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UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

October 15, 2009

UN#09-421

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Response to Request for Additional Information for the
Calvert Cliffs Nuclear Power Plant, Unit 3,
RAI No. 146, Evaluation of Potential Accidents

Reference: Surinder Arora (NRC) to Robert Poche (UniStar Nuclear Energy), "FINAL RAI No. 146 RSAC 2594" email dated September 3, 2009

The purpose of this letter is to respond to the request for additional information (RAI) identified in the NRC e-mail correspondence to UniStar Nuclear Energy, dated September 3, 2009 (Reference). This RAI addresses Evaluation of Potential Accidents, as discussed in Section 2.2.3 of the Final Safety Analysis Report (FSAR), as submitted in Part 2 of the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 Combined License Application (COLA), Revision 6.

The enclosure provides our response to RAI No. 146, Question 02.02.03-8, and includes revised COLA content. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA.

Our response to RAI No. 146 Question 02.02.03-8 does not include any new regulatory commitments. Our response to RAI No. 146 Question 02.02.03-8 does not contain any sensitive or proprietary information.

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NRO

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Michael J. Yox at (410) 495-2436.

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

Executed on October 15, 2009

Greg Gibson

Enclosure: Response to NRC Request for Additional Information RAI No. 146, Question 02.02.03-8, Evaluation of Potential Accidents, Calvert Cliffs Nuclear Power Plant, Unit 3

cc: Surinder Arora, NRC Project Manager, U.S. EPR Projects Branch
Laura Quinn, NRC Environmental Project Manager, U.S. EPR COL Application
Getachew Tesfaye, NRC Project Manager, U.S. EPR DC Application (w/o enclosure)
Loren Plisco, Deputy Regional Administrator, NRC Region II (w/o enclosure)
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GTG/SFW/mdf

Enclosure

Response to NRC Request for Additional Information RAI No. 146, Question 02.02.03-8, Evaluation of Potential Accidents, Calvert Cliffs Nuclear Power Plant, Unit 3

RAI No. 146

Question 02.02.03-8

The information that is needed to ensure potential hazards in the site vicinity are identified and evaluated to meet the siting criteria in 10 CFR 100.20(b) and 10 CFR 100.21(e). The NRC staff's confirmatory analysis for the quantities of sodium hypochlorite and hydrochloric acid identified in the FSAR resulted in concentrations exceeding the Immediate Danger to Life and Health (IDLH) values and the concentration presented in the FSAR Table 2.2-10. Provide specific assumptions used to model sodium hypochlorite and hydrochloric acid for toxic chemical concentrations at the intake to the control room and inside the control room. Provide the assumptions and methodology along with the model inputs used for determining the concentrations.

Response

The ALOHA computer program is used to model sodium hypochlorite and hydrochloric acid and to determine the distance to the Immediately Danger to Life and Health (IDLH) values and the control room concentration.

The ALOHA Model Inputs/Assumptions are shown in Table 1 and provide the basis for the program for sodium hypochlorite and hydrochloric acid. This table identifies the ALOHA menu inputs and associated parameters; the user data input into the model; and the basis for the input.

Table 1
ALOHA Model Inputs, Assumptions and Basis

Menu	Parameter	Input	Basis
Site Atmospheric Data			
Site Data	Location	Seaford, Delaware	Seaford, DE was selected as the location for the meteorological data since it is the geographically closest station to the CCNPP that is listed in ALOHA. ALOHA utilizes the location to determine sun angle and elevation (ALOHA, 2007).
Site Data	Number of Air Exchanges	0.4452 air exchanges/hour	The CR air exchange rate is 0.4452 exchanges per hour.
Site Data	Date and Time	12:00 pm on July 1, 2006	July 1, 2006 at noon was chosen due to solar radiation being highest in the summer during midday. Higher solar radiation leads to a higher evaporation rate and thus, a larger vapor cloud. Using noon as the time required overriding the calculated stability class to ensure that F stability class is achieved. Otherwise a less stable heating would create conditions that will cause the cloud to disperse more.

Menu	Parameter	Input	Basis
Site Atmospheric Data			
Setup/ Atmospheric	Wind Speed	For each chemical a meteorological sensitivity analysis was performed at varying wind speeds and meteorological stability classes – Refer to Tables 2 and 3	For the toxic chemical accident category, RG 1.206 requires that for each postulated event, the evaluation should determine a range of concentrations at the site for a spectrum of meteorological conditions. For the flammable vapor cloud (delayed ignition) accident category, RG 1.206 requires the evaluation determine the extent of the cloud and concentrations of gas that could reach the plant under worst-case meteorological conditions. (NRC, 2007) For both the toxic and flammable vapor cloud accident categories, the ALOHA model was run under a spectrum of meteorological conditions to determine the worst-case for each postulated event. This spectrum of meteorological conditions includes the most stable meteorological class, F, allowable with the ALOHA model.
Setup/ Atmospheric	Wind Direction	W	The wind direction determines which way a pollutant cloud will drift. (ALOHA, 2007) For the ALOHA modeling runs conducted for CNPP Unit 3, the threat at point function was chosen which sets the receptor location directly downwind from the source for a worst-case determination; i.e. the model will not take into account the wind direction.
Setup/ Atmospheric	Wind Measurement Height	10 meters	ALOHA calculates a wind profile based on where the meteorological data is taken. ALOHA assumes the MET station is at 10 m. The National Weather Service usually reports wind speeds from a height of 10 m and (ALOHA, 2007) wind rose data for this project was taken at a height of 10 m. Additionally, surface wind speeds for determining Pasquill Stability Class are defined at 10 m. (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 ground and air passing over the ground is one cause of atmospheric turbulence. Because air nearest the ground is slowed more than the air at higher altitudes, 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 forest because it encounters fewer, smaller roughness elements to create turbulence. (ALOHA, 2007) Selecting "open country" indicates the terrain is generally flat and there are no obstructions to hinder travel/dispersion of the vapor cloud—therefore more conservative distances are modeled. This selection also meets the requirements of the 40 CFR 68.22 (e) (CFR 68.22, 1996) of the US Environmental Protection Agency's (EPA) Risk Management Program.
Setup/ Atmospheric	Cloud Cover	50%	ALOHA uses this value to estimate the amount of incoming solar radiation at the time of a chemical release. (ALOHA, 2007)

Menu	Parameter	Input	Basis
Site Atmospheric Data			
Setup/ Atmospheric	Air Temperature	25°C	Air temperature influences evaporation rate from a puddle surface (the higher the air temperature, the faster the substance evaporates). (ALOHA, 2007) Given the selection of either F or E stability class, which occur at night time with a cloud cover fraction of ≤3/8, 25°C is a conservative selection (Seinfeld, 1986).
Setup/ Atmospheric	Stability Class	For each chemical, a meteorological sensitivity analysis was performed at varying wind speeds and meteorological stability classes. (Refer to Tables 2 and 3.)	The atmosphere may be more or less turbulent, depending on the amount of incoming solar radiation as well as other factors. When moderate to strong incoming solar radiation heats air near the ground, the air rises and generate large eddies which results in the atmosphere being 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). A dispersing gas mixes rapidly with the air around it in unstable conditions and ALOHA calculates the cloud will not extend as far downwind as it would under more stable conditions, because the pollutant is soon diluted. (ALOHA, 2007) Per RG 1.206, a sensitivity analysis was performed for each postulated event (Refer to Tables 2 and 3 below). (NRC, 2007)
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. (Seinfeld, 1986) Additionally, as depicted in a paper by the EPA (EPA, 1972) morning mixing heights range from under 300 m to over 900 m with comparatively high values generally along the coasts. This is due to high relative humidity and/or low cloudiness, which inhibit formation of intense radiation inversions.
Setup/ Atmospheric	Humidity	50%	ALOHA uses relative humidity values to estimate atmospheric transmissivity value; estimate evaporation rate 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 water vapor and other atmospheric components. (ALOHA, 2007)

Menu	Parameter	Input	Basis
		Liquid Releases	
Setup/ Source	Puddle	Puddle (For Liquid Releases)	In ALOHA, the source describes 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) Additionally if one compares this selection to the parameter selection requirements for the US EPA's Risk Management Program 40 CFR 68.25(d)(1), this selection is conservative (CFR 68.25, 1999) 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.
Setup/ Source	Puddle	Type of Puddle/ Evaporating Puddle	As a toxic or flammable puddle evaporates, it forms a vapor cloud above the puddle. To calculate concentration, flammable range, or overpressure from a vapor cloud explosion, this type of puddle option chosen. (ALOHA, 2007)
Setup/ Source	Puddle	Puddle Area and Volume	The puddle area influences the evaporation rate. Larger puddle area has a higher 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 onto the ground without 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 in 40 CFR 68.25 (d) (1) (i) (CFR 68.25, 1999)
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 the ground does not absorb any spilled chemical (and none spilled onto water dissolves into the water). ALOHA expects 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	Ground temperature influences the 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 ground temperature is unknown. (ALOHA, 2007).
Setup/ Source	Puddle/Initial Puddle Temp	Air Temperature	Per ALOHA, selecting ambient air temperature if the initial puddle temperature is unknown. (ALOHA, 2007).

Hydrochloric acid was analyzed in ALOHA by selecting the appropriate chemical in the chemical library along with the inputs provided in Table 1. The physical properties for hydrochloric acid were also obtained from the ALOHA chemical library. The following summarizes the inputs specific to hydrochloric acid. The results of the meteorological sensitivity analysis are shown in Table 2. The highlighted row represents the values used to determine the IDLH results.

<u>Properties</u>
Physical State: Liquid (CHRIS, 1999)
IDLH: 50 ppm (CAMEO, 2008)
Molecular Weight: 36.46 g/mol (CAMEO, 2008)
Ambient Boiling Point: 194.6° F (CAMEO, 2008)

Solution Strength: 30%

Storage
Hydrochloric Acid is stored in a 3,000 gallon tank at the tank farm 2,994 ft from the control room.

Puddle area:
3,000 gallons = 11,356,235 cm^3
11,356,235 $cm^3 = 2\pi rh$, where (h = 1 cm)
Area = 1,135.6 m^2

Table 2
Hydrochloric Acid Sensitivity Analysis

Stability Class	Wind Speed(m/s)	Concentration Outside Control Room (Toxic) (ppm)	Concentration Inside Control Room (Toxic) (ppm)	Distance to IDLH (feet)
F	1	22.1	4.32	1,800
F	2	52.9	14.1	3,102
F	3	45.3	11.8	2,817
E	1	13.2	2.76	1,287
E	2	16.8	4.58	1,563
E	3	14.4	3.78	1,422
E	4	13.4	3.33	1,362
E	5	12.7	2.98	1,317
D	3	5.97	1.58	801
D	4	5.58	1.39	765
D	5	5.28	1.24	735
D	6	5.04	1.13	711

Since sodium hypochlorite does not exist in the ALOHA chemical library, the chemical properties listed below were added into the chemical library in order to add sodium hypochlorite as a new chemical. The results of the meteorological sensitivity analysis are shown in Table 3. The highlighted row represents the values used to determine the IDLH results.

Sodium hypochlorite does not have a determined IDLH value listed in NIOSH – however, MSDS sheets have listed a toxicity for sodium hypochlorite as 10 ppm. The vapor pressures of sodium hypochlorite solutions are less than the vapor pressure of water at the same temperature. However, because of the potential for sodium hypochlorite to decompose and release gas upon heating, sodium hypochlorite was conservatively evaluated for toxicity. (CI, 2006) In order to model sodium hypochlorite, one must account for the significantly lower vapor pressure of sodium hypochlorite versus chlorine.

Chemical Name:	Sodium Hypochlorite	
Molecular Weight:	74.44 g/mol	(CHRIS, 1999)
Normal Boiling Point:	373.15 K	(Science Lab, 2005)
Normal Freezing Point:	270.15K	(Science Lab, 2005)
Critical Temperature:	417.15K	(CAMEO, 2008)

Critical Pressure: 7,711,000 Pa (Yaws, 1999)

Heat Capacity (gas, const. pressure):
486.94 J/(kg K) at 293.15K and 101,325 Pa (Yaws, 1999)

Heat Capacity (liq., const. pressure):
946 J/(kg K) at 173.15K and 101,325 Pa (Yaws, 1999)

Solution Strength: 12.5%

Properties

Physical State: Liquid (CHRIS, 1999)
Toxicity Limit: 10 ppm as chlorine (IDLH) (CAMEO, 2008)
Vapor Pressure: 0.349124 Pa at 293.15 K (as calculated by CAMEO, 2008)

Storage

Sodium hypochlorite (8,500 gal): This chemical is stored at the CCNPP Unit 1 & Unit 2 intake building which is located 2,472 feet from the CCNPP Unit 3 control room.

Puddle area for Sodium hypochlorite (8,500 gal):

8,500 gallons = 32,176,000 cm^3
32,176,000 cm^3 = $2\pi rh$, where (h = 1 cm)
Area = 3,217.6 m^2

Table 3
Sodium Hypochlorite (8,500 gal) Sensitivity Analysis

Stability Class	Wind Speed (m/s)	Concentration Outside Control Room (Toxic) (ppm)	Concentration Inside Control Room (Toxic) (ppm)	Distance to IDLH (feet)
F	1	0.206	0.0364	189
F	2	0.230	0.0480	183
F	3	0.235	0.0490	174[a]
E	1	0.0758	0.0140	105
E	2	0.0822	0.0175	105
E	3	0.0841	0.0177	105
E	4	0.0800	0.0176	105
E	5	0.0765	0.0174	105
D	3	0.0359	0.00765	105
D	4	0.0340	0.00759	105
D	5	0.0326	0.00746	105
D	6	0.0313	0.00732	105

[a] The worst case meteorological conditions determined for each postulated event were based upon those meteorological conditions yielding the highest concentration in the control room during the postulated event.

References:

(ALOHA, 2007) U.S. EPA and NOAA, ALOHA® Users Manual, February 2007.

(CAMEO, 2008) U.S. EPA and NOAA's Office of Response and Restoration, *Computer-Aided Management of Emergency Operations*, accessed June 2008 re-accessed August 31, 2009.

(CFR 68.22, 1996) Code of Federal Regulations, Title 40–Protection of Environment Part 68 –Chemical Accident Prevention Provisions, Subpart B-Hazard Assessment, June 1996.

(CFR 68.25, 1999) Code of Federal Regulations, Title 40–Protection of Environment Part 68 –Chemical Accident Prevention Provisions, Subpart B-Hazard Assessment, May 1999.

(CHRIS, 1999) U.S. Coast Guard, *Chemical Hazards Response Information System (CHRIS)*, June 1999.

(CI, 2006) The Chlorine Institute, Inc., Pamphlet 96, Sodium Hypochlorite Manual, Edition 3, April 2006.

(EPA, 1972) U.S. EPA, Holzworth, G., *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution in the Contiguous United States*, January 1972.

(NRC, 2007) U.S. NRC, Regulatory Guide 1.206, *Combined License Applications for Nuclear Power Plants* (LWR Edition), June 2007.

(Science Lab, 2005) Science Lab.com, Chemicals & Laboratory Equipment, Sodium Hypochlorite 12% Material Safety Data Sheet, October 2005.

(Seinfeld, 1986) Seinfeld, John H., *Atmospheric Chemistry and Physics of Air Pollution*, John Wiley & Sons, Inc., 1986.

(Yaws, 1999) Yaws, C.L., *Chemical Properties Handbook*. McGraw-Hill, 1999.

COLA Impact

Section 2.2.3.1.3 of the FSAR will be revised as follows in a future version of the COLA:

2.2.3.1.3 Toxic Chemicals

Accidents involving the release of toxic or asphyxiating chemicals from onsite storage facilities and nearby mobile and stationary sources were considered. Toxic chemicals known to be present on site or in the vicinity of the CCNPP site or to be frequently transported in the vicinity were evaluated. NRC Regulatory Guide 1.78, Revision 1, Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release (NRC, 2001), requires evaluation of control room habitability after a postulated external release of hazardous chemicals from mobile or stationary sources, offsite or onsite.

The potential onsite chemicals are identified in Table 2.2-5~~,~~; hazardous materials potentially transported on MD 2/4 are identified in Table 2.2-6~~.~~; and ~~H~~hazardous materials transported on navigable waterways are identified in Table 2.2-7. These chemicals were evaluated to ascertain which hazardous materials were subsequently analyzed with respect to their potential to form a toxic or asphyxiating vapor cloud after an accidental release.

The ALOHA air dispersion model was used to predict the concentrations of toxic or asphyxiating chemical clouds as they disperse downwind. In the case of a toxic vapor cloud, ~~determine~~ the maximum distance ~~various~~ a postulated vapor cloud~~s~~ would travel before ~~they~~ it dispersed enough to fall below the associated National Institute of Occupational Safety and Health (NIOSH) defined Immediately Dangerous to Life and Health (IDLH) threshold value~~s~~ or other defined toxicity limit concentration in the vapor cloud was determined. Asphyxiating chemicals were evaluated to determine the maximum distance an asphyxiating cloud would travel prior to falling below a concentration which could result in the displacement of a significant fraction of the control room air. The ALOHA model was also used to predict the post-release chemical concentrations in the control room to ensure that under a worst case scenario event the control room operators will have sufficient time to take appropriate action.

The IDLH is defined by the NIOSH as a situation that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment. The IDLH values determined by NIOSH are established such that workers are able to escape such an environment without suffering permanent health damage. Where an IDLH value was unavailable for a toxic chemical, the time weighted average or short term exposure limit, promulgated by OSHA or adopted by the American Conference of Governmental Hygienists, was used as the concentration level. ~~The storage of gas cylinders stored on-site were also considered as potential asphyxiants, and were therefore evaluated to determine if a significant displacement of oxygen would occur in the CCNPP Unit 3 control room.~~

~~Conservative meteorological assumptions were used to determine gasoline concentrations:~~ Each postulated event involving a toxicity/asphyxiation analysis conducted using the ALOHA model was evaluated over a spectrum of meteorological conditions. These meteorological sensitivity analyses were performed to determine the worst case combination of meteorological stability class and windspeed for each postulated event. The selected worst case meteorological condition was based upon those meteorological conditions yielding the highest concentration in the control room during each postulated event. Unless otherwise noted, the worst case meteorological conditions from the sensitivity analysis were: Pasquill stability class F (stable), with a wind speed of 1 m/sec. Along with the determined worst case meteorological conditions, the following meteorological assumptions were used as inputs to the computer model, ALOHA: ambient temperature of 25°C; relative humidity of 50%; cloud cover, 50%; and an atmospheric pressure of 1 atmosphere. Where applicable, ~~F~~ for each of the identified chemicals, it was conservatively assumed that the entire contents of the vessel leaked to form a 1 cm thick puddle and toxic vapor cloud. For sources that are described using the ALOHA model, a control room rate of 0.45 air changes per hour was used. This air exchange rate was calculated from the control room volume and the rate of air intake. U.S. EPR FSAR Section 9.4.1 provides a description of the Control Room HVAC System. Under normal operation, outside air is brought in through two air intakes in order to maintain the control room envelope at a positive pressure. The control room envelope has a volume of approximately 200,000 ft^3 and the flow rate of outside air through the two air intakes is as much as 1,000 cfm (total). Using this information results in an effective air change rate (based on outside air) of:

$$(1{,}000 \text{ cfm} * 60) / 200{,}000 \text{ ft}^3 = 0.3 \text{ air changes per hour} \qquad \text{Eq. 2.2.3-1}$$

The evaluation of toxic chemical hazards used a value of 1,484 cfm for the outside air flow rate. Use of this value results in an effective air change rate (based on outside air) of:

(1,484 cfm * 60) / 200,000 ft^3 = 0.45 air changes per hour Eq. 2.2.3-2

Therefore, the use of this value (i.e., 1,484 cfm) in the toxic chemical hazards evaluation results in a conservative estimation of the chemical concentration in the control room.

The effects of toxic chemical releases from internal and external sources are summarized in Table 2.2-10 and are described in the following sections relative to the release source.

Pipelines

The only pipeline within the vicinity of the CCNPP site is the DCPLNG pipeline. The DCPLNG pipeline carries natural gas and is not expected to carry a different product in the future. There is no IDLH value or other toxicity limit present for natural gas.

Waterway Traffic

Using data from the U.S. Army Corps of Engineers for the Port of Baltimore, the quantity of ammonia transported annually in proximity to the CCNPP site is 2 million pounds (0.9 million kg) (USACE, 2004a) (USACE 2004b). It is conservatively assumed that there are a minimum of 50 shipments per NRC Regulatory Guide 1.78, Revision 1 (NRC, 2001), and that each shipment contains the same quantity 40,000 pounds (18,100 kg). A partition coefficient of 0.6 was applied to the individual shipment quantity to account for the high rate at which ammonia dissolves in water as ALOHA does not account for this phenomena (Raj, 1974). The quantity of ammonia assumed in the analysis of toxic control room habitability was 16,000 pounds (7,300 kg). The results of the toxic chemical releases are summarized in Table 2.2-10.

Except for gasoline, the total quantity of the shipment was assumed to be released into the water into a 1 cm thick pool. Due to the large quantity of gasoline spilled, 5.2 million pounds, a 1 cm thick puddle is not realistic. Spilling this quantity over a 1 cm thick puddle would essentially diffuse the vapor cloud over a very large area. Thus, ~~F~~for gasoline, a surface area of 31,400 square meters was assumed for consistency with the maximum allowable surface area provided by the ALOHA model. In each case, under the worst case meteorological conditions, the control room would remain habitable. ~~the vapor cloud did not reach the control room within 1 hour of the spill.~~ And, with the exception of ammonia, the distance the cloud traveled prior to dispersing enough to fall below the identified toxicity limit was less than the distance from the spill site to the control room for CCNPP Unit 3.

Highways

The CCNPP Unit 3 control room is located 6,531 ft (2.0 km) from MD 2/4 at its closest approach. The hazardous materials potentially transported on MD 2/4 that were identified for further analysis with regard to the potential of forming a toxic vapor cloud after an accidental release and traveling to the control room were: ammonium hydroxide (19% solution), gasoline, gasoline (aviation), and liquid propane.

The methodology presented in Section 2.2.3.1.3 was used to determine the distance from the release site to the point where the toxic vapor cloud reaches the IDLH limit boundary. For gasoline and gasoline (aviation) the time weighted average (TWA) and short term exposure (STEL) toxicity limits were conservatively used since no IDLH value is available for either of these hazardous materials. The TWA is the average value of exposure over the course of an 8 hour work shift. The STEL is a 15 minute TWA concentration that may not be exceeded, even if the 8 hour TWA is within the standards.

The maximum concentration of the evaluated chemicals attained in the control room, under worst case meteorological conditions, during the first hour of the release was also determined for the identified hazardous materials. In each scenario, it was conservatively estimated that the transport vehicle lost the entire contents, 50,000 pounds (22,680 kg), as provided in Regulatory Guide 1.91 (NRC, 1978a). The results indicate that any toxic vapor clouds that form after an accidental release on MD 2/4 and travel toward the control room will not cause an airborne concentration above the IDLH limit (or TWA/STEL in the case of gasoline or aviation gasoline) in the control room.

Therefore, toxic vapor clouds resulting from chemical spills on MD 2/4 will not adversely affect the safe operation of CCNPP Unit 3. The effects of toxic chemical releases are summarized in Table 2.2-10.

Onsite Chemical Storages
The hazardous materials stored onsite that were identified for further analysis with regard to the potential of the formation of toxic vapor clouds formed after an accidental release are: gasoline; ammonium hydroxide (28% solution); sodium hypochlorite; hydrazine (35% solution); monoethanolamine; dimethylamine (2% solution); hydrochloric acid (30% solution); hydrogen (asphyxiant) and liquid nitrogen (asphyxiant). Gas cylinders stored at CCNPP Unit 3 containing argon, argon-methane, hydrogen, and nitrogen, which are all asphyxiants, were identified for further analysis for the formation of toxic/asphyxiating vapor clouds.

As described in Section 2.2.3.1.3, the identified hazardous materials~~, with the exception of gasoline,~~ were analyzed utilizing the ALOHA dispersion model to determine whether the formed vapor cloud will reach the control room intake and what the concentration of the toxic chemical will be in the main control room after an accidental release.

Hydrogen and liquid nitrogen concentrations were determined at the control room after a release of the largest vessel. In each case, the concentration at the CCNPP Unit 3 control room of the asphyxiants located at CCNPP Unit 1 and 2, (~~1.91~~ 53.0 ppm for hydrogen, and ~~474~~ 635 ppm for liquid nitrogen,) would not displace enough oxygen for the CCNPP Unit 3 main control room to become an oxygen-deficient environment. Similarly, ~~the concentration of~~ the asphyxiants ~~at the control room~~ associated with the gas cylinder storage at CCNPP Unit 3, are stored farther than the determined safe distance (the distance to where the vapor cloud would travel prior to falling below a concentration which could result in the displacement of a significant fraction of the the control room air--defined by the OSHA) under worst case meteorological conditions (~~45.7 ppm~~ 42 ft for argon gas ~~cylinder, 154 ppm for~~ and argon-methane gas cylinders, ~~147 ppm~~ 39 ft for hydrogen gas cylinders, and ~~129 ppm~~ 36 ft for nitrogen gas cylinders) ~~would not displace enough oxygen for the CCNPP Unit 3 control room to become an oxygen-deficient environment~~.

With the exception of ammonium hydroxide and the 3,500 gallon (13,250 l) gasoline delivery truck, the remaining chemical analyses indicate that the control room would remain habitable for the worst case release scenario. The worst case release scenario in these analyses included a total loss of the largest vessel into an unconfined puddle under determined worst case meteorological ~~stable atmospheric~~ conditions.

The evaluation of toxic chemical release events was performed for each of the identified chemicals to determine if any of these events would qualify as a design-basis event. That is, an accident that has a probability of occurrence on the order of magnitude of 1E-7 per year, or greater, with potential consequences serious enough to affect the safety of the plant to the extent that the guidelines in 10 CFR Part 100 could be exceeded.

An expected rate of occurrence for exceeding the guidelines in 10 CFR Part 100 (on the order of magnitude of 1E-6 per year) is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower. Further, Regulatory Guide 1.78 (NRC, 2001) provides that releases of toxic chemicals that have the potential to result in a significant concentration in the control room need not be considered for further evaluation if the releases are of low frequencies (1E-6 per year, or less) because the resultant low levels of radiological risk are considered acceptable. In evaluating the gasoline tanker spill, the following inputs were used in the model (a confirmatory meteorological sensitivity analysis was conducted that demonstrated the inputs represented the worst case):

Table 2.2-10 of the FSAR will be updated as follows in a future version of the COLA. For clarity, only the new and revised information is shown.

Table 2.2-10—{Toxic Vapor Cloud Analysis}

Source	Chemical	Quantity	IDLH	Distance to CCNPP Unit 3 Control Room Intake	Distance to IDLH (Note 1)	Maximum Control Room Concentration (Note 2)
Maryland 2/4	Gasoline	8,500 gal/ 32,200 l	300 ppm TWA /500 ppm STEL (Note 3)	6,531 ft/ 1,991 m	1,752 ft/ 534 m	9.44 ppm (Note 4)
	Gasoline (aviation)	8,500 gal/ 32,200 l	300 ppm TWA /500 ppm STEL (Note 3)		1,752 ft/ 534 m	9.45 ppm (Note 4)
	Propane	50,000 lbs/ 22,700 kg	2,100 ppm		5,022 ft/ 1,531 m	114 ppm
	Ammonia Hydroxide (19% Solution)	50,000 lbs/ 22,700 kg	300 ppm for ammonia		8,448 ft/ 2,575 m	70.9 ppm (Note 5)
Waterway (Chesapeake Bay)	Gasoline	5,200,000 lbs/ 24,000,000 kg	300 ppm TWA /500 ppm STEL (Note 7)	11,701 ft/ 3,566 m	6,336 ft/ 1,931 m	18.5 ppm (Note 4)
	Benzene (Note 6)	560,000 lbs/ 254,000 kg	500 ppm		5,808 ft/ 1,770 m	33.0 ppm (Note 4)
	Toluene (Note 6)	560,000 lbs/ 254,000 kg	500 ppm		4,551 ft/ 1,387 m	19.7 ppm (Note 4)
	Ammonia	16,000 lbs/ 7,257 kg (Note 7)	300 ppm		18,480 ft/ 5,633 m	83.5 ppm (Notes 5 and 8)

Source	Chemical	Quantity	IDLH	Distance to CCNPP Unit 3 Control Room Intake	Distance to IDLH (Note 1)	Maximum Control Room Concentration (Note 2)
On-site (CCNPP Units 1 & 2)	Ammonium Hydroxide (28% solution)	8,500 gal/ 32,176 l	300 ppm as ammonia	2,994 ft/ 913 m	13,200 ft/ 4,023 m	704 ppm (Note 9)
	Gasoline (Note 10)	3,500 gal/ 13,250 l	300 ppm TWA /500 ppm STEL	617 ft/ 188 m	1,230 ft/ 375 m	343 ppm (Note 9)
	Sodium Hypochlorite	8,500 gal/ 32,176 l	10 ppm as chlorine	2,472 ft/ 753 m	174 ft/ 53 m	0.0490 ppm (Note 4)
	Hydrazine (35% solution)	350 gal/ 1,325 l	50 ppm	1,489 ft/ 454 m	1,197 ft/ 365 m	10.1 ppm (Note 5)
	Monoethanolamine	350 gal/ 1,325 l	30 ppm	2,889 ft/ 881 m	135 ft/ 41 m	0.0784 ppm (Note 5)
	Dimethylamine (2% solution)	350 gal/ 1,325 l	500 ppm	2,889 ft/ 881 m	288 ft/ 88 m	0.743 ppm
	Hydrochloric Acid (30% Solution)	3,000 gal/ 11,360 l	50 ppm	2,994 ft/ 913 m	3,102 ft/ 945 m	14.1 ppm (Note 5)
	Hydrogen	460 cu ft/ 13 cu m	Asphyxiant	2,994 ft/ 913 m	Asphyxiant	53.0 ppm
	Liquid Nitrogen	11,300 gal/ 42,775 l	Asphyxiant	2,994 ft/ 913 m	Asphyxiant	635 ppm (Note 5)
On-site (CCNPP Unit 3)	Argon	270 scf/ 7.64 Nm^3	Asphyxiant	42 ft/13 m	Asphyxiant	(Note 11)
	Argon-Methane (considered as Methane)	282 scf/ 7.99 Nm^3	Asphyxiant	42 ft/13 m	Asphyxiant	(Note 11)
	Hydrogen	278 scf/ 7.87 Nm^3	Asphyxiant	39 ft/12 m	Asphyxiant	(Note 11)
	Nitrogen	235 scf/ 6.65 Nm^3	Asphyxiant	36 ft/11 m	Asphyxiant	(Note 11)

Note 1: The reported value for the distance to the IDLH (or other determined toxicity limit) is the resultant distance to the IDLH for the determined worst case meteorological conditions for each postulated event. The worst case meteorological conditions were based upon those meteorological conditions yielding the highest concentration in the control room during a postulated event.

Note 2: The concentrations reported represent indoor concentrations. The air exchange rate of 0.45 air exchanges per hour that was used in the ALOHA model was calculated from the control room volume and the rate of fresh air intake. Unless noted, the worst case combination of stability class and wind speed is F stability and a wind speed of 1 m/sec.

Note 3: For gasoline and gasoline (aviation), the time weighted average (TWA) and short term exposure limit (STEL) were conservatively used as no IDLH is available for either of these hazardous materials.

Note 4: The worst case combination of stability class and wind speed is F stability and a wind speed of 3 m/sec.

Note 5: The worst case combination of stability class and wind speed is F stability and a wind speed of 2 m/sec.

Note 6: For benzene and toluene, a combined total of 28,000 short tons/year are shipped by barge. It is conservatively assumed that they are shipped in equal quantities (14,000 short tons per year each) and that they each have the minimum 50 shipments (Regulatory Guide 1.78) and each shipment contains the same quantity, 560,000 lbs each.

Note 7: The amount of ammonia transported by barge near the plant is 1,000 short tons. It is conservatively assumed that there are 50 shipments per year (Regulatory Guide 1.78), with each shipment, therefore, containing 40,000 lbs. This quantity was reduced further because of the high rate at which ammonia dissolves in water. A 0.60 partition coefficient was assigned, reducing the volume to 16,000 lbs/shipment.

Note 8: This event was evaluated to not be a credible event based on screening criteria for event frequency in accordance with Regulatory Guide 1.78. Refer to Section 2.2.3.1.3 for the analysis of this event.

Note 9: An additional probabilistic evaluation was conducted for this postulated event and this spill event was determined not to be a credible event, in accordance with Regulatory Guide 1.78 risk frequency evaluation requirements. Refer to Section 2.2.3.1.3 for the analysis of this event.

Note 10: The 4,000 gallon gasoline tank reported in Table 2.2-2 is an underground storage tank. Therefore, the toxicity event is bounded by the 3,500 gallon gasoline delivery tank truck.

Note 11: The reported distance to the IDLH for this asphyxiant is the distance at which the concentration outside the control room is such that enough oxygen may become displaced to create an oxygen deficient atmosphere.