TVA

**Tennessee Valley Authority**, 1101 Market Street, LP 5A, Chattanooga, Tennessee 37402-2801

July 09, 2008

10 CFR 52.79

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

In the Matter of )
Tennessee Valley Authority )

Docket No. 52-014 and 52-015

BELLEFONTE COMBINED LICENSE APPLICATION – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION – HAZARDS ANALYSIS

Reference: Letter from Joseph Sebrosky (NRC) to Andrea L. Sterdis (TVA), Request for Additional Information Letter No. 036 Related to SRP Section 02.02.03 for the Bellefonte Units 3 and 4 Combined License Application, dated June 9, 2008

This letter provides the Tennessee Valley Authority's (TVA) response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) items included in the reference letter.

A response to each NRC request in the subject letter is addressed in the enclosure and also identifies any associated changes that will be made in a future revision of the BLN application.

Attachments 02.02.03-01A, 02.02.03-03A, and 02.02.03-04A to this letter contain
**Sensitive Unclassified Non-Safeguards Information (SUNSI)**
that should be withheld from public disclosure under 10 CFR 2.390(d).

If you should have any questions, please contact Phillip Ray at 1101 Market Street, LP5A, Chattanooga, Tennessee 37402-2801, by telephone at (423) 751-7030, or via email at pmray@tva.gov.

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

Executed on this 9th day of July, 2008.

Andrea L. Sterdis
Manager, New Nuclear Licensing and Industry Affairs
Nuclear Generation Development & Construction

Enclosure/Attachments
cc: See Page 2

D085
NRO

cc: (Enclosures)

J. P. Berger, EDF
J. M. Sebrosky, NRC/HQ
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M. C. Kray, NuStart
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M. M. Comar, NRC/HQ
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M. C. Kray, NuStart
A. M. Monroe, SCE&G
C. R. Pierce, SNC
R. Reister, DOE/PM
L. Reyes, NRC/RII
T. Simms, NRC/HQ

Enclosure
TVA letter dated July 09, 2008
RAI Responses

Responses to NRC Request for Additional Information letter No. 036 dated June 9, 2008
(49 pages, including this list)

Subject: Hazards Analysis in the Final Safety Analysis Report

| RAI Number | Date of Response |
|---|---|
| 02.02.03-01 | This letter – see following pages |
| 02.02.03-02 | This letter – see following pages |
| 02.02.03-03 | This letter – see following pages |
| 02.02.03-04 | This letter – see following pages |
| 02.02.03-05 | This letter – see following pages |
| 02.02.03-06 | This letter – see following pages |
| 02.02.03-07 | This letter – see following pages |

| Attachments / Enclosures | Pages Included |
|---|---|
| Attachment 02.02.03-01A | 9 pages |
| Attachment 02.02.03-03A | 2 pages |
| Attachment 02.02.03-04A | 2 pages |

**NRC Letter Dated: June 9, 2008**

**NRC Review of Final Safety Analysis Report**

**NRC RAI NUMBER: 02.02.03-01**

FSAR Tables 2.2-209, 2.2-210, and 2.2-211 identify commodities transported via the Tennessee River near the proposed site. The application mentions (page 2.2-13) that the applicant assessed potential hazards from explosive cargo transported past the proposed site via barge on the Guntersville Reservoir and that "initial screening of hazardous commodities eliminated all but two...". Which of the commodities/chemicals listed in the above-referenced tables were considered for screening? (Relatedly, please clarify why the two chemicals selected for further analysis, styrene and ethanol, are not listed in the tables.) Please clarify what bases, bounding assumptions, amounts, release rates, frequencies, traffic statistics, and other data TVA used in determining the safe standoff distances resulting from explosion, vapor cloud explosion, and probability presented.

**BLN RAI ID: 426**

**BLN RESPONSE:**

FSAR Tables 2.2-209, 2.2-210, and 2.2-211 were created via initial data supplied by the United States Army Corps of Engineers Waterborne Commerce Statics Center. Initial screening was performed on the list to determine commodities of interest that may require further information and to determine if any of the commodities listed require clarification. Commodities are screened out based on their physical properties. The primary physical parameter is the commodities' flash point. The National Fire Protection Association Hazard Identification System (NFPA 704) is used. Only commodities with flammability hazards classified as three or four (serious hazard and severe hazard, respectively) are considered. The original USACE data listed commodities in broad categories, such as "alcohols" or "other hydrocarbons". For screening purposes more information was needed. Upon request, USACE provided waterborne commerce statistics past mile point 391 on the Tennessee River for the calendar years of 2003 and 2004 for those commodities identified in Tables 2.2-210 as being potential hazards or requiring further information. These statistics listed specific commodities (styrene and ethanol among others), barge capacity, number of trips, and total tons. The subsequent data provided by the USACE will be added as FSAR Tables 2.2-216 and 2.2-217.

<u>Overall Approach for Explosion and Plume Ignition Risk Assessment</u>

The approach to this detonation and plume risk assessment consisted of the following steps:

1. Reviewing the applicable historic data on spills from the United States Army Corps of Engineers and the United States Coast Guard.
2. Determining the spill frequency on the Tennessee River and its feeder rivers from this data.
3. Determining an explosion frequency of similar events from the hazardous cargo traffic data obtained.

Spill Frequency on the Tennessee and Associated Rivers

To calculate the spill frequency on the Tennessee and associated rivers, the USCG data bases were consulted. The data is from the MISLE database (Reference 240). Data was obtained for the period of mid December 2001 through January of 2006. The location of spills is identified by name and latitude and longitude. There are 5,687 records for US waters. To reduce these to only applicable events, the data was sorted to only include events that occurred between longitude W89° and W80°. Due to obvious incorrectly labeled longitudes in the data, data containing the names "Tennessee", "Alabama", "Ohio", or cities within these states that fell outside the previously stated longitude range were included. This results in a record size of 1189 events. Further paring is done by eliminating records south of N29° 10' and north of N39°, to exclude Gulf events and events north of the Tennessee River, giving 583 records. Additional location by location review removed the Mississippi, Ohio, Gulf, and their nearby feed river events. This reduced the record count to 94 events.

The remaining 94 items compose the spills on the Tennessee, Tennessee-Tombigbee Waterway, Black Warrior, Tombigbee, Alabama, Mobile and their associated feed rivers as well as events in Mobile Bay. These specific waterways are chosen to provide a robust sampling of vessels that pass through the Tennessee River (from longitude W84° to W89°). These were further pared by the type of spill. Spills that were excluded were bilge slops, lubricating oil, motor oil, hydraulic fluid, and waste oil since these do not have explosive potential. This reduced the number of event records to 75.

These 75 spill events date from 2001 through the 2005. However, the data from 12/2001 through 12/2004 (3 years, 1 month) shows multiple spills per month, whereas only one incident was recorded before 12/2001 and only one incident was recorded after 12/2004. It is conservative for frequency development to exclude those two incidents and use the time period of 3 + 1/12 = 3.083 years. Therefore the 73 spill events over a period of 3.083 years are used to develop spill frequency.

The total river length is taken to be 1822 miles. This includes 650 for the Tennessee, 234 for the Tennessee-Tombigbee, 178 for the Black Warrior, 315 for the Alabama, 45 for the Mobile, and 400 for the Tombigbee (FSAR Table 2.2-218). Hence the spill rate per river mile per year is 73/(3.083*1822) = 0.013 spills/mile-yr. Note that it is reasonable to apply this general rate to the area around the site, since the site has no particular obstacles such as bridges or major terminals, while other areas with such obstacles presumably have higher incident rates.

A frequency distribution is established by binning the spills according to size. A range of spill sizes is established to encompass the upper and lower bounds of the data, with the maximum limit enveloping the maximum spill size of 16,800 gallons (Reference 240). The midpoint of each bin is calculated by finding the midpoint on a log scale. The mass in units of tons is calculated based on a specific gravity of 0.9 based on the fact that the fluid must float to produce a vapor cloud and explosion risk. Hence the calculation of tons is a multiple of the midpoint volume by:

$$1/(7.481\ \text{gal/ft}^3) * 62.4 * 0.9\ \text{lbm/ft}^3 * 1/(2000\ \text{lbm/ton})$$

The frequency per mile-year is the number of spill events divided by the product of the time period of 3.0833 years and river length of 1822 miles. The binned spill frequency data is shown in FSAR Table 2.2-219.

The data in FSAR Table 2.2-219 is plotted on a log-log chart (FSAR Figure 2.2-203), and a linear curve fit was made giving the form:

$$\text{Spill Frequency (spills per mile-yr.)} = f = 10^{(-0.3431*\text{Log(spill tonnage)}-3.1743)}$$

A further conservatism is applied below, when these spills are assumed to be associated with the critical cargo types and apportioned among them according to total river traffic volume.

Quantified Risk of Detonation

The overall risk is calculated based on the series of events that must occur in order for a very large explosion to impact the Bellefonte Nuclear Site. The events are that a barge carrying detonable material passes by the site, has a significant accident that releases its detonable material to mix with air, an ignition occurs resulting in an explosion, and the explosion is large enough to result in an overpressure of 1 psi at the site boundary. This calculation is performed for the hazardous materials which have been analyzed for maximum detonation overpressure with potential adverse impact on the Bellefonte Nuclear Site. The important inputs to this analysis are the maximum cargo size based on USACE records for this location on the Tennessee River, and a conservative treatment of the material properties, with the very conservative assumption of full detonation of the contained combustibles.

Screening of the hazardous materials shipped showed only styrene potentially impacting the site. For the confined vapor cloud explosion (VCE) scenarios, none of the commodities evaluated were shown to pose a hazard of an overpressure greater than 1 psi to the site. For the unconfined VCE, styrene was determined to pose some level of risk that would have to be evaluated.

The length of the river on which an accident could occur and potentially create an overpressure of 1 psi is called the "at risk" length, "L". For styrene, this length was determined to be less than 3 miles – from 1.5 miles upstream of the plant to 1.5 miles downstream of the plant. "At risk" river lengths as a function of cargo size are listed in FSAR Table 2.2-220. Shipping information obtained from the USACE for styrene, ethyl alcohol, and sodium hydroxide solution is listed in FSAR Table 2.2-221. Although alcohols were screened out of the consequence calculations due to their high solubility in water, they are included here for the purpose of assessing spill frequency, since they increase the database size and, therefore, the accuracy of spill frequency projections. Likewise, aqueous sodium hydroxide is included for the purpose of assessing spill frequency. This commodity is neither flammable nor explosive and is included here to increase the database size for the purpose of more accurately assessing spill frequency.

To be conservative, the proportion of spills associated with styrene is made based on the maximum of the associated percentage values for either tonnage or trips. For example, in 2003, styrene shipments composed 13.4% of the tonnage and 11.9% of the trips. In 2004, it composed 9.63% of the tonnage and 8.6% of the trips. Therefore, the portion of spills on the Tennessee that are styrene is the maximum of these, or 13.4%. The spill frequency for styrene is the result of the above spill frequency calculation multiplied by commodity's percentage of volume. Thus, the risk from styrene is calculated as:

$$\text{Risk} = f'(\text{spills/mile-yr.})*L(\text{miles})*P(\text{explosion/spill});$$

Where f' is the product of the spill frequency calculated above and the commodity percentage, L is the "at risk" length, and P is the rate of explosions per spill.

The frequency of spills "f '" is dependent on the assumed mass and decreases as mass increases. However, the at-risk length "L" is dependent on mass and increases as mass increases. To seek the worst case, the product of "f ' *L" is calculated for the styrene assuming both the maximum cargo size and 70% of the maximum size. The f ′*L columns in FSAR Table 2.2-222 show that the two offsetting effects make the results relatively insensitive to the assumed cargo size. The spills of smaller cargoes are roughly 12% more likely, but the "at-risk" path length is roughly 14% shorter.

The remaining term in the risk equation is the probability that the spilled cargo is involved in a detonation. Of the 73 spills identified above in the MISLE data, none is associated with an explosion. Therefore, the data was expanded to include events between latitude N29° and N36° and between longitude W84°and W89°. This resulted in 850 events of which there was one incendiary explosion. Further widening the search to include the explosions in US waters results in four occurrences on the Mississippi or Ohio Rivers. However, only one of these was a Boiling Liquid/Expanding Vapor Explosion (BLEVE); the other three are described as "incendiary explosions." Common causes of explosions on board vessels are events such as sparks igniting vapors; but these are incapable of causing the full vessel contents to explode due to limitations of air exposure. Therefore, it is assumed the one remaining event, the BLEVE of 11/28/2000 at Port Sulfur, LA, was associated with a spill. In that case, the explosion per spill frequency is 1/850 = 0.001176 explosions/spill.

The results for the calculated explosion risk from styrene for various percentages of the maximum cargo capacity are presented in FSAR Table 2.2-223. The results of the detonation risk assessment show a risk value less than 1.9 E-8 explosions per year, which is an order of magnitude less than the acceptance criterion of $10^{-7}$ per year.

This response is PLANT-SPECIFIC.

**ASSOCIATED BLN COL APPLICATION REVISIONS:**

1. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.1.1, will be revised from:

For these two commodities of interest, additional detailed shipment information was obtained from the U.S. Army Corps of Engineers Waterborne Commerce Statistics Center (WCSC) and used to develop reasonably bounding assumptions regarding the amount of each commodity included in a single barge shipment past the BLN site. This WCSC data also provided shipping frequency (pass-the-point data) for each commodity.

To read:

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2. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.1.1, will have the following information inserted after the third paragraph on page 2.2-13:

Spill Frequency on the Tennessee and Associated Rivers

To calculate the spill frequency on the Tennessee and associated rivers, the USCG data bases were consulted. The data is from the MISLE database (Reference 240). Data was obtained for the period of mid December 2001 through January of 2006. The location of spills is identified by name and latitude and longitude. There are 5,687 records for US waters. To reduce these to only applicable events, the data was sorted to only include events that occurred between longitude W89° and W80°. Due to obvious incorrectly labeled longitudes in the data, data containing the names "Tennessee", "Alabama", "Ohio", or cities within these states that fell outside the previously stated longitude range were included. This results in a record size of 1189 events. Further paring is done by eliminating records south of N29° 10' and north of N39°, to exclude Gulf events and events north of the Tennessee River, giving 583 records. Additional location by location review removed the Mississippi, Ohio, Gulf, and their nearby feed river events. This reduced the record count to 94 events.

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The results for the calculated explosion risk from styrene for various percentages of the maximum cargo capacity are presented in Table 2.2-223. The results of the detonation risk assessment show a risk value less than 1.9 E-8 explosions per year, which is an order of magnitude less than the acceptance criterion of $10^{-7}$ per year.

3. COLA Part 2, FSAR, Chapter 2, Section 2.2, will be revised to add new Tables 2.2-216 through Table 2.2-223 as shown below:

Table 2.2-216

Barge Movements Passed Mile Point 391
on the Tennessee River for Calendar Years 2003*

| |
|---|
| **Security-Related Information - Withhold Under 10 CFR 2.390(d)**<br>**(See Part 9 of this COL Application)** |

Table 2.2-217

Barge Movements Passed Mile Point 391
on the Tennessee River for Calendar Years 2004*

| |
|---|
| **Security-Related Information - Withhold Under 10 CFR 2.390(d)**<br>**(See Part 9 of this COL Application)** |

Table 2.2-218

Rivers in Alabama

| River Name | Length (miles) |
|---|---|
| Alabama | 315 |
| Black Warrior | 178 |
| Mobile | 45 |
| Tennessee | 650 |
| Tennessee-Tombigbee Waterway | 234 |
| Tombigbee | 400 |
| **TOTAL** | **1822** |

Table 2.2-219

Spill Frequency Data from MISLE

| Spill Volume (gallons) | Log Midpoint (gallons) | Number of Events | Spill Volume (tons) | Spill Frequency (per mile-yr.) |
|---|---|---|---|---|
| 1 – 2.80 | 1.67 | 28 | 0.0063 | 4.98E-03 |
| 2.8 – 7.84 | 4.69 | 9 | 0.0176 | 1.60E-03 |
| 7.84 – 22.0 | 13.12 | 12 | 0.0492 | 2.14E-03 |
| 22.0 – 61.5 | 36.73 | 11 | 0.138 | 1.96E-03 |
| 61.5 – 172 | 103 | 5 | 0.386 | 8.90E-04 |
| 172 – 482 | 288 | 3 | 1.08 | 5.34E-04 |
| 482 – 1349 | 806 | 2 | 3.03 | 3.56E-04 |
| 1349 - 3778 | 2258 | 2 | 8.47 | 3.56E-04 |
| 3778 – 10578 | 6322 | 0 | 23.73 | 0.00E+00 |
| 10578 - 29620 | 17701 | 1 | 66.44 | 1.78E-04 |

Table 2.2-220

Critical Cargo and "At-Risk" River Lengths

| |
|---|
| **Security-Related Information - Withhold Under 10 CFR 2.390(d)**<br>**(See Part 9 of this COL Application)** |

Table 2.2-221

Shipping Data from USACE Records

| |
|---|
| **Security-Related Information - Withhold Under 10 CFR 2.390(d)**<br>**(See Part 9 of this COL Application)** |

Table 2.2-222

Development of f '*L Term, Cargo Size Sensitivity for Styrene

| |
|---|
| **Security-Related Information - Withhold Under 10 CFR 2.390(d)**<br>**(See Part 9 of this COL Application)** |

Table 2.2-223

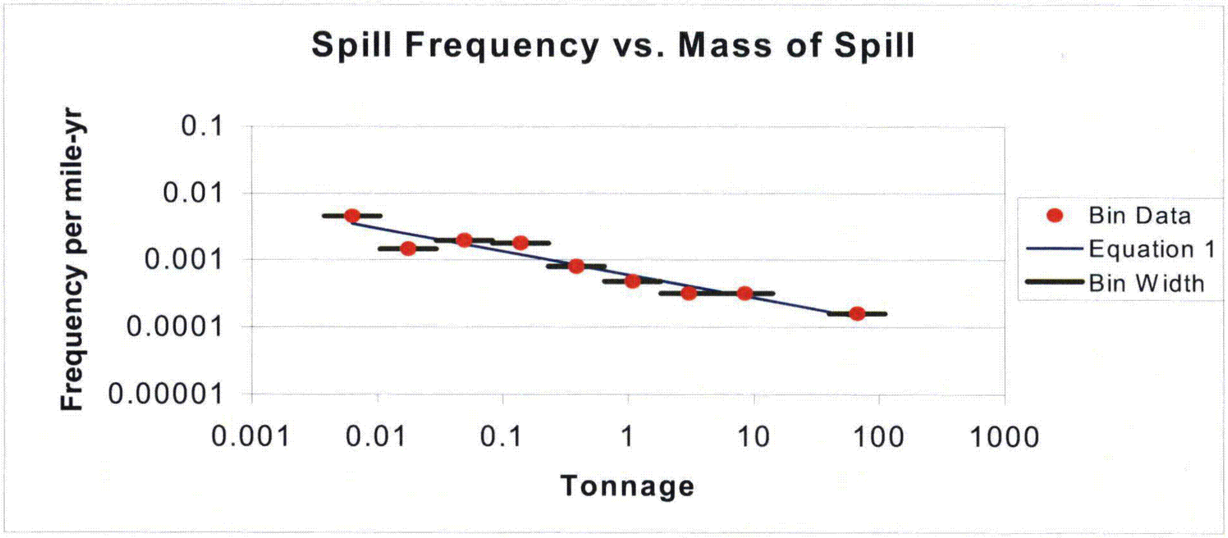
Results of Probability Analysis

| |
|---|
| **Security-Related Information - Withhold Under 10 CFR 2.390(d)**<br>**(See Part 9 of this COL Application)** |

4. COLA Part 2, FSAR, Chapter 2, Section 2.2, will be revised to add new Figure 2.2-203 as shown below:

Figure 2.2-203

Spill Frequency of Combustible Material on the Tennessee and Associated Major Rivers of Alabama, 2001-2004




5. COLA Part 2, FSAR, Section 2.2.5, will be revised to add the following new reference:

204. Marine Information for Safety and Law Enforcement (MISLE) Database, United States Coast Guard (USCG) with data as of 1/26/2006.

6. COLA Part 9, Withheld Information, will be revised to include complete new Tables 2.2-216, 2.2-217, 2.2-220, 2.2-221, 2.2-222, and 2.2-223 as shown in Attachment 02.02.03-01A.

**ATTACHMENTS/ENCLOSURES:**

Attachment 02.02.03-01A (contains ***Security-Related Information — Withheld Under 10 CFR 2.390***)

**NRC Letter Dated: June 9, 2008**

**NRC Review of Final Safety Analysis Report**

**NRC RAI NUMBER: 02.02.03-02**

Please explain how the applicant determined (in Section 2.2.3.1.1.3) the gasoline vapor amounts for the Fuel Center storage in calculating the standoff distances resulting from confined and unconfined vapor explosions.

**BLN RAI ID: 427**

**BLN RESPONSE:**

Regulatory Guide 1.91 cites an inequality for R, the minimum safe distance to an overpressure of 1 psi, as

$$R \geq 45\ W^{1/3} \tag{1}$$

Where W = equivalent mass of trinitrotoluene (TNT) ($lb_m$), and R is in feet.

Reg. Guide 1.91 states "For solid substances not intended for use as explosives but subject to accidental detonation, it is conservative to use TNT equivalence of one in establishing safe standoff distances, i.e., use the cargo mass."

Therefore, the equivalent mass of TNT in this scenario is estimated as W equals M, where M is the mass of maximum cargo of that commodity. Equation 1 becomes

$$R \geq 45\ M^{1/3} \tag{2}$$

For those substances intended for usage as an explosive Equation 2 becomes,

$$R \geq 45 *[(RE)*M]^{1/3} \tag{2a}$$

Where RE = the relative effectiveness factor. This is the measurement of an explosive's power for military purposes, and is used to compare an explosive's effectiveness relative to TNT by weight only.

The equivalent mass of TNT for other commodities for the VCE is found by

$$W = m\ (HC_{commodity}\ /HC_{TNT}) \tag{3}$$

where m = the mass of the commodity in question and $HC_{TNT}$ and $HC_{commodity}$ are the heats of combustion of TNT and the commodity, respectively. The heat of combustion for TNT is 4,680 kJ/kg.

In an enclosed vapor cloud explosion the internal pressure rises rapidly and eventually ruptures the vessel due to the confined space. This magnifies the detonation effects. The blast energy has an assumed (from Regulatory Guide 1.91) mass equivalence of 240 percent.

The mass of explosive gas mixture that can be confined a tank is limited by the vapor space volume available. The analysis assumes the entire tank was void of any liquid, thus maximizing the mass of the explosive vapor mixture. The mass of the commodity involved in a confined vapor space explosion is derived by the following:

$$M_{full} = \frac{M}{0.8}$$

Where $M_{full}$ is the mass of the commodity needed to fill the entire container and M is the maximum possible storage amount of that quantity. The 80% factor effectively assigns an additional 20% vessel volume on top of the volume necessary to house the maximum liquid mass.

The volume of the container is,

$$V_{container} = \frac{M_{full}}{\rho_{liquid}} = \frac{M}{0.8} * \frac{1}{\rho_{liquid}}$$

In order to quantify the material involved in the confined vapor cloud explosion, it is necessary to determine the amount of vapor in the container.

$$m = m_{vapor} = V_{container} * \rho_{vapor} = \frac{M}{0.8} * \frac{1}{\rho_{liquid}} * \rho_{vapor}$$

Finally,

$$m = M\,(\rho_{vapor}/\rho_{liquid})\,/\,0.80 \qquad (4)$$

where $\rho_{vapor}$ is the vapor density, $\rho_{liquid}$ is the liquid density, and M and m are defined previously.

Therefore, for the confined VCE, combining equations 1, 3, 4 and assuming a mass equivalency of 240%, yields

$$R \geq 45\,[(2.40/0.80)\,M\,(\rho_{vapor}/\rho_{liquid})\,(HC_{commodity}/HC_{TNT})]^{1/3} \qquad (5)$$

where

| | |
|---|---|
| R | = The safe distance to an overpressure of 1 psi (feet) |
| M | = The mass of the maximum cargo of that commodity ($lb_m$) |
| $\rho_{vapor}$ | = The vapor density ($lb_m/ft^3$) |
| $\rho_{liquid}$ | = The liquid density ($lb_m/ft^3$) |
| $HC_{commodity}$ | = The heat of combustion of the commodity (kJ/kg) |
| $HC_{TNT}$ | = The heat of combustion of TNT (4,680 kJ/kg) |

The vapor density in Equation 5 is derived from the ideal gas law.

$$\rho_{vapor} = \frac{n}{V} * MW = \frac{moles}{unit\ of\ volume} * \frac{unit\ of\ mass}{mole} = \frac{unit\ of\ mass}{unit\ of\ volume} \quad (6)$$

Where n is the number of moles of the commodity, V is the volume, and MW is its molecular weight. The ideal gas law is,

$$P\,V = nRT \quad (7)$$

Where P is the absolute pressure, R is the universal gas constant and T is the absolute temperature. Thus:

$$\frac{n}{V} = \frac{P}{RT} \quad (8)$$

Substituting Equation 8 into Equation 6 yields,

$$\rho_{vapor} = \frac{P}{RT} * MW$$

Based on the specific gravity of gasoline is 0.8, the density of water is 998.2 $\frac{kg}{m^3}$, and the combined capacity of the Fuel Center is 184,500 gallons, the mass of gasoline involved in an explosion is,

$$Gasoline\ Mass\,(lb_m) = 184{,}500\,gallons * 0.80 * 998.2\frac{kg}{m^3} * \frac{8.345(10^{-3})\frac{lb_m}{gallon}}{\frac{kg}{m^3}} = 1{,}229{,}505\ lb_m$$

Based on an assumed temperature of 50 F, the universal gas constant is 10.73 ($ft^3$-psia/lbmol-°R), and the molecular weight of gasoline is 110, the vapor density is determined through Equation 9.

$\rho_{vapor}$ = (P/RT) MW (9)

$\rho_{vapor}$ = [14.7 psia/{10.73 (ft3-psia/lbmol-°R) (460°R+50°F)}] (110 lbm/lbmol)

$\rho_{vapor}$ = 0.2955 lbm/ft3

The safe distance to an overpressure of 1 psi for a confined VCE is found by application of Equation 5

$$R \geq 45\ [(2.40/0.80)\ M\ (\rho_{vapor}/\rho_{liquid})\ (HCcommodity\ /HCTNT)]1/3 \qquad (5)$$

where

| | |
|---|---|
| $R$ | = The safe distance to an overpressure of 1 psi (feet) |
| $M$ | = 1,229,505 lbm |
| $\rho_{vapor}$ | = 0.2955 lbm/ft3 |
| $\rho_{liquid}$ | = 62.4 lbm/ft3 x 0.8 = 49.92 lbm/ft3 |
| $HC_{commodity}$ | = 46,800 kJ/kg (Table 5.6) |
| $HC_{TNT}$ | = 4,680 kJ/kg (Design Input 5.4) |

$$R \geq 45\ [3\ (1{,}229{,}505\ lbm)\ (0.2955\ /\ 49.92)\ (46{,}800\ /\ 4{,}680)]1/3$$

$$R \geq 45\ [218{,}340]1/3$$

$$R \geq 45\ [60.22]$$

$$R \geq 2{,}709\ ft = 0.51\ miles$$

The safe distance from an unconfined VCE is determined applying Equation 10 with the same inputs as above,

$$R \geq 45\ [0.10\ M\ (HC_{commodity}\ /HC_{TNT})]1/3 \qquad (10)$$

where

| | |
|---|---|
| $R$ | = The safe distance to an overpressure of 1 psi (feet) |
| $M$ | = 1,229,505 lbm |
| $H_{Ccommodity}$ | = 46,800 kJ/kg |
| $HC_{TNT}$ | = 4,680 kJ/kg |

$$R \geq 45\ [0.10\ (1{,}229{,}505\ lbm)\ (46{,}800\ /\ 4{,}680)]1/3$$

$$R \geq 45\ [1{,}229{,}505]1/3$$

$$R \geq 45\ [107.13]$$

$$R \geq 4{,}820\ ft = 0.91\ miles$$

The results for both a confined and unconfined local VCE are less than the standoff distance of the gasoline storage area of 2.49 miles. Therefore, the postulated explosion at The Fuel Center does not generate an overpressure above 1 psi at the site.

This response is PLANT-SPECIFIC

**ASSOCIATED BLN COL APPLICATION REVISIONS:**

COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.1.3 will be revised from:

The Fuel Center is located 2.49 miles west of the BLN site boundary. The Fuel Center has a combined registered storage tank capacity of 184,500 gallons. For evaluation purposes, it is assumed that these tanks are filled with gasoline and they rupture simultaneously. The Fuel Center represents the largest quantity of registered storage tank capacity of the facilities near the BLN site and is the closest above-ground storage facility. The safe standoff distance for the confined vapor explosion was determined to be 0.51 miles and the safe standoff distance for the unconfined vapor explosion was determined to be 0.91 miles. Therefore, the distance from the Fuel Center to the BLN site meets the safe distance requirements as defined in Equation 1 of Regulatory Guide 1.91.

To read:

The Fuel Center is located 2.49 miles west of the BLN site boundary. The Fuel Center has a combined registered storage tank capacity of 184,500 gallons. For evaluation purposes, it is assumed that these tanks are filled with gasoline and they rupture simultaneously. The Fuel Center represents the largest quantity of registered storage tank capacity of the facilities near the BLN site and is the closest above-ground storage facility. The mass of gasoline involved in the explosion is determined by the following equation:

$$Gasoline\ Mass\,(lb_m) = 184{,}500\,gallons * 0.80 * 998.2\frac{kg}{m^3} * \frac{8.345(10^{-3})\dfrac{lb_m}{gallon}}{\dfrac{kg}{m^3}} = 1{,}229{,}505\ lb_m$$

The term "184,500 gallons" is the combined capacity of the Fuel Center, the specific gravity of gasoline is 0.8, and the density of water is 998.2. The safe standoff distance for the confined vapor explosion was determined to be 0.51 miles and the safe standoff distance for the unconfined vapor explosion was determined to be 0.91 miles. Therefore, the distance from the Fuel Center to the BLN site meets the safe distance requirements as defined in Equation 1 of Regulatory Guide 1.91.

## ATTACHMENTS/ENCLOSURES:

None

**NRC Letter Dated: June 9, 2008**

**NRC Review of Final Safety Analysis Report**

**NRC RAI NUMBER: 02.02.03-03**

Please clarify the basis for the screening of chemicals stored at Maples Industries and the subsequent selection of three chemicals (isopropyl alcohol, gasoline, and cyclohexylamine) for further evaluation as discussed in Section 2.2.3.1.1.3. Please identify which chemicals were screened and what quantities of those chemicals are present. (Relatedly, please clarify why the three selected chemicals and their quantities are not presented in FSAR Table 2.2-203.) Please clarify how the safe standoff distances were calculated and presented.

**BLN RAI ID: 428**

**BLN RESPONSE:**

The basis for the screening process was the assumption that commodities with flash points greater than 38 °C (100°F) are not considered credible explosion threats. The National Fire Protection Association Hazard Identification System (NFPA 704M) cites this temperature as the transition point between flammability hazard ratings two and three (moderate hazard and serious hazard, respectively). Therefore only hazards classified as three or four (serious hazard and severe hazard, respectively) were considered in the analysis. Some commodities that may form a vapor cloud that will support a flame, but are known to have chemical properties such that an open vapor cloud will form a deflagration rather than a detonation. Some commodities are water soluble, so a spill onto water will disperse the material rather than form a large vapor cloud. Such commodities may still have risks associated with enclosed vapor cloud explosions, but free vapor cloud explosions will not pose a legitimate risk and can be eliminated from further consideration.

The Lower and Upper Explosive Limits for the chemicals are as follows:

| Chemical | LEL % | UEL% | Flash Point °C |
|---|---|---|---|
| Isopropyl Alcohol | 2 | 12 | 11.7 |
| Gasoline | 1.3 | 7.1 | < -21 |
| Cyclohexylamine | 1.5 | 9.4 | 28 |

Quantities of these chemicals are presented in Table 2.2-203. The remainder of the chemicals listed in Table 2.2-203 were screened out based on the criteria given above.

FSAR Table 2.2-203 was originally based on information reported to the Jackson County Emergency Management Agency. This information did not include all of the chemicals housed by Maple Industries, nor did it include quantities. Subsequent contact with Maple Industries yielded a complete list of hazardous chemicals stored at the facility and their respective quantities.

FSAR Table 2.2-203 will be replaced to indicate quantities and chemical inventory at Maple Industries.

Determination of safe standoff distances considered explosion of solid substances both intended and unintended for use as explosive, confined Vapor Cloud Explosion (VCE), and local unconfined VCE.

Solid Material Explosion

Regulatory Guide 1.91 cites an inequality for R, the minimum safe distance to an overpressure of 1 psi, as

$$\mathbf{R \geq 45\ W^{1/3}} \qquad \textbf{(1)}$$

Where W = equivalent mass of trinitrotoluene (TNT) (lbm), and R is in feet.

Regulatory Guide 1.91 states "For solid substances not intended for use as explosives but subject to accidental detonation, it is conservative to use TNT equivalence of one in establishing safe standoff distances, i.e., use the cargo mass." Therefore, the equivalent mass of TNT in this scenario is estimated as W equals M, where M is the mass of maximum cargo of that commodity. Equation **(1)** becomes

$$\mathbf{R \geq 45\ M^{1/3}} \qquad \textbf{(2)}$$

For those substances intended for usage as an explosive Equation **(2)** becomes

$$\mathbf{R \geq 45\ [(RE)*M]^{1/3}} \qquad \textbf{(2A)}$$

where RE = the relative effectiveness factor. This is the measurement of an explosive's power for military purposes, and is used to compare an explosive's effectiveness relative to TNT by weight only.

Confined Vapor Cloud Explosion

The equivalent mass of TNT for other commodities for the VCE is found by

$$\mathbf{W = m\ (HC_{commodity}\ /HC_{TNT})} \qquad \textbf{(3)}$$

where m = the mass of the commodity in question and HCTNT and $HC_{commodity}$ are the heats of combustion of TNT and the commodity, respectively. The heat of combustion for TNT is 4,680 kJ/kg.

The enclosed vapor cloud explosion scenario assumes that the container has been breached and sufficient material has been lost to leave a vapor space filled with an explosive gas mixture. An ignition source is introduced and combustion occurs. Due to the confined space, the internal pressure rises rapidly and eventually ruptures the container. This magnifies the detonation effects. The blast energy has a mass equivalence of 240 percent. The mass of explosive gas mixture that can be confined in the container is limited by the vapor space volume available. The analysis assumes the entire container was void of any liquid thus maximizing the mass of the explosive vapor mixture. The mass of the commodity involved in a confined vapor space explosion is derived by the following:

$$\mathbf{M_{full} = M/0.8}$$

where $M_{full}$ is the mass of the commodity needed to fill the entire container and M is the maximum possible storage amount of that quantity. The 80% factor is based on assumption that the volume of the storage container is initially assumed to be 80% full of liquid, with 20% vapor space remaining. This implicitly assumes that the mass values of commodity involved constitute the liquid portion of the container. This assumption effectively assigns an additional 20% container volume on top of the volume necessary to house the maximum liquid mass. Further, in deriving the mass of the commodity retained in the enclosed container, it is assumed the entire container is filled with vapor.

The volume of the container is,

$$V = M_{full} / \rho_{liquid} = (M/0.8)*(1/\rho_{liquid})$$

In order to quantify the material involved in the confined vapor cloud explosion, it is necessary to determine the amount of vapor in the container.

$$m = m_{vapor} = V_{container} * \rho_{liquid} = (M/0.8)*(1/\rho_{liquid})* \rho_{vapor}$$

Finally,

$$m = M (\rho_{vapor}/\rho_{liquid}) / 0.80 \quad (4)$$

where $\rho_{vapor}$ is the vapor density, $\rho_{liquid}$ is the liquid density, and M and m are defined previously.

Therefore, for the confined VCE, combining equations (1), (3), ( 4) and assumption that the blast energy potentially available from detonations of confined vapor clouds is a TNT mass equivalence of 240 percent, yields

$$R \geq 45 \, [(2.40/0.80) \, M \, (\rho_{vapor}/\rho_{liquid}) \, (HC_{commodity} / HC_{TNT})]^{1/3} \quad (5)$$

Where R = The safe distance to an overpressure of 1 psi (feet)

M = The mass of the maximum cargo of that commodity (lbm)

$\rho_{vapor}$ = The vapor density (lbm/ft3)

$\rho_{liquid}$ = The liquid density (lbm/ft3)

$HC_{commodity}$ = The heat of combustion of the commodity (kJ/kg)

$HC_{TNT}$ = The heat of combustion of TNT (4,680 kJ/kg)

The vapor density in Equation (5) is derived from the ideal gas law

$$\rho_{vapor} = (P*MW)/(R*T)$$

where P is the absolute pressure, R is the universal gas constant, T is the absolute temperature and MW is molecular weight.

Unconfined Local Vapor Cloud Explosions

Regulatory Guide 1.91 states that for "detonations of vapor clouds formed after an accidental release," "there have been accidents in which estimates of the calorific energy released were as high as 10 percent." For the most conservative free VCE case in terms of the mass involved in the VCE, all of the possible storage mass is involved in the VCE. For VCEs remote to the site, this is overly conservative and dispersion effects should be taken into account. Therefore, for the local VCE, combining equations (1) and (3), and assumptions above, the distance to a 1 psi overpressure is found by

$$R \geq 45 \, [0.10*M*(HC_{commodity} / HC_{TNT})]^{1/3}$$

where R = The safe distance to an overpressure of 1 psi (feet)

M = The mass of the maximum cargo of that commodity (lbm)

$HC_{commodity}$ = The heat of combustion of the commodity (kJ/kg)

$HC_{TNT}$ = The heat of combustion of TNT (4,680 kJ/kg)

The results for commodities that did not meet the screen criteria stored at Maple Industries, Inc. site can be seen in the table below:

| Maple Industries | | | | |
|---|---|---|---|---|
| | | Isopropyl Alcohol | Gasoline (Petroleum Distillate) | Cyclohexylamine |
| Maximum Storage Size | lbs. | [See new FSAR Table 2.2-203] | | |
| Heat of Combustion | Value | 33,380 | 46,800 | 41,050 |
| | Units | kJ/kg | kJ/kg | kJ/kg |
| Molecular Wt | | 60 | 110 | 99.2 |
| Vapor density | $lb_m/ft^3$ | 0.1614 | 0.2955 | 0.2665 |
| Liquid Density | $lb_m/ft^3$ | 49.30 | 49.92 | 53.66 |
| Distance to Overpressure: Confined VCE | miles | 0.09 | 0.13 | 0.05 |
| Distance to Overpressure: Local VCE | miles | 0.19 | 0.23 | 0.10 |
| Explosion Distance from Site | miles | 3.79 | 3.79 | 3.79 |
| "At Risk" Length | miles | No Risk to Site | No Risk to Site | No Risk to Site |

This response is PLANT-SPECIFIC.

**ASSOCIATED BLN COL APPLICATION REVISIONS:**

1. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.1.3, will be revised to add the following sentence after the last paragraph:

The masses of commodities involved in fixed location vapor cloud explosions are summarized in Table 2.2-214.

2. COLA Part 2, FSAR, Chapter 2, Table 2.2-203 will be revised from:

TABLE 2.2-203

HAZARDOUS MATERIALS AT MAPLES INDUSTRIES

| Chemical Inventory |
| --- |
| #2 Diesel Fuel |
| Ammonia |
| Caustic Soda (Solution) |
| Fatty Amine Ethoxylate Mixture |
| Glycol Component Mixture |
| Hydrogen Peroxide (Aqueous Solution) |
| Isopropyl Mixture |
| Phosphoric Acid |
| Sodium Hydroxide |
| Sodium Hydroxide (Bleach Mixture) |
| Sodium Hypochlorite Solution |
| Sodium Hypochlorite |
| Sulfuric Acid |
| Tanaprint (Mixture) |

To read:

***Security-Related Information — Withheld Under 10 CFR 2.390(d)***
***(see COL Application Part 9)***

Table 2.2-203

Hazardous Materials at Maple Industries

| Chemical Inventory | Maximum Amount (lbs) |
| --- | --- |
| Sodium Hydroxide | [ ] |
| Sodium Hydroxide | [ ] |
| Phosphoric Acid | [ ] |
| Sodium Hypochlorite | [ ] |
| Hydrogen Peroxide | [ ] |
| Acetic Acid | [ ] |

| | |
|---|---|
| Acetic Acid | [ ] |
| Citric Acid | [ ] |
| Citric Acid | [ ] |
| Calcium Hydroxide | [ ] |
| Sodium Thiosulfate Liquid | [ ] |
| Sodium Hydrosulfite | [ ] |
| Chromium Dye Compound | [ ] |
| Silicon Polymer | [ ] |
| Surfactant | [ ] |
| Copper Compound | [ ] |
| Amino Polysiloxane | [ ] |
| Isopropyl Alcohol | [ ] |
| EDTA | [ ] |
| Phosphanomethyl Amine | [ ] |
| Maleic Anhydride | [ ] |
| Petroleum Distillate | [ ] |
| Diethylene Glycol Butyl Ether | [ ] |
| Potassium Hydroxide | [ ] |
| Sodium Sulfite | [ ] |
| Lithium Hydroxide | [ ] |
| Triethanolamine | [ ] |
| Glycol Component | [ ] |
| Butanedioc Acid | [ ] |
| Diethylaminoethanol | [ ] |
| Diethylhydroxylamine | [ ] |
| Cyclohexylamine | [ ] |
| Monoethanol Amine | [ ] |
| Fatty Amine | [ ] |
| Ethoxylated Alcohol | [ ] |
| Ammonium Hydroxide | [ ] |
| Zinc Compound | [ ] |
| Sulfuric Acid | [ ] |
| Diesel Fuel | [ ] |

3. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.1, will be revised to add the following general discussion of determination of safe standoff distances:

Determination of safe standoff distances considered explosion of solid substances both intended and unintended for use as explosive, confined VCE, and local unconfined VCE.

Solid Material Explosion

Regulatory Guide 1.91 cites an inequality for R, the minimum safe distance to an overpressure of 1 psi, as

$$R \geq 45\ W^{1/3} \qquad (1)$$

Where W = equivalent mass of trinitrotoluene (TNT) (lbm), and R is in feet.

Regulatory Guide 1.91 states "For solid substances not intended for use as explosives but subject to accidental detonation, it is conservative to use TNT equivalence of one in establishing safe standoff distances, i.e., use the cargo mass." Therefore, the equivalent mass of TNT in this scenario is estimated as W equals M, where M is the mass of maximum cargo of that commodity. Equation **(1)** becomes

$$R \geq 45\ M^{1/3} \qquad (2)$$

For those substances intended for usage as an explosive Equation **(2)** becomes

$$R \geq 45\ [(RE)^*M]^{1/3} \qquad (2A)$$

where RE = the relative effectiveness factor. This is the measurement of an explosive's power for military purposes, and is used to compare an explosive's effectiveness relative to TNT by weight only.

Confined Vapor Cloud Explosion

The equivalent mass of TNT for other commodities for the VCE is found by

$$W = m\ (HC_{commodity}\ /HC_{TNT}) \qquad (3)$$

where m = the mass of the commodity in question and HCTNT and $HC_{commodity}$ are the heats of combustion of TNT and the commodity, respectively. The heat of combustion for TNT is 4,680 kJ/kg.

The enclosed vapor cloud explosion scenario assumes that the container has been breached and sufficient material has been lost to leave a vapor space filled with an explosive gas mixture. An ignition source is introduced and combustion occurs. Due to the confined space, the internal pressure rises rapidly and eventually ruptures the container. This magnifies the detonation effects. The blast energy has a mass equivalence of 240 percent. The mass of explosive gas mixture that can be confined in the hold of the barge is limited by the vapor space volume available. The analysis assumes the entire hold was void of any liquid thus maximizing the mass of the explosive vapor mixture. The mass of the commodity involved in a confined vapor space explosion is derived by the following:

$$M_{full} = M/0.8$$

where $M_{full}$ is the mass of the commodity needed to fill the entire container and M is the maximum possible storage amount of that quantity. The 80% factor is based on assumption that the volume of the storage container is initially assumed to be 80% full of liquid, with 20% vapor space remaining. This implicitly assumes that the mass values of commodity involved constitute the liquid portion of the container. This assumption effectively assigns an additional 20% container volume on top of the volume necessary to house the maximum liquid mass. Further, in deriving the mass of the commodity retained in the enclosed container, it is assumed the entire hold is filled with vapor.

The volume of the container is,

$$V=M_{full} / \rho_{liquid} = (M/0.8)*(1/ \rho_{liquid})$$

In order to quantify the material involved in the confined vapor cloud explosion, it is necessary to determine the amount of vapor in the container.

$$m= m_{vapor}= V_{container}* \rho_{liquid}= (M/0.8)*(1/ \rho_{liquid})* \rho_{vapor}$$

Finally,

$$m = M (\rho_{vapor}/\rho_{liquid}) / 0.80 \quad (4)$$

where $\rho_{vapor}$ is the vapor density, $\rho_{liquid}$ is the liquid density, and M and m are defined previously.

Therefore, for the confined VCE, combining equations (1), (3),( 4) and assumption that the blast energy potentially available from detonations of confined vapor clouds is a TNT mass equivalence of 240 percent, yields

$$R \geq 45 [(2.40/0.80) M (\rho_{vapor}/\rho_{liquid}) (HC_{commodity} /HC_{TNT})]^{1/3} \quad (5)$$

Where R = The safe distance to an overpressure of 1 psi (feet)

M = The mass of the maximum cargo of that commodity (lbm)

$\rho_{vapor}$ = The vapor density (lbm/ft3)

$\rho_{liquid}$ = The liquid density (lbm/ft3)

$HC_{commodity}$ = The heat of combustion of the commodity (kJ/kg)

$HC_{TNT}$ = The heat of combustion of TNT (4,680 kJ/kg)

The vapor density in Equation (5) is derived from the ideal gas law

$$\rho_{vapor}=(P*MW)/(R*T)$$

where P is the absolute pressure, R is the universal gas constant, T is the absolute temperature and MW is molecular weight.

<u>Unconfined Local Vapor Cloud Explosions</u>

Regulatory Guide 1.91 states that for "detonations of vapor clouds formed after an accidental release," "there have been accidents in which estimates of the calorific energy released were as high as 10 percent." For the most conservative free VCE case in terms of the mass involved in the VCE, all of the possible storage mass is involved in the VCE. For VCEs remote to the site, this is overly conservative and dispersion effects should be taken into account. Therefore, for the local VCE, combining equations (1) and (3), and assumptions above, the distance to a 1 psi overpressure is found by

$$R \geq 45 [0.10*M*(HC_{commodity} /HC_{TNT})]^{1/3}$$

where R = The safe distance to an overpressure of 1 psi (feet)

M = The mass of the maximum cargo of that commodity (lbm)

$HC_{commodity}$ = The heat of combustion of the commodity (kJ/kg)

$HC_{TNT}$ = The heat of combustion of TNT (4,680 kJ/kg)

4. COLA Part 2, FSAR, Chapter 2, Section 2.2, will be revised to add the following Table 2.2-214:

Table 2.2-214

Masses of Commodities Involved in Fixed Location VCE

| Maple Industries | | | | |
|---|---|---|---|---|
| | | Isopropyl Alcohol | Gasoline (Petroleum Distillate) | Cyclohexylamine |
| Maximum Storage Size | lbs. | [See Table 2.2-203] | | |
| Heat of Combustion | Value | 33,380 | 46,800 | 41,050 |
| | Units | kJ/kg | kJ/kg | kJ/kg |
| Molecular Wt | | 60 | 110 | 99.2 |
| Vapor density | $lb_m/ft^3$ | 0.1614 | 0.2955 | 0.2665 |
| Liquid Density | $lb_m/ft^3$ | 49.30 | 49.92 | 53.66 |
| Distance to Overpressure: Confined VCE | miles | 0.09 | 0.13 | 0.05 |
| Distance to Overpressure: Local VCE | miles | 0.19 | 0.23 | 0.10 |
| Explosion Distance from Site | miles | 3.79 | 3.79 | 3.79 |
| "At Risk" Length | miles | No Risk to Site | No Risk to Site | No Risk to Site |

| Great Western Products | | | | |
|---|---|---|---|---|
| | | Calfoam | Isopropyl Alcohol | Glycol Ether PM |
| Maximum Storage Size | lbs. | [See Table 2.2-215] | | |
| Heat of Combustion | Value | 29,670 | 33,380 | 26,000 |
| | Units | kJ/kg | kJ/kg | kJ/kg |
| | kJ/kg | 29,670 | 33,380 | 26,000 |
| Molecular Wt | | 414 | 60 | 90 |
| Vapor density | $lb_m/ft^3$ | 1.1121 | 0.1614 | 0.2418 |
| Liquid Density | $lb_m/ft^3$ | 64.90 | 49.30 | 57.41 |

| | | | | |
|---|---|---|---|---|
| Distance to Overpressure: Confined VCE | miles | 0.09 | 0.06 | 0.03 |
| Distance to Overpressure: Local VCE | miles | 0.12 | 0.12 | 0.05 |
| Explosion Distance from Site | miles | 1.49 | 1.49 | 1.49 |
| "At Risk" Length | miles | No Risk to Site | No Risk to Site | No Risk to Site |

5. COLA Part 9, Withheld Information, will be revised to include a complete Table 2.2-203 as shown in Attachment 02.02.03-03A.

**ATTACHMENTS/ENCLOSURES:**

Attachment 02.02.03-03A (contains ***Security-Related Information — Withheld Under 10 CFR 2.390***)

**NRC Letter Dated: June 9, 2009**

**NRC Review of Final Safety Analysis Report**

**NRC RAI NUMBER: 02.02.03-04**

In section 2.2.2.2.4 (page 2.2-5), with respect to Great Western Products, the application states that "no hazardous materials are listed as being stored at this location." However, in Section 2.2.3.1.1.3, on page 2.2-16, the application indicates that an assessment was performed to evaluate potential hazards of chemicals stored at the Great Western Products facility and that based on an initial screening, three chemicals needed further analysis with respect to potential adverse impacts to the proposed site from an accident at that facility. Please explain how these statements are consistent, explain the basis for the initial screening process used (including which chemicals and amounts were considered), and clarify how the three chemicals (isopropyl alcohol, Calfoam, and Glycol Ether PM) were selected for further analysis and evaluated. Please also explain how the resulting safe standoff distances were calculated.

**BLN RAI ID: 429**

**BLN RESPONSE:**

The basis for the screening process was the assumption that commodities with flash points greater than 38 °C (100°F) are not considered credible explosion threats. The National Fire Protection Association Hazard Identification System (NFPA 704M) cites this temperature as the transition point between flammability hazard ratings two and three (moderate hazard and serious hazard, respectively). Therefore only hazards classified as three or four (serious hazard and severe hazard, respectively) were considered in the analysis. Some commodities that may form a vapor cloud that will support a flame, but are known to have chemical properties such that an open vapor cloud will form a deflagration rather than a detonation. Some commodities are water soluble, so a spill onto water will disperse the material rather than form a large vapor cloud. Such commodities may still have risks associated with enclosed vapor cloud explosions, but free vapor cloud explosions will not pose a legitimate risk and can be eliminated from further consideration.

*Isopropyl Alcohol* - has a lower explosive limit (LEL) of approximately 2% and a UEL of 12%. It has a flash point of 11.7°C(<38 °C required). Therefore, it was selected for further analysis and evaluated.

*Calfoam* ® - has a flash point of about 74°F (<100 °F required). Therefore, it was selected for further analysis and evaluated.

*Glycol Ether PM* - has a LEL of approximately 1.9% and a UEL of 13.1%. It has a flash point of 30°C(<38 °C required). Therefore, it was selected for further analysis and evaluated.

The statement currently in Subsection 2.2.2.2.4 of the FSAR that states no hazardous materials are stored at Great Western Products was originally based on information reported to the Jackson County Emergency Management Agency. Subsequent contact with Great Western Products yielded a list of hazardous chemicals stored at the facility and their respective quantities. A new FSAR Table 2.2-215 (as shown in the Application Revisions section below) will be added to indicate the inventory of raw materials at Great Western Products.

Determination of safe standoff distances considered explosion of solid substances both intended and unintended for use as explosive, confined Vapor Cloud Explosion (VCE), and local unconfined VCE.

Solid Material Explosion

Regulatory Guide 1.91 cites an inequality for R, the minimum safe distance to an overpressure of 1 psi, as

$$R \geq 45\ W^{1/3} \tag{1}$$

Where W = equivalent mass of trinitrotoluene (TNT) (lbm), and R is in feet.

Regulatory Guide 1.91 states "For solid substances not intended for use as explosives but subject to accidental detonation, it is conservative to use TNT equivalence of one in establishing safe standoff distances, i.e., use the cargo mass." Therefore, the equivalent mass of TNT in this scenario is estimated as W equals M, where M is the mass of maximum cargo of that commodity. Equation **(1)** becomes

$$R \geq 45\ M^{1/3} \tag{2}$$

For those substances intended for usage as an explosive Equation **(2)** becomes

$$R \geq 45\ [(RE)*M]^{1/3} \tag{2A}$$

where RE = the relative effectiveness factor. This is the measurement of an explosive's power for military purposes, and is used to compare an explosive's effectiveness relative to TNT by weight only.

Confined Vapor Cloud Explosion

The equivalent mass of TNT for other commodities for the VCE is found by

$$W = m\ (HC_{commodity}\ /HC_{TNT}) \tag{3}$$

where m = the mass of the commodity in question and HCTNT and $HC_{commodity}$ are the heats of combustion of TNT and the commodity, respectively. The heat of combustion for TNT is 4,680 kJ/kg.

The enclosed vapor cloud explosion scenario assumes that the container has been breached and sufficient material has been lost to leave a vapor space filled with an explosive gas mixture. An ignition source is introduced and combustion occurs. Due to the confined space, the internal pressure rises rapidly and eventually ruptures the container. This magnifies the detonation effects. The blast energy has a mass equivalence of 240 percent. The mass of explosive gas mixture that can be confined in the container is limited by the vapor space volume available. The analysis assumes the entire container was void of any liquid thus maximizing the mass of the explosive vapor mixture. The mass of the commodity involved in a confined vapor space explosion is derived by the following:

$$M_{full} = M/0.8$$

where $M_{full}$ is the mass of the commodity needed to fill the entire container and M is the maximum possible storage amount of that quantity. The 80% factor is based on assumption that the volume of the storage container is initially assumed to be 80% full of liquid, with 20% vapor space remaining. This implicitly assumes that the mass values of commodity involved constitute the liquid portion of the container. This assumption effectively assigns an additional 20% container volume on top of the volume necessary to house the maximum liquid mass. Further, in deriving the mass of the commodity retained in the enclosed container, it is assumed the entire container is filled with vapor.

The volume of the container is,

$$V=M_{full} / \rho_{liquid} = (M/0.8)*(1/ \rho_{liquid})$$

In order to quantify the material involved in the confined vapor cloud explosion, it is necessary to determine the amount of vapor in the container.

$$m= m_{vapor}= V_{container}* \rho_{liquid}= (M/0.8)*(1/ \rho_{liquid})* \rho_{vapor}$$

Finally,

$$m = M (\rho_{vapor}/\rho_{liquid}) / 0.80 \quad (4)$$

where $\rho_{vapor}$ is the vapor density, $\rho_{liquid}$ is the liquid density, and M and m are defined previously.

Therefore, for the confined VCE, combining equations (1), (3),(4) and the assumption that the blast energy potentially available from detonations of confined vapor clouds is a TNT mass equivalence of 240 percent, yields

$$R \geq 45 \, [(2.40/0.80) \, M \, (\rho_{vapor}/\rho_{liquid}) \, (HC_{commodity} / HC_{TNT})]^{1/3} \quad (5)$$

Where R = The safe distance to an overpressure of 1 psi (feet)

M = The mass of the maximum cargo of that commodity (lbm)

$\rho_{vapor}$ = The vapor density (lbm/ft3)

$\rho_{liquid}$ = The liquid density (lbm/ft3)

$HC_{commodity}$ = The heat of combustion of the commodity (kJ/kg)

$HC_{TNT}$ = The heat of combustion of TNT (4,680 kJ/kg)

The vapor density in Equation (5) is derived from the ideal gas law

$$\rho_{vapor}=(P*MW)/(R*T)$$

where P is the absolute pressure, R is the universal gas constant, T is the absolute temperature and MW is molecular weight.

Unconfined Local Vapor Cloud Explosions

Regulatory Guide 1.91 states that for "detonations of vapor clouds formed after an accidental release," "there have been accidents in which estimates of the calorific energy released were as high as 10 percent." For the most conservative free VCE case in terms of the mass involved in the VCE, all of the possible storage mass is involved in the VCE. For VCEs remote to the site, this is overly conservative and dispersion effects should be taken into account. Therefore, for the local VCE, combining equations (1) and (3), and assumptions above, the distance to a 1 psi overpressure is found by

$$R \geq 45 \, [0.10*M*(HC_{commodity} / HC_{TNT})]^{1/3}$$

where R = The safe distance to an overpressure of 1 psi (feet)

M = The mass of the maximum cargo of that commodity (lbm)

$HC_{commodity}$ = The heat of combustion of the commodity (kJ/kg)

$HC_{TNT}$ = The heat of combustion of TNT (4,680 kJ/kg)

The results for commodities that did not meet the screen criteria stored at Great Western Products site can be seen in the new FSAR Table 2.2-215 as shown in the Application Revisions section below.

This response is PLANT-SPECIFIC

**ASSOCIATED BLN COL APPLICATION REVISIONS:**

1. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.2.2.4, will be revised from:

Great Western Products has no plans to expand this manufacturing facility (Reference 206). According to the Jackson County Emergency Management Agency, no hazardous materials are listed as being stored at this location.

To read:

Great Western Products has no plans to expand this manufacturing facility (Reference 206). A list of potentially hazardous materials stored at this location is shown in Table 2.2-215.

2. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.1.3, will be revised to add the following new sentence to the end of the last paragraph as shown in the response to NRC RAI No. 02.02.03-03.

3. COLA Part 2, FSAR, Chapter 2, Section 2.2, will be revised to add new Table 2.2-215 to read:

***Security-Related Information — Withheld Under 10 CFR 2.390(d)***

***(see COL Application Part 9)***

Table 2.2-215

List of Raw Materials at Great Western Products

| Item | Description | Quantity |
|---|---|---|
| 67108 | Dye Pink | [ ] |
| 67109 | Fragrance Pink Floral | [ ] |
| 67110 | Fragrance Lemon/Lime | [ ] |
| 67111 | Fragrance Clean Fresh | [ ] |
| 67112 | Fragrance Arylene | [ ] |
| 67114 | Fragrance Cherry | [ ] |
| 67115 | Fragrance Fresh Linen | [ ] |

| | | |
|---|---|---|
| 67119 | Dye Dark Blue | [ ] |
| 67144 | Fragrance Pine Oil | [ ] |
| 67105 | Dye | [ ] |
| 67106 | Dye | [ ] |
| 67107 | Dye | [ ] |
| 67118 | Dye | [ ] |
| 67036 | Floor Absorbent | [ ] |
| 67146 | Surfonc/T DET N | [ ] |
| 67148 | Tergiton/NP-9 | [ ] |
| 67152 | Calfoam/SLES ES-60 | [ ] |
| 67154 | Trisodiumphosphate | [ ] |
| 67156 | Petro BA Liquid | [ ] |
| 67158 | Tetrapotassium pyrophosphate TKPP | [ ] |
| 67160 | Glycol Ether EB | [ ] |
| 67165 | Dodecylbenzene Sulfonic Acid | [ ] |
| 61766 | Caustic potash liquid | [ ] |
| 67170 | Mackamide/Clamide C/Ninol 40-C | [ ] |
| 67172 | D-Limonene | [ ] |
| 67174 | Isopropyl Alcohol | [ ] |
| 67201 | Dissolvine/EDTA | [ ] |
| 67202 | Sodium metasilicate pentahyd | [ ] |
| 67210 | Monoethanolamine | [ ] |
| 67212 | Sodium hydroxide/caustic soda liquid | [ ] |
| 67214 | Oxalic Acid | [ ] |
| 67216 | Phosphoric Acid 75% | [ ] |
| 67218 | Glycol Ether PM/PGE Solvent PM | [ ] |
| 67220 | Mackam/Amphosol | [ ] |
| 67222 | Sodium Silicate | [ ] |
| 67224 | Sodium Xylene Sulfonate | [ ] |
| 67225 | Sodium tripolyphosphate | [ ] |
| 67226 | Tomadol/Alcohol ethoxylate | [ ] |
| 67227 | Triethanolamine/TEA | [ ] |
| 67229 | Acusol-Opacifier | [ ] |
| 67231 | BTC 2125/Ammonium Chloride | [ ] |

| | | |
|---|---|---|
| 67232 | Sodium Gluconate Food Grade | [ ] |
| 67234 | Glycol Ether DB | [ ] |
| 67236 | DPM | [ ] |
| 67238 | Berol DGR 81 | [ ] |
| 67239 | Lonza Bardac 208M/Benzyl Ammonium Chloride | [ ] |
| 67242 | Lonza FMB A0-8 | [ ] |
| 67243 | Lonza FMB 1210-8 Quat | [ ] |

4. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.1, will be revised to add the general discussion of determination of safe standoff distances as shown in the response to NRC RAI No. 02.02.03-03.

5. COLA Part 2, FSAR, Chapter 2, Section 2.2, will be revised to add new Table 2.2-214 as shown in the response to NRC RAI No. 02.02.03-03.

6. COLA Part 9, Withheld Information, will be revised to include a complete Table 2.2-215 as shown in Attachment 02.02.03-04A.

**ATTACHMENTS/ENCLOSURES:**

Attachment 02.02.03-04A (contains ***Security-Related Information — Withheld Under 10 CFR 2.390***)

**NRC Letter Dated: June 9, 2008**

**NRC Review of Final Safety Analysis Report**

**NRC RAI NUMBER: 02.02.03-05**

Provide the tanker truck volume, rail car tanker volume and chemicals, and barge shipment volume used for flammable vapor cloud (delayed ignition) analysis in FSAR Subsection 2.2.3.1.2. Please explain why two rupture sizes were considered. (For Example, an equivalent tank with volume 184,500 gallons at the Fuel Center is used with rupture sizes of 53.8 and 10.7 sq.ft.) Please also provide the tank length, diameter, or width and liquid height, and other input values used in the Areal Location of Hazardous Atmospheres (ALOHA) modeling.

**BLN RAI ID: 430**

**BLN RESPONSE:**

Tanker Truck:

The volume for tanker trucks was conservatively assumed to be 9,000 gallons. This was rounded up from a value of 7,865 gallons based on Iowa Department of Transportation data. The tank dimensions were arbitrarily assumed to be 23.9 ft. long with a diameter of 8 ft. The ALOHA program will not allow a rupture size that is greater than the cross sectional area of the tank or greater than 10 percent of the tank's surface area. For these reasons, two rupture sizes of 10.7 sq. ft. and 48.4 sq. ft. were assumed for tanker truck releases, with the larger of the two rupture sizes approaching the cross sectional area of the tank. The smaller size was arbitrarily chosen to demonstrate that the larger size was bounding. In either case, the sizes are large enough to empty the entire contents in a relatively short period of time. During the run time of the program, the liquid housed in the tanker truck was released from both rupture sizes in the first few minutes, therefore ALOHA's constraints on the maximum hole size do not have an impact on the calculation, nor does the assumed geometry of the tank factor into the results. The spill is practically instantaneous, thus the results are more dependent on the quantity, evaporation and dispersion and less on the geometry and hole size in the tank. Both of the ruptures were conservatively assumed to occur at the bottom of the tank, allowing for the greatest release. The tanker truck scenarios examined were assumed to have tanks that were 100 percent full.

Because almost any commodity can be transported along the highways, various commodities were assumed. Gasoline and propane were analyzed due to the fact that these are commonly transported commodities. Other less popular commodities, such as acetylene, ethylacetylene, ethylene oxide, propylene oxide, and 1,3 propylene oxide were analysed because they are most capable of resulting in a high overpressure in ALOHA (ALOHA User Manual). Hydrogen (which is extremely lighter than air and assumed to dissipate quickly into the atmosphere) and chlorine monoxide (which is a greenhouse gas and consequently is highly regulated or banned) were not considered.

Rail Car Tanker:

The volume for rail tankers was conservatively assumed to be 40,000 gallons. This is rounded up from the 30,240 gallons based on Iowa Department of Transportation data. The tank dimensions were arbitrarily assumed to be 100 ft. long with a diameter of 8.25 ft. The ALOHA program will not allow a rupture size that is greater than the cross sectional area of the tank or greater than 10 percent of the tank's surface area. For these reasons, two rupture sizes of 10.7 sq. ft. and 48.4 sq. ft. were assumed for rail car releases, with the larger of the two rupture sizes approaching the cross sectional area of the tank. The smaller size was arbitrarily chosen to demonstrate that the larger size was bounding. In either case, the sizes are large enough to empty the entire contents in a relatively short period of time. During the run time of the program the liquid housed in the tanker truck was released from both rupture sizes within the first few minutes, therefore ALOHA's constraints do not have an impact on the calculation, nor does the assumed geometry of the tank factor into the results. Both of the ruptures were conservatively assumed to occur at the bottom of the tank, allowing for the greatest release. The rail tanker scenarios examined were assumed to have tanks that were 100 percent full.

Based on data provided by the NSRC for top 25 commodities transported through Hollywood, Alabama listed in FSAR Table 2.2-208, the following chemicals were determined to pose a vapor cloud explosion hazard. Screening of the chemicals was based on the assumption that commodities with flash points greater than 38°C (100°F) are not considered credible explosion threats. The National Fire Protection Association Hazard Identification System (NFPA 704M) cites this temperature as the transition point between flammability hazard ratings two and three (moderate hazard and serious hazard, respectively). Therefore only hazards classified as three or four (serious hazard and severe hazard, respectively) are considered.

- Xylene
- Butane
- Butyralehyde
- Methyl Methacrylate
- Propionaldehyde
- Ammonia
- N-Propanol

However, there may be other undisclosed materials that travel past the BLN site that are not listed by the NSRC in FSAR Table 2.2-208. Therefore, the chemicals most capable of resulting in a high overpressure in ALOHA (ALOHA User Manual) were chosen to be examined in order to account for these unknown commodities. These chemicals are:

- Acetylene
- Ethylacetylene
- Ethylene Oxide
- Propylene Oxide
- 1,3 Propylene Oxide

Hydrogen (which is extremely lighter than air and assumed to dissipate quickly into the atmosphere) and chlorine monoxide (which is a greenhouse gas and consequently is highly regulated or banned) were not considered.

Barge:

The volume for barges was conservatively assumed to be 850,000 gallons. This is rounded up from a value of 453,600 gallons based on Iowa Department of Transportation data. The barge dimensions were arbitrarily assumed to be 100 ft. long with a diameter of 38 ft. Two rupture sizes of 10.7 sq. ft. and 53.8 sq. ft were assumed for barge releases. The larger of these sizes was chosen, based on judgment, to represent a large hole in the barge. The smaller size was chosen to demonstrate that the larger size was bounding. These rupture sizes were arbitrary assumptions and the entire volume of the tank was not released during the run time of the program. To account for larger ruptures and/or greater releases a second scenario was created in ALOHA. This second scenario assumed an instantaneous release of the contents of the barge, which would be the most conservative situation. Both of the ruptures were conservatively assumed to occur at the bottom of the tank, allowing for the greatest release. The barge scenarios examined were assumed to have tanks that were 100 percent full.

Fuel Center:

The volume for the fuel center tank was conservatively assumed to be 185,000 gallons based on information provided by Dicus Oil, the proprietors of the fuel center. Note that this volume is based on the rounded up combined capacity of the tanks at this site, with the largest being 30,000 gallons per FSAR Table 2.2-201. The tank dimensions were arbitrarily assumed to be 100 ft. long with a diameter of 17.7 ft. Two rupture sizes of 10.7 ft. sq. and 53.8 ft. sq. were assumed for fuel center releases. The larger of these sizes was chosen, based on judgment, to represent a large hole in the tank. The smaller size was chosen to demonstrate that the larger size was bounding. These rupture sizes are adequate because of the conservative volume of the tank and the unlikelihood of a stationary tank rupturing in such a catastrophic manner. Both of the ruptures were conservatively assumed to occur at the bottom of the tank, allowing for the greatest release. The fuel center scenarios examined were assumed to have tanks that were 100 percent full.

Release Locations:

The following release locations were analyzed (FSAR Subsection 2.2.1 and FSAR Subsection 2.2.2):

| Location | Distance (miles) |
|---|---|
| US Highway 72 | 1.5 |
| NSRC | 2.5 |
| Tennessee River | 0.65 |
| Dicus Oil | 3.0 |

Weather Conditions:

As discussed in FSAR Subsection 2.2.3.1.2, for each commodity of interest, the vapor dispersion was determined based on a wind speed of 1.8 miles per hour, a Stability Class of D, and a 90°F ambient air temperature. These meteorological conditions were chosen to maximize the vaporization rate of the commodity of interest while limiting the downwind dispersion. The calculation performed a sensitivity of meteorological conditions to demonstrate that this combination is bounding.

This response is PLANT-SPECIFIC.

**ASSOCIATED BLN COL APPLICATION REVISIONS:**

COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.2, will be revised from:

For the evaluation of the potential effects of accidents on U.S. 72, conservatively large tanker truck volumes, based on Alabama Department of Transportation values, were assumed along with assumed rupture sizes of 48.4 sq. ft. and 10.7 sq. ft. Because almost any commodity can be transported along the highways, various commodities were assumed. Gasoline and propane were analyzed due to the fact that these are commonly transported commodities. Other less popular commodities were analyzed that have a relatively high enough reactivity to result in a vapor cloud explosion when the cloud is ignited by a spark or a flame. The evaluation determined that there is a negligible overpressure at the site resulting from a delayed ignition of a vapor cloud and the concentrations remain below the lower explosive limit at the BLN site.

Similarly, for the Norfolk Southern Railroad, various commodities were analyzed. with the ALOHA code, assuming conservatively large tanker sizes, based on Alabama Department of Transportation values, and rupture sizes of 48.4 sq. ft. and 10.7 sq. ft. The evaluation determined that there is a negligible overpressure at the site resulting from a delayed ignition of a vapor cloud and the concentrations remain below the lower explosive limit at the BLN site.

The gasoline stored at the Fuel Center was analyzed assuming tank rupture sizes of 53.8 sq. ft. and 10.7 sq. ft. The evaluation determined that there is a negligible overpressure at the BLN site resulting from a delayed ignition of a vapor cloud and the concentrations at the BLN site are negligible.

The release rate from a postulated barge accident is based on two assumed rupture sizes of 53.8 sq. ft. and 10.7 sq. ft. Based on the screening of the commodities transported via barge past the BLN site, only styrene was identified as having the potential to form an unconfined vapor cloud. The analysis determined that the peak overpressure resulting from a delayed ignition of styrene is 0.309 lb/in$^2$. The maximum concentration of styrene at the BLN site is 5670 ppm, which is less than 52 percent of the lower explosive limit concentration of 11,000 ppm, hence no deflagrations would be expected at the BLN site.

To read:

The volume for tanker trucks was conservatively assumed to be 9,000 gallons. This was rounded up from a value of 7,865 gallons based on Iowa Department of Transportation data. The tank dimensions were arbitrarily assumed to be 23.9 ft. long with a diameter of 8 ft. The ALOHA program will not allow a rupture size that is greater than the cross sectional area of the tank or greater than 10 percent of the tank's surface area. For these reasons, two rupture sizes of 10.7 sq. ft. and 48.4 sq. ft. were assumed for tanker truck releases, with the larger of the two rupture sizes approaching the cross sectional area of the tank. The smaller size was arbitrarily chosen to demonstrate that the larger size was bounding. In either case, the sizes are large enough to empty the entire contents in a relatively short period of time. During the run time of the program, the liquid housed in the tanker truck was released from both rupture sizes in the first few minutes, therefore ALOHA's constraints on the maximum hole size do not have an impact on the calculation, nor does the assumed geometry of the tank factor into the results. The spill is practically instantaneous, thus the results are more dependent on the quantity, evaporation and dispersion and less on the geometry and hole size in the tank. Both of the ruptures were conservatively assumed to occur at the bottom of the tank, allowing for the greatest release. The tanker truck scenarios examined were assumed to have tanks that were 100 percent full.

Because almost any commodity can be transported along the highways, various commodities were assumed. Gasoline and propane were analyzed due to the fact that these are commonly transported commodities. Other less popular commodities, such as acetylene, ethylacetylene, ethylene oxide, propylene oxide, and 1,3 propylene oxide because they are most capable of resulting in a high overpressure in ALOHA (ALOHA User Manual). Hydrogen (which is extremely lighter than air and assumed to dissipate quickly into the atmosphere) and chlorine monoxide (which is a greenhouse gas and consequently is highly regulated or banned) were not considered. The evaluation determined that there is a negligible overpressure at the site resulting from a delayed ignition of a vapor cloud and the concentrations remain below the lower explosive limit at the BLN site.

Similarly, the volume for Norfolk Southern Railroad was conservatively assumed to be 40,000 gallons. This is rounded up from the 30,240 gallons based on Iowa Department of Transportation data. The tank dimensions were arbitrarily assumed to be 100 ft. long with a diameter of 8.25 ft. The ALOHA program will not allow a rupture size that is greater than the cross sectional area of the tank or greater than 10 percent of the tank's surface area. For these reasons, two rupture sizes of 10.7 sq. ft. and 48.4 sq. ft. were assumed for rail car releases, with the larger of the two rupture sizes approaching the cross sectional area of the tank. The smaller size was arbitrarily chosen to demonstrate that the larger size was bounding. In either case, the sizes are large enough to empty the entire contents in a relatively short period of time. During the run time of the program, the liquid housed in the tanker truck was released from both rupture sizes within the first few minutes, therefore ALOHA's constraints do not have an impact on the calculation, nor does the assumed geometry of the tank factor into the results. Both of the ruptures were conservatively assumed to occur at the bottom of the tank, allowing for the greatest release. The rail tanker scenarios examined were assumed to have tanks that were 100 percent full.

Based on data provided by the NSRC for top 25 commodities transported through Hollywood, Alabama, listed in Table 2.2-208, the following chemicals were determined to pose a vapor cloud explosion hazard. Screening of the chemicals was based on the assumption that commodities with flash points greater than 38°C (100°F) are not considered credible explosion threats. The National Fire Protection Association Hazard Identification System (NFPA 704M) cites this temperature as the transition point between flammability hazard ratings two and three (moderate hazard and serious hazard, respectively). Therefore only hazards classified as three or four (serious hazard and severe hazard, respectively) are considered.

- <u>Xylene</u>
- <u>Butane</u>
- <u>Butyralehyde</u>
- <u>Methyl Methacrylate</u>
- <u>Propionaldehyde</u>
- <u>Ammonia</u>
- <u>N-Propanol</u>

However, there may be other undisclosed materials that travel past the BLN site that are not listed by the NSRC in Table 2.2-208. Therefore, the chemicals most capable of resulting in a high overpressure in ALOHA (ALOHA User Manual) were chosen to be examined in order to account for these unknown commodities. These chemicals are:

- Acetylene
- Ethylacetylene
- Ethylene Oxide
- Propylene Oxide
- 1,3 Propylene Oxide

Hydrogen (which is extremely lighter than air and assumed to dissipate quickly into the atmosphere) and chlorine monoxide (which is a greenhouse gas and consequently is highly regulated or banned) were not considered. The evaluation determined that there is a negligible overpressure at the site resulting from a delayed ignition of a vapor cloud and the concentrations remain below the lower explosive limit at the BLN site.

The volume for the fuel center tank was conservatively assumed to be 185,000 gallons based on information provided by Dicus Oil, the proprietors of the fuel center. Note that this volume is based on the rounded up combined capacity of the tanks at this site, with the largest being 30,000 gallons per Table 2.2-201. The tank dimensions were arbitrarily assumed to be 100 ft. long with a diameter of 17.7 ft. Two rupture sizes of 10.7 sq. ft. and 53.8 sq. ft. were assumed for fuel center releases. The larger of these sizes was chosen, based on judgment, to represent a large hole in the tank. The smaller size was chosen to demonstrate that the larger size was bounding. These rupture sizes are adequate because of the conservative volume of the tank and the unlikelihood of a stationary tank rupturing in such a catastrophic manner. Both of the ruptures were conservatively assumed to occur at the bottom of the tank, allowing for the greatest release. The fuel center scenarios examined were assumed to have tanks that were 100 percent full. The evaluation determined that there is a negligible overpressure at the BLN site resulting from a delayed ignition of a vapor cloud and the concentrations at the BLN site are negligible.

The volume for barges was conservatively assumed to be 850,000 gallons. This is rounded up from a value of 453,600 gallons based on Iowa Department of Transportation data. The barge dimensions were arbitrarily assumed to be 100 ft. long with a diameter of 38 ft. Two rupture sizes of 10.7 sq. ft. and 53.8 sq. ft were assumed for barge releases. The larger of these sizes was chosen, based on judgment, to represent a large hole in the barge. The smaller size was chosen to demonstrate that the larger size was bounding. These rupture sizes were arbitrary assumptions and the entire volume of the tank was not released during the run time of the program. To account for larger ruptures and/or greater releases a second scenario was created in ALOHA. This second scenario assumed an instantaneous release of the contents of the barge, which would be the most conservative situation. Both of the ruptures were conservatively assumed to occur at the bottom of the tank, allowing for the greatest release. The barge scenarios examined were assumed to have tanks that were 100 percent full. Based on the screening of the commodities transported via barge past the BLN site, only styrene was identified as having the potential to form an unconfined vapor cloud. The analysis determined that the peak overpressure resulting from a delayed ignition of styrene is 0.309 lb/in2. The maximum concentration of styrene at the BLN site is 5670 ppm, which is less than 52 percent of the lower explosive limit concentration of 11,000 ppm, hence no deflagrations would be expected at the BLN site.

**ATTACHMENTS/ENCLOSURES:**

None

**NRC Letter Dated: June 9, 2008**

**NRC Review of Final Safety Analysis Report**

**NRC RAI NUMBER: 02.02.03-06**

Section 2.2.3.1.3.2.2 of the FSAR states that a preliminary statistical analysis evaluated the general risk from mobile sources. The section states that preliminary risk analysis indicated a low risk, but not lower than $1x10^{-6}$ per year, and, therefore, that a wholly risk-based approach was not considered. Please clarify how the risk analysis was performed and identify the calculated preliminary risk.

**BLN RAI ID: 431**

**BLN RESPONSE:**

**Rail Statistical Analysis**

Regulatory Guide 1.78 section 2 allows and encourages the use of a risk based approach for evaluating hazardous materials. At this time, detailed data from Norfolk Southern regarding chemical quantities and frequencies is not available, precluding a rigorous risk-based analysis. However estimated risk figures can be calculated utilizing publicly available rail accident information from the Federal Railway Administration Office of Safety Analysis, along with specific site data from FSAR Subsection 2.2.2.4. This information is tabulated as follows:

| Totals From NS 1997-2006 Statistic Data | Total |
|---|---|
| HAZMAT RELEASES | 34 |
| Cars carrying hazmat | 2,964 |
| Hazmat cars damaged/derailed | 590 |
| Cars releasing | 62 |
| Total train miles | 889,122,984 |

BLN FSAR Subsection 2.2.2.4 states that an average of 40 trains per day use this route. Therefore total train miles within a 5 mile radius of the BLN site can be calculated per year using:

*Track Length * Frequency = rail miles per year*

*10 (miles) * 40 (trains/day) * 365 (days/year) = 146,000 rail miles per year.*

The risk of hazmat release per mile traveled is calculated by:

*HAZMAT RELEASES / Total train miles = release per mile*

*34 / 889,122,984 = 3.82399E-08 releases per rail mile traveled*

The estimated yearly risk of any hazardous material release is:

*Rail miles per year * release per rail mile traveled = release risk*

*146,000 * 3.82399E-08 =* ***0.00559*** *releases per year.*

Regardless of chemical, the risk of 0.00559 incidents per year is significantly higher than the 0.000001 per year release rate as defined by the NRC in Regulatory Guide 1.78 Section 2 and thus does not preclude further analysis of materials carried along the rail lines.

**Highway Statistical Analysis**

BLN FSAR Subsection 2.2.2.3 describes Highway 72 as having approximately 16720 vehicles per day of traffic. The highway passes relatively close to the BLN site, at approximately 1.5 miles. A 5 mile radius from the BLN site is considered for analysis, therefore 10 miles will be used as the area of Route 72 under concern. Using information taken from the Federal Motor Carrier Safety Administration ("Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents", 2001, prepared by Battelle), the following table can be constructed, which is used for the calculations which relate to highway incidents.

| Item | Value |
|---|---|
| % Truck Travel | 18 |
| % HAZMAT Travel | 5 |
| HAZMAT Accident Rate Per Mile | 3.20E-07 |
| Total Number of Incidents | 2484 |
| HAZMAT 2.3 Accident Rate Per Mile | 2.39E-07 |
| HAZMAT Class 2.3 Miles | 50,300,000 |
| Total HAZMAT Miles Driven | 7,763,000,000 |

The number of vehicle miles per year past the BLN site is calculated as:

*16720 vehicles per day * 10 Miles * 365 days per year = 61028000 vehicle miles per year.*

To calculate HAZMAT risk the accident per mile information is multiplied by the hazmat miles in one year past the site:

*61028000 * 18% * 5% * 3.2E-7 = 1.76E-01 accidents per year*

The most important HM Class/Division for the sake of this calculation is class 2.3, which represents poison gasses. From the above data the percentage of HAZMAT trucks, which are generally Class 2.3 are determined:

% HM 2.3 = 50,300,000 / 7,763,000,000 * 100 = 0.648%.

For Hazardous materials of class 2.3, the above 0.648% factor is added to the above equation, with the appropriate accident rate:

*61028000 * 18% * 5% * .648% * 2.39E-7 = 8.49E-4*

However the incidents do not involve a release of material; the final calculation of release risk involves calculating the actual number of expected hazardous material releases. The following table is a summary from Battelle of the HAZMAT class release rates.

| HM Category | Fire | Explosion | Release-Only | Total |
|---|---|---|---|---|
| 1.1, 1.2, 1.3 | 0.1 | 0.1 | 2 | 2.20 |
| 1.4, 1.5, 1.6 | 0.1 | 0.001 | 9 | 9.10 |
| 2.1 | 7 | 2 | 38 | 47.00 |
| 2.2 | 2 | 0 | 24 | 26.00 |
| 2.3 | 0 | 0 | 2.02 | 2.02 |
| 3 | 50 | 22.0205 | 418 | 490.02 |
| 4.1, 4.2, 4.3 | 0 | 0 | 8 | 8.00 |
| 5.1, 5.2 | 2 | 0 | 27 | 29.00 |
| 6.1, 6.2 | 1 | 0 | 14 | 15.00 |
| 7 | 0 | 0.0005 | 6 | 6.00 |
| 8 | 2 | 0 | 71 | 73.00 |
| 9 | 1 | 0.3 | 59 | 60.30 |
| **All Categories** | **65.2** | **24.422** | **678.02** | **767.64** |
| **% of Total Enroute Release Accidents** | **8.49%** | **3.18%** | **88.33%** | **100.00%** |
| **% of Total Hazmat Accidents** | **2.63%** | **0.98%** | **27.30%** | **30.91%** |

The standard release rate is 767 releases per year. Dividing that by the total number of incidents (2484) yields approximately a 31% release rate.

Taking the 31% release factor and multiplying it with the accident rates gives the following truck accident release risk per year:

Release risk for all Hazmat: 5.45E-02

Release risk for all Hazmat 2.3: 2.63E-04
From these calculations, we see that the total risk for a road based hazardous material release is much higher than the .000001 screening release probability that is required by Regulatory Guide 1.78. Therefore, further analysis on road sources is required.

This response is PLANT-SPECIFIC.

**ASSOCIATED BLN COL APPLICATION REVISIONS:**

1. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.3.2.2, will be revised from:

Preliminary statistical analysis evaluated the general risk from mobile sources of hazardous materials. This preliminary risk analysis indicates that although the accident risk is quite low, it is not less than the evaluation limit of $1x10^{-6}$ per year for mobile sources set in Regulatory Guide 1.78. Therefore, a wholly risk-based approach was not considered.

To read:

Local Railway Analysis

Regulatory Guide 1.78 section 2 allows and encourages the use of a risk based approach for evaluating hazardous materials. At this time, detailed data from Norfolk Southern regarding chemical quantities and frequencies is not available, precluding a rigorous risk-based analysis.

Estimated risk figures can be calculated utilizing publicly available rail accident information along with specific site data from Subsection 2.2.2.4. This information is in Table 2.2-225. Subsection 2.2.2.4 states that an average of 40 trains per day use this route. Therefore total train miles within a 5 mile radius of the BLN site can be calculated:

Track Length * Frequency = rail miles per year

10 (miles) * 40 (trains/day) * 365 (days/year) = 146,000 rail miles per year.

The risk of hazmat release per mile traveled is calculated by:

HAZMAT RELEASES / Total train miles = release per mile

34 / 889,122,984 = 3.82399E-08 releases per rail mile traveled

The estimated yearly risk of any hazardous material release is:

Rail miles per year * release per rail mile traveled = release risk

146,000 * 3.82399E-08 = 0.00559 releases per year.

Regardless of chemical, the risk of .00559 incidents per year is significantly higher than the .000001 per year release rate as defined by the NRC in Regulatory Guide 1.78 Section 2 and thus does not preclude further analysis of materials carried along the rail lines.

Local Highway Analysis

Subsection 2.2.2.3 describes Highway 72 as having approximately 16720 vehicles per day of traffic. The highway passes relatively close to the BLN site, at approximately 1.5 miles. A 5 mile radius from the BLN site is considered for analysis, therefore 10 miles is used as the area of Route 72 under concern. Table 2.2-226 is summarized key input data used for the calculations related to highway incidents.

The number of vehicles traveling past the BLN site is:

16720 vehicles per day * 10 Miles * 365 days per year = 61,028,000 vehicle miles per year

To calculate HAZMAT risk the accident per mile information is multiplied by the hazmat miles in one year past the site:

61028000 * 18% * 5% * 3.2E-7 = 1.76E-01 accidents per year

The most important HM Class/Division for the sake of this calculation is class 2.3, which represents poison gasses. From the data in Table 2.2.-226, the percentage of % HAZMAT trucks which are generally Class 2.3 are calculated:

% HM 2.3 = 50,300,000 / 7,763,000,000 * 100 = 0.648%

For Hazardous materials of class 2.3, the above 0.648% factor is added to the above equation, with the appropriate accident rate:

61028000 * 18% * 5% * .648% * 2.39E-7 = 8.49E-4

However all incidents do not involve a release of material; the final calculation of release risk involves calculating the actual number of expected hazardous material releases. The standard release rate is 767 releases per year. Dividing that by the total number of incidents (2484) yields approximately a 31% release rate. Taking the 31% release factor and multiplying it with the accident rates gives the following truck accident release risk per year. The release risk for all Hazmat transportation is 5.45E-02. The release risk for Hazmat class 2.3 is 2.63E-04. From these calculations we see that the total risk for a road based hazardous material release is much higher than the .000001 screening release probability that is required by Regulatory Guide 1.78. Therefore, further analysis on road sources is required.

2. COLA Part 2, FSAR, Chapter 2, Section 2.2, will be revised to add new Tables 2.2-225 and 2.2-226 to read:

Table 2.2-225

Rail Road Statistical Data

| Totals From NS 1997-2006 Statistic Data | Total |
|---|---|
| HAZMAT RELEASES | 34 |
| Cars carrying hazmat | 2,964 |
| Hazmat cars damaged/derailed | 590 |
| Cars releasing | 62 |
| Total train miles | 889,122,984 |

Table 2.2-226

Highway Statistical Data

| Item | Value |
|---|---|
| % Truck Travel | 18 |
| % HAZMAT Travel | 5 |
| HAZMAT Accident Rate Per Mile | 3.20E-07 |
| Total Number of Incidents | 2484 |
| HAZMAT 2.3 Accident Rate Per Mile | 2.39E-07 |
| HAZMAT Class 2.3 Miles | 50,300,000 |
| Total HAZMAT Miles Driven | 7,763,000,000 |

**ATTACHMENTS/ENCLOSURES:**

None

**NRC Letter Dated: June 9, 2008**

**NRC Review of Final Safety Analysis Report**

**NRC RAI NUMBER: 02.02.03-07**

Please explain in greater detail the chemicals screening analysis discussed in FSAR Subsection 2.2.3.1.3 and the basis for selecting only chlorine for further control room habitability analysis in Chapter 6.4

**BLN RAI ID: 432**

**BLN RESPONSE:**

Appendix A of Regulatory Guide 1.78 outlines a procedure for determining weights of hazardous chemicals for control room evaluation. This procedure is a means of screening out potentially hazardous chemicals. The table in Appendix A of Regulatory Guide 1.78 provides the weights of hazardous chemicals that require further consideration in control room evaluations for a 50 $mg/m^3$ toxicity limit and stable meteorological conditions. The table from appendix A in RG 1.78 is shown below.

| Distance From Control Room (Miles) | Weight (1000 lb) | | |
|---|---|---|---|
| | A.E.R. 0.015/hr | A.E.R. 0.06/hr | A.E.R. 1.2/hr |
| 0.3-0.5 | 9 | 2.25 | 0.11 |
| 0.5-0.7 | 35 | 8.75 | 0.43 |
| 0.7-1.0 | 120 | 30 | 1.5 |
| 1.0-2.0 | 270 | 67.5 | 3.37 |
| 2.0-3.0 | 1300 | 325 | 16.25 |
| 3.0-4.0 | 3700 | 925 | 46.25 |
| 4.0-5.0 | 8800 | 2200 | 110 |

This table provides the maximum weight of a released chemical that will not exceed the toxicity limits in the control room based on the distance from the source to the control room, the air exchange rate of the control room, the toxicity limit of the subject chemical, and the atmospheric stability class. The values in the Appendix A table are based on a 50 $mg/m^3$ toxicity limit and a stability class F. The values in the table are adjusted based on the actual toxicity limits, stability class, and air exchange rate.

The weights in the Appendix A table can be represented mathematically as:
CW = Table Mass * [AER / Actual AER] *[TL / 50] * SCF
where the inputs are defined as:

- Chemical Weight (CW), [this is maximum potential release weight of the subject chemical]
- Table Mass (the value from RG 1.78 Appendix A table)
- Air Exchange Rate of Control Room (AER)
- Toxicity Limit (TL) of the subject chemical
- Atmospheric Stability Class Factor (SCF)
- Distance from Control Room(DC)

**Air Exchange Rate** (AER): Control room volumes and exchange rates were calculated using values from Chapter 15 of the AP1000 DCD.

Volume of HVAC total = 105,500 cubic feet

Air Intake Flow = 1925 Cubic Feet per Minute

Air Exchange Rate (per hour) = Air Flow per Hour / Volume of Room

Air Exchange Rate (per hour) = (1925*60) / 105500 = 1.09 rooms/hour

The Chemical Weight (CW) is the maximum potential release weight of the toxic chemical. For the rail and truck shipments, this is limited to the maximum cargo size. A chlorine rail tank car holds 90 tons (180,000 lbs) of chlorine. This reference weight was used as the transport weight for chlorine and other rail-transported chemicals

A liquefied petroleum tank semi-trailer will hold approximately 42,500 lbs of this chemical. This weight is judged to be a reasonable estimate of cargo capacity for a bulk compressed gas or liquid.

Class G represents the worst 5th percentile condition for the BLN Site. Per RG 1.78, this applies a 0.4 multiplier to the weight calculation.

The maximum weight of a chemical for screening purposes is determined as:

CW = Table Mass * [AER / Actual AER] *[TL / 50] * SCF

Note that since the weight of a particular chemical of concern is determined by the truck or rail tanker size, it is more convenient to use the toxicity limit of a particular chemical as the screening criteria. The above equation is rearranged to solve for the toxicity limits:

TL = CW * [1/Table Mass] * [Actual AER/AER] * 50 * [1/SCF]

The calculation for Rail Toxicity uses the following values:

CW = 180,000 lbs

DC = 2.5 Miles

Actual AER = 1.09

AER = 1.2

Table Mass = 16,250 (for a DC of 2.5 Miles and an AER of 1.2)

SCF = 0.4

TL = 180000 * [1/16250] * [1.09/1.2] * 50 * [1/0.4] = 1385 $mg/m^3$

This approximates to 1400 $mg/m^3$. This means that only chemicals with an IDLH toxicity limit of 1400 $mg/m^3$or lower need be considered for further rail related calculations

The calculation for Truck Toxicity uses the following values:

CW = 42,500 (lbs)

DC = 1.25 Miles

Actual AER = 1.09

AER = 1.2

Table Mass = 3,370 (for a DC of 1.25 Miles and an AER of 1.2)

SCF = 0.4

TL = 42500 * [1/3370] * [1.09/1.2] * 50 * [1/0.4] = 1431.9 $mg/m^3$

This approximates to 1500 $mg/m^3$. This means that only chemicals with an IDLH toxicity limit of 1500 $mg/m^3$or lower need to be considered for further truck related control room habitability calculations.

A commodity survey was conducted on Route 72 in the BLN area in order to find what was being transported by the roadways. The resultant list did not contain any commodities which have toxicity limits lower than 1500 $mg/m^3$. Therefore, no additional evaluation is necessary for road based sources.

The chemicals in FSAR Table 2.2-208 were evaluated against the target IDLH value for rail transport. This list is further screened based on the DOT class shipment information. Engineering judgment dictates that only gaseous compounds are mobile enough to travel in significant quantities through the air for 2.5 miles to reach the control room intake. Gasses are classified as DOT Class 2 chemicals. Further analysis is therefore only conducted on DOT class 2 chemicals.

Based upon this screening analysis, only chlorine and anhydrous ammonia pose a threat to control room habitability and require further evaluation via a more detailed analysis. Where chlorine has an IDLH of 10 ppm and anhydrous ammonia has an IDLH of 300 ppm. Other chemicals are recognized as not being an identified threat by DOT class, or have been screened out via their higher IDLH value.

An analysis was performed on both the anhydrous ammonia and chlorine. It was found through the EXTRAN program that the anhydrous ammonia does not reach IDLH levels inside the control room, whereas chlorine does. Therefore chlorine is the only chemical which poses a threat to the Control Room Habitability.

The chemical inventories at the nearby stationary facilities were reviewed, and similar judgment was used to screen out non-gaseous compounds. The commodities which were gaseous and could pose a threat were not in amounts great enough to warrant any further analysis.

This response is PLANT-SPECIFIC

**ASSOCIATED BLN COL APPLICATION REVISIONS:**

1. COLA Part 2, FSAR, Chapter 2, Subsection 2.2.3.1.3, will be revised from:

Events involving the release of toxic chemicals from onsite storage facilities and nearby mobile and stationary sources are considered for this section. For each identified source and postulated event, the Regulatory Guide 1.78 screening criteria of distance, quantity, and frequency are applied. For releases of hazardous chemicals from stationary sources or from frequently shipped mobile sources in quantities that do not meet the screening criteria, detailed analysis are performed for control room habitability. These detailed analysis are presented in Section 6.4.

To read:

Events involving the release of toxic chemicals from onsite storage facilities and nearby mobile and stationary sources are considered for this section. Appendix A of Regulatory Guide 1.78 outlines a procedure for determining weights of hazardous chemicals for control room evaluation. This procedure is a means of screening out potentially hazardous chemicals. The table in Appendix A of Regulatory Guide 1.78 provides the weights of hazardous chemicals that require further consideration in control room evaluations for a 50 mg/m$^3$ toxicity limit and stable meteorological conditions. The table from appendix A in Regulatory Guide 1.78 is recreated as Table 2.2-224.

Table 2.2-224 provides the maximum weight of a released chemical that will not exceed the toxicity limits in the control room based on the distance from the source to the control room, the air exchange rate of the control room, the toxicity limit of the subject chemical, and the atmospheric stability class. The values in Table 2.2-224 are based on a 50 mg/m$^3$ toxicity limit and a stability class F. These values are adjusted based on the actual toxicity limits, stability class, and air exchange rate.

The weights in Table 2.2-224 can be represented mathematically as:

CW = Table Mass * [AER / Actual AER] *[TL / 50] * SCF

where the inputs are defined as:

- Chemical Weight (CW), [this is maximum potential release weight of the subject chemical]
- Table Mass (the value from RG 1.78 Appendix A table)
- Air Exchange Rate of Control Room (AER)
- Toxicity Limit (TL) of the subject chemical
- Atmospheric Stability Class Factor (SCF)
- Distance from Control Room(DC)

Air Exchange Rate (AER): Control room volumes and exchange rates were calculated using values from Chapter 15 of the AP1000 DCD.

Volume of HVAC total = 105,500 cubic feet

Air Intake Flow = 1925 Cubic Feet per Minute

Air Exchange Rate (per hour) = Air Flow per Hour / Volume of Room

Air Exchange Rate (per hour) = (1925*60) / 105500 = 1.09 rooms/hour

The Chemical Weight (CW) is the maximum potential release weight of the toxic chemical. For the rail and truck shipments, this is limited to the maximum cargo size. A chlorine rail tank car holds 90 tons (180,000 lbs) of chlorine. This reference weight was used as the transport weight for chlorine and other rail-transported chemicals

A liquefied petroleum tank semi-trailer will hold approximately 42,500 lbs of this chemical. This weight is judged to be a reasonable estimate of cargo capacity for a bulk compressed gas or liquid.

Class G represents the worst 5th percentile condition for the BLN Site. Per RG 1.78, this applies a 0.4 multiplier to the weight calculation.

The maximum weight of a chemical for screening purposes is determined as:

CW = Table Mass * [AER / Actual AER] *[TL / 50] * SCF

Note that since the weight of a particular chemical of concern is determined by the truck or rail tanker size, it is more convenient to use the toxicity limit of a particular chemical as the screening criteria. The above equation is rearranged to solve for the toxicity limits:

TL = CW * [1/Table Mass] * [Actual AER/AER] * 50 * [1/SCF]

The calculation for Rail Toxicity uses the following values:

CW = 180,000 lbs

DC = 2.5 Miles

Actual AER = 1.09

AER = 1.2

Table Mass = 16,250 (for a DC of 2.5 Miles and an AER of 1.2)

SCF = 0.4

TL = 180000 * [1/16250] * [1.09/1.2] * 50 * [1/0.4] = 1385 $mg/m^3$

This approximates to 1400 $mg/m^3$. This means that only chemicals with an IDLH toxicity limit of 1400 $mg/m^3$or lower need be considered for further rail related calculations

The calculation for Truck Toxicity uses the following values:

CW = 42,500 (lbs)

DC = 1.25 Miles

Actual AER = 1.09

AER = 1.2

Table Mass = 3,370 (for a DC of 1.25 Miles and an AER of 1.2)

SCF = 0.4

TL = 42500 * [1/3370] * [1.09/1.2] * 50 * [1/0.4] = 1431.9 $mg/m^3$

This approximates to 1500 $mg/m^3$. This means that only chemicals with an IDLH toxicity limit of 1500 $mg/m^3$or lower need to be considered for further truck related control room habitability calculations.

A commodity survey was conducted on Route 72 in the BLN area in order to find what was being transported by the roadways. The resultant list did not contain any commodities which have toxicity limits lower than 1500 PPM. Therefore, no additional evaluation is necessary for road based sources.

The chemicals in Table 2.2-208 were evaluated against the target IDLH value for rail transport. This list is further screened based on the DOT class shipment information. Engineering judgment dictates that only gaseous compounds are mobile enough to travel in significant quantities through the air for 2.5 miles to reach the control room intake. Gasses are classified as DOT Class 2 chemicals. Further analysis is thus only conducted on DOT class 2 chemicals.

Based upon this screening analysis, only chlorine and anhydrous ammonia pose a threat to control room habitability and require further evaluation via a more detailed analysis. Where chlorine has an IDLH of 10 ppm and anhydrous ammonia has an IDLH of 300 ppm. Other chemicals are recognized as not being an identified threat by DOT class, or have been screened out via their higher IDLH value.

An analysis was performed on both the anhydrous ammonia and chlorine. It was found through the EXTRAN program that the anhydrous ammonia does not reach IDLH levels inside the control room, whereas chlorine does. Therefore chlorine is the only chemical which poses a threat to the Control Room Habitability.

The chemical inventories at the nearby stationary facilities were reviewed, and similar judgment was used to screen out non-gaseous compounds. The commodities which were gaseous and could pose a threat were not in amounts great enough to warrant any further analysis.

For releases of hazardous chemicals from stationary sources or from frequently shipped mobile sources in quantities that do not meet the screening criteria, detailed analysis are performed for control room habitability. These detailed analyses are presented in Section 6.4.

2. COLA Part 2, FSAR, Chapter 2, Section 2.2, will be revised to add the following table:

Table 2.2-224

WEIGHTS OF HAZARDOUS CHEMICALS THAT REQUIRE CONSIDERATION IN CONTROL ROOM EVALUATIONS (FOR A 50 mg/m3 TOXICITY LIMIT AND STABLE METEOROLOGICAL CONDITIONS)

| Distance From Control Room (Miles) | Weight (1000 lb) | | |
|---|---|---|---|
| | A.E.R. 0.015/hr | A.E.R. 0.06/hr | A.E.R. 1.2/hr |
| 0.3-0.5 | 9 | 2.25 | 0.11 |
| 0.5-0.7 | 35 | 8.75 | 0.43 |
| 0.7-1.0 | 120 | 30 | 1.5 |
| 1.0-2.0 | 270 | 67.5 | 3.37 |
| 2.0-3.0 | 1300 | 325 | 16.25 |
| 3.0-4.0 | 3700 | 925 | 46.25 |
| 4.0-5.0 | 8800 | 2200 | 110 |

**ATTACHMENTS/ENCLOSURES:**

None