Tennessee Valley Authority, 1101 Market Street, Chattanooga, TN 37402

CNL-17-033

March 27, 2017

10 CFR 52, Subpart A

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

Clinch River Nuclear Site
NRC Docket No. 52-047

Subject: Submittal of Supplemental Information Related to Control Room Habitability in Support of Early Site Permit Application for Clinch River Nuclear Site

Reference: Letter from TVA to NRC, CNL-16-081, "Application for Early Site Permit for Clinch River Nuclear Site," dated May 12, 2016

By letter dated May 12, 2016 (Reference), Tennessee Valley Authority (TVA) submitted an application for an early site permit for the Clinch River Nuclear (CRN) Site in Oak Ridge, TN. During a public meeting held on February 13, 2017, the NRC requested that TVA provide supplemental information regarding the evaluation of transport chemicals in the vicinity of the CRN Site.

The enclosure to this letter provides supplemental information related to the transportation of chemicals in the vicinity of the CRN Site to support the NRC staff review.

There are no new regulatory commitments associated with this submittal. If any additional information is needed, please contact Dan Stout at (423) 751-7642.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 27th day of March 2017.

Respectfully,

J. W. Shea
Vice President, Nuclear Licensing

Enclosure

cc: See Page 2

Enclosure:

Supplemental Information Regarding Transportation of Chemicals in Vicinity of the Clinch River Nuclear Site

cc (enclosure):

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cc (without enclosure):

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Supplemental Information Regarding Transportation of Chemicals in the Vicinity of the Clinch River Nuclear Site

By letter dated May 12, 2016 (Reference), Tennessee Valley Authority (TVA) submitted an application for an early site permit for the Clinch River Nuclear (CRN) Site in Oak Ridge, TN. During a public meeting phone call held on February 13, 2017, the NRC requested that TVA consider providing supplemental information to commit to a control room habitability evaluation of two of the identified transport chemicals (anhydrous ammonia and chlorine) at the combined licensing application (COLA) stage. The NRC indicated that, given the current lack of control room design information available at the early site permit application (ESPA) stage, the control room habitability evaluation of these chemicals could be made at the time of the COLA, when control room design information will be available. TVA agreed that the indicated transport chemicals, anhydrous ammonia and chlorine, in the vicinity of the CRN Site could be more definitively evaluated at the time of the COLA, when control room design information will be available.

This enclosure provides supplemental information related to the transport of chemicals in the vicinity of the CRN Site to support the NRC staff review. These changes will be incorporated in a future revision of the ESPA.

Reference:

Letter from TVA to NRC, CNL-16-081, "Application for Early Site Permit for Clinch River Nuclear Site," dated May 12, 2016

Supplemental Information

NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," and RS-002, "Processing Applications for Early Site Permits," require that applicants identify and evaluate potential design basis events, including the potential effects of those events. Design basis events are defined as those accidents/events, with potential consequences serious enough to affect the safety of the plant to the extent that the guidelines in 10 CFR Part 100 could be exceeded, where a realistic estimate of the annual probability of occurrence is greater than an order of magnitude of 10^{-7} per year.

Site Safety Analysis Report (SSAR) Subsections 2.2.1 and 2.2.2 identify potential hazards, including toxic materials associated with nearby transportation routes. SSAR Subsection 2.2.3.1.3.2 describes whether the transport of an identified toxic material in the vicinity of the CRN Site is a potential design basis event. As described in SSAR Subsection 2.2.3.1.3.2, a deterministic evaluation of postulated accidents involving the release of the identified toxic materials in relation to the CRN Site power block area was performed. This evaluation determined the distance to the toxicity limit for plausible toxic clouds that could form following an accidental release without regard to control room design. The results of the evaluation indicated that, except for anhydrous ammonia and chlorine, the distances to the toxicity limit for the identified materials at the closest approach from the transportation route are less than the minimum separation distances from the CRN Site power block area.

Following the results of the deterministic evaluation, a probabilistic evaluation was performed to determine if the transport of anhydrous ammonia and chlorine in the vicinity of the CRN Site are design basis events (i.e., the annual probability of occurrence is greater than an order of

magnitude of 10^{-7} per year.) The results of this evaluation were presented in SSAR Subsection 2.2.3.1.3.2.

However, given the lack of control room design information available at the ESPA stage, TVA has determined that the transport of anhydrous ammonia and chlorine in the vicinity of the CRN Site could be more definitively addressed at the time of COLA, when a reactor vendor has been selected and control room design information is available.

Therefore, the discussion of the probabilistic evaluation of anhydrous ammonia and chlorine is being removed from SSAR Subsection 2.2.3 and is being replaced with a statement that a main control room habitability impact analysis will be performed at the COLA stage for anhydrous ammonia and chlorine. Additional conforming changes are being made to SSAR Table 1.9-2 and SSAR Table 2.2-11.

Supplemental Information Regarding Transportation of Chemicals in the Vicinity of the Clinch River Nuclear Site

SSAR Table 1.9-2 is being revised as indicated. Underlines indicate text to be added.

Table 1.9-2 (Sheet 1 of 6)
Conformance with Standard Review Plan

Section of NUREG-0800	Rev.	Title	Applicable SSAR Section(s)	Conformance[a]	Comments
1.0	2	Introduction and Interfaces	1.1–1.11	Conforms	Supplementary information related to reactor design and construction is addressed in the COLA, when a vendor has been selected.
2.0	0	Site Characteristics and Site Parameters	2.0	Conforms	
2.1.1	3	Site Location and Description	2.1.1	Conforms	
2.1.2	3	Exclusion Area Authority and Control	2.1.2	Conforms	
2.1.3	3	Population Distribution	2.1.3	Conforms	
2.2.1–2.2.2	3	Identification of Potential Hazards in Site Vicinity	2.2.1–2.2.2	Conforms	
2.2.3	3	Evaluation of Potential Accidents	2.2.3	Conforms	The locations, quantities, and effects of chemicals to be stored onsite are addressed in the COLA. Evaluations of the impacts of toxic gases on main control room habitability are addressed in the COLA.

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SSAR Subsection 2.2.3.1.3 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.2.3.1.3 Toxic Chemicals

Accidents involving the release of toxic or asphyxiating chemicals from nearby facilities and nearby transportation sources were considered. Toxic chemicals known to be present within the vicinity of the CRN Site, or to be frequently transported in the vicinity, were evaluated. The materials stored at nearby facilities (Table 2.2-2) and potentially transported along I-40 (Table 2.2-3) and by pipeline (Table 2.2-4) were evaluated to ascertain which chemicals should be analyzed with respect to their potential to form a toxic or asphyxiating vapor cloud following an accidental release.

Each identified chemical is evaluated based upon the chemical's properties, quantities, and distance in relation to the power block area without consideration of plant design factors, such as control room ventilation. TVA has not selected a reactor technology. Control room characteristics (e.g., the control room volume and outside air infiltration and circulation rates) are unknown. Therefore, chemicals that lead to concentrations above the Immediately Dangerous to Life and Health (IDLH) limit at the power block boundary will be identified and evaluated during development of the COLA.

The ALOHA air dispersion model was used to predict the chemical concentrations within a toxic or asphyxiating vapor cloud as it disperses downwind for all facilities and sources. ALOHA is a diffusion model that permits temporal as well as spatial variations. In the case of a toxic vapor cloud, the maximum distance a cloud can travel before it disperses enough to fall below the ~~Immediately Dangerous to Life or Health (~~IDLH~~)~~ or other determined toxicity limit concentration in the vapor cloud is determined using ALOHA. Asphyxiating chemicals were evaluated to determine if their release resulted in the displacement of a significant fraction of the control room air. The Occupational Safety and Health Administration (OSHA) provides guidance on what is considered an oxygen-deficient atmosphere.

SSAR Subsection 2.2.3.1.3.2 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.2.3.1.3.2 Nearby Transportation Routes/Roadways

The nearest approach from I-40 to the CRN Site power block area is approximately 1.1 mi (5800 ft). Table 2.2-3 details the hazardous materials potentially transported on I-40. The materials identified for further analysis with regard to formation of toxic vapor clouds were anhydrous ammonia, chlorine, gasoline, nitric acid, and sulfur hexafluoride (Table 2.2-6). It is conservatively assumed that the maximum quantity of the anhydrous ammonia and butane potentially transported on the roadway is 11,500 gal, which is the maximum transport quantity in an MC-331 high pressure tank truck (49 CFR 173.315 and Reference 2.2-42). For chlorine, a maximum transport quantity of 22 T is assumed (Reference 2.2-18). For nitric acid, it was conservatively assumed that the maximum quantity potentially transported on the roadway is 6000 gal, which is the maximum transport quantity in an MC-312/DOT412 Corrosive Tanker (Reference 2.2-42). For gasoline, it was conservatively assumed that 8500 gal is potentially transported on I-40. For sulfur hexafluoride, it was assumed that the maximum quantity

transported is 50,000 lb which is the maximum probable solid cargo highway transport quantity identified in RG 1.91.

An analysis for the identified chemicals was conducted using ALOHA as described in Subsection 2.2.3.1.3. The results indicated that, except for anhydrous ammonia and chlorine, that the distances to the identified toxicity limit for any plausible toxic vapor cloud that could form following an accidental release at the closest approach from the transportation route (I-40) are less than the minimum separation distances from the CRN Site power block area to I-40 (Table 2.2-11).

A release of anhydrous ammonia results in a distance of 13,728 ft to the toxicity endpoint and a release of chlorine results in a distance of 23,760 ft to the toxicity endpoint. Both determined distances to the toxic endpoints are greater than the distance of 5800 ft to the CRN Site power block area. Therefore, a main control room habitability impact analysis will be performed at the COL stage for anhydrous ammonia and chlorine. ~~Therefore, a probabilistic analysis was performed for anhydrous ammonia and chlorine to determine whether either is considered to be a design-basis event. A design-basis event is an accident that has a probability of occurrence on the order of magnitude of 10-7 per year, or greater, and potential consequences serious enough to affect the safety of the plant to the extent that would exceed the guidelines in 10 CFR 100. A probability of occurrence on the order of magnitude of 10-6 per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower. Further, RG 1.78 provides that releases of toxic chemicals that have the potential to result in a significant concentration in the control room need not be considered for further evaluation if the releases are of low frequencies (10-6 per year, or less) because the resultant low levels of radiological risk are considered acceptable.~~

~~The evaluation of the spill events was performed in accordance with procedures outlined in RG 1.91 and the Handbook of Chemical Hazard Analysis Procedures (Reference 2.2-44). The following equation was used to define the exposure rate for potentially toxic material in transit:~~

$$\cancel{r = n_1 n_2 f s} \qquad \cancel{\text{Equation 2.2-10}}$$

~~Where r is the exposure rate; n_1 is the accidents per mi for the transportation mode; n_2 is the conditional spill probability (probability of a significant spill); f is the frequency of shipment; and s is the exposure distance.~~

~~Given that definitive transportation routes for the end users of either anhydrous ammonia or chlorine are unknown and that the transport of either anhydrous ammonia or chlorine is not prohibited on I-40, the calculation involved determining the maximum number of allowable trips such that the probability of occurrence is below the design-basis event threshold. This value was then compared with survey data of major end users within the vicinity of the CRN Site.~~

~~The accident rates per mi were calculated using data from the U.S. transportation flows for all truck traffic in the 1993 Commodity Flow Survey reported by the Federal Motor Carrier Safety Administration's Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents (Reference 2.2-45). Anhydrous ammonia is considered a Class 2, Division 2.2 (non-flammable gas) and chlorine is considered a Class 2, Division 2.3 (poisonous gas) (49 CFR 172.101). The Federal Motor Carrier Safety Administration's~~

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~~Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents provides accident rates of 1.3 x 10^{-7} and 2.4 x 10^{-7} per mi for Hazardous Materials categories 2.2 and 2.3, respectively (Reference 2.2-45, Table 24).~~

~~The probability of a significant spill per accident was determined using data from the Handbook of Chemical Hazard Analysis Procedures and the Federal Motor Carrier Safety Administration's Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents (References 2.2-44 and 2.2-45). The probability of a significant spill (total cargo release) was calculated by determining the number of enroute releases/spills (Reference 2.2-45, Table 9) divided by the total number of hazardous materials (hazmat) accidents (Reference 2.2-45, Table 24) and multiplying by the spill distribution value, 0.2, for significant spills (Reference 2.2-44). For anhydrous ammonia, the probability of a significant spill is 0.03 significant spills per accident; and for chlorine, the probability of a significant spill is 0.034 significant spills per accident.~~

~~The exposure distances for anhydrous ammonia and chlorine was determined using the safe distances, 13,728 ft and 23,760 ft, respectively, from the worst case ALOHA modeling run. The length of I-40 in which a potential accident would be separated from the CRN Site power block area by a distance less than or equal to the safe distance is then determined utilizing Geographic Information Systems (GIS) software. For, anhydrous ammonia the resultant exposure distance is 5 mi, and for chlorine the resultant exposure distance is 9.6 mi.~~

~~With the reasonable qualitative arguments presented in the subsequent bullets, there is a sufficiently low risk of a design-basis accident occurring from an anhydrous ammonia or chlorine truck accident. The maximum number of allowable trips such that the probability of occurrence is below the design-basis event threshold, with the use of conservative assumptions, is 250 trips per year for anhydrous ammonia and 64 trips per year for chlorine. For comparison, the anhydrous ammonia shipment frequency for TVA Bull Run Fossil Plant is approximately 9 deliveries per year and the shipment frequency for chlorine at the Oak Ridge WTP is approximately 13 deliveries per year.~~

~~Further, no other storage of ammonia or chlorine within 20 mi of the CRN Site was noted.~~

~~In evaluating the release of either anhydrous ammonia and/or chlorine, the following conservative inputs were used in the model (using more realistic conditions would generate a smaller exposure distance, s):~~

- ~~Pasquill Stability Class F included in the meteorological sensitivity analysis to represent the most limiting 5 percent of meteorological conditions observed (RG 1.78). (The determined worst case meteorological condition for anhydrous ammonia is F stability class with a wind speed of 1 m/s and for chlorine, F stability class with a wind speed of 3 m/s.)~~
- ~~A maximum transport quantity of 44,000 lb (3727 gal) of chlorine is released over a 10-min period in the toxic vapor cloud analysis and is based on the Chlorine Institute's maximum tank motor vehicle storage capacity of 22 T (Reference 2.2-18). According to the Oak Ridge WTP, DPC Enterprises delivers 5 to 7 cylinders, each weighing 3700 lb, for a maximum quantity of 25,900 lb (2188 gal) of chlorine.~~
- ~~A maximum transport quantity of 11,500 gal (the maximum capacity in an MC-331 high pressure tank truck) of anhydrous ammonia is released over a 10-min period in the toxic~~

~~vapor cloud analysis (49 CFR 173.315 and Reference 2.2-42). Per 49 CFR 173.315, the maximum permitted filling density by percent volume for anhydrous ammonia is 82 percent or 87.5 percent provided certain conditions are met. The maximum filling density is not taken into account in the analysis.~~

- ~~The critical distances reported by ALOHA do not take into account variables such as building wake, terrain effects, and wind rose data. Chlorine gas has a vapor specific gravity of 2.4 (Reference 2.2-46). The ALOHA analyses does not take into account chlorine's specific gravity in relation to the terrain in the vicinity of the CRN Site. It is conservative to assume that there is no elevation change between the release and the receptor. However, there is an elevation change from the release and receptor location to the Clinch River arm of the Watts Bar Reservoir. Because of chlorine's specific gravity, a release would most likely result in the vapors sinking into the nearby reservoir before reaching the CRN Site power block area.~~
- ~~RG 1.145 discusses plume meander during low wind speeds and suggests that during neutral (D) or stable (E, F, or G) atmospheric stability conditions, when the wind speed at the 10-m level is less than 6 m/s, that horizontal plume meander may be considered and provides correction factors. ALOHA does not consider plume meander in its analyses. ALOHA conservatively models the release as a straight trajectory toward the receptor (Reference 2.2-43).~~
- ~~The exposure distance does not account for a control room air exchange rate. In accordance with RG 1.78, the control room and emergency ventilation system is anticipated to be designed to have low-leakage capabilities.~~

~~Further, in evaluating the accident and spill rates for anhydrous ammonia and/or chlorine, the following conservative inputs were used (using more realistic conditions would generate a lower accident rate, n_4):~~

- ~~The Handbook of Chemical Hazard Analysis Procedures (Reference 2.2-44) suggests obtaining more precise data at the local, county, state, or regional level to refine probability estimates. To this end, three queries were made to the U.S. Department of Transportation (DOT) Incident Reports Database (Reference 2.2-47).~~
- ~~First, the database was searched for records of in transit Class 2 hazardous materials in the state of Tennessee. The query resulted in no major or catastrophic accidents involving the shipment of chlorine on any highway in the state (Reference 2.2-47).~~
- ~~Second, a database search was conducted for all in transit accidents along I-40 in Tennessee. The query did not reveal any major or catastrophic accidents involving the shipment of chlorine. (Reference 2.2-47)~~
- ~~Lastly, a query was made for accidents involving the shipment of chlorine in the state of Tennessee. The results revealed no major or catastrophic accidents involving chlorine. Various chemicals with chlorine containing compounds are identified in the search results; however, these chemical do not exhibit the same toxic characteristics or physical properties as chlorine gas and would be screened from further analysis.~~

~~In summary, the DOT Incident Report database searches resulted in no major or catastrophic chlorine truck accidents in the state of Tennessee or along the I-40 route in Tennessee (Reference 2.2-47).~~

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~~Using these conservative assumptions, the probabilities of exposure to anhydrous ammonia and chlorine would not exceed the guidelines in 10 CFR 100 (on the order of magnitude of 10^{-6} per year) with up to 250 trips per year for anhydrous ammonia and 64 trips per year for chlorine.~~

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SSAR Table 2.2-11 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.2-11 (Sheet 2 of 2)
Design-Basis Events –Toxic Vapor Clouds

Source	Chemical Evaluated	Quantity Analyzed[n]	IDLH Limit	Distance to CRN Site Power Block Area (ft)	Distance to IDLH (ft)
Nearby Transport Routes/Pipelines					
East Tennessee Pipeline 1 (6-in)	Natural Gas (as methane)	666,312 lb[m]	71,400 ppm[b]	5,800	282[h]
East Tennessee Pipeline 2 (22-in)		9,624,751 lb[m]		15,800	846[h]

(a) Worst-case scenario meteorological condition is F stability class at one meter per second (m/s).
(b) Asphyxiation Limit.
(c) Worst-case scenario meteorological condition is F stability class at three m/s.
(d) Worst-case scenario meteorological condition is F stability class at two m/s.
(e) Gasoline does not have an identified IDLH. The Threshold Limit Value–Short Term Exposure Limit (TLV–STEL) is 500 ppm; the Threshold Limit Value–Time-weighted Average (TLV–TWA) is 300 ppm; and the Protective Action Criteria (PAC) PAC-2 guideline is 1000 ppm for gasoline. For the analyses, n-Heptane is used as a surrogate and has an IDLH of 750 ppm. This selection is conservative given the PAC-2 guideline most closely correlates with the definition of IDLH.
(f) The distance to the TLV–STEL is 99 ft, and the distance to the TLV–TWA is 132 ft.
(g) The distance to the TLV–STEL is 111 ft, and the distance to the TLV–TWA is 150 ft.
(h) Worst-case scenario meteorological condition is D stability class at 5.5 m/s.
(i) TLV–TWA Limit.
(j) The toxicity limit at the CRN Site power block area is exceeded. A main control room habitability impact analysis will be performed at the COL stage for this chemical.~~; therefore, a probabilistic analysis is then performed for anhydrous ammonia to determine whether it a design-basis event. Using conservative assumptions and estimates, the probabilities of exposure to anhydrous ammonia due to offsite transport would not exceed the guidelines in 10 CFR 100 (on the order of magnitude of 10-6 per year) and are sufficiently low to not result in a design-basis event or affect the safe operation or shutdown of the units within the power block area at the CRN Site (Subsection 2.2.3.1.3.2).~~
(k) The toxicity limit at the CRN Site power block area is exceeded. A main control room habitability impact analysis will be performed at the COL stage for this chemical.~~; therefore, a probabilistic analysis is then performed for chlorine to determine whether it a design-basis event. Using conservative assumptions and estimates, the probabilities of exposure to chlorine due to offsite transport would not exceed the guidelines in 10 CFR 100 (on the order of magnitude of 10-6 per year) and are sufficiently low to not result in a design-basis event or affect the safe operation or shutdown of the units within the power block area at the CRN Site.~~
(l) The distance to the TLV–STEL is 843 ft and the distance to the TLV–TWA is 1089 ft.
(m) Quantity of natural gas (as methane) released from a break in the natural gas pipeline under worst case meteorological condition for the toxic vapor cloud scenario; assumed pipeline length of 200 times the diameter; pressure 734.7 pounds per square inch atmosphere (psia); complete break; and connected to infinite source. (Subsection 2.2.3.1.2.3)
(n) Where a capacity number was obtained from the Superfund Amendments and Reauthorization Act (SARA) Title III, Tier II report, the upper range number is shown and was used in the analysis.