Greg Gibson
Vice President, Regulatory Affairs

750 East Pratt Street, Suite 1600
Baltimore, Maryland 21202

UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

August 24, 2010

UN#10-230

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. 198, Probabilistic Risk Assessment

References:
1) Surinder Arora (NRC) to Robert Poche (UniStar Nuclear Energy), "FINAL RAI No. 198 SPLA 3946" email dated January 4, 2010

2) UniStar Nuclear Energy Letter UN#10-227, from Greg Gibson to Document Control Desk, U.S. NRC, Submittal of Response to RAI No. 198, Probabilistic Risk Assessment, dated August 11, 2010

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 January 4, 2010 (Reference 1). This RAI addresses Probabilistic Risk Assessment, as discussed in Chapter 19 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.

Reference 2 provided an August 25, 2010 schedule for the response for RAI No. 198, Questions 19-20 through 19-24. The enclosure provides our responses to RAI No. 198, Questions 19-20 through 19-24, 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.

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Our response does not include any new regulatory commitments. This letter does not contain any sensitive or proprietary information.

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Wayne A. Massie at (410) 470-5503.

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

Executed on August 24, 2010

Greg Gibson

Enclosure: Responses to NRC Request for Additional Information RAI No. 198, Questions 19-20 through 19-24, Probabilistic Risk Assessment, 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)
Silas Kennedy, U.S. NRC Resident Inspector, CCNPP, Units 1 and 2
U.S. NRC Region I Office

GTG/RDS/mdf

Enclosure

Responses to NRC Request for Additional Information
RAI No. 198, Questions 19-20 through 19-24, Probabilistic Risk Assessment,
Calvert Cliffs Nuclear Power Plant, Unit 3

RAI No. 198

Question 19-20

(Follow-up to RAI 93, Question 19-13) The most recent version of RG 1.200, Revision 2, Section C.1.2.5 states that "It is recognized that for those new reactor designs with substantially lower risk profiles (e.g., internal events CDF below 1E-6/year), the quantitative screening value should be adjusted according to the relative baseline risk value." Thus, please reassess the external events using an appropriate PRA screening value, or quantitatively justify that when all conservatisms are removed from the analysis, the resulting CDF and LRF would be significantly lower than the total baseline U.S. EPR CDF and LRF of 5.3E-7/yr and 2.6E-8/yr, respectively.

Response

The quantitative screening threshold has been considered in light of the core damage frequency of the U.S. EPR. The risk has been found to be low in absolute terms and low relative to the baseline risk values.

The external events have been reassessed using the relative approach to screening. The results of the reassessment are described in the responses to Questions 19-21 and 19-22 and are provided in the updates to the CCNPP Unit 3 FSAR.

COLA Impact

FSAR Section 19.1.5.4 is being updated to reflect the responses to Questions 19-20, 19-21 and 19-22, as shown in the COLA Impact section of the response to Question 19-22.

Question 19-21

(Follow-up to RAI 93, Question 19-15) The staff observes that, as mentioned in the response to RAI 93, Question 19-13, UniStar has screened out the airplane crash events based on the conservative risk assessment performed in accordance with RG 1.200 guidance. However, the resulting CDF of 1.1E-7/yr does not conform to the RG 1.200 screening criteria which describe that the screening value should be reasonably lower than the baseline risks. Without a more detailed assessment, the staff cannot conclude that the risk posed by aircraft crash events is insignificant and can be screened from the PRA. Thus,

a) Please provide the analysis which demonstrates that the more realistic CDF is reasonably lower than the baseline U.S. EPR CDF, otherwise, include the calculated aircraft crash CDF of 1.1E-7/yr in the CCNPP Unit 3 baseline risk profile.

b) CCNPP Unit 3 COLA, FSAR, Section 19.1.5.4.4 "Aircraft Crash Hazard Risk Evaluation", indicates that UniStar has modeled a scenario representing an airplane crash into the turbine building, which disables all the equipment within the turbine building, but provides no discussion on the result. Please provide the resulting CDF from this scenario.

c) Please provide the large release frequencies (LRFs) from the analyzed scenarios in Section 19.1.5.4.4 and/or justify that these LRFs are reasonably lower than the baseline LRF and can be screened from the PRA.

Response to Question 19-21 a)

The airplane crash event was re-considered and confirmed to be screened from the PRA by using the relative approach, as the risk is low in absolute terms and relative to the baseline risk. The aircraft crash analysis was revised to consider the ability of the Safeguards Buildings (SB) 1 and 4 to withstand an impact from a general aviation aircraft. Based on an aircraft impact analysis (Safeguards Information) performed to support the safeguards aircraft crash analysis, it was concluded that the crash of a general aviation aircraft into SB 1 or 4 (i) would not result in a breach of a steam or main feedwater line inside the protected area (i.e., between the containment wall and the isolation valves), (ii) would not physically damage the main steam isolation valves in a way that would prevent them to close, and (iii) would not result in a breach of any fluid-carrying system located inside the Safeguard Building. Therefore, a general aviation impact onto the SB 1 or 4 was modeled as an isolable steam line break initiating event, with failure of the electrical division housed within the impacted structure.

Accordingly, in order to account for the differences in the damage assessment, the SB 1/4 aircraft crash scenario is calculated separately based on aircraft type:

- The large aircraft scenario results in large scale building damage (including items (i), (ii) and (iii) above) but the aircraft crash frequency is limited to commercial and military aircrafts.
- The general aviation aircraft scenario is modeled as an isolable steam line break initiating event concurrent with failure of the electrical division in the affected Safeguards Building.

The Turbine Building (TB)/Switchgear Building (SWGB) aircraft crash scenario is not modified. All aircraft types are assumed to inflict the maximum damage.
The results of this refined analysis are shown below in Table 1. The total aircraft crash CDF, obtained by summing the three scenarios, is 4.7E-08 per year, which is low in relative and absolute terms and is screened out.

Table 1: CCNPP3 Aircraft Crash Evaluation – Summary of Results

Aircraft Crash Scenario	Frequency (1/yr)	CDF (1/yr)
Aircraft Crash into SB 1 or 4 – Large aircraft	6.8E-07	3.9E-08
Aircraft Crash into SB 1 or 4 – Small aircraft	1.5E-06	4.5E-10
Aircraft Crash into the TB and SWGB	8.5E-06	7.4E-09
Total Aircraft Crash CDF		**4.7E-08**

Response to Question 19-21 b)

The CCNPP Unit 3 aircraft crash analysis models a scenario in which an aircraft crash impacts the Turbine Building and the Switchgear Building. This scenario assumes unrecoverable loss of offsite power, as well as the loss of all equipment within these two buildings, including the SBO diesel generators and the 12-hour batteries. The results of this scenario are shown above in Table 1. The associated CDF is 7.4E-09 per year. The dominant cutsets in this scenario are:

- Station blackout due to common-cause emergency diesel generator failure, and
- RCP seal LOCA, failure of partial cooldown failure of feed and bleed due to loss of power.

Response to Question 19-21 c)

As shown in the response to Question 19-21a), the CDF associated with aircraft crash is low in absolute terms and low relative to the baseline U.S. EPR CDF. Therefore the risk from aircraft crash can be screened out for CCNPP Unit 3 and no detailed Level 2 analysis is required.

Additionally the U.S. EPR containment building is hardened against airplane crash hazards, and the U.S. EPR level 2 results indicate that airplane crash induced CDF scenarios are relatively unlikely to result in large release (relative to the average core damage event). The dominant large release frequency (LRF) release scenarios for airplane crash are steam line breaks outside containment with failure of secondary cooling and feed and bleed, and LOOP or station blackout events.

Since the conditional probability of a large release given these aircraft crash initiating events is lower than the average large release probability for all internal events (i.e., 7.5% per FSAR Section 19.1.4.2.2.8 or approximately 3.3% per the response to U.S. EPR RAI Set 22, Question

19-160[1]), and since the aircraft CDF value is estimated using demonstrably conservative analysis, it is concluded that airplane crash induced LRF is a small contributor to the total U.S. EPR LRF.

COLA Impact

FSAR Section 19.1.5.4 is being updated to reflect the responses to Questions 19-20, 19-21 and 19-22, as shown in the COLA Impact section of the response to Question 19-22.

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1 R. Wells (AREVA) to G. Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 22, FSAR Ch. 19, Supplement 3," email dated November 4, 2008.

Question 19-22

(Follow-up to RAI 93, Question 19-16) According to RG 1.200, Revision 2, Section C.1.2.5, for new reactor designs, all external natural hazards and man-made events can be screened out if they can be shown using a demonstrably conservative analysis that the resulting CDF is less than the baseline risk value. Thus, please reassess all industrial and transportation accidents and nearby facilities hazards according to the RG 1.200 screening criteria.

Response

An evaluation of the risks posed by an industrial or transportation accident involving hazardous material occurring within 5 miles (8 km) from the plant site has been performed. The results of the evaluation, which are summarized in FSAR Chapter 2.2, found the largest minimum separation distance of the evaluated hazardous materials to the nearest safety-related structure, or to the main control room for toxic chemicals, to be less than the actual distance in all cases except for:

- Gasoline at Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 & 2
- Ammonia on the Chesapeake Bay

For gasoline, a quantitative risk assessment was used to show that:

- The rate of exposure to a peak positive incident overpressure in excess of 1 psi is less than 1E-07 per year.
- The rate of exposure to a postulated vapor cloud at or above the 8-hour Time-Weighted Average (TWA) threshold value in the control room is approximately 2.66E-07 per year. However, as shown in FSAR Table 2.2-10, gasoline has an 8-hour TWA threshold value of 300 ppm, a Short-Term Exposure Limit (STEL) of 500 ppm and a maximum control room concentration of 343 ppm. Given that the maximum control room concentration is less than the STEL and only approximately 15% greater than the 8-hour TWA, it is expected that this will give the control room operators longer than 2 minutes to don a respirator. This meets the acceptance criteria of Regulatory Guide 1.78, therefore gasoline at CCNPP Units 1 & 2 is not considered to be a significant contributor to risk and is screened from further consideration.

For ammonia releases from the Chesapeake Bay waterway, Regulatory Guide 1.78 states that releases of toxic chemicals from barge traffic need not be considered if there are fewer than 50 shipments per year within a 5 mi (8 km) radius of a nuclear power plant. The U.S. Army Corps of Engineers estimates that there are less than 5 shipments per year of ammonia passing within the vicinity of the CCNPP site (FSAR Section 2.2.3.1.3). Since the frequency of ammonia shipments is much less than 50 per year, the probability of an accident occurring involving a barge within the exposure distance from the control room is below the screening criteria established by Regulatory Guide 1.78, and is therefore screened from further consideration.
The previous discussion of the CCNPP Unit 1 & 2 ammonia hydroxide tank spill contained in FSAR Section 2.2.3, Revision 6 is being removed. The discussion of the event was based on a probabilistic assessment performed to determine if it could be screened from further consideration. The probability based screening analysis was based on the regulatory guidance presented in RG 1.206, where a probability of occurrence value of 1E-07 per year with consequences serious enough to affect the safety of the plant (or 1E-06 per year when

combined with reasonable arguments that the realistic probability can be shown to be lower) were used as the screening criteria.

In lieu of demonstrating that this event could be screened out by showing that the resulting CDF is less than the baseline risk value analysis, a quantitative analysis of the 8,500 gallon ammonium hydroxide tank was performed.

The evaluation of the ammonium hydroxide tank was performed taking into account the site layout. The ammonium hydroxide tank is stored at the CCNPP Units 1 & 2 tank farm. The vapor cloud formed from a release would have to travel directly over and/or around many CCNPP Unit 1 & 2 structures to reach the CCNPP Unit 3 control room air intake. Therefore, the vapor cloud dispersion was modeled using a release scenario with a conservative ground roughness value, 50 cm, to account for the roughness elements present at the site (buildings, trees, and other structures create eddies that would further disperse the vapor cloud prior to reaching the control room).

In summary, a sensitivity analysis was completed for ammonium hydroxide to determine the worst case scenario for atmospheric stability class and wind speed. A worst case scenario meteorological stability class F at 1 m/s was used. The analysis of a spill of the 8,500-gallon tank of ammonium hydroxide (28%) stored at the CCNPP Unit 1 & 2 tank farm (2,994 feet from the CCNPP Unit 3 control room) yielded a maximum concentration of 194 ppm inside the CCNPP Unit 3 control room over a 60 minute period. This is below the 300 ppm IDLH limit for ammonium hydroxide (as ammonia). Therefore, no adverse impacts to CCNPP Unit 3 control room habitability are expected due to the postulated CCNPP Unit 1 & 2 ammonium hydroxide release.

COLA Impact

FSAR Section 2.2.3.1.3 is being updated as follows to reflect the responses to Questions 19-20, 19-21 and 19-22:

2.2.3.1.3 Toxic Chemicals

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). Two water treatment chemicals, a non-oxidizing biocide containing ethanol and sodium hypochlorite, 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 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, (53.0 ppm for hydrogen, and 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 asphyxiants 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 control room air - - defined by OSHA) under worst case meteorological conditions (42 ft for argon gas and argon-methane gas cylinders, 39 ft for hydrogen gas cylinders, and 36 ft for nitrogen gas cylinders).

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~~ this analysis included a total loss of the largest vessel into an unconfined puddle under determined worst case meteorological 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 1 E-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 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 mode (a confirmatory meteorological sensitivity analysis was conducted confirming the meteorological inputs were worst case):

- Pasquill Stabilty Class F selected to represent the most limiting 5% of meteorological conditions observed.
- A low wind speed of 1 meter per second selected to represent the most limiting 5% conditions. Low wind speed conditions prevent the vapor cloud from dispersing as it travels.
- The time of day selected was 12:00 pm on July 1, 2006. This day and time were chosen because temperatures are highest in the summer during the midday. Higher temperatures lead to a higher evaporation rate, and thus, a larger vapor cloud.
- The tank was filled to capacity and a catastrophic tank failure was assumed where the total amount of the substance leaked forming a 1 cm thick puddle. A 1 cm thick puddle allows for greater evaporation, and thus, a larger vapor cloud.

A probabilistic analysis was then performed for any identified chemicals that were analyzed to have significant potential consequences that could exceed the guidelines of 10 CFR Part 100.

The evaluations identified one ~~two~~ chemical~~s~~, gasoline ~~and ammonia hydroxide~~ that merited probabilistic analysis.

The evaluation of the gasoline tanker spill event was performed in accordance with Regulatory Guide 1.91 (NRC, 1978a). The probability of an accident occurring involving a truck within the exposure distance from the control room for CCNPP Unit 3 was identified as 2.66E-7 per year. This analysis was based upon Maryland State Highway Administration large truck accident data for Calvert County, Maryland (MSHA, 2004). Large trucks are defined as over 10,000 pounds (4,540 kg) gross vehicle rating. The actual accident rate for gasoline delivery tankers would be expected to be somewhat lower than the cited accident rate given that vehicle operation speeds in the vicinity of CCNPP Unit 3 are considerably lower than on the highways.

~~The evaluation of the ammonia hydroxide tank spill event was based on empirical data for vessel failures. A catastrophic vessel failure frequency of approximately 5E-7 per year was identified as reasonable (Beerens, 2006). This failure rate is applicable to loss of containment failures involving release of the complete tank inventory over a ten minute period at a constant rate of release, and catastrophic tank failures resulting in instantaneous release of the entire tank contents. The assumptions used in analyzing the ammonium hydroxide tank involved a worst case scenario which involved the instantaneous release of the entire tank contents into an unconfined puddle 1 cm in thickness. There is considerable conservatism in this failure rate since the ammonium hydroxide tank is double walled and located in a tank farm that contains a sump.~~

With the exception of gasoline ~~and ammonia hydroxide~~, the identified chemicals had analyzed consequences that were below the guidance provided in 10 CFR Part 100. The gasoline ~~and ammonia~~ spill event~~s were~~ was evaluated and ~~have~~ has an event ~~probabilities~~ probability that ~~are~~ is below the 1E-6 criteria provided in Regulatory Guide 1.78 (NRC, 2001). Therefore, toxic vapor clouds resulting from chemical spills of onsite chemicals will not adversely affect the safe operation of CCNPP Unit 3. The effects of toxic chemical releases are summarized in Table 2.2-10.

FSAR Table 2.2-10 is being updated as follows to reflect the responses to Questions 19-20, 19-21 and 19-22:

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	9.44 ppm (Note 4)
	Propane	50,000 lbs/ 22,700 kg	2,100 ppm		5,022 ft/ 1,531 m	114 ppm
	Ammonium 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 (Note4)
	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 (Note4)
	Ammonia	16,000 lbs/ 7,257 kg (Note 7)	300 ppm		18,480 ft/ 5,633 m	83.5 ppm (Notes 5 and 8)
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~~ 6,864 ft/ 2,092 m	~~704 ppm (Note 9)~~ 194 ppm (Note 15)
	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	0.049 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)

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)
	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)
	Sodium Hypochlorite	40,000 gal/ 150,000 l	10 ppm as Cl_2	(Note 14)	396 ft/ 121 m	(Note 14)
	Sodium Hypochlorite	2,000 gal/ 7,600 l	10 ppm as Cl_2	(Note 14)	93 ft/ 28 m	(Note 14)
	Non-Oxidizing Biocide (ethanol)	1,000 gal/ 3,800 l (Note 12)	3,300 ppm as ethanol	(Note 14)	75 ft/ 23 m	(Note 14)
	Non-Oxidizing Biocide (ethanol)	350 gal/ 1,300 l (Note 13)	3,300 ppm as ethanol	(Note 14)	45 ft/ 14 m	(Note 14)

TLV-TWA: Threshold Limit Value-Time-Weighted Average
STEL: Short term exposure limit
IDLH: Immediately Dangerous to Life and Health threshold value
scf: Standard cubic feet
Nm^3: Normal cubic meter

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 to16,000 lbs.

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.

Note 12: The actual quantity of ethanol analyzed (10 percent by weight of non-oxidizing biocide) was 122 gal/ 462 l.

Note 13: The actual quantity of ethanol analyzed (10 percent by weight of non-oxidizing biocide) was 42.66 gal/ 161.3 l.

Note 14: The evaluated chemical is stored at a distance greater than the reported safe distance (the distance the chemical cloud could travel before it disperses enough such that the concentration in the vapor cloud falls below the IDLH limit, other determined toxicity limit concentration, or at a level where an oxygen deficient atmosphere is plausible). For these evaluated chemicals the control room air exchange rate was not accounted for in the analyses.

Note 15: Because the ammonium hydroxide (28%) is stored at the tank farm and must travel directly over/around structures to reach the control room air intake, a ground roughness value of 50 cm was entered.

FSAR Section 19.1.5.4 is being updated as follows to reflect the responses to Questions 19-20, 19-21 and 19-22:

19.1.5 SAFETY INSIGHTS FROM THE EXTERNAL EVENTS PRA FOR OPERATIONS AT POWER

19.1.5.4 Other External Risk Evaluations

The U.S. EPR FSAR includes the following COL Item in Section 19.1.5.4:

> A COL applicant that references the U.S. EPR design certification will perform the site-specific screening analysis and the site-specific risk analysis for external events applicable to their site, including a site-specific PRA-based SMA for soil effects (including sliding and overturning, liquefaction, and slope failure).

This COL Item is addressed as follows:

{A screening analysis of the risks posed by external events to the CCNPP Unit 3 site was performed. All of the external events listed in Appendix A of ANSI/ANS-58.21-~~2003~~2007 (ANSI, 2007) have been addressed. For each external event, a progressive approach is used following the guidance in ANSI/ANS-58.21-~~2003~~2007 and in NUREG-1407 (NRC, 1991). The low risk profile of the U.S. EPR is considered in screening.

An external event that meets the ANSI/ANS-58.21-2007 screening criteria, and is assessed as having a low risk value both in absolute terms and with consideration of the low risk values for the U.S. EPR assessment, is not considered to be a significant contributor to risk and is screened from further consideration.

The plant design bases for external events are compared against ANSI/ANS-58.21-2007 and ~~SRP screening criteria, as defined in~~ NUREG-0800 (NRC, 2007c) screening criteria. If the event cannot be qualitatively screened, a quantitative PRA assessment is performed to assess the risk posed by that external event against the~~SRP~~ quantitative screening criteria~~, as defined in the appropriate section of NUREG-0800~~.

As defined in ANSI/ANS-58.21-~~2003~~2007, Table 19.1-1 provides a list of all external events considered. Also provided is the reason for screening each event or the relevant section where screening is discussed.

19.1.5.4.1 High Winds and Tornado Risk Evaluation

The risks posed by high winds, tornado wind loads and tornado missile events at the CCNPP Unit 3 site on U.S. EPR structures were evaluated versus NUREG-0800 acceptance criteria. The design requirements for safety-related structures of the U.S. EPR FSAR meet these criteria. The non-safety-related structures located on-site and not designed for tornado loads are evaluated in Section 3.3.

The non-safety-related structures which have systems and components modeled in the PRA include:

- Turbine Building
- Switchgear Building
- Transformer and Switchyard Areas
- Normal Heat Sink
- Nuclear Auxiliary Building
- Ultimate Heat Sink Makeup Structure

High Wind Load

The U.S. EPR safety related structures are designed to withstand high wind load characteristics as specified in NUREG-0800, Section 3.3.1. The SRP acceptance criteria for high winds specify that the design velocity pressure for safety-related structures must be greater than or equal to the velocity pressure corresponding to the speed of the 100-year return period 3-second wind gust. The design basis wind speed is 145 mph (233 kph) in open terrain with a 50-year mean recurrence interval. For the safety-related structures, the design wind speed is increased by an importance factor of 1.15 to obtain a 100-year mean recurrence interval.

As documented in Section 2.3.1.2.2.15, the 100 year return period 3-second wind gust for the CCNPP Unit 3 site is 102 mph (164 kph). This is significantly less than the design basis wind speed. Site-specific structures will be designed in compliance with ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," (ASCE, 2006), therefore the design wind speed for those structures will be no less than 102 mph. Therefore the NUREG-0800, Section 3.3.1 screening criteria are met for high winds (other than tornadoes).

The non-safety-related structures located on-site and not designed for high wind loads are evaluated in Section 3.3, to show that their collapse would not result in an impact on any of the safety related structures. A subset of these structures that contain systems and components modeled in the PRA are listed below:

- Switchgear Building
- Transformer and Switchyard Areas
- Normal Heat Sink
- Turbine Building

The Ultimate Heat Sink Make-up Structure also contains equipment that supports systems and components credited in the PRA. However, it's function is not credited within the mission time assumed in the PRA model.

Tornado Wind Load

The U.S. EPR safety-related structures are designed to meet the design-basis tornado wind characteristics of Tornado Intensity Region I as specified in NUREG-0800, Section 3.3.2. Tornado Intensity Region 1 (Central U.S.) is the most limiting for tornado wind loads and is characterized by a maximum tornado wind speed of 230 mph (370 kph) (184 mph (296 kph) maximum rotational speed, 46 mph (74 kph) maximum translational speed). These design-basis tornado wind characteristics are bounding for all U.S. regions within the contiguous 48 states.

The safety-related structures of the U.S. EPR are designed for the tornado wind loads corresponding to a maximum tornado wind speed of 230 mph (370 kph). Additionally, non-safety-related structures must not, upon failure caused by a tornado, ~~The tornado requirement for non-safety-related structures is that upon failure, they cannot~~ cause failure of adjacent safety-related structures.

Tornado Wind Load Quantitative Analysis

A more detailed quantitative analysis is performed to evaluate plant risk as a result of tornado impact on non-safety-related structures, which contain systems and components modeled in the PRA. The detailed quantitative analysis considers a bounding tornado event plant impact scenario and tornado event frequency. The screening core damage frequency associated with the bounding scenario is the plant impact (conditional core damage probability) multiplied by the event frequency.
As stated above, safety-related structures are screened from further evaluation based on NUREG-0800 criteria and their tornado design features. Therefore, it is assumed that a tornado event will not affect safety-related structures or associated systems and components. A bounding plant impact scenario is used to develop risk insights associated with a tornado wind loading on non-safety-related U.S. EPR plant structures, which contain systems and components credited in the PRA model. The following non-safety-related structures of the U.S. EPR plant and associated systems and components are considered in the bounding impact scenario.

1. Auxiliary Power Transformer Area and Switchyard Area - contain components related to offsite power. Unrecoverable loss of offsite power event (LOOP) is assumed in the bounding scenario.

2. Switchgear Building - contains the two station black-out diesel generators (SBO DG), non-1E switchgear equipment, load centers, motor control centers and 12-hour severe accident battery divisions. Failure of both SBO DGs and failure of all non-1E electrical buses and buses powered by the 12-hour severe accident battery divisions is assumed in the bounding scenario.

3. Turbine Building/Normal Heat Sink - contains systems and components associated with secondary heat removal, for example, main condenser and feedwater. The risk impact from a loss of these locations is enveloped by the impact from the switchgear building.

4. Nuclear Auxiliary Building - contains the operational chilled water system (OCWS). Note – because of its proximity to safety-related structures, the Nuclear Auxiliary Building is a reinforced concrete structure and designed for tornado loading per Regulatory Guide 1.76 (NRC, 2007d). Therefore, the plant impact scenario assumes that this structure and associated equipment are not affected by the postulated tornado event.

The U.S. EPR FSAR Level 1 PRA LOOP event tree model is used to calculate the conditional core damage probability (CCDP). Based on the above scenario, the CCDP is approximately 8.8E-04. The dominant CCDP sequence involves common cause failure of all four emergency diesel generators (EDGs), resulting in a station blackout event.

NUREG/CR-4461, Tornado Climatology of the Contiguous United States (NRC, 2007e) is used to determine the tornado strike frequency. The tornado strike frequency is the likelihood that a tornado will strike a given point or structure on an annual basis. It is calculated as the sum of two terms: (1) point structure probability (which is calculated based on recorded tornado dimensions within a certain area) and (2) the life-line term (which is based on the dimensions of the plant-specific target structure).

The point structure probability, life-line term, and the total strike probability are calculated for the local 2° box containing the CCNPP Unit 3 site (37-39° N, 76-78° W). The characteristic dimension used to calculate the plant-specific life-line term is the Turbine Building length of 300 feet (91 m).

Based on the NUREG/CR-4461 information, the CCNPP Unit 3 site-specific strike frequency of a tornado with a wind speed greater than 95 mph (152 kph), the design wind velocity for non-safety-related structures at CCNPP Unit 3 site, is determined as approximately 6.1E-05/yr.

~~The screening core damage frequency associated with the bounding scenario is the plant impact CCDP (8.8E-04) multiplied by the event frequency (6.1E-05/yr). The core damage frequency (CDF) for this scenario is approximately 5.4E-08/yr.~~

The assessed core damage frequency is revised qualitatively based on relaxing the following conservatism:

- The strike frequency was conservatively calculated for tornadoes with wind speed greater than 95 mph (152 kph). However, the Switchgear Building is designed for a design basis tornado with a maximum wind speed of 230 mph (370 kph). Therefore, credit is given for the availability of the SSC in the Switchgear Building, including the two SBO DGs, non-1E switchgear equipment, load centers, motor control centers and 12-hour uninterruptible power supply system. These SSC had been conservatively considered to be failed in the bounding impact scenario discussion above.

External events can be screened if the CDF, or initiating event frequency, calculated using a demonstrably conservative analysis, demonstrates a high confidence that the risk is low in absolute and relative terms. The results of this demonstrably conservative analysis, combined with the qualitative insights, show that the contribution to CDF from tornado winds is low. ~~Therefore, the frequency of a release resulting in dose exceeding the guidelines of 10 CFR 100 (CFR, 2008y) is judged to be less than 1E-07/yr, which is a criterion used in NUREG-0800 for external events screening.~~

Tornado Missiles

The U.S. EPR safety-related structures are designed for the tornado missile characteristics of Region 1 (most limiting U.S. region) as specified in NUREG-0800, Section 3.5.1.4. The design basis missiles include: (1) a massive high kinetic energy missile that deforms on impact, (2) a rigid missile that tests penetration, and (3) a small rigid missile of a size sufficient to pass through any opening in protective barriers. Therefore, tornado missiles are screened for CCNPP Unit 3 according to NUREG-0800.

The bounding tornado strike scenario defined and quantified above conservatively assumes failure of all non-safety-related structures of the plant. The tornado strike scenario is judged bounding for all credible tornado and tornado missile events. Therefore, tornado missile effect on unprotected plant structures is not evaluated further.

High Winds and Tornado Evaluation Conclusion

~~The preceding plant high winds and tornado structural design bases allow the risk posed by high winds, tornadoes and tornado missiles to be screened for the CCNPP Unit 3 site. Additional analysis has demonstrated the robustness of the U.S. EPR design with respect to high wind and tornado events by showing that the risk posed by those events is low and the screening criteria are met.}~~It is concluded that CCNPP Unit 3 satisfies the screening criteria set forth in NUREG-0800 (NRC, 2007c), RG 1.76 (NRC, 2007d), and ANSI/ANS 58.21-2007 (ANSI, 2007). High winds can be screened directly based on the CCNPP Unit 3 design basis. A quantitative PRA analysis was performed to evaluate the risk associated with tornadoes (including tornado missiles). The results of this demonstrably conservative analysis, combined with the qualitative insights, show that the contribution to CDF from tornado winds and tornado generated missiles is low in absolute terms and relative to the baseline values of risk for the U.S. EPR. As a result, high winds, tornadoes and tornado missiles can be screened from the PRA for CCNPP Unit 3.

19.1.5.4.4 Aircraft Crash Hazard Risk Evaluation

This section is added as a supplement to the U.S. EPR FSAR.

The risk posed by random airplane crash events to the CCNPP Unit 3 site are evaluated using a progressive screening approach. The location of the site with respect to airports, military training routes and airways was evaluated against the screening criteria presented in Section 19.1.5.4 and NUREG-0800, Section 3.5.1.6.

Screening Analysis for Airplane Crash

NUREG-0800, Section 3.5.1.6 acceptance criteria for airplane crash hazard stipulates that the frequency of an event causing radiological consequences greater than the 10 CFR 100 exposure guidelines should be less than 1E-07/yr. This acceptance criterion can be met provided that all of the following conditions exist:

- The plant-to-airport distance D is between 5 and 10 statute miles (8 and 16 km), and the projected annual number of operations is less than the numerical value of 500 D^2.

- The plant is at least 5 statute miles (8 km) from the nearest edge of military training routes, including low-level training routes, except for those military training routes associated with usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation.

- The plant is at least 2 statute miles (3.2 km) beyond the nearest edge of a Federal airway, holding pattern, or approach pattern.

The following information is specific to the CCNPP Unit 3 site:

- The CCNPP Unit 3 site lies just within 10 statute miles (16 km) from the Patuxent Naval Air Station. The distances from the CCNPP Unit 3 site to various runways at Patuxent NAS vary from ~~43,100 ft to 52,736 ft (13,136 to 16,074 m)~~ 8.2 miles to 10.0 miles (13.1 km to 16.1 km). The Captain Walter Duke Regional Airport is also located just within 10 statute miles from the CCNPP Unit 3 site.

- According to 2005 data, the number of annual operations at Patuxent NAS is 52,626 and the number of annual operations at Captain Walter Duke Regional Airport is 52,618.

Using the screening methodology presented in NUREG-0800 and assuming a value of 10 miles for D, the total number of operations per year at Patuxent NAS and Walter Duke Regional Airport would have to be less than 50,000 operations (10 * 10 * 500) to meet the screening criteria. In addition, the CCNPP Unit 3 site is within 2 statute miles of a federal airway. Therefore, the risk from airplane crash at CCNPP Unit 3 cannot be screened using the above NUREG-0800 criteria. Therefore, an assessment was performed to quantitatively assess the risk posed by an airplane crash against NUREG-0800 acceptance criteria.

Detailed Airplane Crash Assessment

~~U.S. EPR FSAR Section 3.5.1.6 states: "The U.S. EPR design employs geographical separation or residence within shielded buildings to provide a minimum number of SSCs to achieve and maintain the plant in cold shutdown and prevent damage to fuel in the spent fuel pool following an aircraft hazard (ACH). Specifically, sufficient geographical separation between redundant or diverse SSCs limits the extent of damage from an ACH. Similarly, placing SSCs within shield buildings designed to~~

~~prevent penetration by aircraft provides protection of redundant or diverse SSCs to achieve and maintain the plant in cold shutdown and prevent damage to fuel in the spent fuel pool."~~

<u>Based on the</u> ~~Given the above~~ U.S. EPR building design, a quantitative assessment of aircraft hazard was performed for various random aircraft hazard scenarios using the U.S. EPR FSAR PRA. ~~The assessment is judged to be a conservative and bounding approach for screening purposes to satisfy Section 3.5.1.6 of NUREG-0800.~~

~~A detailed assessment was performed to better estimate the hazard posed by an airplane crash into CCNPP Unit 3. It consisted~~The analysis was performed using ~~of~~ the following steps:

1. Develop target sets based on similar building structural strength (hardened or non-hardened), site location and expected response.

2. Calculate the estimated impact frequency (initiating event frequency) for each target set based on representative dimensions of the buildings within each target set.

3. Incorporate the calculated initiating event frequencies with PRA event trees to analyze the plant response and obtain a conservative/bounding core damage frequency estimate for each scenario.

Target sets were screened when it was judged that one of the following conditions applies:

- A crash into the target set would not result in damages to SSCs modeled in the PRA (e.g., shielded buildings).

- The consequences of a crash into the target set would be enveloped by an initiating event already modeled in the PRA, and the frequency of this initiating event is several orders of magnitude higher than the postulated airplane crash frequency.

Target sets that were retained for the analysis are: (a) Safeguard Building 1 (or 4) and (b) Turbine and Switchgear Building. Aircraft crash frequencies into these two target sets are estimated using the methodology of DOE Standard 3014-2006 (DOE, 2006). Bounding aircraft crash scenarios are developed for the two target sets defined. The most limiting failures of all the components in the affected building are assumed. This is a demonstrably conservative approach since~~:~~

~~♦ Bounding~~ <u>conservative</u> consequence assumptions were applied, including that the PRA models used for the defined scenarios conservatively estimate the crash impacts based on a limiting direction of movement and then conservatively apply that scenario to all impacts, and the emergency feedwater (EFW) suction cross-connect valves are conservatively assumed to be open.

- ~~Aircraft crash frequencies used are inherently conservative, including conservative damage assessments for the damage incurred from a general aviation aircraft impact onto safeguards building 1 or 4.~~

~~The assessment is judged to provide a conservative and bounding approach for screening purposes to satisfy Section 3.5.1.6 of NUREG-0800. The core damage frequency was estimated as 1.3E-7 per year for airplane impacts into Safeguards Buildings 1 or 4 and 8E-09 per year for airplane strikes into the Turbine and/or Switchgear Buildings. Since the core damage frequency from airplane impacts into Safeguards Building 1 or 4 was greater than 1E-7 per year an assessment of the containment release frequency associated with this event was performed. To that effect, the bounding airplane crash scenario was assessed using the U.S. EPR FSAR Level 2 PRA model. As previously identified in Section 19.1.4.2, the U.S. EPR FSAR Level 2 PRA model is applicable to CCNPP Unit 3 without modification. All systems and equipment affected by the crash, including the Severe Accident Heat Removal System, are assumed to be unavailable for the Level 2 analysis. Based on this analysis, the frequency of a release from airplane strikes onto Safeguards Buildings 1 or 4 resulting in a dose exceeding the guidelines of 10 CFR 100 is estimated to be less than 3E-08/yr.~~ Based on an aircraft impact analysis (Safeguards Information) performed to support the safeguards aircraft crash analysis it was concluded that the crash of a general aviation aircraft into SB 1 or 4 (i) would not result in a breach of a steam or main feedwater line inside the protected area (i.e., between the containment wall and the isolation valves), (ii) would not physically damage the main steam isolation valves in a way that would prevent them to close, and (iii) would not result in a breach of any fluid-carrying system located inside the safeguard building. Therefore, a general aviation impact onto the safeguards building 1 or 4 was modeled as an isolable steam line break initiating event, with failure of the electrical division housed within the impacted structure.

Accordingly, in order to account for the differences in the damage assessment, the SB1/4 aircraft crash scenario is calculated separately based on aircraft type:

- The commercial\military aircraft scenario results in large scale building damage (including items (i), (ii) and (iii) above) but the aircraft crash frequency is limited to commercial and military aircrafts.

- The general aviation aircraft scenario is modeled as an isolable steam line break initiating event concurrent with failure of the electrical division in the affected safeguards building.

The Turbine and Switchgear Building target set is not modified. All aircraft types are assumed to inflict the maximum damage.

The results of this analysis are as follows:

- Large Aircraft Crash into Safeguards Building 1 or 4 is estimated to have a CDF of 3.9E-08 per year

- Small Aircraft Crash into Safeguards Building 1 or 4 is estimated to have a CDF of 4.5E-10 per year

- Aircraft Crash into the Turbine and Switchgear Buildings is estimated to have a CDF of 7.4E-09 per year

Conclusion for Detailed Airplane Crash Hazard Assessment

External events can be screened if the CDF, or initiating event frequency, calculated using a demonstrably conservative analysis, demonstrates that the risk is low in absolute terms and relative to the risk values for the U.S. EPR. Also, t~~T~~he NUREG-0800 screening criteria are met if the frequency of a release exceeding 10 CFR 100 limits is less than 1E-07 per year. The total CDF (CDF bounds large release frequency) from airplane crash into CCNPP Unit 3, using a demonstrably conservative analysis, is calculated as ~~frequency of an aircraft crash initiating event that results in a release in excess of 10CFR100 guidelines was estimated for the two bounding scenarios as~~

- ~~A~~ having a core damage frequency of 4.7E-08 ~~1.3E-07~~ per year ~~and a radiological release frequency of less than 3E-08 per year for scenarios involving airplane impact onto Safeguards Building 1 and 4~~.

- ~~A core damage frequency of less than 8E-09 per year for scenarios involving airplane impact into the turbine building and\or switchgear buildings~~

Based on a comparison of this analysis to NUREG-0800 and ANSI/ANS-58.21-2007, it is concluded that that CCNPP Unit 3 design can be screened. As a result, aircraft crash has been screened from the PRA.~~Therefore the total frequency of a release in excess of 10 CFR 100 guidelines is determined to be less than 1E-07 per year and it is therefore concluded that the CCNPP Unit 3 design meets the SRP acceptance criteria.~~

19.1.5.4.5 Industrial and Transportation Accidents Risk Evaluation

This section is added as a supplement to the U.S. EPR FSAR.

The risks posed by potential industrial and transportation accidents to CCNPP Unit 3 are evaluated against the ANSI/ANS-58.21-2007 and SRP screening criteria as defined in NUREG-0800, Section 2.2.3. External events can be screened if the CDF, or initiating event frequency, calculated using a demonstrably conservative analysis, demonstrates that the risk is low in absolute terms and with consideration of the low risk values for the U.S. EPR.~~ANSI/ANS-58.21-2007 allows quantitative screening if the core damage frequency, calculated using a bounding or demonstrably conservative analysis, has a mean frequency less than 1.E-06/yr.~~

The following types of hazards are evaluated: highway hazards, waterway hazards, pipeline hazards, railroad hazards, and nearby facilities hazards:

Highway Hazards

In Section 2.2.3.1, an evaluation is made of the risks posed by an accident involving hazardous material occurring on the major highway in Calvert County, Maryland Highway 2/4, which is adjacent to the CCNPP Unit 3 site. CCNPP Unit 3 is located approximately 1.2 miles (1.9 km) from Maryland Highway 2/4 at its closest approach. For each type of event and for the largest amount of hazardous material susceptible to being involved in that event, the minimum separation distance (i.e., safe distance) is calculated. The results are summarized in Table 2.2-8 (for explosions), Table 2.2-9 (for flammable vapor clouds) and Table 2.2-10 (for toxic chemicals). In each case, the largest minimum separation distance is found to be less than 1.2 miles (1.9 km). Therefore, highway hazards have been screened from the PRA ~~would not adversely affect the safe operation of CCNPP Unit 3~~.

Waterway Hazards

In Section 2.2.3.1, an evaluation is made of the risks posed by an accident involving transportation of hazardous material along the Chesapeake Bay. Per Section 2.2.3.1.1, the distance between potential waterway traffic and the nearest structure (UHS makeup water intake structure) is about 2.2 miles (3.5 km). For each type of event and for the largest amount of hazardous material susceptible to being involved in that event, the minimum separation distance is calculated. The results are summarized in Table 2.2-8 (for explosions), Table 2.2-9 (for flammable vapor clouds) and Table 2.2-10 (for toxic chemicals). ~~In each case, the largest minimum separation distance is found to be less than 2.2 miles (3.5 km).~~ 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.

For ammonia on the Chesapeake Bay, the U.S. Army Corps of Engineers estimates that there are less than 5 shipments per year of ammonia passing within the vicinity of the CCNPP site. Given that the frequency of ammonia shipments is less than 50 per year passing within the vicinity of the CCNPP site, the probability of an accident occurring involving a barge within the exposure distance from the control room is below the screening criteria established by Regulatory Guide 1.78. Therefore, waterway hazards have been screened from the PRA ~~would not adversely affect the safe operation of CCNPP Unit 3~~.

Pipeline Hazards

The Dominion Cove Point pipeline passes within the vicinity of the Calvert Cliff site. The closest distance between the plant and the pipeline is 1.54 miles (2.5 km). Section 2.2.3.1.1 addresses the risk from the pipeline and concludes that an explosion following a rupture in the pipeline would not adversely affect the safe operation of CCNPP Unit 3. The safe distance for exposure to thermal consequences from a rupture in the pipeline is 0.45 mi (0.72 km), which is significantly less than the actual separation. Therefore, pipeline hazards have been screened from the PRA.

Railroad Hazards

There are no railroads within 5 miles (8 km) of the CCNPP Unit 3 site. Therefore, railroad hazards have been screened from the PRA ~~this external event is screened per the SRP acceptance criteria~~.

Nearby Facilities Hazards

Section 2.2.1 identifies three potential external hazard facilities within 5 miles of the CCNPP Unit 3 site: CCNPP Unit 1 and 2, the Dominion Cove Point Liquid Natural Gas (DCPLNG) Terminal and the Dominion Cove Point pipeline (see above).

The safe distance for each of the hazardous chemicals inventories stored on the CCNPP Unit 1 and 2 sites is shown in Table 2.2-8 (for explosions) and Table 2.2-9 (for flammable vapor clouds). Toxic chemicals release is also evaluated. It is shown in Section 2.2.3.1.3 ~~Table 2.2-10~~ that the main control room would remain habitable after the worst case release in all scenarios, except the 3500 gallon ~~but two (~~gasoline delivery truck ~~and ammonia) of the toxic chemical release scenarios identified~~. A probabilistic assessment was performed for the gasoline release, which could not be qualitatively screened. ~~is done for the two scenarios that were not qualitatively screened. It is found that the frequency of a gasoline truck accident or an ammonia tank spill is less than the screening criteria of 1E-06 per year.~~

For gasoline, a quantitative risk assessment was used in Section 2.2.3.1 to show that:

- The rate of exposure to a peak positive incident overpressure in excess of 1 psi is less than 1E-07 per year.
- The rate of exposure to a postulated vapor cloud at or above the 8-hour Time-Weighted Average (TWA) threshold value in the control room is approximately 2.66E-07 per year.

However, as shown in FSAR Table 2.2-10, gasoline has an 8-hour TWA threshold value of 300 ppm, a Short-Term Exposure Limit (STEL) of 500 ppm and a maximum control room concentration of 343 ppm. Given that the maximum control room concentration is less than the STEL and is approximately 15% greater than the 8-hour TWA, it is expected that a control room operator will take protective measures within 2 minutes (adequate time to don a respirator and protective clothing) after the detection and, therefore, will not be subjected to prolonged exposure at dangerous concentration levels. This meets the acceptance criteria of Regulatory Guide 1.78, therefore gasoline at CCNPP Units 1 & 2 has been screened from the PRA.

The DCPLNG terminal is located approximately 3.2 miles (5.1 km) away from the CCNPP Unit 3 site. Section 2.2.3.1.1 shows that the risk of an explosion resulting from a complete tank failure at the DCPLNG terminal would not adversely affect the safe operation of CCNPP Unit 3. The safe distance for exposure to a flash fire resulting from a total loss of the storage tanks is 1.0 mile (1.6 km), which is significantly less than the actual separation. Therefore, nearby facilities hazards have been screened from the PRA.

Based on the above evaluations, the risks posed by potential industrial and transportation accidents to the CCNPP Unit 3 site have been screened from the PRA ~~meet NUREG-0800 screening criteria~~.

19.1.5.4.6 Other External Events Risk Evaluation

This section is added as a supplement to the U.S. EPR FSAR.

Two types of external events from Table 19.1-1 are addressed in this section. These are turbine generated missiles and collisions with the UHS Makeup Water Intake Structure or UHS Electrical Building.

Turbine Missiles

NUREG-0800, Section 3.5.1.3 provides acceptance criteria for turbine missile hazard based on the frequency of a turbine failure resulting in the ejection of turbine rotor (or internal structure) fragments through the turbine casing. The acceptance criteria are 1E-04/year for favorably oriented turbines and 1E-05/yr for unfavorably oriented turbines. A favorable orientation is one that excludes the containment and all, or mostly all, safety-related structures, systems or components (SSCs) from the low trajectory missile (LTM) pathway. Meeting these criteria provides confidence that the frequency of unacceptable damage from turbine missiles is less than or equal to 1E-07/yr.

- <u>The design includes a favorably oriented turbine with respect to containment.</u> CCNPP Unit 3 is designed so that the probability of steam turbine failure resulting in ejection of turbine disk (or internal structure) fragments through the turbine casing shall be less than 1E-04/yr for a favorably oriented turbine and shall be less than 1E-05/yr for an unfavorably oriented turbine. The design includes a favorably oriented turbine with respect to containment. Detailed analyses and assessments show that the probability of turbine rotor failure resulting in ejection of the turbine rotor fragments through the turbine casing is less than 1E-04 for a favorable oriented turbine with respect to containment. Furthermore, reconciliation of minor energy turbine missiles for CCNPP Unit 3 shows that the potential missile effects on the Essential Service Water Buildings 3 and 4 (located directly adjacent to the Turbine Building in an unfavorable orientation) are consistent with RG 1.115 (NRC, 1977) in that the CCNPP Unit 3 design will ensure that minor missiles which could be ejected will not result in any damage to essential systems. Therefore, the risk to CCNPP Unit 3 from a turbine missile from the CCNPP Unit 3 turbine is within the NRC acceptance criteria as provided in NUREG-0800, Section 3.5.1.3.

- The threat to CCNPP Unit 3 from turbine missiles generated from CCNPP Units 1 and 2 was also considered. The CCNPP Unit 1 and Unit 2 turbines are unfavorably oriented to their respective safety-related buildings, and favorably oriented to the safety-related buildings of CCNPP Unit 3. The frequency of a turbine missile accident is found sufficiently low to screen SRP screening criteria for their own, unfavorably oriented safety-related buildings. Therefore, it can also be screened for the favorably oriented safety-related buildings of CCNPP Unit 3. Therefore, the threat to CCNPP Unit 3 from turbine missiles generated from CCNPP Unit 1 or Unit 2 turbines meets the acceptance criteria provided in NUREG-0800.

Therefore it is concluded that turbine missiles do not constitute a significant core damage risk to CCNPP Unit 3, and can be screened.

Collisions with UHS Makeup Water Intake Structure or UHS Electrical Building

CCNPP Unit 3 is located on a navigable waterway. The only safety-related structures located near the shore line are the UHS Makeup Water Intake Structure and UHS Electrical Building. These are safety-related structures located adjacent to the CWS Makeup Intake Structure. The UHS Makeup Water Intake Structure and the UHS Electrical Building for CCNPP Unit 3 are situated in an area that is set back from the Chesapeake Bay shoreline at the south end of the intake structure for CCNPP Units 1 and 2. Additionally, the portion of the Chesapeake Bay in the vicinity of the intake structure is sufficiently shallow that any vessel of significant size that could possibly cause damage to the intake structure would most likely run aground before it could impact the intake structure (Section 2.2.3.1.5). In the unlikely event of a collision involving the UHS Makeup Water Intake Structure or UHS Electrical Building, no initiating event would occur. If a plant trip were to occur (automatic or manual), the initial inventory of the four Essential Service Water Cooling Tower Structures would have adequate capacity for more than six days of heat removal assuming all four divisions are available. This would provide ample time to provide alternate means to supply the Essential Service Water Cooling Tower Structures. Makeup to the Essential Service Water Cooling Tower Structures is not credited in the PRA. Therefore, collisions with the UHS Makeup Water Intake Structure or UHS Electrical Building have been screened from the PRA.}

19.1.9 REFERENCES

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Question 19-23

The discussion of the tornado strike frequency calculation in CCNPP Unit 3 COLA, FSAR, Section 19.1.5.4.1, is not detailed enough for the staff to draw conclusions about the calculated frequency. Please describe in detail how the CCNPP Unit 3 site-specific tornado strike frequency of 6.1E-5/yr was derived.

Response

FSAR Section 19.1.5.4.1 provides the following summary of the tornado strike frequency calculation:

- NUREG/CR-4461 is used to determine the tornado strike frequency
- The tornado strike frequency is the sum of the point structure term and the life-line term
- The total strike probability is calculated for the local 2 degree box containing the CCNPP Unit 3 site, which is 37-39 degrees North, 76-78 degrees West
- The characteristic dimension used to calculate the plant-specific life-line term is the Turbine Building length of 300 feet
- The total strike probability is calculated for a wind speed greater than 95 mph

The derivation of the tornado strike probability is shown in details below. It should be noted that NUREG/CR-4461calculates the probability of at tornado strike in a year. For low numbers, the strike frequency per year is equal to the probability of a tornado strike in a year.

As shown in Section 4 of NUREG/CR-4461, the total strike probability for a tornado with a maximum wind speed higher than u_0 is the sum of two terms, as follows:

$$P(u \geq u_o) = P_p(u \geq u_o) + P_l(u \geq u_o)$$

P_p is the "point structure strike probability term". This represents the probability that a given point (e.g. the center of a structure) is struck by a tornado in a year.

P_l is the "life-line strike probability term". If a structure is large, the point structure approximation becomes inaccurate and this term is added to take into account the size of the structure.

u_0 is the minimum tornado wind speed used to calculate the strike probability. Here u_0=95mph.

The calculation of the point structure strike probability term is detailed in Section 4.1 of NUREG/CR-4461. The calculation of the life-line strike probability term is detailed in Section 4.2 of NUREG/CR-4461.

The combination of the two yields the following equation (Eq. 4.9 in NUREG/CR-4461)

$$P(u \geq u_o) = \frac{A_t}{NA_r} e^{-\left(\frac{u_o-65}{a_p}\right)^{b_p}} + \left(\frac{w_s L_t}{NA_r} e^{-\left(\frac{u_o-65}{a_l}\right)^{b_l}}\right)\frac{L}{L_0}$$

The significance of each factor in the above equation is explained in the relevant section of NUREG/CR-4461. NUREG/CR-4461 provides tabulated values for these factors, applicable to the Calvert Cliffs site.

(A_t/NA_r) is the point structure strike probability without regard to the tornado intensity. Its numerical value is obtained from NUREG/CR-4461 page A-15, for the 2 degree box described above.

(w_sL_t/NA_r) is the life-line strike probability without regard to the tornado intensity, assuming a characteristic dimension of 200 feet. Its numerical value is also obtained from NUREG/CR-4461 page A-15, for the 2 degree box described above.

a and b are the Weibull distribution terms. These are different for the point structure strike probability and the life-line strike probability and are taken from NUREG/CR-4461 page 5-1, Table 5-1, expected values for the "East" region.

As stated in NUREG/CR-4461 page A-1, if a strike probability is desired for a different size structure, the value should be adjusted by the ratio of the characteristic dimension for the structure to 200 feet.

L_o is the characteristic dimension assumed by NUREG/CR-4461 of 200 feet.

L is the characteristic dimension used for CCNPP Unit 3 of 300 feet, as stated above. 300 ft is selected as the approximate length of the turbine and switchgear buildings, which together constitute the target for the tornado scenario.

Entering this information into the equation for P results in

$$P(u \geq u_o) = 1.228 * 10^{-4} * e^{-\left(\frac{95-65}{24.63}\right)^{1.164}} + \left(3.686 * 10^{-5} * e^{-\left(\frac{95-65}{36.65}\right)^{1.507}}\right)\frac{300}{200}$$

=6.1E-05 per year.

COLA Impact

The COLA FSAR will not be revised as a result of this response.

Question 19-24

CCNPP Unit 3 COLA, FSAR, Table 19.1-1 states that "hurricane winds are bounded by the analysis in Section 19.1.5.4.1;" however, no discussion of the hurricane winds could be found in this section or elsewhere in the FSAR, Chapter 19. Therefore, please validate the above statement and also provide the frequencies and potential consequences of hurricanes at the CCNPP Unit 3 site.

Response

The design wind for CCNPP Unit 3 FSAR of 102 mph used in the analysis in Section 19.1.5.4.1 is determined using ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures, as proposed by NUREG-0800 Section 3.3.1, and includes consideration of hurricane winds. Therefore, the risk from hurricane winds is included in the assessment of risk from high winds in CCNPP Unit 3 FSAR.

The risk from high winds (including hurricane winds) is qualitatively screened out by showing that the U.S. EPR design wind speed of 145 mph bounds the CCNPP Unit 3 site specific wind speed.

In addition to the qualitative screening of high winds, a demonstrably conservative quantitative analysis has been performed specifically for tornadoes, in order to confirm the conclusions of the qualitative screening, i.e. that the risk posed by tornadoes to non-safety structures is acceptably small.

Such an analysis has not been performed for hurricanes. However, the conclusion that the hazard from high winds can be qualitatively screened is supported by the following:

- Based on the U.S. EPR design as described in the U.S. EPR FSAR, a high wind event will not adversely impact safety-related equipment. This includes the four independent Emergency Diesel Generators (EDGs), which would remain available following a high-wind induced loss of offsite power (LOOP).
- Based on the empirical definition of the Saffir-Simpson hurricane scale, only an extreme hurricane (Category 5) would have the potential to inflict damage on an industrial structure such as the U.S. EPR non-safety structures. Most hurricanes would only result in a loss of offsite power (LOOP), and their frequency of occurrence is included in the weather-related LOOP frequency.
- The only non-safety structure which contains equipment credited in the PRA following a LOOP is the switchgear building. In particular the SBO diesel generators, which provide backup to the EDGs, are located in the Switchgear Building. The Switchgear Building consists of a structural steel frame and a reinforced concrete basemat.

The preceding discussion supports the conclusion that the risk from high winds, including hurricanes, can be screened for CCNPP Unit 3.

COLA Impact

The COLA FSAR will not be revised as a result of this response.