solar radiation (latitude, longitude and time of day of calculation) and atmospheric pressure (determined by the location's elevation) (ALOHA 2007)
Site Data	Date and Time	12:00 pm on July 1, 2006	ALOHA calculates the amount of energy coming into the puddle from the atmosphere and from the ground—if the sun is high in the sky (around noon), the amount of energy coming into the puddle is greater than it would be in the early morning or late afternoon, when the sun is lower. The more energy coming in, the higher the evaporation rate. The

			position of the sun for the date and time is used in determining the solar radiation. (ALOHA 2007)
Site Data	Building Type	No. of Air Changes: 0.391	This value was determined utilizing the design parameters of the control room HVAC system during normal operations, it is discussed further in the answer to VCSNS RAI 06.04-2a.
Setup/Atmospheric	Wind Speed	1 m/s	Typically wind speeds of about 1 m/s represents the worst 5% of meteorological conditions observed at a majority of nuclear power plant sites (Murphy, Campe 1974). Note, this is conservative if compared to the parameter selection requirements for the US EPA's Risk Management Program *"40 CFR 68.22 Offsite consequence analysis parameters. (b)...For the worst case release analysis, the owner or operator shall use a wind speed of 1.5 meters per second."* Additionally, the minimum surface wind speed at 10 m for Pasquill Stability Class F is 2 m/s (Seinfeld 1986). Lower wind

			speeds will prevent the chemical vapor cloud from dispersing prior to reaching the control room.
Setup/Atmospheric	Wind Direction	W	The wind direction determines which way a pollutant cloud will drift. (ALOHA 2007) Note, that in the ALOHA modeling runs conducted, the threat at point function was chosen which allows the user to set the receptor location directly downwind from the source for a worst-case determination. Because the "threat at point" function is utilized, the wind direction selection becomes inconsequential.
Setup/Atmospheric	Wind Measurement Height	10 meters	ALOHA calculates a wind profile based on where the meteorological data is taken. ALOHA assumes that the MET station is at 10 meters. The National Weather Service usually reports wind speeds from a height of 10 meters (ALOHA 2007). Wind rose data for this project was also taken at a height of 10 meters. The surface wind speeds for determining the

			Pasquill Stability Class are defined at 10m (Seinfeld 1986).
Setup/Atmospheric	Ground Roughness	"Open Country"	The degree of atmospheric turbulence influences how quickly a pollutant cloud moving downwind will mix with the air around it and be diluted. Friction between the ground and air passing over it is one cause of atmospheric turbulence. Because the air nearest the ground is slowed the most, eddies can develop. The rougher the ground surface, the greater the ground roughness (Z_0), and the greater the turbulence that develops. A chemical cloud generally travels farther across open country and open water than over an urban area or a forest. This is because it encounters fewer, smaller roughness elements to create turbulence. (ALOHA 2007) This is also the conservative approach when compared to the parameter selection requirements for the US EPA's Risk Management Program *"40 CFR 68.22 Offsite*

			consequence analysis parameters. (e) Surface roughness. The owner or operator shall use either urban or rural topography as appropriate." Selecting "open country" indicates that the terrain is generally flat and there are no obstructions to hinder the travel/dispersion of the vapor cloud—therefore more conservative distances are modeled.
Setup/Atmospheric	Cloud Cover	50%	ALOHA default value—ALOHA uses this value to estimate the amount of incoming solar radiation at the time of a chemical release (ALOHA 2007). Taking into consideration the time of day selected, date and temperature, the determined solar radiation value generated will be conservative especially when taken into account that F stability does not provide for a solar radiation value (F stability is defined as night-time with a cloud cover fraction of ≤ 3/8 and a wind speed of 2-3 m/s) (Seinfeld 1986).

Setup/Atmospheric	Air Temperature	25°C	Air temperature influences ALOHA's estimate of the evaporation rate from a puddle surface (the higher the air temperature, the more the puddle is warmed by the air above it, the higher the liquid's vapor pressure is, and the faster the substance evaporates)(ALOHA 2007). Given the selection of F stability, which occurs at night time with a cloud cover fraction of ≤ 3/8 (Seinfeld 1986), 25°C is a reasonable selection.
Setup/Atmospheric	Stability Class	F	The atmosphere may be more or less turbulent, depending on the amount of incoming solar radiation as well as other factors. Meteorologists have defined atmospheric stability classes, each representing a different degree of turbulence in the atmosphere. When moderate to strong incoming radiation heats air near the ground, causing it to rise and generate large eddies, the atmosphere is considered unstable

			(relatively turbulent). When solar radiation is weak or absent, air near the surface has a reduced tendency to rise, and less turbulence develops (stable atmospheres). Stability class has a large effect on ALOHA's prediction of the threat zone size for dispersion scenarios. Under unstable conditions, a dispersing gas mixes rapidly with the air around it and ALOHA predicts that the cloud will not extend as far downwind as it would under more stable conditions, because the pollutant is soon diluted (ALOHA 2007). F stability represents the worst 5% of meteorological conditions observed at majority of nuclear plant sites (Regulatory Guide 1.78, 2001). This is also the most stable meteorological class allowed by ALOHA. One must over-ride the meteorological stability class to choose "F" because generally an F stability class only occurs at nighttime with a cloud fraction of ≤ 3/8 and a wind speed of between 2-3

			m/s (Seinfeld 1986). The selection of a stable stability class such as "F" prevents the vapor cloud from dispersing as it travels towards the control room. This is a conservative assumption when considering the assumptions taken regarding the time of day was taken to maximize "solar radiation"—and this magnitude of solar radiation is generally not plausible with "F" stability class. Therefore, the assumptions taken serve to maximize the evaporation rate to obtain a large vapor cloud while choosing a stable meteorological class to prevent the cloud from dispersing and therefore traveling greater distances.
Setup/Atmospheric	Inversion Height	None	An inversion is an atmospheric condition that serves to trap the gas below the inversion height thereby not allowing it to disperse normally. Inversion height has no effect on the heavy gas model.
Setup/Atmospheric	Humidity	50%	ALOHA uses the relative humidity

			values to estimate the atmospheric transmissivity value; estimate the rate of evaporation from a puddle; and make heavy gas dispersion computations. Atmospheric transmissivity is a measure of how much thermal radiation from a fire is absorbed and scattered by the water vapor and other atmospheric components (ALOHA 2007).
For Liquid Releases:			
Setup/Source	Puddle	Puddle (For Liquid Releases) *(Note: Direct source is chosen for pollutant gases—see next section of table)*	In ALOHA, the source is the vessel or pool from which a hazardous chemical is released. ALOHA can model four types of sources: (1) direct-chemical releases directly into the atmosphere; (2) puddle-chemical has formed a liquid pool; (3) tank-chemical is escaping from a tank; and (4) gas pipeline-chemical escaping from a ruptured gas pipeline (ALOHA 2007). For liquids, assuming a puddle release is a conservative option especially when one considers that by

			choosing the puddle option, the total quantity of the vessel is assumed to be instantaneously spilled. Additionally, if one compares this selection to the parameter selection requirements for the US EPA's Risk Management Program *"40 CFR 68.25 Worst-case release scenario analysis. (d) (1) For regulated toxic substances that are normally liquids at ambient temperature, the owner or operator shall assume that the quantity in the vessel or pipe…is spilled instantaneously to form a liquid pool."*
Setup/Source	Puddle	Type of Puddle/ Evaporating Puddle	As a flammable puddle evaporates, it forms a vapor cloud above the puddle, in order for ALOHA to predict the overpressure from a vapor cloud explosion, this type of puddle option is chosen (ALOHA 2007).
Setup/Source	Puddle	Puddle Area and Volume	The puddle area strongly influences the evaporation rate. The larger the area of a puddle, the higher its evaporation rate (ALOHA 2007). The area of the puddle is

			conservatively estimated by taking the entire contents of the tank and assuming the quantity is spilled unto the ground with no containment or depressions in the ground and forms a 1 cm thick puddle. This is also indicative of the worst-case Risk Management Program (RMP) requirements when compared to the parameter selection requirements for the US EPA's Risk Management Program *"40 CFR 68.25 (d) Worst-case release scenario—toxic liquids (1) For regulated toxic substances that are normally liquids at ambient temperature, the owner or operator shall assume that the quantity in the vessel ... is spilled instantaneously to form a liquid pool. (i) the surface area of the pool shall be determined by assuming that the liquid spreads to 1 centimeter deep unless passive mitigation systems are in place..."*
Setup/Source	Puddle/Ground Type	Soil	This is the ALOHA default setting. Ground type

			influences the amount of heat energy transferred from the ground to an evaporating puddle. (ALOHA assumes that the ground does not absorb any of the spilled chemical, and that none of the chemical spilled onto water dissolves into the water.) ALOHA assumes the heat to be transferred most readily from default ground or concrete surfaces into a puddle, and least readily from sandy ground (ALOHA 2007).
Setup/Source	Puddle/Input Ground Temperature	Air Temperature (25°C)	Ground temperature influences the amount of heat transferred between the ground and the puddle. The warmer the ground, the warmer the puddle and the higher the evaporation rate. ALOHA suggests using air temperature if the ground temperature is unknown (ALOHA 2007).
Setup/Source	Puddle/Initial Puddle Temperature	Air Temperature (25°C)	ALOHA suggests selecting ambient air temperature if the initial puddle temperature is unknown (ALOHA

			2007).
For Releases of Gases:			
Setup/Source	Direct	Direct (This option was chosen for gas releases)	Source option if the amount of pollutant is known and the gas is released directly. To model a direct release of gas into the atmosphere, an estimate of the amount of pollutant directly entering the atmosphere as a gas is used. This would not apply to liquids spilling from a tank and forming a puddle, because the liquid is not directly entering the atmosphere (Seinfeld 1986).
Setup/Source	Direct/Release	Continuous	A continuous direct release is chosen to account for a release over 10 minutes. A 10-minute release was chosen based upon RMP guidance-- *"40 CFR 68.25 Worst-case release scenario analysis (e) (1) for regulated flammable substances that are normally gases at ambient temperature...the owner or operator shall assume that the quantity in the vessel or pipe... is released as a gas over 10*

			minutes."
Setup/Source	Direct/Amount Entering the Atmosphere	Total amount over 10 minutes	A continuous direct release is chosen to account for a release over 10 minutes. Again, a release of the entire contents over a 10-minute release period was chosen based upon RMP guidance-- *"40 CFR 68.25 Worst -case release scenario analysis (e) (1) for regulated flammable substances that are normally gases at ambient temperature...the owner or operator shall assume that the quantity in the vessel or pipe... is released as a gas over 10 minutes."*
Setup/Source	Direct/Source height	0	The source height is the height of the location of a chemical release above the ground. Source height is zero if the chemical is released at ground-level. A ground-level release is more conservative than an elevated release: ALOHA will predict a longer threat zone for a ground-level release (ALOHA 2007). Additionally, for comparison, RMP guidance suggests

			using a ground-level release for worst-case- - *"40 CFR 68.22 Offsite consequence analysis parameters (d) Height of release. The worst-case release of a regulated toxic substance shall be analyzed assuming a ground-level (0 feet) release."*
Display	Threat Zone	Toxic Area of Vapor Cloud	This option is chosen to determine the safe distance for a toxic vapor cloud scenario.
Display	Toxic Level of Concern	Set to Known Limit in Order of Precedence: IDLH, TLV-TWA, TEEL	The toxic concentration level of concern shows the maximum calculated distance that the toxic chemical exists at that concentration.
Display	Threat Zone	Blast Area of Vapor Cloud Explosion	This option is chosen to determine the safe distance for a vapor cloud explosion scenario.
Display	Threat Zone/Blast Area of Vapor Cloud Explosion/Time of Vapor Cloud Ignition	Unknown	The ignition time represents the length of time that the cloud mixes with the air around it and becomes diluted in concentration. Therefore, the amount of the vapor cloud that is between the Lower and Upper Explosive Limits (LEL and UEL) will depend on the

			ignition time. By choosing the unknown ignition time, ALOHA runs explosion scenarios for a range of ignition times that encompass all of the possible ignition times for the scenario. ALOHA takes the results from all of the scenarios and combines them on a single threat zone plot (ALOHA 2007).
Display	Threat Zone/Blast Area of Vapor Cloud Explosion/Type of Ignition	Ignited by detonation	The "ignited by spark or flame" option is chosen if a typical accidental explosion is modeled. The "ignited by detonation" option is chosen if an intentional explosion or a worst-case accidental explosion is to be modeled (ALOHA 2007). Therefore, "ignited by detonation" was conservatively chosen.
Display	Threat Zone/Blast Area of Vapor Cloud Explosion/Overpressure Level of Concern	Threat zone Red: 8 psi Orange: 3.5 psi Yellow: 1.0 psi	The yellow threat zone plot of 1.0 psi was chosen to determine the safe distance requirement in accordance with Regulatory Guide 1.91.
Display	Threat at Point	Relative Coordinates	This option is chosen to obtain specific information about the hazard at a point of

			interest (ALOHA 2007). By choosing this option, the hazard value expected if the wind were to carry the cloud of escaping gas directly toward the point of interest is determined.
Display	Threat at Point	Input X, the downwind distance = the straight line distance from where the chemical is stored to the closest safety related structure. Input Y, the crosswind distance = 0 feet	In order to determine the hazard value expected if the wind were to carry the cloud directly toward the site, the minimum distance from the stored chemical to the closest safety related structure was entered with no cross wind distance. These results represent the worst-case hazard levels that could develop at that distance downwind of the source (ALOHA 2007).
Chemical	Chemical Library	A vapor cloud analysis was modeled for each on-site and railroad chemical with determined toxic or flammability limits	(See chemical inputs below)

Chemical Inputs/Assumptions:

For each on-site toxic, flammable or explosive chemical, a vapor cloud analysis was performed following the assumptions listed above. The following on-site chemicals were analyzed, by selecting the appropriate chemical in ALOHA's chemical library:

1. Ammonium Hydroxide
2. Carbon Dioxide
3. Chlorine
4. Gasoline—n-Heptane was chosen from the chemical library to model gasoline (see Note 1)
5. Hydrazine
6. Nitrogen
7. Sodium Hypochlorite (see Note 2)

For each railroad toxic, flammable, or explosive chemical, a vapor cloud analysis was performed following the assumptions listed above. The following railroad chemicals were analyzed by selecting the appropriate chemical in ALOHA's chemical library:

1. Ethanol
2. Isopropanol
3. Cyclohexylamine

Note 1: As recommended by the U.S. Environmental Protection Agency (US EPA), gasoline was modeled for vapor cloud explosions by selecting n-Heptane in ALOHA's chemical library. As indicated in correspondence from Len Wallace of the US EPA, gasoline contains hundreds of hydrocarbons (Wallace 2007). Because of this, gasoline boils over a range of temperatures—the boiling point of gasoline is listed as a range, 140-390°F (CHRIS 1999). At the lower end of range of gasoline's boiling point, only a small fraction of the gasoline would be able to evaporate and form a vapor cloud. It was assumed that the entire quantity of gasoline, 12,000 gallons, was modeled as n-Heptane and therefore available to form a vapor cloud. Below is an excerpt from that correspondence from the US EPA (Wallace 2007), along with a provided distillation graph.

> "*Gasoline is a mixture of hundreds of hydrocarbons, many of which have different boiling points. Thus gasoline boils or distills over a range of temperatures, unlike a pure compound — water, for instance, that boils at a single temperature. A gasoline's distillation profile or distillation curve is the set of increasing temperatures at which it evaporates for a fixed series of increasing volume percentages — 5, 10, 20, 30 percent, etc. — under specific*

conditions e . (Alternatively, it may be the set of increasing evaporation volume percentages for a fixed series of increasing temperatures.) Figure 1-1 shows the distillation profiles of average conventional summer and winter gasolines. A distillation profile also is shown for a summer reformulated gasoline containing ethanol.

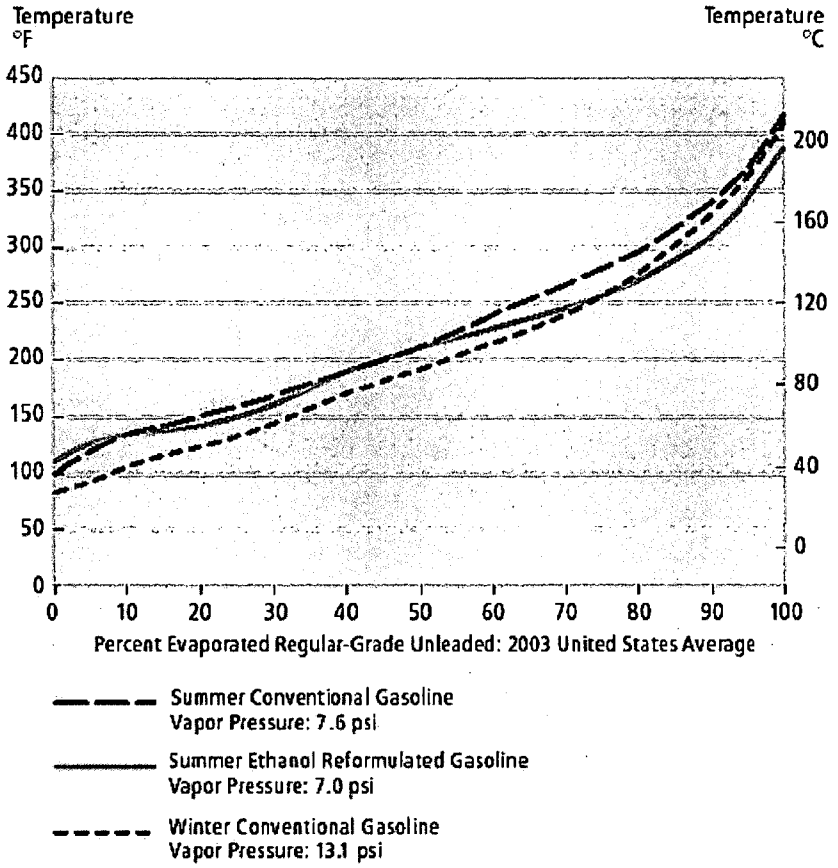
Gasoline VP range is 38-300 mmHg (NIOSH)

Just three chemicals from Gasoline: Butane 760 mmHg

Ethanol 40 mmHg

N-Heptane 37 mmHg

300 mmHg is the mid range



"

Note 2: Sodium Hypochlorite does not exist in the ALOHA chemical library, therefore, in order to model Sodium Hypochlorite it was necessary to explicitly input the chemical properties (CHRIS 1999, Science Lab 2007, MSU 2007, Solvay 2007):

- Molecular Weight = 74.44 g/mol
- Boiling Point = 373.15 K
- Critical Pressure = 7,711,000 Pa (Chlorine)
- Critical Temperature = 417.15 K (Chlorine)
- Gas Density = 0.62 kg/m^3 at 288.71 K and 101,325 Pa
- Freezing Point = 270.15 K
- Heat Capacity (gas, const. pressure) = 486.94 J/(kg K) at 293.15 K and 101,325 Pa (as chlorine)
- Heat Capacity (liq., const. pressure) = 946 J/(kg K) at 173.15 K and 101,325 Pa (as chlorine)
- IDLH = 10 ppm (as chlorine)
- Vapor Pressure = 0.349124 Pa at 293.15 K (Calculated by ALOHA)

References to Part b:

(40CFR68.22 1999) Title 40 Code of Federal Regulations Part 68.22 "Offsite consequence analysis parameters," Revised July 1999.

(40CFR68.25 1996) Title 40 Code of Federal Regulations Part 68.25 "Worst-case release scenario analysis," June 1996.

(ALOHA 2007) U.S Environmental Protection Agency and National Oceanic and Atmospheric Administration. *Areal Locations of Hazardous Atmospheres User's Manual,* February 2007.

(Murphy, Campe 1974) Murphy, K.G., and K.M. Campe, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Criterion 19," U.S. Atomic Energy Commission, 13th Air Cleaning Conference, 1974.

(Regulatory Guide 1.78 2001) U.S. Nuclear Regulatory Commission, Regulatory Guide 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," Revision 1, December 2001.

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(MSU 2007) MSU Sodium Hypochlorite Material Safety Data Sheet, http://www.pp.msu.edu/cust/Safety/MSDS_Webs/SodiumHypochlorite.htm Michigan State University, Last Updated: 01 November 2001, Visited: 12 June 2007.

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ASSOCIATED VCSNS COLA REVISIONS PART b:

None

ASSOCIATED ATTACHMENTS PART b:

None

RESPONSE TO PART c:

Only the unit closest to the release point was evaluated. The analysis of the closer unit is considered bounding and therefore the further unit is inherent to the analysis. Because there was no impact on the closer of the two units, the conclusion can be drawn that the farther unit also will not be affected. As addressed in response to VCSNS RAI 06.04-2 part a, the indoor concentrations in the closest control room for cyclohexylamine and 28% ammonium hydroxide do not exceed their respective IDLH limits.

ASSOCIATED VCSNS COLA REVISIONS PART c:

The fifth paragraph of FSAR Section 2.2.3.1.1 will be revised as follows:

The hazardous effects due to a postulated explosion are described in the following sections and summarized in Table 2.2-207. The hazardous effects are calculated at the nearest safety related structure of either Unit 2 or Unit 3. If no hazard from explosion is predicted at the nearest safety related structure then no hazard will exist at structures farther from the explosion.

The sixth paragraph of FSAR Section 2.2.3.1.2 will be revised as follows:

The hazardous effects due to a flammable/explosive vapor cloud are described in the following sections and summarized in Table 2.2-208. The hazardous effects are calculated for the nearest safety related structure of either Unit 2 or Unit 3. If no hazard from flammable/explosive vapor clouds exists at the nearest safety related structure then no hazard will exist at structures farther from the release site.

The seventh paragraph of FSAR Section 2.2.3.1.3 will be revised as follows:

For each of the identified chemicals, it was conservatively assumed that the entire contents of the vessel leaked, forming a 1-centimeter-thick puddle, where accommodated by the model. For those identified hazardous materials in the gaseous state, it was conservatively assumed that the entire contents of the vessel or pipeline were released over a 10-minute period into the atmosphere as a continuous direct source (Reference 229). The effects of toxic chemical releases from onsite and offsite sources are summarized in Table 2.2-209 and are described in the following subsections relative to the release sources. The effects are calculated at the nearest control room air intake and inside the nearest control room for either Unit 2 or Unit 3. If no hazard exists at the nearest control room then no hazard will exist at the control room farther from the release site.

ASSOCIATED ATTACHMENTS PART c:

FSAR Tables 2.2-207, Table 2.2-208, and Table 2.2-209

FSAR Table 2.2-207 will be revised as shown below:

Table 2.2-207
Potential Design Basis Events, Explosions

Source	Pollutant Evaluated	Quantity	Heat of Combustion (Btu/lb)	Distance to nearest safety-related structure (ft)[d]	Distance for Explosion to have less than 1 psi of Peak Incident Pressure (ft)
Pipeline – SCE&G	Natural Gas[a]	1,265,386 lb		6,944 (Unit 3)	6,284
Norfolk Southern Railroad Line	Ethanol	132,000 lbs	11,570	4,200 (Unit 3)	317
	Isopropanol		12,960		316
	Cyclohexylamine		18,000		363
Onsite (includes Unit 1)	Gasoline[b] (50,000 lbs tanker truck).	50,000 lbs	18,720	2,362 (Unit 2)	260
	35% Hydrazine (as 100%)	280 lbs	8,345	3,600 (Unit 2)	52
Nearby Facilities	Fuel Oil[c]	800,000 gal	18,400	7,267 (Unit 3)	1,456
Highway-Bounded by onsite gasoline tanker truck					

(a) This is based on a 10-minute release
(b) Onsite delivery tanker truck that refuels the gasoline underground storage tank at Unit 1.
(c) Tank location is 7,267 feet from Unit 3, near the Parr Combustion Turbines.
(d) This is the distance to the nearest safety-related structure for the closer of Units 2 and 3. The closer Unit is bounding for the farther Unit.

FSAR Table 2.2-208 will be revised as shown below:

Table 2.2-208
Potential Design Basis Events, Vapor Cloud Explosions and Flammable Vapor Clouds
(Delayed Ignition)

Source	Pollutant Evaluated	Quantity	Distance to Nearest Safety-Related Structure (ft)[c]	Distance to UFL (ft)	Distance to LFL (ft)	Safe Distance for Vapor Cloud Explosions (ft)	Peak Over Pressure at Nearest Safety-Related Structure
Pipeline – SCE&G	Natural Gas	1,370.09 lb	6,944 (Unit 3)		575	1,677	No significant overpressure
Norfolk Southern Railroad Line	Ethanol			231	396	897	0.117
	Isopropanol	132,000 lbs	4,200 (Unit 3)	273	513	1,074	0.142
	Cyclohexylamine			Never reached	222	543	No significant overpressure
Onsite (includes Unit 1)	Gasoline[a] (50,000 lbs tanker truck)	50,000 lbs	2,362 (Unit 2)	228	387	981	0.271
	35% Hydrazine (as 100%)	280 lbs	3,600 (Unit 2)	<33	<33	No explosion	No explosion
Nearby Facilities	Fuel Oil[b]	800,000 gal	7,267 (Unit 3)			Never reaches LFL	Not available
Highway-Bounded by onsite gasoline tanker truck							

(a) Onsite delivery tanker truck that refuels the gasoline underground storage tank at Unit 1.
(b) Tank location is 7,267 feet from Unit 3, near the Parr Combustion Turbines.
(c) This is the distance to the nearest safety-related structure for the closer of Units 2 and 3. The closer Unit is bounding for the farther Unit.

LFL = lower flammability limit
UFL = upper flammability limit

FSAR Table 2.2-209 will be revised as shown below:

Table 2.2-209
Potential Design Basis Events, Toxic Clouds

Source	Chemical	Quantity	IDLH	Distance to nearest control room (ft)[g]	Distance to IDLH(ft)	Maximum Control Room Concentration[f]
Norfolk Southern Railroad Line	Cyclohexylamine	132,000 lbs	30 ppm TEEL-3[c]	4,200 (Unit 3)	4,818	5.5 ppm
Onsite (includes Unit 1)	28% Ammonium Hydroxide	56,000 lbs	300 ppm	4,264 (Unit 2)	12,672	291 ppm[d]
	Carbon Dioxide	20,000 lbs	40,000 ppm	3,999 (Unit 2)	1,452	393 ppm
	Chlorine	50 lbs	10 ppm	4,264 (Unit 2)	2,220	0.225 ppm
	Gasoline[a] (50,000 lbs tanker truck)	50,000 lbs	300 ppm TWA[e]	2,362 (Unit 2)	1,932	24.1 ppm
	35% Hydrazine (as 100%)	280 lbs	50 ppm	3,600 (Unit 2)	411	0.132 ppm
	Nitrogen	4,000 lbs	Asphyxiant	4,624 (Unit 2)	Asphyxiant	96.2 ppm
	Sodium Hypochlorite 12%	45 lbs	10 ppm	3,600 (Unit 2)	<33	Not Significant
Nearby Facilities	Fuel Oil[b]	800,000 gal	None Listed	7,267 (Unit 3)	Never exceeds IDLH	0.672 ppm
Highway-Bounded by onsite gasoline tanker truck						

(a) Onsite delivery tanker truck that refuels the Gasoline UST at Unit 1.
(b) Tank location is 7,267 feet from Unit 3, near the Parr Combustion Turbines.
(c) Temporary emergency exposure limit (TEEL)
(d) ALOHA does not report values after 1 hour because it assumes that the weather conditions or other release circumstances are likely to change after the first hour.
(e) Time-weighted average (TWA)
(f) Indoor concentrations are based on an air exchange rate of 0.391 air changes per hour.
(g) This is the distance to the control room for the closer of Units 2 and 3. The closer Unit is bounding for the farther Unit.

RESPONSE TO PART d:

FSAR Section 2.2.2.2.1.1 states that the chemicals associated with Units 2 and 3 are bounded by those listed in the AP1000 DCD, Table 6.4.1. Currently there are no chemicals proposed for use at VCSNS Units 2 and 3 other than those listed in the AP1000 DCD Table 6.4-1. The chemicals listed in DCD Table 6.4-1 have been evaluated by Westinghouse for their possible effect on control room habitability and no site-specific evaluation of them has been required. If Westinghouse updates or changes DCD Table 6.4-1, SCE&G will update the COLA to address any necessary changes.

ASSOCIATED VCSNS COLA REVISIONS PART d:

None

ASSOCIATED ATTACHMENTS PART d:

None