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February 16, 2015

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

Serial No. NA3-14-033RA
Docket No. 52-017
COL/DBE

DOMINION VIRGINIA POWER
NORTH ANNA UNIT 3 COMBINED LICENSE APPLICATION
REVISED RESPONSE TO RAI LETTER 129

On July 18, 2014, the NRC transmitted a letter requesting additional information to support the review of certain portions of the North Anna Unit 3 Combined License Application (COLA), which consisted of one question. Dominion responded to the question in a letter submitted on September 3, 2014 (ML14251A060). After further discussions with the NRC staff, it was determined that a revised response to the Request for Additional Information (RAI) question was required.

The revised response to the RAI question listed below is provided in the attached enclosure:

- RAI 7546, Question 02.02.03-10 Evaluation of Potential Accidents

The revised response supersedes the previous response submitted by Dominion on September 3, 2014.

This information will be incorporated into a future submission of the North Anna Unit 3 COLA, as described in the enclosure.

Please contact Regina Borsh at (804) 273-2247 (regina.borsh@dom.com) if you have questions.

Very truly yours,

Mark D Mitchell

Mark D. Mitchell

D089
NRO

Enclosure:

Revised Response to NRC RAI Letter No. 129, RAI 7546 Question 02.02.03-10

Commitments made by this letter:

This information will be incorporated into a future submission of the North Anna Unit 3 COLA, as described in the enclosure.

COMMONWEALTH OF VIRGINIA

COUNTY OF HENRICO

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mark D. Mitchell, who is Vice President–Generation Construction of Virginia Electric and Power Company (Dominion Virginia Power). He has affirmed before me that he is duly authorized to execute and file the foregoing document on behalf of the Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 16 day of FEBRUARY, 2015

My registration number is ______________ and my

Commission expires: SEPTEMBER 30, 2016

Kathy W. Prokopis
Notary Public

KATHY W. PROKOPIS
NOTARY PUBLIC
MY COMMISSION NUMBER 253183
COMMONWEALTH OF VIRGINIA

cc: U. S. Nuclear Regulatory Commission, Region II
P. H. Buckberg, NRC
T. S. Dozier, NRC
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ENCLOSURE

Revised Response to NRC RAI Letter No. 129

RAI 7546 Question 02.02.03-10

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

North Anna Unit 3

Dominion

Docket No. 52-017

RAI NO.: 7546 (RAI Letter 129)

SRP SECTION: 02.02.03 – EVALUATION OF POTENTIAL ACCIDENTS

DATE OF RAI ISSUE: 7/18/2014

QUESTION NO.: 02.02.03-10

RG 1.206 provides guidance regarding the information that is needed to ensure potential hazards in the site vicinity are identified and evaluated to meet the siting criteria in 10 CFR 100.20 and 10 CFR 100.21. In North Anna 3 COLA FSAR, two 6000 gallon liquid hydrogen storage tanks, and a 13000 liquid hydrogen delivery truck were evaluated and addressed for potential explosion impacts by determining their minimum safe distances. In order for the staff to determine acceptability for the safe distances of the nearest safety related structure (SSC), the staff requests that the applicant provide the following information:

1. North Anna 3 COLA FSAR Table 2.2-204 indicates that for the 6000 gallon liquid hydrogen tank, the minimum safe distance to reach an over pressure of 1 psi due to source explosion is 2009 ft (using RG 1.91) which is greater than the distance of 750 ft. to the nearest safety-related structure. As such, the applicant performed further analysis based on the capability of the safety-related structures to withstand blast/missile effects using Appendix B of the EPRI Guideline NP-5283-SR-A. Using the EPRI method, the applicant determined that the safe separation distance from the source (hydrogen tank) is 495 ft for a source explosion and 677 ft. for a vapor cloud explosion. Since both of these distances are less than the distance to the nearest safety-related structures and the Radwaste Building (750 ft.) from the liquid hydrogen tank, the applicant concluded that the storage of liquid hydrogen would not adversely affect safe operation of Unit 3.

   The staff reviewed the referenced Appendix B of the EPRI guide and the associated safety evaluation report (issued on July 1987). The EPRI method is based on a reinforced concrete wall of at least 18 inches thick with a specified minimum static pressure capacity, a tensile steel factor between 120 psi and 300 psi, and permissible ductility ratio (1.0, 3.0, and 5.0). The staff also noted that in determining the safe distance, the applicant used the following properties for the nearest safety-related structure: (a) concrete wall thickness of 18 inches with a tensile factor of 120 psi, (b) a static wall pressure capacity of 3 psi, and (c) a permissible ductility of 3.0.

The staff noted that the EPRI guide recommends estimating the minimum static wall pressure capacity based on the tornado region for which the wall has been designed. Table 5.1-1 of Tier I ESBWR DCD specifies the tornado pressure drop parameter used for the ESBWR standard plant design to be 2.4 psi. Since the standard plant tornado site parameter pressure drop value (2.4 psi) is less than the assumed pressure capacity (3.0 psi) considered in the analysis using the EPRI guide, the calculated safe distance for the nearest safety-related structure may not be conservative unless the safety-related structures are able to withstand a static pressure of at least 3.0 psi. As such, the applicant is requested to provide in the COLA FSAR Section 2.2.3.1.3 an analysis demonstrating that the standard plant static wall pressure capacity is at least 3.0 psi for the applicable SSCs.

2. For the 13,000 gallon liquid hydrogen delivery truck, the applicant determined minimum safe distance is greater than the actual distance of 750 ft to nearest SSC, and therefore, the applicant performed a screening analysis and determined the expected frequency of a liquid hydrogen explosion to be less than 1x10-6 per year, without providing any details. No additional evaluation of the risk of this potential explosion hazard was performed by the applicant because they had determined the screening criterion for determining the necessity of further evaluation had been met that is provided in Regulatory Guide (RG) 1.91, Evaluations of Explosions Postulated to Occur at Nearby Facilities and on Transportation Routes Near Nuclear Power Plants, Revision 2, April 2013. RG 1.91 indicates that if the frequency of an explosion at a nearby facility or the exposure rate, based on the theory in the Federal Emergency Management Agency's Handbook of Chemical Hazard Analysis Procedures, November 2007 for material in transit, and computed on a best-estimate basis, can be shown to be less than 1x10-7 per year, or less than1x10-6 per year when computed on a conservative-estimate basis, then the risk of damage caused by explosions can be assumed to be sufficiently low without further evaluation. The staff requests the following additional information regarding the explosion hazard of the liquid hydrogen delivery truck in order for them to complete their review of Section 2.2.3 of the FSAR. The applicant should provide a description of the analysis which supports the conclusion that the screening criterion in RG 1.91 has been satisfied. The calculation method, input data, assumptions and results should be provided along with suitable justification of the approach taken, i.e., best-estimate or conservative estimate. Section 2.2.3 of the FSAR should be revised to include this information.

3. RG 1.206 provides guidance regarding the information that is needed to ensure potential hazards in the site vicinity are identified and evaluated to meet the siting criteria in 10 CFR 100.20 and 10 CFR 100.21. In North Anna 3 COLA FSAR, the applicant evaluated a 8500 gallon spill from a gasoline truck by analyzing and

determining the distance of 936 ft to reach the IDLH concentration of 750 ppm. Since this determined distance is less than the actual distance to the control room, the applicant concluded that the toxic concentration of gasoline would not adversely affect the control room habitability. Based on the review of the applicant's analysis for the gasoline tanker truck impact evaluation during the staff's audit performed on June 17, 2014, the staff noticed that the gasoline is modeled as n-Heptane using n-Heptane IDLH value of 750 ppm for the control room habitability. Although, n-Heptane may physically behave similarly as gasoline, n-Heptane would not give the same toxicological effects as that of gasoline. Therefore, the staff considers that using n-Heptane IDLH value of 750 ppm for gasoline is not appropriate. The recommended concentration value for gasoline (in the absence of IDLH concentration) is the Time Weighted Average (TWA) value of 300 ppm, which is considered as applicable IDLH concentration for gasoline but not 750 ppm that is used for the analysis. Hence, the staff requests the applicant to evaluate the control room habitability using the IDLH value of 300 ppm for the gasoline.

Dominion Response:

This revised RAI response supersedes Dominion's response submitted on September 3, 2014 (ML14251A060) to provide the associated analysis and the licensing basis to ensure that the Fuel Building and Radwaste Building meet the safe separation distances for liquid hydrogen. For ease of review, revisions to the original response are presented using redline/strikethrough formatting.

1. Standard Plant Static Wall Pressure Capacity

   The key structures nearest to the liquid hydrogen tank are the Fuel Building (safety-related) and Radwaste Building. The calculations performed for the Fuel Building are based on wall thickness, tensile steel factor, static lateral load capacity, and permissible ductility determined from DCD Figure 3G.3-5. A description of these calculations is included below.

   In a teleconference with the NRC on December 11, 2014, it was explained that the calculation for the Radwaste Building was based on preliminary design details and that the final design is verified through ITAAC. As a result of the discussion, it was determined that the calculation for the Radwaste Building should be deleted from the response and that the requirements for static lateral load capacity should be included in the final design requirements that are verified through ITAAC. Because the final design of the Radwaste Building is not yet available, the North Anna Unit 3 COLA will be revised to specify the Radwaste Building unit parameters required to meet safe separation distances of the liquid hydrogen storage tanks. The ACI 349 calculation methodology will be used to ensure a minimum static lateral load capacity of 3 psi for design of the exterior walls of the Radwaste Building to meet the safe separation distances for 6000 gallons of liquid hydrogen.

Fuel Building Static Capacity

Analysis of the Fuel Building has ~~Analyses have~~ been conducted to demonstrate that the static ~~plant~~ wall pressure capacity is at least 3 psi. ~~for the Fuel Building, which is the safety-related structure nearest to the liquid hydrogen tank, and the Radwaste Building.~~ This analysis ~~These analyses~~, which is ~~are~~ described below, demonstrates that the storage of liquid hydrogen would not adversely affect safe operation of the Unit 3 Fuel Building. ~~Some of the data included in the analyses is taken from preliminary design drawings.~~ A summary of the results of ~~these analyses~~ this analysis will be added to FSAR Section 2.2.3.1.3.

~~Using the method provided in EPRI NP-5283-SR-A (as referenced in Information Notice No. 98-44) and providing conservative values for wall thickness (1.5 ft), tensile steel factor (120 psi), minimum static lateral load capacity (3 psi), and permissible ductility of 3.0, the safe separation distances for 6000 gallons of liquid hydrogen, which is the capacity of each tank, were determined.~~

Using the method consistent with NUREG/CR-2462, the analyseis for determining the static wall pressure capacity for the Fuel Building ~~and Radwaste Building are~~ is provided below:

~~Fuel Building Static Capacity~~

Dimensions:

l = 34 ft. (10, 250 mm) Column FB - FC
t = 40 in. (1,000 mm)
b = 12 in.
d = 40 in. – 2 in. (clr) – 1.410 in. (dia. Bar) – 3 in. (1/2 space) ≈ 34 in.

Determine Ratio of Nonprestressed Tension Reinforcement, ρ:

2 - #11 Bars @ 200 mm (No Compression Steel Considered)
2 x 1.56 in^2 = 3.12 in^2 @ 200 mm
A_s = 3.12 in^2 x 300/200 = 4.68 in^2 @ 300 mm (12 in.)

$$\rho = \frac{A_s}{bd} = \frac{4.68}{(12)(34)} = 0.011$$

Determine Wall Static Capacity, w:

$$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{4.68\ in^2 (60{,}000\ psi)}{0.85(4{,}000\ psi)(12\ in)} = 6.88 \text{ in}$$

$$\Phi M = 0.9 A_s f_y \left[d - \frac{a}{2}\right] = 0.9(4.68\ in^2)(60{,}000\ psi)\left[34\ in - \frac{6.88\ in}{2}\right]$$

= 7,723,123 lb-in/ft
= 643,594 lb-ft/ft

$\Phi M = \frac{wl^2}{8}$

$w = \frac{8\Phi M}{l^2} = \frac{8(643{,}594\ lb-ft)/ft}{(34\ ft)^2}$
= 4,454 psf
= 30.9 psi

Use w = 3 psi

Where:

l	=	span length for positive moment
t	=	wall thickness
b	=	width of compression face of wall section
d	=	distance from extreme compression fiber to centroid of compression reinforcement
ρ	=	ratio of nonprestressed tension reinforcement
A_s	=	area of nonprestressed tension reinforcement
a	=	depth of equivalent rectangular stress block
f_y	=	specified yield strength of nonprestressed reinforcement 60,000 psi
f'_c	=	specified compressive strength of concrete, 4,000 psi
Φ	=	strength reduction factor
M	=	moment capacity of wall section
w	=	wall static capacity

<u>Radwaste Building Static Capacity</u>

<u>Because the design of the Radwaste Building is not yet available, FSAR Section 3.7.2.8.2 will be revised to specify the Radwaste Building exterior wall design parameters to meet the requirements for safe separation distance from the liquid hydrogen storage tanks. The ACI 349 calculation methodology will be used to ensure a minimum static lateral load capacity of 3 psi for the design of the Radwaste Building exterior walls. The ACI Code provides minimum reinforcing steel requirements as well as the methodology for calculating static wall pressure.</u>

<u>In addition, COLA Part 10, Section 2.4.16 and the associated ITAAC, will be revised to ensure that the Radwaste Building exterior walls have minimum static lateral load capacity of 3 psi in order to meet the requirements for safe separation distance from the liquid hydrogen storage tanks.</u>

~~**Dimensions:**~~

~~l_{span} *(max)* = 44.3 ft. (13, 500 mm)~~
~~*t* = 20 in. (500 mm)~~
~~*b* = 12 in.~~
~~*d* = 20 in. – 2 in. (clr) – ½(1 in) = 17.5 in.~~

~~**Determine Ratio of Nonprestressed Tension Reinforcement, *ρ*:**~~

~~Minimum reinforcement of flexural members (ρ = 0.0033)~~
~~ACI 349 Sec. 10.5 Minimum Steel~~
~~Use ρ = 0.0066~~
~~$A_s = \rho bd = (0.0066)(12\ in)(17.5\ in) = 1.4\ in^2$~~

~~**Determine Wall Static Capacity, *w*:**~~

$$\cancel{a = \frac{A_s f_y}{0.85 f'_c b} = \frac{1.4\ in^2 (60{,}000\ psi)}{0.85(4{,}000\ psi)(12\ in)} = 2\ in}$$

$$\cancel{\Phi M = 0.9 A_s f_y \left[d - \frac{a}{2}\right] = 0.9(1.4\ in^2)(60{,}000\ psi)\left[17.5\ in - \frac{2\ in}{2}\right]}$$
~~= 1,247,400 lb-in/ft~~
~~= 103,950 lb-ft/ft~~

$$\cancel{\Phi M = \frac{wl^2}{8}}$$

$$\cancel{w = \frac{8\Phi M}{l^2} = \frac{8(103{,}950\ lb-ft)/ft}{(44.3\ ft)^2}}$$
~~= 423.7 psf~~
~~= 3 psi~~
~~*w* = 3 psi~~

~~Where:~~

~~l~~	~~=~~	~~span length for positive moment~~
~~t~~	~~=~~	~~wall thickness~~
~~b~~	~~=~~	~~width of compression face of wall section~~
~~d~~	~~=~~	~~distance from extreme compression fiber to centroid of compression reinforcement~~
~~ρ~~	~~=~~	~~ratio of nonprestressed tension reinforcement~~
~~As~~	~~=~~	~~area of nonprestressed tension reinforcement~~
~~a~~	~~=~~	~~depth of equivalent rectangular stress block~~
~~fy~~	~~=~~	~~specified yield strength of nonprestressed reinforcement, 60,000 psi~~
~~f'c~~	~~=~~	~~specified compressive strength of concrete, 4,000 psi~~
~~Φ~~	~~=~~	~~strength reduction factor~~
~~M~~	~~=~~	~~moment capacity of wall section~~

~~w = wall static capacity~~

~~The static wall pressure capacity for the Fuel Building and the Radwaste Building using representative values for wall thickness and tensile steel is at least 3 psi.~~

2. Liquid Hydrogen Delivery Truck PRA

A Probabilistic Risk Analysis (PRA) of a liquid hydrogen transport explosion was performed to determine the potential risks. This PRA evaluation followed the methods described in RG 1.91 and supports the conclusion that the screening criteria of RG 1.91 have been satisfied. The analysis method, input data, assumptions, results, and the justification for the approach used are provided below. A summary of the PRA will be added to FSAR Section 2.2.3.

Description of Analysis

A PRA of a liquid hydrogen transport explosion was performed to determine the potential risks. The PRA results are used to determine if the probability and consequences of liquid hydrogen transportation and transfer activities are acceptable per RG 1.91. If the probability is greater than 1E-6 per year when based on conservative assumptions, or 1E-7 per year when based on realistic assumptions, then an assessment of the missile impacts on safety-related structures is made. This PRA was based on conservative assumptions.

Calculation Method

The risk of explosion due to liquid hydrogen delivery truck failure is calculated from the liquid hydrogen release frequency (leak frequency) and hydrogen ignition probabilities. The liquid hydrogen release frequency is based on the initial accident frequency and the probability of release, exposure distance and frequency of deliveries. The hydrogen ignition probabilities (immediate and delayed) are based on industry experience and are used as inputs in an event tree to determine hydrogen leak risk consequences.

This PRA evaluation follows the methods described in RG 1.91. The risk assessment is performed according to RG 1.91 Method 2. Data for risk assessment and frequency/probability calculations are based on the Publication Series on Dangerous Substances (PGS 3), Guidelines for Quantitative Risk Assessment (The Purple Book), December 2005 (Reference 1).

After the frequency of the damaging event (overpressure >1 psi) due to the transportation or transfer of liquid hydrogen is calculated, the following steps are performed:

a) If the frequency of damage event < 1E-6 /yr with conservative assumptions, risk insights are applied

b) If the frequency of damage event ≥ 1E-6 /yr with conservative assumptions, then a missile assessment is performed

For this risk assessment, the Computer Aided Fault Tree Analysis (CAFTA) tool is used for the development of event trees used for scenario development. CAFTA is a non-Level 2 Engineering Computer Program. The CAFTA code is applied for this risk assessment similar to other applications, such as the ESBWR DCD PRA development.

Liquid Hydrogen Release Frequency

The product of the initial accident frequency and the release probability is called the outflow frequency. Generic values (per transport unit km) for different road types are derived for pressurized transport units.

The equation for the liquid hydrogen release frequency (/yr) is defined as follows:

$$f_{release} = \sum (Exposure\ Distance * Outflow\ Frequency) * Delivery\ Frequency$$

Hydrogen Ignition Probabilities

The hydrogen immediate and delayed ignition probabilities are based on INEEL/EXT-99-00522, Safety Issues with Hydrogen as a Vehicle Fuel (Reference 2).

Hydrogen Leak Risk Consequences

To account for the immediate and delayed hydrogen ignition probabilities, the hydrogen leak risk consequences can be developed with an event tree approach. Pool fires and no effect class sequences are not of concern for detonation in this evaluation. All flash fire sequences are conservatively assumed to affect the SSCs of interest.

The flash fire sequence frequencies are below the threshold of 1E-6/yr with bounding assumptions. Therefore, a missile assessment is not required for the risks associated with the liquid hydrogen delivery trucks.

Input Data and Assumptions with Justifications

The following input data and assumptions are used in this risk assessment:

1. The PRA analysis is based on the liquid hydrogen delivery truck servicing two 6,000 gallon liquid hydrogen storage tanks on-site.
2. The liquid hydrogen delivery tanker truck is assumed to have a capacity of 13,000 gallons.

3. The liquid hydrogen delivery tanker truck frequency is conservatively assumed to be 24 deliveries per year for two 6,000 gallon tanks.
4. Based on the analysis results for both the vapor cloud (delayed ignition) scenario estimated from ALOHA and the explosion at the tank source (immediate ignition) assuming a 13,000 gallon liquid hydrogen storage tank failure, the most limiting distance to 1 psi for vapor cloud explosion (VCE) scenarios is 2,275 ft (1 psi and 90% yield). The distance to 1 psi with 15% yield is determined to be 1,546 ft and the distance to 1 psi for source explosion (at the tanker) is 2,600 ft. Therefore, the most limiting required separation distance to 1 psi is assumed to be 2,600 ft.
5. Within a circle centered at either the NA3 Fuel Building or the Radwaste Building and a radius of 2,600 ft, the total driving distance of the liquid hydrogen delivery tanker is about 1.2 km. For conservatism, 1.5 km is assumed in this risk assessment and 1/3 of the total travel distance (0.5 km) is assumed to be outside of the gate and 2/3 of the distance (1.0 km) is inside the gate.
6. Hydrogen storage component failure data is extremely limited. For stationary and delivery truck cryogenic liquid hydrogen storage tanks, the failure rates from the Purple Book (Reference 1), UK Health and Safety Executive (HSE) Failure rates, the Hydrogen Safety Report (Reference 2) and the Department of Energy (DOE) EH-33 Guide (Reference 3) are considered. In addition, input from one of the leading experts on hydrogen detonation at the Sandia National Lab is also considered.
7. It is assumed that 85% of all leaks due to hydrogen delivery truck failures are involved with a small release. This differs from the 75% industry failure rate assumed for stationary storage tanks involved with a small inventory loss. Applying 85% is based on the fact that failure data is not readily available. Applying this assumption produces more conservative results because modeling a small release (which has a lower probability of an immediate ignition) increases the probability of delayed ignition and the probability of a flash fire that results in detonation risk. Immediate ignition for the total inventory loss condition is more likely to result in a pool fire which is less of a concern for detonation.

Results

The case for the hydrogen delivery truck has been evaluated. By applying the immediate and delayed ignition probabilities, the flash fire sequence frequencies have been calculated for this case and the results are summarized below:

Case	Flash Fire Sequences
Liquid Hydrogen Delivery Truck (13,000 gal.)	Leak frequency = 2.31E-7 /yr Flash fire frequency = 4.45E-8 /yr

The results demonstrate that the hydrogen risks due to the transportation vehicle alone are acceptably low (< 1E-6/yr with conservative assumptions). Therefore, no missile assessment is required for the hydrogen risks due to the transportation vehicle.

To validate the above risk results, a review of the historical hydrogen incidents has been performed. The hydrogen incident review confirms the risk evaluation performed (i.e., the catastrophic liquid hydrogen tank failures are highly unlikely). These historical incidents identify human errors during the refueling operation as a potential hydrogen risk contributor. None of the incidents had catastrophic tank failure; safety features on the hydrogen delivery truck and storage system and operator recovery actions were used to isolate the leak and prevent the catastrophic failure.

Justification of the Approach

This PRA evaluation follows the methods described in RG 1.91. Method 2 requires evaluation of the risk for the transportation routes closer to SSCs important to safety than the minimum safe distance computed using RG 1.91 Equation (1). The PRA demonstrates that the rate of exposure to a peak positive incident overpressure in excess of 1.0 psi (6.9 kPa) is less than 1×10^{-6} per year when based on conservative assumptions.

Inputs for risk assessment and frequency/probability calculations are based on best available industry guidelines. Conservative assumptions have been applied when there are uncertainties in the data estimates. The risk assessment methodology is consistent with methods used for other hazard analyses.

A summary of the PRA evaluation, which supports the conclusion that the screening criteria of RG 1.91 have been satisfied, will be added to FSAR Section 2.2.3.1.3.

References:

1. P.A.M. Uijt de Haag and B.J.M. Ale, “Guideline for Quantitative Risk Assessment” 'Purple Book', December 2005. http://infonorma.gencat.cat/pdf/AG_AQR_3_PB_%202005.pdf
2. L. Cadwallader and J. S. Herring, INEEL/EXT-99-00522, “Safety Issues with Hydrogen as a Vehicle Fuel,” September 1999.
3. DOE, EH-33 Guide Rev. 0, “HAZARD AND BARRIER ANALYSIS GUIDANCE DOCUMENT,” November 1996.

3. Gasoline Toxicity Evaluation

The analysis for the gasoline tanker truck impact evaluation was revised to include an additional toxicity evaluation using the 300 ppm Threshold Limit Value-Time Weighted Average (TLV-TWA) for gasoline. The re-analysis concluded that the TLV-TWA selected toxic endpoint was not reached in the control room (CR) and, therefore, the onsite transport of gasoline would not adversely affect the control room habitability. The results of this additional analysis and the basis for Dominion's original analysis are described below.

The toxicity limits specified in RG 1.78 are based on the National Institute for Occupational Safety and Health (NIOSH) Immediately Dangerous to Life and Health (IDLH) standards. The IDLH limit is based on a 30-minute exposure level—that is, at this level it is likely to cause death or immediate or delayed permanent adverse health effects if no protection is afforded within 30 minutes. Thus, when choosing a toxic endpoint for a chemical, it is preferred to select the IDLH value for that chemical.

With respect to gasoline, there is no IDLH standard set by NIOSH. For chemicals where NIOSH has not set an IDLH value, there are multiple ways to address toxicity concerns and select an appropriate toxicity endpoint in the absence of an IDLH value. Dominion's original analysis used a value of 750 ppm, which is the IDLH value of n-heptane, the surrogate used in the toxicity dispersion modeling.

The basis for this selection was as follows:

i. As shown below, the toxicity limits for gasoline are generally similar but less restrictive than n-Heptane. The permissible exposure limits (PEL)/ recommended exposure limit (REL) set by the Occupational Safety and Health Administration, NIOSH, and the American Conference of Governmental Industrial Hygienists (ACGIH) in air are tabulated below for both gasoline and n-Heptane (Sittig 2012):

PEL/REL Criteria	Gasoline	n-Heptane
OSHA PEL	None	500 ppm
NIOSH REL	Potential occupational carcinogen	85 ppm TWA; 440 ppm 15 minute ceiling
ACGIH TLV	300 ppm TWA*; 500 ppm STEL**	400 ppm TWA; 500 ppm STEL

**The TLV-TWA is defined as a Threshold Limit Value (TLV) 8-hour Time Weighted Average (TWA) whereby an employee's exposure to a substance shall not exceed the 8-hour TWA given for that substance in any 8-hour work shift of a 40-hour work week. (29 CFR 1919.1000).*

***The STEL, Short Term Exposure Limit, is the employee's 15-minute time weighted average exposure which shall not be exceeded at any time during a work day unless another time limit is specified in a parenthetical notation below the limit. If another time period is specified, the time weighted average exposure over that time period shall not be exceeded at any time during the working day. (29 CFR 1919.1000).*

Additionally, the Protective Action Criteria (PAC) for gasoline and n-Heptane are tabulated below (Sittig 2012)—AEGLs (Acute Emergency Guideline Levels) & ERPGs (Emergency Response Planning Guideline) are shown.

PAC Criteria	**Gasoline**	**n-Heptane**
PAC-1	200 ppm	440 ppm
PAC-2	1000 ppm	440 ppm
PAC-3	4000 ppm	750 ppm

*The ERPG-1, or **PAC-1,** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient health effects or perceiving a clearly defined, objectionable odor. (CAMEO 2014)*

*The ERPG-2, or **PAC-2,** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action. (CAMEO 2014)*

*The ERPG-3, or **PAC-3,** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects. (CAMEO 2014)*

ii. The ERPG or PAC-2 guideline most closely correlates with the definition of IDLH. This comparison is supported by the U.S. Department of Energy which specifies in DOE O 151.1C that AEGL-2; ERPG-2; and the TEEL-2 [**level -2 PAC**] are to be used in order of preference as PACs for non-radioactive hazardous materials (DOE 2007).

The NRC staff has recommended, in the absence of an IDLH concentration for gasoline, that the more conservative TWA value of 300 ppm for gasoline be used in the revised analysis. The revised analysis has included the TLV-TWA value as the toxic endpoint in the toxicity analysis for gasoline. This revised analysis concluded that the TLV-TWA selected toxic endpoint was not reached in the control room and, therefore, the onsite transport of gasoline would not adversely affect the control room habitability. FSAR Section 2.2.3.3 and FSAR Table 2.2-205 will be revised to incorporate the inclusion of the TLV-TWA toxic endpoint for gasoline.

References

(CAMEO 2014) U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration's Office of Response and Restoration, *Computer-Aided Management of Emergency Operations*, Emergency Response Planning Guidelines available at: http://cameochemicals.noaa.gov/help/cameo_chemicals_help.htm#9_reference/locs/locs.htm, accessed July 2014.

(DOE 2007) U.S. Department of Energy, *Technical Planning Basis, Emergency Management Guide,* DOE G 151.1-2, July 11, 2007.

(Sittig 2012) Pohanish, Richard P., *Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens* (6th Edition).

In addition to evaluating control room habitability using the IDLH value of 300 ppm for gasoline, the NRC reviewers for FSAR Section 6.4 requested two additional factors for the evaluation. A new control room air exchange rate of 0.49 air exchanges per hour for the ventilation system's normal operation was used, as well as an update to the location of the Communications Shelter (NOVEC 1230). FSAR Sections 2.2.3.1.3 and 2.2.3.3 and Tables 2.2-203, 2.2-204 and 2.2-205 will be revised based on the new control room habitability evaluation.

Proposed COLA Revision

FSAR Sections 2.2.3 and 3.7.2.8.2 and FSAR Tables 2.2-203, 2.2-204, 2.2-205, and 2.2-206 (new) will be revised as indicated on the attached markup. In addition, COLA Part 10, Section 2.4.16 and the associated ITAAC, will be revised as shown in the attached markup.

Markup of North Anna COLA

The attached markup represents Dominion's good faith effort to show how the COLA will be revised in a future COLA submittal in response to the subject RAI. However, the same COLA content may be impacted by responses to other COLA RAIs, other COLA changes, plant design changes, editorial or typographical corrections, etc. As a result, the final COLA content that appears in a future submittal may be somewhat different than as presented herein.

delivery truck route is approximately 1033 ft from the nearest Unit 3 safety-related structure (this distance is bounding for the distance to the Radwaste Building, which is considered in accordance with RG 1.143). For a full gasoline truck entering the site, the calculated safe distance to 1 psi is 747 ft, based on a postulated catastrophic failure and ensuing vapor cloud (i.e., the truck spills its total contents and forms a traveling vapor cloud). For a gasoline truck leaving the site, the calculated safe distance to 1 psi is 272 ft, based on a postulated explosion at the truck's location anywhere along the route (i.e., the truck is full of gasoline vapor at the upper flammability limit (UFL)). The methodology used to calculate the safe distance to 1 psi is described in Section 2.2.3.1.3. Because the calculated safe distances do not exceed the separation distances between the point of explosion and the Unit 3 safety-related structures or Radwaste Building, there is no threat posed from a postulated accident involving a gasoline delivery truck.

NAPS ESP COL 2.2-2

2.2.3.1.3 On-Site Chemicals

The chemical materials stored on-site at Units 1, 2, and 3 are identified in Table 2.2-202. This table also identifies storage locations and the quantity of each chemical/material. Properties relative to the hazards of each chemical and the results of a screening analysis based on these hazardous properties are provided in Table 2.2-203. The on-site chemicals with the potential to be flammable or explosive are evaluated for possible effects on Unit 3 safety-related SSCs and the Radwaste Building (in accordance with RG 1.143).

Table 2.2-203 lists the chemicals determined to require a flammable vapor cloud or explosion analysis at Unit 3 as: hydrogen (gas and liquid) and Nalco H-130. Table 2.2-203 lists the chemicals determined to require analysis at Units 1 and 2 as: acetone, ammonium hydroxide (30 percent), Nalco H-130, hydrazine, hydrogen, and carboline #2 paint thinner. Additionally, an 8500 gallon gasoline delivery truck is analyzed for the consequences of a postulated accident. The methodology used to analyze these chemicals is described later in this section.

For each of these chemicals, the minimum safe separation distances resulting from source explosions and flammable vapor clouds (delayed ignition) were determined for comparison with the actual distance from the storage location to the nearest Unit 3 safety-related SSC.

Table 2.2-204 provides the safe separation distances for flammable and explosive materials in relation to the actual distance to the nearest Unit 3 safety-related structure. The results indicate that a fire or explosion from the identified hazardous chemicals and materials stored or transported at Units 1, 2, and 3 would not adversely affect the safe operation or shutdown of Unit 3 (including the Radwaste Building, in accordance with RG 1.143), with the exception of liquid hydrogen stored at Unit 3 and a 13,000 gallon liquid hydrogen delivery truck.

As shown in Table 2.2-204, for the storage of liquid hydrogen in two 6000 gallon tanks and delivery of 13,000 gallons of liquid hydrogen via a delivery truck, the distances to 1 psi of overpressure are greater than the distance to the nearest safety-related structure for both a source explosion and a vapor cloud explosion.

In the case of liquid hydrogen, an analysis was performed, in accordance with RG 1.91, based on the capability of the safety-related structures (and the Radwaste Building, in accordance with RG 1.143) to withstand blast effects associated with the detonation of liquid hydrogen. The explosion at the tank site was analyzed using the Electric Power Research Institute (EPRI) recommended methods in NP-5283-SR-A, "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations - 1987 Revision," Appendix B (Reference 2.2-217). The EPRI method used is based on a reinforced concrete wall at least 1.5 ft thick, a tensile steel factor between 120 psi and 300 psi, and the minimum static lateral load capacities for the tornado intensity region in which the plant is located. The properties used for the nearest safety-related structure (the Fuel Building) and Radwaste Building are 18 inches of concrete, 120 psi tensile steel factor, 3 psi of static pressure capacity, and a permissible ductility of 3.0. Using methodology provided in NUREG/CR-2462 and applying representative structural properties, the static wall pressure capacity for the Fuel Building is determined to be at least 3 psi. Section 3.7.2.8.2 describes the Radwaste Building (RW) design features that ensure safe separation distance from liquid hydrogen storage tanks. To determine the effects associated with a vapor cloud explosion, the ALOHA model is used to simulate the travel of the cloud and obtain the mass of hydrogen in the cloud for the determined worst-case detonation scenario modeled by ALOHA. The EPRI method is then used with the mass ALOHA provides to determine a safe separation distance. Using the methods described in this paragraph, the safe separation distances of these distances are less than the distance from the liquid hydrogen storage location to the nearest Unit 3 safety-related structure and Radwaste Building. Therefore, the storage of liquid hydrogen would not adversely affect the safe operation or shutdown of Unit 3 (including the Radwaste Building).

The hydrogen delivery truck carrying 13,000 gallons of liquid hydrogen may come closer to the safety-related structures or Radwaste Building than the determined safe distances. A probabilistic analysis was also performed for both the 6000 gallon storage tanks and 13,000 gallon delivery truck. The results show the probability of an accident (a postulated scenario involving a 13,000 gallon delivery truck of liquid hydrogen) is sufficiently low (less than 10^{-6}/year with conservative assumptions) that this scenario need not be considered a design basis event. The risk of explosion due to liquid hydrogen delivery trucks is calculated from the liquid hydrogen release frequency (leak frequency) and hydrogen ignition probabilities. The liquid hydrogen release frequency is based on the initial accident frequency and the probability of release, exposure distance and frequency of deliveries. The hydrogen ignition probabilities (immediate and delayed), are based on industry experience and used as inputs in an event tree to determine hydrogen leak risk consequences. The PRA evaluation follows the methods described in RG 1.91. The risk assessment is performed according to RG 1.91 Method 2. Data for risk assessment and frequency/probability calculations are based on the Publication Series on Dangerous Substances (PGS 3), Guidelines for Quantitative Risk Assessment (The Purple Book), December 2005 (Reference 2.2-240).

After the frequency of the damaging event (overpressure >1 psi) due to the transportation or transfer of liquid hydrogen is calculated, the following steps are performed:

- If the frequency of damage event $<10^{-6}$/year with conservative assumptions, risk insights are applied
- If the frequency of damage event $\geq 10^{-6}$/year with conservative assumptions, then a missile assessment is performed

For this risk assessment, the Computer Aided Fault Tree Analysis (CAFTA) tool is used for the development of event trees used for scenario development.

Liquid Hydrogen Release Frequency

The product of the initial accident frequency and the release probability is called the outflow frequency. Generic values (per transport unit km) for different road types are derived for pressurized transport units. The equation for the liquid hydrogen release frequency (per year) is defined as follows:

$$f_{release} = \sum(\text{Exposure Distance} \times \text{Outflow Frequency}) \times \text{Delivery Frequency}$$

Hydrogen Ignition Probabilities

The hydrogen immediate and delay ignition probabilities are based on INEEL/EXT-99-00522, Safety Issues with Hydrogen as a Vehicle Fuel (Reference 2.2-241).

Hydrogen Leak Risk Consequences

To account for the immediate and delayed hydrogen ignition probabilities, the hydrogen leak risk consequences can be developed with an event tree approach. Pool fires and no effect class sequences are not of concern for detonation in this evaluation. Only the flash fire sequences are of concern for detonation in this evaluation. All flash fire sequences are conservatively assumed to affect the SSCs of interest. The total flash fire sequence frequencies are below the threshold of 10^{-6}/year with bounding assumptions. Therefore, a missile assessment is not required for the risks associated with the liquid hydrogen delivery trucks. The input data, assumptions and results of the hydrogen delivery truck risk assessment are provided in Table 2.2-206, Hydrogen Delivery Truck Transportation Sensitivity-Input Data, Assumptions and Hazards.

2.2.3.2.2 Airways

The second and subsequent paragraphs of this SSAR section are supplemented as follows with information on effective plant areas for Unit 3 and the evaluation results.

NAPS COL 2.0-6-A

For the SSAR, which used a plant parameter envelope (PPE) approach, the type of reactor with the tallest reactor building height (71.323 m (234 ft) above grade) was evaluated. For Unit 3, the ESBWR Reactor Building, Control Building, Fuel Building, and Radwaste Building are evaluated. See DCD Figures 1.2-1 through 1.2-11 for the nuclear island (Reactor, Control, and Fuel Buildings) and DCD Figures 1.2-21 through

2.2.3.3 Toxic Chemicals

The third and subsequent paragraphs of this SSAR section are supplemented as follows with updated toxic chemical information and evaluation results.

NAPS COL 2.0-5-A

The on-site chemicals at Units 1 and 2, and Unit 3 (Table 2.2-202) were evaluated to ascertain which chemicals require control room habitability analysis with respect to their potential to form a toxic vapor cloud following an accidental release, using methods provided in RG 1.78.

The on-site chemicals identified in Table 2.2-203 were modeled using the ALOHA air dispersion model (Reference 2.2-205). Deliveries of on-site chemicals were also analyzed. ALOHA calculates the maximum distance a cloud can travel before it disperses enough to fall below the IDLH or other determined toxicity limit concentration. Asphyxiating chemicals were evaluated to determine if their release resulted in the displacement of a significant fraction of the control room air - defined by the Occupational Safety and Health Administration's (OSHA) definition of an oxygen-deficient environment. Where an IDLH is unavailable for a toxic chemical, the time-weighted average (TWA) or threshold limit value (TLV), promulgated by OSHA, was used as the toxicity concentration level. The ALOHA model is used to calculate the concentration inside the control room if the distance to the IDLH limit, asphyxiating limit, oxygen-enriched limit (for storage of oxygen only), or other toxicity limit is greater than the distance to the control room.

In accordance with RG 1.206, the toxicity/asphyxiation analyses conducted using the ALOHA model use a spectrum of meteorological conditions (stability class, wind speed, time of day, and cloud cover) to ensure the worst-case scenario is represented. The meteorological sensitivity analysis includes the most stable meteorological class, F, allowable with the ALOHA model. Stable meteorological conditions and low wind speeds generate less turbulence. Therefore, less mixing and dilution of the formed chemical vapor cloud occurs.

Table 2.2-205 provides the distances to each hazardous chemical's toxic, asphyxiating, or oxygen-enriched limit as well as concentrations determined inside the control room, as applicable. ~~Of all~~ Each of the hazardous chemicals analyzed, with the exception of nitrogen, oxygen, ~~ammonium hydroxide (30 percent solution),~~ carbon dioxide,

~~NOVEC 1230, and a~~ an 8500 gallon gasoline delivery truck, and a 13,000 gallon liquid hydrogen delivery truck, ~~each~~ had distances to their respective toxic or asphyxiating limit less than the distance to the control room. The control room concentrations for nitrogen, oxygen, ~~ammonium hydroxide (30 percent solution),~~ carbon dioxide, ~~NOVEC 1230,~~ gasoline, and liquid hydrogen were below the asphyxiating or toxic limits for each hazardous chemical. ~~Additionally, an 8500 gallon spill from a gasoline delivery truck was analyzed and determined that the distance to the IDLH is 936 ft, which is less than the distance from the closest point of the delivery route to the control room, 1078 ft.~~ Therefore, the release of toxic or asphyxiating chemicals from permanent storage locations or an accident on a delivery route would not adversely affect the safe operation or shutdown of Unit 3.

NAPS COL 2.0-6-A

2.2.3.4 Fires

An accident in the vicinity of Unit 3 could lead to a fire, but the absence of industrial facilities, pipelines, and commercial navigation in the Unit 3 vicinity results in a low probability of chemical explosions and fires. Similarly, land transportation routes are some distance from the Unit 3 site and are unlikely to start a fire that affects Unit 3. The potential for off-site wildfires exists due to the rural nature of the NAPS site and presence of off-site vegetation to the west and south of the site.

The analysis of a wildfire near Unit 3 was performed using the methodology in NUREG-1805 (Reference 2.2-206) to determine the incident heat flux on Unit 3. The conservative assumptions in the analysis included the following:

- The wildfire is assumed to occur at plant elevation.
- The closest forest area with a significant fire line is southeast of the Unit 3 control building. The fire line is modeled as approximately 917 ft wide at a distance of 1086 ft from the nearest safety-related structure, the Unit 3 Fuel Building. The length and distance of the fire is bounded by a road east of the hybrid cooling tower.
- The wildfire burns through the forest toward Unit 3 in a uniform fire line perpendicular to the line of closest separation between the approximately 917 ft wide fire line and the Unit 3 Fuel Building. While more of the forested area could burn toward the south, using a wider

2.2-217 Electric Power Research Institute, EPRI NP-5283-SR-A, Guidelines for Permanent BWR Hydrogen Water Chemistry Installations - 1987 Revision, 1987.

2.2-218 Allied Universal Corporation, Sodium Hypochlorite Material Safety Data Sheet, September 6, 2007.

2.2-219 Sodium Bicarbonate International Chemical Safety Card, 1994.

2.2-220 National Institute for Occupational Safety and Health (NIOSH), Pocket Guide to Chemical Hazards, http://www.cdc.gov/niosh/npg/, Accessed June 2013.

2.2-221 J.T. Baker Inc. Sodium Bromide Material Safety Data Sheet, October 19, 2005.

2.2-222 NALCO Company, H-130 Material Safety Data Sheet, July 31, 2009.

2.2-223 International Programme on Chemical Safety, Bromotrifluoromethane Material Safety Data Sheet, 1999.

2.2-224 DOW Company, DOWEX* HCR-S/S Cation Exchange Resin Material Safety Data Sheet, June 13, 2006.

2.2-225 Chemical Book, Isothiazolin Chemical Properties, http://www.chemicalbook.com/ProductChemicalPropertiesCB0193926_EN.htm#MSDSA. Accessed June 26, 2013.

2.2-226 3M Company, Novec 1230 Material Safety Data Sheet, April 9, 2007.

2.2-227 CHEMTREC Transportation, Carboline #2 Material Safety Data Sheet, May 22, ~~2013~~ 2012.

2.2-228 PPG Company, KL1638 Thinner Material Safety Data Sheet, January 18, 2011.

2.2-229 PPG Company, KL700 Thinner Material Safety Data Sheet, July 31, 2012.

2.2-230 PPG Company, KL3700 Kolor-Proxy Thinner Material Safety Data Sheet, September 27, 2012.

2.2-231 United States Environmental Protection Agency and the National Oceanic and Atmospheric Administration's Office of Response and Restoration, *Computer-Aided Management of Emergency Operations (CAMEO)*, available online at http://cameochemicals.noaa.gov/, Accessed June 2013.

2.2-232 General Electric Company, Dianodic DN2472 Material Safety Data Sheet, February 27, 2012.

2.2-233 ScienceLab, Hydrazine Material Safety Data Sheet, May 21, 2013.

2.2-234 ScienceLab, Toluene Material Safety Data Sheet, May 21, 2013.

2.2-235 ScienceLab, Sodium Carbonate Material Safety Data Sheet, May 21, 2013.

2.2-236 ScienceLab, N-Methyl-2-pyrrolidinone Material Safety Data Sheet, May 21, 2013.

2.2-237 D. Fardad and N. Ladommatos, *Evaporation of hydrocarbon compounds, including gasoline and diesel fuel, on heated metal surfaces*, Department of Mechanical Engineering, Brunel University, Uxbridge, UK, Proc Instn Mech Engrs Vol 213 Part D, 1999.

2.2-238 U.S. Environmental Protection Agency, *Risk Management Program Guidance for Offsite Consequence Analysis*, March 2009.

2.2-239 Lenhert, David Burton, *The Oxidation of a Gasoline Fuel Surrogate in the Negative Temperature Coefficient Region*, July 2004.

2.2-240 Publication Series on Dangerous Substances (PGS 3), Guidelines for Quantitative Risk Assessment (The Purple Book), December 2005.

2.2-241 Cadwallader, L., and J. S. Herring, INEEL/EXT-99-00522, "Safety Issues with Hydrogen as a Vehicle Fuel," September 1999.

2.2-242 Department of Energy (DOE) EH-33 Guide Rev. 0, "Hazard and Barrier Analysis Guidance Document," November 1996.

NAPS ESP COL 2.2-2 **Table 2.2-203 North Anna Unit 3 On-Site Chemicals, Disposition**

Chemical/Material (Formula/Trade/ State)	Toxicity Limit (IDLH)	Flammable/ Explosive?	Vapor Pressure	Disposition
		Unit 3		
Carbon Dioxide	40,000 ppm	No/No	56.5 atm (42,940 mm Hg) @68°F	Toxicity Analysis
Hydrogen (cryogenic)	Asphyxiant	Yes (4% - 75%)/Yes	29.030 psi (1501 mm Hg) @-418°F	Flammable/Explosive Vapor Cloud Analysis Toxicity Analysis (as Asphyxiant) Source Explosion Analysis
Hydrogen (gas)	Asphyxiant	Yes (4% - 75%)/Yes	29.030 psi (1501 mm Hg) @-418°F	Source Explosion Analysis[22]
Nitrogen	Asphyxiant	No/No	65.820 psi (3404 mm Hg) @-294°F	Toxicity Analysis (as Asphyxiant)
Oxygen	Oxygen-enriched[1]	No/No	36.260 psi (1875 mm Hg) @-280°F	Toxicity Analysis (oxygen-enriched)
Trisodium Phosphate (0.72% Solution)	None Established	No/No	Not Pertinent (solid)	No Further Analysis Required[2]
Sodium Sulfite (2.2% Solution)	None Established	No/No	Not Pertinent (solid)	No Further Analysis Required[3]
Disodium Phosphate (0.18% Solution)	None Established	No/No	Not Pertinent (solid)	No Further Analysis Required[4]
Diesel Fuel	None Established	Yes (1.3% - 6%)/Yes	0.042 psi (2.17 mm Hg) @70°F	No Further Analysis Required[5]
Urea (Dry Power aqua solution, 40% $(NH_2)2CO$)	None Established	No/No	Not Pertinent (solid)	No Further Analysis Required[6]
Depleted Zinc Oxide (DZO) sintered pellets	None Established	No/No	Not Pertinent (solid)	No Further Analysis Required[7]

NAPS ESP COL 2.2-2 **Table 2.2-203 North Anna Unit 3 On-Site Chemicals, Disposition**

~~(1)~~ (7) Zinc oxide, in its pure form, is a noncombustible solid and, therefore, has a very low vapor pressure. There is no toxicity limit established for this chemical. Therefore, an air dispersion hazard is not a likely route of exposure.

(8) Sodium bromide, in its pure form, is a noncombustible solid and, therefore, has a very low vapor pressure. There is no toxicity limit established for this chemical. Therefore, an air dispersion hazard is not a likely route of exposure.

(9) Sodium bisulfite, in its pure form, is a noncombustible solid and, therefore, has a very low vapor pressure. There is no toxicity limit established for this chemical. Therefore, an air dispersion hazard is not a likely route of exposure.

(10) The IDLH limit is for pure ethanol, the main hazardous component of Nalco H-130. Additionally, the flammability limits provided are for pure ethanol.

(11) The main hazardous constituent of ChemTreat CL1355 is polyacrylic acid. Properties given are for polyacrylic acid.

(12) The hazardous component of ChemTreat SC2010 is fumaric acid. Fumaric acid, in its pure form, is a noncombustible solid and, therefore, has a very low vapor pressure. There is no toxicity limit established for this chemical. Therefore, an air dispersion hazard is not a likely route of exposure.

(13) The two hazardous components of ChemTreat CL5633 are fumaric acid and citric acid. Both of these chemicals, in their pure form, are noncombustible solids and, therefore, have very low vapor pressures. Therefore, an air dispersion hazard is not a likely route of exposure.

(14) Aluminum sulfate (Alum), in its pure form, is a noncombustible solid and, therefore, has a very low vapor pressure. There is no toxicity limit established for this chemical. The MSDS documentation provided by CHRIS describes it as a gray-white solid. Therefore, an air dispersion hazard is not a likely exposure route.

(15) Sodium bicarbonate, in its pure form, is a crystalline white noncombustible solid and, therefore, has a very low vapor pressure. No toxicity limit is established for this chemical. Therefore, an air dispersion hazard is not a likely route of exposure.

(16) Sodium hydroxide, in its pure form, is a noncombustible solid and, therefore, has a very low vapor pressure. The IDLH documentation provided by NIOSH provides the following description of the substance—"colorless to white, odorless solid (flakes, beads, granular form)" and provides the following basis for establishing the 10 mg/m^3 IDLH limit for the solid form—"the revised IDLH for sodium hydroxide is 10-mg/m^3 based on acute inhalation toxicity data for workers [Ott et al. 1977]" where the reference for Ott et al. gives the following description "Mortality among employees chronically exposed to caustic dust". Thus, this toxicity limit was established for the exposure to the solid form is not applicable to the solution. Therefore, an air dispersion hazard is not a likely route of exposure.

(17) The toxic limit and vapor pressure provided for the 30% ammonium hydroxide solution is that of pure anhydrous ammonia.

(18) Blasting media is a noncombustible solid and, therefore, has a very low vapor pressure. Thus, an air dispersion hazard is not a likely route of exposure.

(19) Boric acid, in its pure form, is a noncombustible solid and, therefore, has a very low vapor pressure. No toxicity limit is established for this chemical. Therefore, an air dispersion hazard is not a likely route of exposure.

(20) The gasoline storage tank is underground. Because of the underground confinement, formation of a flammable vapor cloud is not a credible scenario. No further analysis is required.

(21) The vapor pressure provided is for pure hydrogen chloride.

(22) Modeling a vapor cloud for gaseous hydrogen is not appropriate due to the buoyancy of hydrogen gas (the vapor specific gravity of hydrogen is 0.067). That is, any release from a tube or bank would rapidly rise and not create a traveling vapor cloud. Therefore, the source explosion analysis is the bounding analysis for gaseous hydrogen.

NAPS ESP COL 2.2-2 **Table 2.2-204 Source Explosions, Flammable Vapor Clouds, and Vapor Cloud Explosions (Delayed Ignition)**

Chemical Evaluated	Quantity	Distance to Nearest Safety-Related Structure for Unit 3 (ft)	Distance to 1 psi – Source Explosions (ft)	Distance to Lower Flammability Limit (ft)	Distance to 1 psi – Vapor Cloud Explosion (Delayed Ignition) (ft)
		Unit 3			
Hydrogen (cryogenic liquid)	2 x 6000 gallons[a]	750	2009[c]	651	1662[d]
Hydrogen (gaseous)	45,000 scf	774	724	N/A	N/A
Nalco H-130 (Circulating Water Pump House)	3000 gallons	1315	174	~~45~~ 63	147
Nalco H-130 (Service Water Building)	1500 gallons	638	138	75	63
Hydrogen (cryogenic liquid) Delivery Truck	13,000 gallons	750	2600[e]	924	2262[e]
		Units 1 & 2			
Acetone	55 gallons	2214	44	36	132
Ammonium Hydroxide (30% Solution)	55 gallons	1228	23	~~39~~ 42	~~78~~ 87
Nalco H-130	2000 gallons	1406	152	51	111
Hydrazine (35% Solution)	345 gallons	1228	117	<33	No Explosion
Hydrogen (gaseous)	700 lbs	1821	1039	N/A	N/A
Carboline #2 (as toluene)	55 gallons	1683	47	< 33	< 33
Carboline #2 (as methyl ethyl ketone)	55 gallons	1683	48	< 33	No Explosion
Gasoline Delivery Truck[b]	8500 gallons	1033	272	315	747

NAPS ESP COL 2.2-2 **Table 2.2-205 Toxic Vapor Clouds**

Chemical Evaluated	Quantity	IDLH	Distance to Unit 3 Control Room (ft)	Distance to Toxic Limit (ft)	Control Room Concentration (ppm)[a]
		Unit 3			
Carbon Dioxide (cryogenic liquid)	800 gallons	40,000	887	798	-
Hydrogen (cryogenic liquid)	2 x 6000 gallons[g]	71,400[b]	1004	906	-
Nitrogen (cryogenic liquid)	25,000 gallons	71,400[b]	806	2130	~~26,800~~ 36,000
Oxygen (cryogenic liquid)	9000 gallons	235,000[c]	1009	1446	~~26,600~~ 35,700
Sodium Hypochlorite (Circulating Water Pump House)	16,000 gallons	10	1542	444	-
Sodium Hypochlorite (Service Water Building)	6000 gallons	10	638	276	-
Sodium Hypochlorite (Station Water Intake)	10,000 gallons	10	1030	354	-
Nalco H-130 (Circulating Water Pump House)	3000 gallons	3300	1542	~~219~~ 279	-
Nalco H-130 (Service Water Building)	1500 gallons	3300	638	189	-
Hydrogen (cryogenic liquid) Delivery Truck	13,000 gallons	71,400[b]	1004	~~1311~~ 1314	~~9570~~ 12,700
		Units 1 & 2			
Acetone	55 gallons	2500	2214	102	-
Ammonium Hydroxide (30% Solution)	55 gallons	300	1228	~~1278~~ 1206	~~26.7~~ -

NAPS ESP COL 2.2-2 **Table 2.2-205 Toxic Vapor Clouds**

Chemical Evaluated	Quantity	IDLH	Distance to Unit 3 Control Room (ft)	Distance to Toxic Limit (ft)	Control Room Concentration (ppm)[(a)]
		Units 1 & 2 *(continued)*			
Carbon Dioxide	34,000 lbs	40,000	1146	1446	~~5330~~ 7090
Nalco H-130	2000 gallons	3300	1406	~~177~~ 219	-
Halon 1301	400 lbs	40,000	1228	72	-
Hydrazine (35% Solution)	345 gallons	50	1228	~~849~~ 873	-
Hydrochloric Acid (31%)	55 gallons	50	1628	438	-
Nitrogen (cryogenic liquid)	4500 lbs	71,400[(b)]	1146	618	-
NOVEC 1230	304 lbs	150[(d)]	~~858~~ 2180	1065[(f)]	~~13.1~~ -
Carboline #2 (as toluene)	55 gallons	500	1683	99	-
Carboline #2 (as methyl ethyl ketone)	55 gallons	3000	1683	60	-
Sodium Hypochlorite (15% solution)	400 gallons	10	1769	~~54~~ 57	-
Gasoline Delivery Truck[(e)]	8500 gallons	~~750[(e)]~~ 300[(d)]	1078	~~936~~ 1443	~~-~~ 167

NAPS ESP COL 2.2-2

Table 2.2-206 Hydrogen Delivery Truck Transportation Sensitivity-Input Data, Assumptions and Hazards

Hydrogen Delivery Truck Transportation Sensitivity – Input Data and Assumptions

1. The PRA analysis is based on the liquid hydrogen delivery truck servicing two 6,000 gallon liquid hydrogen storage tanks on-site.
2. The liquid hydrogen delivery tanker truck is assumed to have a capacity of 13,000 gallons.
3. The liquid hydrogen delivery tanker truck frequency is conservatively assumed to be 24 deliveries per year for two 6,000 gallon tanks.
4. Based on the analysis results for both the vapor cloud (delayed ignition) scenario estimated from ALOHA and the explosion at the tank source assuming a 13,000 gallon liquid hydrogen storage tank failure, the most limiting distance to 1 psi for vapor cloud explosion (VCE) scenarios is 2,275 ft (1 psi and 90% yield). The distance to 1 psi with 15% yield is determined to be 1,546 ft and the distance to 1 psi for source explosion (at the tanker) is 2,600 ft. Therefore, the most limiting required separation distance to 1 psi is assumed to be 2,600 ft.
5. Within a circle centered at either the NA3 Fuel Building or the Radwaste Building and a radius of 2,600 ft, the total driving distance of the liquid hydrogen delivery tanker is about 1.2 km. For conservatism, 1.5 km is assumed in this risk assessment and 1/3 of the total travel distance (0.5 km) is assumed to be outside of the gate and 2/3 of the distance (1.0 km) is inside the gate.
6. Hydrogen storage component failure data is extremely limited. For stationary and delivery truck cryogenic liquid hydrogen storage tanks, the failure rates from the Purple Book (Reference 2.2-240), UK Health and Safety Executive (HSE) Failure rates, the Hydrogen Safety Report (Reference 2.2-241) and the Department of Energy (DOE) EH-33 Guide (Reference 2.2-242) are considered. In addition, input from one of the leading experts on hydrogen detonation at the Sandia National Lab is also considered.
7. It is assumed that 85% of all leaks due to hydrogen delivery truck failures are involved with a small release. This differs from the 75% industry failure rate assumed for stationary storage tanks involved with a small inventory loss. Applying 85% is based on the fact that failure data is not readily available. Applying this assumption produces more conservative results because modeling a small release with a lower probability of an immediate ignition increases the probability of delayed ignition and the probability of a flash fire that results in detonation risk. Immediate ignition for the total inventory loss condition is more likely to result in a pool fire which is less of a concern for detonation.

Hydrogen Delivery Truck Transportation Sensitivity – Results

Hydrogen Leak Frequency	=	2.31E-7	per year
Detonation frequency due to total inventory loss	=	3.12E-10	per year
Detonation frequency due to small releases	=	4.42E-8	per year
Combined detonation frequency	=	4.45E-8	per year

described in Section 3.7.1.1.3. The site-specific effects of structure-soil-structure interaction with adjacent Seismic Category I structures are evaluated, if necessary, following an approach consistent with the one used for the standard design that is described in DCD Section 3A.8.11.

The Turbine Building location is shown in Figure 2.1-201. The seismic gaps between the Turbine Building and the Reactor Building are no less than the calculated maximum relative displacements between the two buildings during an SSE event, considering out-of phase motion.]*

3.7.2.8.2 **Radwaste Building**

Replace the second paragraph with the following.

NAPS DEP 3.7-1

[*The site-specific SSI analysis and seismic evaluation of the Radwaste Building (RW) are performed following the same methodology as the one used for the Seismic Category I buildings in Section 3.7.2.4.1. A seismic design motion is used that is compatible to site-specific FIRS that are developed considering the site-specific subgrade conditions under the RW foundation. The development of these FIRS follows the same methodology as the one used for the development of the FIRS for Seismic Category I buildings in Section 2.5.2. The site-specific SSI analysis of RW uses subgrade dynamic properties that are compatible to the strains generated by the site-specific ground motion and are developed using the methodology described in Section 3.7.1.1.3. The site-specific effects of structure-soil-structure interaction with adjacent Seismic Category I structures are evaluated, if necessary, following an approach consistent with the one used for the standard design that is described in DCD Section 3A.8.11.*

The RW location is shown in Figure 2.1-201. It is at least 10 meters from the RB. The building height is shown in DCD Figure 1.2-25.]*

<u>Add the following at the end of this section.</u>

<u>NAPS SUP 3.7-8</u>

<u>To meet the requirements for safe separation distance from the liquid hydrogen storage tanks, the RW exterior walls have a static wall pressure capacity of at least 3 psi. based on analysis using the exterior wall</u>

* Text sections that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior NRC approval is required to change.

thickness, wall span, and wall reinforcement ratio as defined by ACI 349, as referenced in RG 1.143 (see DCD Sections 3.8.4.4.2 and 3.8.4.5.4).

3.7.2.8.3 Service Building

Replace the second paragraph with the following.

NAPS DEP 3.7-1

[*The site-specific SSI analysis and seismic evaluation of the Service Building are performed following the same methodology as the one used for the Seismic Category I buildings in Section 3.7.2.4.1. A seismic design motion is used that is compatible to site-specific FIRS that are developed considering the site-specific subgrade conditions under the Service Building. The development of these FIRS follows the same methodology as the one used for the FIRS for Seismic Category I buildings in Section 2.5.2. The site-specific SSI analysis uses subgrade dynamic properties that are compatible to the strains generated by the site-specific ground motion and are developed using the methodology described in Section 3.7.1.1.3.*

The site-specific effects of structure-soil-structure interaction with adjacent Seismic Category I structures are evaluated, if necessary, following an approach consistent with the one used for the standard design that is described in DCD Section 3A.8.11.

The Service Building location is shown in Figure 2.1-201. The seismic gaps between the Service Building and the Reactor Building/Fuel Building are no less than the calculated maximum relative displacements between the two buildings during an SSE event, considering out-of-phase motion.]*

3.7.2.8.4 Ancillary Diesel Building

Replace the second paragraph with the following:

NAPS DEP 3.7-1

[*The site-specific SSI analysis and seismic evaluation of the Ancillary Diesel Building are performed following the same methodology as the one used for the Seismic Category I buildings in Section 3.7.2.4.1. A seismic design motion is used that is compatible to site-specific FIRS that are developed considering the site-specific subgrade conditions under the Ancillary Diesel Building. The development of these FIRS follows the same methodology as the one used for the FIRS for Category I buildings in Section 2.5.2. The site-specific SSI analysis uses subgrade dynamic properties that are compatible to the strains generated by the*

2.4.16 **ITAAC for the Radwaste Building**

Design Description

The Radwaste Building is a Seismic Category NS building. The design and analysis of the Radwaste Building will preclude any adverse interaction with Seismic Category I structures, considering the soil properties. The Unit 3 seismic design response spectra are based on 5% damping of the free-field outcrop spectra at the foundation level (bottom of the base slab): 1) the scaled CSDRS shown in DCD Figures 2.0-1 and 2.0-2; and 2) the FIRS for each individual structure. Foundation input response spectra will be developed for the Radwaste Building at the foundation level. Site-specific soil structure interaction (SSI) analyses using the Unit 3 seismic design response spectra and using site-specific soil properties will be performed for the Radwaste Building following the same methodology used in FSAR Section 3.7.2 to determine SSI enveloping seismic loads and to develop in-structure response spectra. The Radwaste Building has an exterior static wall pressure capacity of at least 3 psi.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.4.16-1 provides a definition of the inspections, tests, and/or analyses, together with associated acceptance criteria for the Radwaste Building.

Table 2.4.16-1 ITAAC for the Radwaste Building

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The Radwaste Building structure seismic load demands are within acceptable limits to ensure that the structure is seismically adequate.	Perform site-specific SSI analysis, following the methodology specified for Seismic Category I structures in FSAR Section 3.7.2, to address ground motion exceedances and site-specific effects of subgrade properties, and (if necessary) perform a structural evaluation for the Radwaste Building structure.	(1) Seismic load demands obtained from the site-specific SSI analysis for the Radwaste Building structure are acceptable because the seismic loads are bounded by the standard design seismic loads used for the Radwaste Building; or, (2) If the site-specific seismic loads exceed the standard design seismic loads, the Radwaste Building structure is seismically adequate for the Unit 3 site if the results from the structural evaluation demonstrate that the total stresses are bounded by Code allowable stress limits.
2. The Radwaste Building has an exterior wall static pressure capacity of at least 3 psi.	Perform an analysis to determine the static wall pressure capacity of the exterior walls of the as-built Radwaste Building.	Results of the Radwaste Building analysis demonstrate that the exterior wall static pressure capacity is at least 3 psi.