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UniStar NUCLEAR ENERGY

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

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Toxic-Flammable Explosive Transport Hazards in Calvert Cliffs Units 1 & 2
Impact on Calvert Cliffs Nuclear Power Plant, Unit 3

The purpose of this letter is to provide additional information regarding the impact of the Toxic-Flammable Explosive Transport Hazards in Calvert Cliffs Units 1 & 2 on Calvert Cliffs Nuclear Power Plant, Unit 3, as discussed in Section 2.2 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 9.

UniStar Nuclear Energy (UNE) identified that there are additional Calvert Cliffs Units 1 & 2 chemical hazard materials transported/stored, which required evaluation for impact on the CCNPP Unit 3 chemical hazards analysis. This condition was entered into the UNE corrective action program for disposition. Corrective action included identifying the additional chemical hazard materials and identifying the COLA impact of the additional information.

Enclosure 1 provides the COLA impact of the additional information to the Toxic-Flammable Explosive Transport Hazards in Calvert Cliffs Units 1 & 2 on Calvert Cliffs Nuclear Power Plant, Unit 3. This additional information resulted in no impact on the control room habitability analysis. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA.

Enclosure 2 provides a table of changes to the CCNPP Unit 3 COLA associated with this additional information.

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

If there are any questions regarding this transmittal, please contact me at (410) 369-1907 or Mr. Wayne A. Massie at (410) 369-1910.

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

Executed on July 19, 2013

FOR

Mark T. Finley

Enclosures: 1) Changes to CCNPP Unit 3 COLA Associated with the Impact of the Toxic-Flammable Explosive Transport Hazards in Calvert Cliffs Units 1 & 2 on Calvert Cliffs Nuclear Power Plant, Unit 3

2) Table of Changes to CCNPP Unit 3 COLA Associated with the Impact of the Toxic-Flammable Explosive Transport Hazards in Calvert Cliffs Units 1 & 2 on Calvert Cliffs Nuclear Power Plant, Unit 3

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UN#13-096

Enclosure 1

Changes to CCNPP Unit 3 COLA
Associated with the Impact of the Toxic-Flammable Explosive
Transport Hazards in Calvert Cliffs Units 1 & 2 on
Calvert Cliffs Nuclear Power Plant, Unit 3

clouds (delayed ignition), toxic chemicals, fires, collisions with intake structure, liquid spills, and radiological hazards. The postulated accidents that would result in a chemical release were analyzed at the following locations:

- Nearby transportation routes MD 2/4, the Chesapeake Bay navigable waterway, and DCPLNG Pipeline
- Nearby chemical and fuel storage facilities (DCPLNG)
- Onsite chemical storage (CCNPP Units 1, 2, and 3)

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With regard to the DCPLNG facility and Dominion Cove Point LNG pipeline, the Maryland Power Plant Research Program (PPRP) commissioned an independent risk study (i.e., hazard study), "Cove Point LNG Terminal Expansion Risk Study," to assess the risks associated with the expansion of the DCPLNG facility and associated pipeline to nearby residential communities and the CCNPP site.

The probability of occurrence of a fatality at CCNPP from hazardous events associated with the existing DCPLNG facility is estimated to be 2.3E-9 per year. The probability of occurrence of physical damage to CCNPP is estimated to be lower still. Further, the probability of occurrence for a fatality involving the proposed expansion of the DCPLNG facility is estimated to be 6.6E-9 per year at CCNPP, with the risk of physical damage to the CCNPP estimated to be even smaller (MDNR, 2006).

The quantified risks to CCNPP presented in the PPRP study are below the threshold of acceptable risks defined by the U.S. Nuclear Regulatory Commission (i.e., less than 1E-7 per year). Where more specific analyses are available for individual accident categories than are provided in the PPRP study (e.g., jet fire, flash fire), those results will be presented in the following sections.

2.2.3.1.1 Explosions

Accidents involving detonations of high explosives, munitions, chemicals, or liquid and gaseous fuels were considered for facilities and activities in the vicinity of the plant or onsite, where such materials are processed, stored, used, or transported in quantity. The effects of explosions are a concern in analyzing structural response to blast pressures. The effects of blast pressure from explosions from nearby railways, highways, navigable waterways, or facilities to critical plant structures were evaluated to determine if the explosion would have an adverse effect on plant operation or would prevent a safe shutdown.

The allowable and actual distances of hazardous chemicals transported or stored were determined in accordance with NRC Regulatory Guide 1.91, Revision 1, Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants (NRC, 1978a). Regulatory Guide 1.91 cites 1 psi (6.9 kPa) as a conservative value of peak positive incident overpressure, below which no significant damage would be expected. Regulatory Guide 1.91 defines this safe distance by the relationship $R \geq kW^{1/3}$ where R is the distance in feet from an exploding charge of W pounds of TNT; and the value k is a constant. The TNT mass equivalent, W, was determined following guidance in NUREG-1805 (NRC, 2004a), where $W=M_{Vapor} * \Delta H_C * Y_f/2000$ and M_{Vapor} is the flammable vapor mass, ΔH_C is the heat of combustion and Y_f is the explosion yield factor.

Conservative assumptions were used to determine a safe distance, or minimum separation distance, required for an explosion to have less than 1 psi (6.9 kPa) peak incident pressure. In

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each of the explosion scenario analyses, an explosion yield factor of 100 percent was applied to account for an in-vessel confined explosion. The yield factor is an estimation of the available combustion energy released during the explosion as well as a measure of the explosion confinement (NRC, 2004a). This is a conservative assumption because a 100 percent yield factor is not achievable (FMIC, 2005):

- For atmospheric liquids (i.e., gasoline, toluene, etc.) the storage vessel was assumed to contain the quantity of fuel vapors in air at the upper explosive limit. This is conservative because this scenario produces the maximum flammable mass given that it is the fuel vapor, not the liquid fuel that explodes (NRC, 2004a). These assumptions are consistent with those used in Chapter 15 of NUREG-1805 (NRC, 2004a).

- For compressed or liquefied gases (i.e., propane, hydrogen), it was conservatively assumed that the entire content of the storage vessel will be between the upper and lower explosive limits, given that the instantaneous depressurization of the vessel would result in vapor concentrations throughout the explosive range at varying pressures and temperatures that could not be assumed. Therefore, the entire content of the storage vessel was considered as the flammable mass.

The onsite chemicals (Table 2.2-5), hazardous materials potentially transported on (MD) 2/4 (Table 2.2-6), and hazardous materials transported on navigable waterways (Table 2.2-7) were evaluated to ascertain which hazardous materials had the potential to explode, thereby requiring further analysis. The effects of selected explosion events from internal and external sources are summarized in Table 2.2-8 and in the following sections relative to the release source.

Pipelines

The DCPLNG facility operates a pipeline corridor that passes with in the vicinity of the CCNPP site. Section 2.2.3 addresses the overall risk from the OCPLNG facility and pipeline. Experiments have indicated that detonations of mixtures of methane (greater than 85%) with air do not present a credible outdoor explosion event. (FMIC, 2005) Further, there have been no reported vapor cloud explosions involving natural gas with high methane content-there have been numerous reports of vapor clouds igniting resulting in flash fires without overpressures. (FMIC, 2005) Therefore, an outdoor natural gas explosion resulting from a ruptured gas pipeline is considered an unlikely event. Thus, the ignition of a natural gas cloud within a confined or congested space, such as woodlands, which may produce damaging explosion overpressures, was considered the bounding event and is presented in Section 2.2.3.1.2. Therefore, it was concluded that damaging overpressures from an explosion from a rupture in the DCPLNG pipeline would not adversely affect the operations of CCNPP Unit 3.

Waterway Traffic

The nearest safety related structure for CCNPP Unit 3, which is the Ultimate Heat Sink makeup intake structure, is located approximately 11,678 ft (3.6 km) at its closest distance to potential waterway traffic. This assumption is very conservative, as it is more likely that waterway traffic will be traveling toward the center of the channel where it is deeper (approximately 3 mi (4.8 km) from CCNPP Unit 3). The hazardous materials transported on barges or chemical parcel tankers that were identified for further analysis with regard to explosion potential were gasoline, benzene, and toluene. Anhydrous ammonia was not included as a point source hazard because ammonia is extremely hard to ignite. Studies have demonstrated that an ammonia-air mixture does not ignite at less than 1562 °F (ANSI, 1989). The U.S. Coast Guard

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designates anhydrous ammonia as "not flammable under conditions likely to be encountered" (USCG, 2006).

The maximum quantity of gasoline, benzene, and toluene assumed to be carried on a vessel was 5.2 million pounds (2.4 million kg) (CRS, 2005). Using the conservative methodology described in Section 2.2.3.1 (i.e, greater than 1 psi (6.9 kPa) peak incident pressure), the nearest safety-related CCNPP Unit 3 structure (i.e., Ultimate Heat Sink makeup intake structure) to a point on the navigable waterway where potential waterway traffic may pass is outside of the minimum separation distance (i.e., safe distance) where peak incident pressures may be assumed to result in damage to structures.

Therefore, an explosion from any of the identified chemicals potentially transported on navigable waters in the Chesapeake Bay, would not adversely affect the safe operation of CCNPP Unit 3. The minimum separation distance for gasoline is 1,222 ft (372 m); for benzene 1,076 ft (328 m); and for toluene, 1,072 ft (327 m) (Table 2.2-8).

Highways

Table 2.2-6 details the hazardous materials potentially transported on MD 2/4 (RAND, 2003) (BGE, 2006). The materials that were identified for further analysis for explosion potential were: gasoline, gasoline (aviation), and liquid propane. The maximum quantity of the identified chemicals assumed to be transported on the roadway was 50,000 pounds (22,680 kg).

An analysis of the identified chemicals was conducted using TNT equivalency methodologies, as described in Section 2.2.3.1.1. The results indicate that the minimum separation distances (i.e., safe distances) are less than the shortest distance to a safety-related CCNPP Unit 3 structure from any point on MD 2/4. The closest safety-related CCNPP Unit 3 structure is located approximately 6,119 ft (1.9 km) from MD 2/4. The minimum separation distance for gasoline was calculated to be 263 ft (80.1 m); for aviation gasoline 260 ft (79.2 m); and for liquid propane, 3,559 ft (1.1 km). (Table 2.2-8). Therefore, an explosion involving potentially transported hazardous materials on MD 2/4, would not adversely affect operation of CCNPP Unit 3.

Onsite Chemicals

acetone, acetylene

The hazardous materials stored onsite that were identified for further analysis with regard to explosion potential were: gasoline, hydrazine (35% solution), dimethylamine (2% solution), and hydrogen stored at Units 1 & 2. One of the water treatment chemicals, a non-oxidizing biocide containing ethanol, and gas cylinders containing argon-methane, hydrogen, and oxygen stored near Unit 3 were also analyzed for explosion potential.

The 4,000 gallon (15,140 L) onsite gasoline tank is an underground storage tank. Therefore, it was assumed that the explosion would be bounded by an event involving a 3,500 gallon (13,250 l) gasoline delivery tanker, either in route, or during or following a filling operation. A conservative analysis using TNT equivalency methods as described in Section 2.2.3.1 was used to determine safe distances for the storage of the identified hazardous materials.

Oxygen is not explosive by ignition, however gas cylinders have the potential for explosion due to overpressure. Therefore, the equivalent mass of TNT from oxygen was calculated using this methodology (NRC, 1985).

for the evaluated hazardous materials, with the exception of acetylene,

The results using this methodology indicate that the minimum separation distances (i.e., safe distances) are less than the shortest distance to ~~a~~ safety-related CCNPP Unit 3 structures and

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the storage location of any of the identified chemicals. ~~Therefore, an explosion from any of the onsite hazardous materials evaluated would not adversely affect operation of CCNPP Unit 3.~~ The safe distance for gasoline is 196 ft (60 m); for hydrazine (35% solution), 114 ft (35 m); for dimethylamine (2% solution), 85 ft (26 m); for hydrogen, ~~224 ft (68 m)~~. Gasoline is stored approximately 310 ft (94 m); hydrazine (35% solution) approximately 891 ft (272 m); dimethylamine (2% solution) approximately 462 ft (141 m); and hydrogen 745 ft (227 m); from the nearest safety-related structure for CCNPP Unit 3 (Table 2.2-8). The non-oxidizing biocide containing ethanol and the argon-methane gas, hydrogen gas, and oxygen gas cylinders are stored at distances greater than those reported in Table 2.2-8.

441 ft (135 m) for acetone, 20 ft (6 m); for acetylene, 1,246 ft (380 m); for oxygen, 103 ft (32 m); and acetone approximately 1,052 ft (321 m); acetylene approximately 1,052 ft (321 m); oxygen approximately 1,052 ft (321 m);

Nearby Facilities

See Insert F for FSAR 2.2.3.1.1

The Dominion Cove Point Liquefied Natural Gas (DCPLNG) facility operates within the vicinity of the CCNPP site. As described in Section 2.2.2.4.2 the DCPLNG facility is bounded for explosions by the LNG pipeline. Furthermore, Section 2.2.3 addresses the overall risk from the DCPLNG facility. Blast overpressure impacts were taken into account in developing the risk analysis. Damaging overpressures from an explosion resulting from a complete tank failure at the DCPLNG facility would not adversely affect the operations of CCNPP Unit 3 (MDNR, 2006).

Explosion Related Impacts Affecting the U.S. EPR Design

The U.S. EPR design is acceptable for any site when reasonable qualitative arguments can demonstrate that the realistic probability of severe consequences from any external accident is less than 1E-6 per year. Regulatory Guide 1.91 (NRC, 1978a) cites 1 psi (6.9 kPa) as a conservative value of peak positive incident overpressure, below which no significant damage would be expected. Safety-related CCNPP Unit 3 structures are designed to withstand a peak positive overpressure of at least 1 psi without loss of function.

The analyses presented in this section demonstrate that a 1 psi (6.9 kPa) peak positive overpressure will not be exceeded at a safety-related structure for any of the postulated explosion event scenarios. As a result, postulated explosion event scenarios will not result in severe consequences.

2.2.3.1.2 Flammable Vapor Clouds (Delayed Ignition)

Flammable gases in the liquid or gaseous state can form an unconfined vapor cloud that could drift toward the plant before ignition occurs. When a flammable chemical is released into the atmosphere and forms a vapor cloud it disperses as it travels downwind. The parts of the cloud where the concentration is within the flammable range, between the lower and upper flammability limits, may burn if the cloud encounters an ignition source. The speed at which the flame front moves through the cloud determines whether it is a deflagration or a detonation. If the cloud burns fast enough to create a detonation an explosive force is generated.

The potential onsite chemicals are shown in Table 2.2-5. Hazardous materials potentially transported on MD 2/4 are shown on Table 2.2-6, and hazardous materials transported on navigable waterways are shown on Table 2.2-7. These chemicals were evaluated to ascertain which hazardous materials had the potential to form a flammable vapor cloud or vapor cloud explosion. For those chemicals with an identified flammability range, the Areal Locations of Hazardous Atmospheres (ALOHA) air dispersion model was used to determine the distances where the vapor cloud may exist between the upper flammability limit (UFL) and the lower flammability limit (LFL), presenting the possibility of ignition and potential thermal radiation effects (ALOHA, 2007).

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Insert F for FSAR Section 2.2.3.1.1

The evaluation of the explosion events was performed for each of the identified chemicals to determine if the safe distances meet the guidance established in Regulatory Guide 1.91 (NRC, 1978a) and if any qualified as a design-basis event; that is, an accident that has a probability of occurrence on the order of magnitude of 1E-07 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. The expected rate of occurrence for exceeding the guidelines in 10 CFR Part 100 (on the order of magnitude of 1E-06 per year) is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower. As described above, the distance to 1 psi for an acetylene tank explosion exceeds the distance to the nearest safety-related structure. The frequency of a catastrophic failure of a gas cylinder is 1E-06 per year (Purple Book, 2005). There is considerable conservatism in this failure rate, as follows:

- The acetylene tank is stored in a confinement cage inside the Unit 1/2 warehouse building.
- The failure rate assumes instantaneous release of the total tank quantity.
- The failure rate does not account for the frequency of detonation or mass involved in the explosion after release. That is, 1E-06 failure frequency reflects the instantaneous release of the entire contents of the tank without accounting for detonation or mass involved in the detonation; it assumes that for each release, the total contents of the vessel are released, a detonation occurs, and the total vapor mass is involved in the explosion (100% yield factor, which is not achievable (FMIC, 2005)).

Therefore, an acetylene explosion inside the Unit 1/2 warehouse does not qualify as a design-basis event for CCNPP Unit 3, and an explosion would not adversely affect the safe operation of Unit 3.

The results of flammable vapor cloud ignition and explosion analyses are summarized in Table 2.2-9.

acetone, acetylene,

Onsite Chemicals

The hazardous materials stored at the CCNPP Units 1 and 2 site that were identified for further analysis with regard to the potential of delayed ignition and explosion of flammable vapor clouds were: gasoline; hydrazine (35% solution); dimethylamine (2% solution); and hydrogen. One of the water treatment chemicals, a non-oxidizing biocide containing ethanol, and argon-methane and hydrogen gas cylinders stored at Unit 3 were identified for further analysis.

As described previously in Section 2.2.3.1.2, the ALOHA dispersion model was used to determine the distance a vapor cloud can travel before reaching the LFL boundary (i.e., the safe distance for exposure to thermal radiation heat flux) once a vapor cloud has formed from release of the identified chemical. The distances to the LFL boundary from the release point for the identified chemicals are: gasoline, 234 ft (71 m); hydrazine (35% solution), less than 33 ft (10 m); dimethylamine (2% solution), 45 ft (14 m); hydrogen; 492 ft (150 m); argon-methane gas cylinder 69 ft (21 m); and hydrogen gas cylinder 75 ft (23 m). Each of these distances is less than the distance from a potential release site to the nearest safety-related CCNPP Unit 3 structure. The non-oxidizing biocide containing ethanol and the argon-methane gas and hydrogen gas cylinders are stored at distances greater than those reported in Table 2.2-9.

acetone, 33 ft (10 m); acetylene, 411 feet (126 m);

A vapor cloud explosion analysis was also performed using the methodology described in Section 2.2.3.1.2 to obtain minimum separation distances (i.e., safe distances) for the identified chemicals. With the exception of a postulated release from a gasoline tanker, the results indicate that the minimum separation distance (i.e., the distance required for an explosion to have less than a 1 psi (6.9 kPa) peak incident pressure) are less than the shortest distance to a safety-related CCNPP Unit 3 structure from the storage location of these chemicals.

The minimum separation distance for the 3,500 gallon (13,250 l) gasoline tank truck is 648 ft (198 m). Minimum separation distance for other identified chemicals are: hydrazine (35% solution), N/A (no explosion can occur at resulting concentrations); dimethylamine (2% solution), 180 ft (55 m); hydrogen, 738 ft (225 m); argon-methane gas cylinder 126 ft (38 m); hydrogen gas cylinder 138 ft (42 m). Except for gasoline, each of these chemicals is stored further away from CCNPP Unit 3 than the minimum separation distance. The filling operation for gasoline occurs approximately 310 ft (95 m) from the nearest safety-related CCNPP Unit 3 structure, which is the Ultimate Heat Sink. The storage of other identified chemicals stored at CCNPP Units 1 and 2 relative to the nearest safety related CCNPP Unit 3 structure, which is the Ultimate Heat Sink makeup intake structure, are: hydrazine, approximately 891 ft (272 m); dimethylamine (2% solution), 462 ft; and hydrogen, 745 ft (227 m).

; acetone, 114 ft (35 m) and acetylene, 828 ft (253 m).

The evaluation of the vapor cloud explosion events was performed for each of the identified chemicals to determine if the safe distances meet the guidance established in Regulatory Guide 1.91 (NRC, 1978a) and if any qualified as a design-basis event; that is, an accident that has a probability of occurrence on the order of magnitude of 1E-07 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. The expected rate of occurrence for exceeding the guidelines in 10 CFR Part 100 (on the order of magnitude of 1E-06 per year) is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

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Flammable Vapor Cloud (Delayed Ignition) Related Impacts Affecting the U.S. EPR Design

The U.S. EPR design is acceptable for any site when reasonable qualitative arguments can demonstrate that the realistic probability of severe consequences from any external accident is less than 1E-6 occurrences per year. Regulatory Guide 1.91 (NRC, 1978a) cites 1 psi (6.9 kPa) as a conservative value of peak positive incident overpressure, below which no significant damage would be expected. Safety-related CCNPP Unit 3 structures are designed to withstand a peak positive overpressure of at least 1 psi without loss of function.

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The analyses presented in this section demonstrate that a 1 psi (6.9 kPa) peak positive overpressure will not be exceeded at a safety-related structure for any of the postulated flammable vapor cloud, delayed ignition event scenarios, except for gasoline. For the vapor cloud, delayed ignition event involving gasoline, it was demonstrated that the event probability is less than 1E-6. As a result, each of the postulated vapor cloud, delayed ignition event scenarios has been demonstrated to either not result in severe consequences, or to have an event frequency that is less than 1E-6 per year.

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 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, the maximum distance a postulated vapor cloud would travel before 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 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,

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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. Regulatory Guide 1.78 also provides a screening criteria for mobile sources, which defines shipments of more than 50 per year within a 5 mi (8 km) radius of a nuclear power plant as being frequent for barge traffic.

Release events involving mobile sources that do not meet this criteria (i.e., 50 or fewer shipments annually, and therefore not frequent) are not required to be evaluated for control room habitability. This frequency is based on transportation accident statistics and conditional spill probability given an accident. 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 (NRC, 2001).

Therefore, the ammonia spill event does not qualify as a design-basis event for CCNPP Unit 3, and toxic vapor clouds formed from the chemicals analyzed would not adversely affect the safe operation of 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:

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gasoline; ammonium hydroxide (28% solution); sodium hypochlorite; hydrazine (35% solution); monoethanolamine; dimethylamine (2% solution); hydrochloric acid (30% solution); carbon dioxide; 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.

; liquid nitrogen (asphyxiant); acetone, acetylene (asphyxiant) and oxygen (oxygen-enriched atmosphere).

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. The worst case release scenario in these analysis included either a total loss of the largest vessel into an unconfined puddle or direct release over 10 minutes under determined worst case meterological conditions.

, liquid nitrogen and acetylene

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 and 80.9 ppm for acetylene), 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 the 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).

Additionally, oxygen is analyzed for its potential to create an oxygen-enriched environment (23.5% as defined by OSHA). It was determined that the concentration in the CCNPP Unit 3 control room after an oxygen release (23.4 ppm) from the warehouse would not create an oxygen-enriched atmosphere.

For each toxic chemical evaluated, with the exception of 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 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):

- Pasquill Stability Class F selected to represent the most limiting 5% of meteorological conditions observed.

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Table 2.2-2— {CCNPP Units 1, 2 and 3 Onsite Chemical Storage}

(Page 1 of 3)

Material	Toxicity Limit (IDLH)	Quantity	Largest Container	Location	Shipping Mode	Annual Frequency
CCNPP Units 1 and 2						
Ammonium Hydroxide (~~28%~~ 19.5% solution)	300 ppm as Ammonia	8500 gal (32,000 l)	8,500 gal (32,000 l)	Tank Farm	Ground	1/year
Boric Acid	None established	~~40,000 lbs (18,000 kg)~~ 90,000 lbs (40,820 kg)	~~450 lb drum (200 kg)~~ 50 lb bag (23 kg)	Warehouse and 27 foot Aux. Bldg.	Ground	2/year
Number 2 Diesel Fuel	None established	350,000 gal (1.3E6 l)	125,000 gal (4.7E5 l)	Transportation Shop, 11, 21 & 1A FOST	Ground	6/year
Gasoline	300 ppm (TWA)/ 500 ppm (STEL)	4,000 gal (15,000 l)	4,000 gal (15,000 l) / 3,500 gal (13,000 l) tank truck (see Note 1)	Transportation Shop	Ground	Monthly
Towerbrom microbicide	None established	8,000 lbs (3600 kg)	(will no longer use)	Waterfront	Ground	2/year
Sodium Hypochlorite	10 ppm for chlorine	500 gal (1900 l)/ 8,500 gal (38,600 l)	8,500 gal (38,600 l)	Intake Building, OTF Well water house & 12 foot NSB	Ground	4/year
Hydrazine (35% solution)	50 ppm	3,000 gal (11,000 l)	350 gal (1300 l) totes	Warehouse and 12 foot NSB	Ground	4/year
Lubricating Oil	None established	~~30,000 gal (110,000 l)~~ 63,000 gal (238,500 l)	~~10,000 gal (38,000 l)~~ 3,000 gal (11,400 l)	Tank Farm, ~~Turbine Bldg., and Warehouse~~ Emergency Diesel Generators	Ground	12/year
Liquid Nitrogen	Asphyxiant	11,300 gal (42,800 l)	11,300 gal (42,800 l)	Tank Farm	Ground	2/year
Mineral Oil	2,500 mg/m^3	~~150,000 gal (570,000 l)~~ 216,331 gal (818,900 l)	~~19,300 gal (73,000 l)~~ 8,000 gal (30,300 l)	Main Transformers	Ground	1/year
Polychlorinated Biphenyl (PCB) Oil	5 mg/m^3 (NIOSH)	4,700 gal (18,000 l)	336 gal (1270 l)	Switchgear rooms & 27 ft NSB Mezzanine	Ground	1/year
Sodium Hydroxide (50% solution)	None established	~~26,000 gal (98,000 l)~~ 11,000 gal (41,700 l)	~~26,000 gal (98,000 l)~~ 5,000 gal (19,000 l)	12 foot NSB	Ground	2/year
Sulfuric Acid (98% solution)	15 mg/m^3	12,000 gal (45,000 l)	12,000 gal (45,000 l)	Tank Farm	Ground	2/year
Fyrquel EHC fluid	1000 mg/m^3 as Triphenyl Phosphate	1,700 gal (6400 l)	800 gal (3000 l)	Turbine Bldg. & Warehouse	Ground	1/year
Sodium Thiosulfate	None established	2,000 lbs (900 kg)	50 lb (23 kg) bags	STP	Ground	2/year
Aluminum Sulfate	None established	2,000 lbs (900 kg)	50 lb (23 kg) bags	STP	Ground	2/year
Monoethanolamine	30 ppm	350 gal (1300 l)	350 gal (1300 l)	12 foot NSB	Ground	3/year
Dimethylamine (2% solution)	500 ppm	350 gal (1300 l)	350 gal (1300 l)	12 foot NSB	Ground	2/year
Hydrogen	None established	460 cu ft (13 cu m)	460 cu ft (13 cu m)	Tank Farm	Ground	8-10/year

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Table 2.2-2— {CCNPP Units 1, 2 and 3 Onsite Chemical Storage}
(Page 2 of 3)

Material	Toxicity Limit (IDLH)	Quantity	Largest Container	Location	Shipping Mode	Annual Frequency
Carbon Dioxide	40,000 ppm	8,000 lbs (3,629 kg)	8,000 lbs (3,629 kg)/ 50,000 lb (22,680 kg) delivery truck (Note 4)	12 foot Turbine Bldg.	Ground	1-4/year
Soda Ash (Sodium Carbonate)	None established	2,000 lbs (907 kg)	50 lb (23 kg) bags	STP	Ground	2/year
Hydrochloric Acid	50 ppm	5,000 gal (19,000 l)	3,000 gal (11,000 l)	Tank Farm	Ground	4/year
CCNPP Unit 3						
Argon (gas cylinder)	Asphyxiant	270 scf (7.65 Nm^3) (see Note 2)	1.76 cu ft cylinders (see Note 2)	Central Gas Supply Systems Building	N/A (see Note 3)	N/A (see Note 3)
Argon-Methane (gas cylinder)	Asphyxiant	282 scf (7.99 Nm^3) (see Note 2)	1.76 cu ft cylinders (see Note 2)	Central Gas Supply Systems Building	N/A (see Note 3)	N/A (see Note 3)
Hydrogen (gas cylinder)	Asphyxiant	278 scf (7.87 Nm^3) (see Note 2)	1.76 cu ft cylinders (see Note 2)	Central Gas Supply Systems Building	N/A (see Note 3)	N/A (see Note 3)
Nitrogen (gas cylinder)	Asphyxiant	235 scf (6.65 Nm^3) (see Note 2)	1.76 cu ft cylinders (see Note 2)	Central Gas Supply Systems Building	N/A (see Note 3)	N/A (see Note 3)
Oxygen (gas cylinder)	Asphyxiant	282 scf (7.99 Nm^3) (see Note 2)	1.76 cu ft cylinders (see Note 2)	Central Gas Supply Systems Building	N/A (see Note 3)	N/A (see Note 3)
Sodium Hypochlorite	10 ppm as Cl_2	20,000 gal (75,700 l) Plant Intake / 40,000 gal (151,400 l) CW / (2) 2,000 gal (7,600 l) UHS	40,000 gal (15,000 l)	CW Cooling Tower	N/A (see Note 3)	N/A (see Note 3)
Sulfuric Acid	15 mg/m^3	25,000 gal (94,600 l) CW / 7,500 gal (28,400 l) Desalination Building	25,000 gal (94,600 l)	CW Cooling Tower	N/A (see Note 3)	N/A (see Note 3)
Sodium Bisulfite	5 mg/m^3 (TLV-TWA)	5,000 gal (18,900 l) CW / (2) 350 gal (1,300 l) UHS / 1,000 gal (3,800 l) Desalination Building	5,000 gal (18,900 l)	CW Cooling Tower	N/A (see Note 3)	N/A (see Note 3)
Scale Inhibitor / Dispersant (2-Phosphono-1,2,4-butane tricarboxylic acid)	None established	10,000 gal (37,900 l) CW / (2) 350 gal (1,300 l) UHS	10,000 gal (38,000 l)	CW Cooling Tower	N/A (see Note 3)	N/A (see Note 3)

Insert A for FSAR Table 2.2-2.

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Material	Toxicity Limit (IDLH)	Quantity	Largest Container	Location	Shipping Mode	Annual Frequency
Acetone	2,500 ppm	5 gal (19 l)	1 liter	Warehouse and Lab	Ground	1/year
Acetylene	Asphyxiant	30,740 cu ft (870 cu m)	30,740 cu ft (870 cu m)	Warehouse and Plant Locations	Ground	4/year
AquaWorks Cleaning Solution	None established	55 gal (208 l)	30 gal (114 l)	Warehouse and Maintenance	Ground	Rare
Freon/ Refrigerants	15,000 ppm	6,900 lbs (3130 kg)	20 lbs (9 kg)	Warehouse, Office area, and plant	Ground	Varies
Halon	40,000 ppm	18,000 lbs (8165 kg)	300 lbs (136 kg) interconnected	Switchgear and Cable Spreading Rooms, 27' Deck	Ground	Rare
Hydraulic Oil	None established	800 gal (3028 l)	55 gal (208 l)	12' NSB Deck	Ground	Varies
Hydrogen Peroxide	75 ppm	300 gal (1136 l)	300 gal (1136 l)	GE Trailers, Aux Building	Ground	4/year
Oxygen	Oxygen-enriched	4,472 cu ft (127 cu m)	4,472 cu ft (127 cu m)	Warehouse and Plant Locations	Ground	4/year

Table 2.2-5— {Onsite Chemicals Disposition}
(Page 2 of 3)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Dimethylamine (2% solution)	500 ppm	2.8-14.4%	May explode	37.21 psi @ 85°F/ 257 kPa @ 29.4°C	Toxicity Analysis Flammability Analysis Explosion Analysis
Hydrogen	None estab.	4.0-75%	Vapor may explode	29.030 @ -418°F/ 200 kPa @ -250°F	Toxicity-consider as asphyxiant Flammability Analysis Explosion Analysis
Carbon Dioxide	40,000 ppm	Not flammable	None listed	833 psi @ 68°F 5,743 kPa @ 20°C	Toxicity Analysis
Soda Ash (Sodium Carbonate)	None estab.	Not flammable	None listed	N/A-solid	No further analysis required
Hydrochloric Acid	50 ppm	Not flammable	None listed	7.929 psi @ 100°F/ 54.7 kPa @ 37.8°C	Toxicity Analysis
CCNPP Unit 3					
Argon	None estab.	Not flammable	None listed	Not available	Toxicity-consider as asphyxiant
Argon-Methane (considered as methane)	None estab.	5-15%	May explode	31.580 psi @ 240°F/ 217 kPa @ 115.5°C	Toxicity-consider as asphyxiant Flammability Analysis Explosion Analysis
Hydrogen	None estab.	4.0-75%	Vapor may explode	29.030 @ 418°F/ 200 kPa @ 214°C	Toxicity-consider as asphyxiant Flammability Analysis Explosion Analysis
Nitrogen gas	None estab.	Not flammable	None listed	65.820 psi @ 294°F/ 453.8 kPa @ 145.5°C	Toxicity-consider as asphyxiant
Oxygen	None estab.	Not flammable	May explode	36.260 psi @ 280°F/ 250 kPa @ 137.8°C	Explosion Analysis
Sodium Hypochlorite	10 ppm as Cl_2	Not flammable	None listed	17.5 mmHg @ 68F	The 20,000 gallon tank located at the plant intake is bounded by the 40,000 gallon tank located at the CW Tower (The 20,000 gallon tank is further away from the control room HVAC intakes.)
Sulfuric Acid	15 mg/m^3	Not flammable	None listed	0.001 mmHg @ 68F	No further analysis required-low vapor pressure (Note 1)
Sodium Bisulfite	5 mg/m^3 (TLV-TWA)	Not flammable	None listed	N/A-solid in a solution	No further analysis required.

Insert B for FSAR Table 2.2-5.

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Insert B for FSAR Table 2.2-5

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Acetone	2500 ppm	2.5 % - 12.8%	Vapor may explode	180 mm Hg @ 68 °F	Flammability Analysis Explosion analysis (Note 2)
Acetylene	Asphyxiant	2.5% - 100%	Vapor may explode	33,592 mm Hg @ 68 °F	Toxicity – Considered as asphyxiant Flammability Analysis Explosion Analysis
AquaWorks Cleaning Solution	None established	Not flammable	None listed	Not available	No further analysis required
Freon/ Refrigerants	15,000 ppm	Not flammable	None listed	4,332 mm Hg @ 68 °F	No further analysis required (Note 2)
Halon	40,000 ppm	Not flammable	None listed	> 760 mm Hg @68 °F	No further analysis required (Note 3)
Hydraulic Oil	None established	Not flammable	None listed	7 mm Hg @ 20 °C	No further analysis required (Note 1)
Hydrogen Peroxide	75 ppm	Not flammable	None listed	5 mm Hg @ 86 °F	No further analysis required (Note 1)
Oxygen	Oxygen-enriched	Not flammable	None listed	1,875 mm Hg @ -280 °F	Toxicity Analysis (oxygen-enriched atmosphere) Explosion Analysis

Table 2.2-5— {Onsite Chemicals Disposition}
(Page 3 of 3)

Material	Toxicity Limit (IDLH)	Flammability	Explosion Hazard?	Vapor Pressure	Disposition
Scale Inhibitor /Dispersant (2-Phosphono-1,2,4-butane tricarboxylic acid)	None estab.	Not flammable	None listed	N/A-solid in a solution	No further analysis required.
Non-Oxidizing Biocide (ethanol)	3,300 ppm as ethanol	3.3-19%	Vapor may explode	44 mmHg @ 68F	Toxicity Analysis Flammability Analysis Explosion Analysis
Antiscalant (Sodium Hexametaphosphate)	None estab.	Not flammable	None listed	N/A-solid in a solution	No further analysis required.

TLV-TWA: Threshold Limit Value-Time-Weighted Average

STEL: Short term exposure limit

IDLH: Immediately Dangerous to Life and Health threshold value

Chemical information was obtained from the CHRIS on-line manual (USCG, 2006), except for Fyrquel EHC (Supresta, 2006), Towerbrom (Occidental, 2003), Polychlorinated Biphenyls (Solutia, 1999), Sodium Carbonate (Mallinckrodt, 2006) Petroleum Jelly (Caltex, 2002), Sodium Thiosulfate (Mallinckrodt, 2004), Argon (NIOSH, 2003) and the STEL value for gasoline (OSHA, 2005).

Note 1: Chemicals with vapor pressures less than 10 torr (0.193 psi, or 0.13 kPa) were not considered. Chemicals with vapor pressures this low are not very volatile. That is, under normal conditions, chemicals cannot enter the atmosphere fast enough to reach concentrations hazardous to people and, therefore, are not considered to be an air dispersion hazard (NOAA, 2007).

Note 2: Chemicals stored in containers less than 20 lbs do not require toxicity analysis, per Regulatory Guide 1.78.

Note 3: A toxicity analysis is not required based on the screening methodology provided in Appendix A of Regulatory Guide 1.78.

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Table 2.2-8— {Explosion Event Analysis}

Source	Pollutant Evaluated	Quantity	Heat of Combustion (Btu/lb)/ (kJ/kg)	Distance to Nearest CCNPP Unit 3 Safety Related Structure	Distance at 1 psi (6.9 kPa) Peak Incident Pressure
Maryland Route 2/4	Gasoline (Note 1)	8,500 gal/ 32,000 l	18,720/ 43,514	6,119 ft/ 1.9 km	263 ft/ 50.2 m
	Gasoline (aviation) (Note 1)	8,500 gal/ 32,000 l	18,720/ 43,514		260 ft/ 79.2m
	Propane (Note 2)	50,000 lbs/ 22,679 kg	19,782/ 45,982		3,559 ft/ 1.1 km
Pipeline-DCPLNG	Liquefied Natural Gas (Note 3)				
Navigable Waterway	Gasoline (Notes 1 and 4)	5,200,000 lbs/ 2,400,000 kg	18,720/ 43,514	11,678 ft/ 3.6 km	1,222 ft/ 372.5 m
	Benzene (Notes 1 and 4)	5,200,000 lbs/ 2,400,000 kg	17,460/ 40,585		1,076 ft/ 328 m
	Toluene (Notes 1 and 4)	5,200,000 lbs/ 2,400,000 kg	17,430/ 40,572		1,072 ft/ 326.7 m
On-Site (CCNPP Units 1 & 2)	Gasoline (Notes 1 and 5) (3,500 gal (15,900l) tank truck) (Notes 1 and 3)	3,500 gal/ 13,250 l	18,720/ 43,514	310 ft/ 94.5 m	196 ft/ 59.7 m
	Hydrazine (35% solution) (Note 1)	350 gal/ 1,325 l	8,345/ 19,397	891 ft/ 271.6 m	114 ft/ 34.7 m
	Dimethylamine (2% solution) (Note 1)	350 gal/ 1,325 l	16,800/ 39,051	462 ft/ 140.8 m	85 ft/ 25.9 m
	Hydrogen (Note 2)	460 cu ft/ 13 cu m	50,080/ 116,411	745 ft/ 271.6 m	~~224 ft/ 68.3 m~~ 441 ft/ 135 m
On-Site (CCNPP Unit 3)	Argon-Methane (considered as methane (Note 2)	282 scf/ 7.99 Nm^3	21,517/ 50,029	(Note 9)	119 ft / 36.2 m
	Hydrogen (Note 2)	278 scf/ 7.87 Nm^3	50,080/ 120,000	(Note 9)	133 ft/ 40.5 m
	Oxygen (Note 2)	282 scf/ 7.99 Nm^3	N/A (Note 6)	(Note 9)	41 ft / 13 m
	Non-Oxidizing Biocide (ethanol) (Note 7)	1,000 gal/ 3,800 l	11,570/ 26,880 kJ/kg	(Note 9)	58 ft / 17.7 m
	Non-Oxidizing Biocide (ethanol) (Note 8)	350 gal/ 1,300 l	11,570/ 26,880 kJ/kg	(Note 9)	41 ft / 12.5 m
Nearby Facilities	DCPLNG (associated hazards) (Note 3)				

Insert C for FSAR Table 2.2-8.

scf: Standard cubic feet

Nm^3: Normal cubic meter

Note 1: For atmospheric liquids, the storage vessel was assumed to contain the quantity of fuel vapors in air at the upper explosive limit.

Note 2: For compressed or liquefied gases, the entire content of the storage vessel was conservatively assumed as the flammable mass.

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Insert C for FSAR Table 2.2-8

Pollutant Evaluated	Quantity	Heat of Combustion (Btu/lb)/(kJ/kg)	Distance to Nearest CCNPP Unit 3 Safety Related Structure	Distance at 1 psi (6.9 kPa) Peak Pressure
Acetone (Note 1)	5 gal/ 19 l	12,250/ 28,494	1,052 ft/ 321 m	20 ft/ 6m
Acetylene (Note 2)	30,470 cu ft/ 870 cu m	20,747/ 48,258	1,052 ft/ 321 m	1,246 ft/ 380 m (Note 10)
Oxygen (Note 2)	4,472 cu ft/ 127 cu m	N/A (Note 6)	1,052 ft/ 321 m	103 ft/ 32 m

Note 3: The DCPLNG pipeline explosion and all explosive hazards from the DCPLNG facility are bounded by the DCPLNG pipeline vapor cloud explosion.

Note 4: The maximum quantity shipped per shipment for gasoline, benzene, and toluene was not available. Therefore, it was assumed that the maximum quantity was 5.2 million lbs. (2.4 million kg) (CRS)

Note 5: The 4,000 gallon gasoline tank is an underground storage tank. The toxicity event is bounded by the 3,500 gallon gasoline delivery tank truck.

Note 6: Oxygen is not explosive by ignition and has no reported heat of combustion; therefore it was analyzed for explosion by overpressure (USCG, 2007).

Note 7: The actual quantity of ethanol analyzed (10 percent by weight of non-oxidizing biocide) was 122 gal/ 462 l.

Note 8: The actual quantity of ethanol analyzed (10 percent by weight of non-oxidizing biocide) was 42.66 gal/ 161.3 l.

Note 9: The evaluated pollutant is stored at a distance greater than the reported safe distance (the minimum distance required for an explosion to have less than 1 psi peak incident pressure).

Note 10: The acetylene explosion event was determined not to be a credible event based on gas cylinder catastrophic failure frequency. Refer to Subsection 2.2.3.1.1 for the analysis of this event.

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Table 2.2-9— {Flammable Vapor Cloud Events (Delayed Ignition) and Vapor Cloud Explosion Analysis}

(Page 1 of 2)

Source	Pollutant Evaluated & Quantity	Distance to Nearest Safety Related CCNPP Unit 3 Structure	Distance to UFL	Distance to LFL	Safe Distance for Vapor Cloud Explosions	Peak Over pressure at Nearest Safety Related CCNPP Unit 3 Structure
Maryland Route 2/4	Gasoline (8,500 gal)/ 32,176 l (Note 7)	6,119 ft/ 1,865 m to Ultimate Heat Sink (UHS)	234 ft/ 71.3 m	393 ft/ 119.8 m	999 ft/ 304.5 m	Not Significant (Note 5)
	Gasoline (aviation) (8, 500 gal)/ 32,176 l (Note 7)		237 ft/ 72.2 m	414 ft/ 126.2 m	1,002 ft/ 305.4 m	Not Significant (Note 5)
	Propane (50,000 lbs)/ 22,680 kg (Note 8)		1,167 ft/ 356 m	2,361 ft/ 720 m	4,185 ft/ 1,276 m	0.526 psi/ 3.63 kPa
Waterway (Chesapeake Bay)	Gasoline (5,200,000 lbs)/ 2,360,000 kg (Note 6)	11,678 ft/ 3,560 m to UHS makeup intake water structure	783 ft/ 239 m	1,464 ft/ 446 m	3,312 ft/ 1,009 m	0.159 psi/ 1.10 kPa
	Benzene (5,200,000 lbs)/ 2,360,000 kg (Note 6)		951 ft/ 290 m	2,172 ft/ 662 m	4,095 ft (1,284 m)	0.209 psi (1.44 kPa)
	Toluene (5,200,000 lbs)/ 2,360,000 kg (Note 6)		696 ft/ 212 m	1,302 ft/ 397 m	2,604 ft (794 m)	0.115 psi (0.793 kPa)
	Ammonia (1,200,000 lbs)/ 544,311 kg (Note 3)		4,746 ft/ 1,447 m	6,864 ft/ 2,092 m	10,032 ft/ 3,058 m	0.684 psi/ 4.72 kPa
On-site (CCNPP Units 1 & 2)	Gasoline (3,500 gal)/ 13,249 l (Note 4)	310 ft/ 94.5 m	144 ft/ 44 m	234 ft/ 71 m	648 ft/ 198 m	5.62 psi/ 38.7 kPa (Note 1)
	Hydrazine (35% solution) (350 gal)/1,325 l	891 ft/ 272 m	<33 ft/ <10.1 m	<33 ft/ <10.1 m	No explosion	No explosion
	Dimethylamine (Note 9) (2% solution) (350 gal)/1,325 l	462 ft/ 141 m	<33 ft/ <10.1 m	45 ft (14 m)	180 ft/ 55 m	0.282 psi/ 1.94 kPa
	Hydrogen (460 cu ft)/ 13 cu m	745 ft/ 227.1 m	108 ft/ 33 m	492 ft/ 150 m	738 ft/225 m	0.984 psi/ 6.78 kPa
On-site (CCNPP Unit 3)	Argon-Methane (Note 10) (282 scf)/ 7.99 Nm^3 (considered as Methane)	(Note 15)	39 ft/ 11.9 m	69 ft/ 21 m	126 ft/ 38 m	(Note 15)
	Hydrogen (Note 11) (278 scf)/ 7.87 Nm^3	(Note 15)	< 33 ft/ <10.1 m	75 ft/ 23 m	138 ft/ 42 m	(Note 15)
	Non-Oxidizing Biocide (ethanol) 1,000 gal/ 3,800 l (Note 12)	(Note 15)	(Note 13)	< 33 ft/ < 10 m	36 ft/ 11 m	(Note 15)
	Non-Oxidizing Biocide (ethanol) / 350 gal/ 1,300 l (Note 14)	(Note 15)	(Note 13)	< 33 ft/ < 10 m	< 33 ft/ < 10 m	(Note 15)
DCPLNG Nearby Facility and Pipeline Scenario for Flammable Vapor Clouds (Note 2)						

Insert D for FSAR Table 2.2-9.

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Insert D for FSAR Table 2.2-9

Pollutant Evaluated & Quantity	Distance to Nearest Safety Related CCNPP Unit 3 Structure	Distance to UFL	Distance to LFL	Safe Distance for Vapor Cloud Explosions	Peak Overpressure at Nearest Safety Related CCNPP Unit 3 Structure
Acetone (5 gal)/ 19 l	1,052 feet	< 33 ft/ 10m	33 ft/ 10 m	114 ft/ 35 m	Not significant
Acetylene (30,470 cu ft)/ 870 cu m	1,052 feet	63 ft/ 20 m	411 ft/ 125 m	828 ft / 252 m	0.692 psi (Note 16)

Table 2.2-9— {Flammable Vapor Cloud Events (Delayed Ignition) and Vapor Cloud Explosion Analysis}
(Page 2 of 2)

Scenario	Frequency per year (Existing)	Frequency per year (Expansion)	Distance to Nearest Safety Related Structure	Maximum Consequence Range
Total loss of ship's tank en route (off CCNPP)	2.18×10^{-7}	2.84×10^{-7}	3.4 mi/ 17,925 ft	1,558 ft- Pool Fire / 13,943 ft- Flash Fire 475 m—Pool Fire/ 4,250 m—Flash Fire
DCPLNG Gas Pipelines	3.60×10^{-3}	7.48×10^{-3}	1.54 mi 8,131 ft	5,808 ft-overpressure/2,362 ft-Jet Fire / 722 ft-Flash Fire 1,770 m-overpressure/720 m—Pool Fire/ 220 m—Flash Fire
Escalation Event-Total loss of all storage tanks	4.00×10^{-6}	4.00×10^{-6}	3.2 mi/ 16,896 ft	1,188 ft-Pool Fire / 5,413 ft- Flash Fire 362 m—Pool Fire/1,295 m—Flash Fire

scf: Standard cubic feet

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Nm^3: Normal cubic meter

Note 1: This event was determined not to be a credible event based on an event probability of less than 1 E-7. Refer to Section 2.2.3.2.4 for the analysis of this event.

Note 2: Overall risk of fatality from DCPLNG facility and associated pipeline to CCNPP Site was evaluated to be 2.3E-9 per year (present operations) and 6.6E-9 per year (planned expansion). (The risk of physical damage to CCNPP Unit 3 is lower) The impact from blast overpressures was taken into account in developing this risk.

Note 3: The annual quantity of ammonia transported in proximity to the CCNPP Unit 3 site is 2.0 million pounds (0.9 million kg). The frequency of transport was not available; consequently, it was conservatively assumed that the entire 2.0 million pounds (0.9 million kg) was transported in one shipment and released. A 0.6 reduction factor was applied to the 2.0 million pounds (0.9 million kg) in the analysis to account for the high rate at which ammonia dissolves in water as ALOHA does not account for this phenomena.

Note 4: The 4,000 gallon gasoline tank is an underground storage tank. Therefore, the toxicity event is bounded by the 3,500 gallon gasoline delivery tank truck.

Note 5: ALOHA output results indicate "not significant" when the peak overpressure is <0.1 psi.

Note 6: The maximum quantity shipped for gasoline, benzene, and toluene was not available. Therefore, it was assumed that the maximum quantity was 5,200,000 lbs. (CRS, 2005)

Note 7: Gasoline and aviation gasoline were modeled in ALOHA as n-heptane. N-heptane is used as a substitute for gasoline because the molecular weight and physical properties are similar.

Note 8: The worst case combination of stability class and wind speed is F stability and a wind speed of 3 m/sec for propane.

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Note 9: The worst case combination of stability class and wind speed is E stability and a wind speed of 1 m/sec for dimethylamine.

Note 10: The worst case combination of stability class and wind speed is E stability and a wind speed of 1 m/sec for argon-methane.

Note 11: The worst case combination of stability class and wind speed is E stability and a wind speed of 1 m/sec for the CCNPP Unit 3 hydrogen.

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

Note 13: The concentration is never reached in the vapor cloud.

Note 14: The actual quantity of ethanol analyzed (10 percent by weight of non-oxidizing biocide) was 42.66 gal/ 161.3 l.

Note 15: The evaluated pollutant is stored at a distance greater than the reported safe distance for either the flammable vapor cloud accident category (the distance to the outer edge of the LFL section of the vapor cloud) or the reported safe distance for the vapor cloud explosion accident category (the minimum distance required for an explosion to have less than 1 psi peak incident pressure should a vapor cloud detonate).

Note 16: Acetylene is stored indoors. To account for this, a release from the building of 55% of the release into the building was applied (EPA 2009).

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Table 2.2-10— {Toxic Vapor Cloud Analysis}
(Page 1 of 3)

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
	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 (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)
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	6,864 ft/ 2,092 m	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
	Carbon Dioxide	50, 000 lb 22,680 kg	40,000 ppm	900 ft/ 274 m	1,749 ft/ 533 m	25,300 ppm (Note 16)
Insert E for FSAR Table 2.2-10. →	Liquid Nitrogen	11,300 gal/ 42,775 l	Asphyxiant	2,994 ft/ 913 m	Asphyxiant	635 ppm (Note 5)

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Insert E for FSAR Table 2.2-10

Pollutant Evaluated	Quantity	IDLH	Distance to CCNPP Unit 3 Control Room Intake	Distance to IDLH (Note 1)	Maximum Control Room Concentration (Note 2)
Acetylene	30,470 cu ft/ 871 cu m	Asphyxiant	1,489 ft/ 454 m	168 ft/ 52 m	80.9 ppm (Note 11)
Oxygen	4,472 cu ft/ 127 cu m	Oxygen-enriched	1,489 ft/ 454 m	< 33 ft/ 10 m	23.4 ppm (Note 17)

Table 2.2-10— {Toxic Vapor Cloud Analysis}
(Page 3 of 3)

Source	Chemical	Quantity	IDLH	Distance to CCNPP Unit 3 Control Room Intake	Distance to IDLH (Note 1)	Maximum Control Room Concentration (Note 2)

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.
Note 16: The toxicity event for the 8,000 lb storage tank Bldg. is bounded by the 50,000 lb delivery truck.

Note 17: The reported distance to the IDLH for oxygen is the distance at which the concentration outside the control room is enough that the atmosphere will become oxygen-enriched.

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UN#13-096

Enclosure 2

Table of Changes to CCNPP Unit 3 COLA
Associated with the Impact of the Toxic-Flammable Explosive
Transport Hazards in Calvert Cliffs Units 1 & 2 on
Calvert Cliffs Nuclear Power Plant, Unit 3

Table of Changes to CCNPP Unit 3 COLA

Associated with the Impact of the Toxic-Flammable Explosive Transport Hazards in Calvert Cliffs Units 1 & 2 on Calvert Cliffs Nuclear Power Plant, Unit 3

Change ID #	Subsection	Type of Change	Description of Change
Part 2 – FSAR			
CC3-10-0256 (original CC3 - 10-0054)	2.2.3	Incorporate COLA markups associated with the response to RAI 146, Question 02.02.03-8, Evaluation of Potential Accidents[1].	The response to RAI 146, Question 02.02.03-8 involves additional information on toxic or asphyxiating chemicals.
CC3-10-0256 (original CC3 - 10-0011)	2.2.3	Incorporate COLA markups associated with the response to RAI 171, Question 09.02.05-2[2].	The response to RAI 171, Question 09.05.05-2, Raw Water Supply System, involves deletion of reference to CCNPP 1&2 chemical storage locations and additional information on chemicals.
CC3-10-0256 (original CC3 - 09-0338)	2.2.3	Incorporate COLA markups associated with the response to RAI 198, Question 19-22[3].	The response to RAI 198, Question 19-22, Probabilistic Risk Assessment, involves deletion of references to Ammonia Hydroxide.

[1]UniStar Nuclear Energy Letter UN#09-421, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 146, Evaluation of Potential Accidents, dated October 15, 2009.

[2]UniStar Nuclear Energy Letter UN#10-022, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 171, Raw Water Supply System, dated February 5, 2010.

[3]UniStar Nuclear Energy Letter UN#10-230, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 198, Probabilistic Risk Assessment, dated August 24, 2010.

Change ID #	Subsection	Type of Change	Description of Change
CC3-13-0099	2.2.3, 2.2.4, Tables 2.2-2, 2.2-5, 2.2-8, 2.2-9, 2.2-10,	Incorporate COLA markups associated with Toxic-Flammable Explosive Transport Hazards in Calvert Cliffs Units 1 & 2 on Calvert Cliffs Nuclear Power Plant, Unit 3 (this submittal).	Markups associated with Toxic-Flammable Explosive Transport Hazards in Calvert Cliffs Units 1 & 2 on Calvert Cliffs Nuclear Power Plant, Unit 3 Part 2, FSAR sections.