United States Nuclear Regulatory Commission Official Hearing Exhibit			
In the Matter of:	TENNESSEE VALLEY AUTHORITY (Clinch River Nuclear Site Early Site Permit Application)		
	Commission Mandatory Hearing		
	Docket #: 05200047		
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	Other:		

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of TENNESSEE VALLEY AUTHORITY (Clinch River Nuclear Site Early Site Permit Application)	Docket No. 52-047-ESP

Hearing Exhibit

Exhibit Number: NRC-005

Exhibit Title: NRC Staff Responses to Commission Prehearing Questions (June 26, 2019).

July 26, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE COMMISSION

In the Matter of	)	
	)	
TENNESSEE VALLEY AUTHORITY	)	Docket No. 52-047-ESP
	)	
(Clinch River Nuclear Site Early Site Permit Application)	)	

NRC STAFF RESPONSES TO COMMISSION PRE-HEARING QUESTIONS

Pursuant to the Commission's "Order (Transmitting Pre-Hearing Questions)" of July 12, 2019, the staff of the U.S. Nuclear Regulatory Commission hereby responds to the questions posed in that Order. The Commission's Order directed some questions only to the staff, some questions only to the Tennessee Valley Authority (the Applicant), and some to both the staff and the Applicant. The attachment to this filing presents the staff's responses.

Respectfully submitted,

/Signed (electronically) by/
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Dated at Rockville, Maryland,
this 26th day of July 2019

ATTACHMENT

NRC Staff Responses to Commission Pre-Hearing Questions

NRC Staff Responses to Commission Pre-Hearing Questions

1. Section 1.6 of the Final Safety Evaluation Report (FSER) states that, "*[u]sually*, [combined license (COL)] Action Items are not necessary for issues covered by Permit Conditions or explicitly covered by the bounding parameters." (emphasis added).

Why was the word "usually" included in this sentence? Did the NRC Staff identify any COL Action Items in the Clinch River early site permit (ESP) application that were duplicative of Permit Conditions or bounding parameters? If so, why were they retained?

Staff Response: The staff used the word "usually" in Section 1.6 of the FSER to reflect the staff's general practice of avoiding duplication between COL action items, permit conditions, and bounding parameters, while retaining flexibility for unusual situations. There were no COL action items in the ESP application. The COL action items in the draft permit are not duplicative of the permit conditions or the bounding parameters.

2. The Site Safety Analysis Report (SSAR) analyses depend, in part, on the design of the reactor(s) that could be located at the Clinch River Nuclear (CRN) Site. As allowed by 10 C.F.R. § 52.17, the Tennessee Valley Authority (TVA) did not select a specific reactor design in the ESP application. Rather, TVA's application defined the plant-site interface through a plant parameter envelope (PPE).

1. **Please describe how TVA's PPE bounds the parameters of the reactors that might be placed at the CRN Site and provides sufficient design detail to support both the NRC safety and environmental review of the ESP application.**
2. **Please explain whether TVA's methodology provides a basis for establishing a plume exposure pathway (PEP) emergency planning zone (EPZ) that maintains the same level of protection at a reduced EPZ at the CRN Site as that which exists for a 10-mile PEP EPZ for large operating power reactors.**

Staff Response: (1) TVA used available technical information from four conceptual small modular reactor (SMR) designs to develop the bounding design parameters for the PPE. As described in the SSAR, Section 2.0, the individual values listed for each specified parameter in Tables 2.0-2 through 2.0-6 are the most bounding (limiting) value for that parameter from any of the four specified designs. As required by 10 CFR 52.39(d), NRC approval is necessary if a COL or CP applicant requests a variance from a design parameter specified in the ESP.

The PPE has sufficient detail and bounding parameters to support the NRC staff's review of the suitability of the site for the safety aspects of future construction and operation of a nuclear power plant, as explained in the FSER. For the environmental review, the staff relied on the PPE and the plant-site interface information in the TVA environmental report (ER). This information was sufficient to support the staff's safety and environmental findings in 10 CFR 52.24(a) and 10 CFR 51.105(a).

(2) TVA requests exemptions from the NRC's requirement for establishing a 10-mile PEP EPZ and provided a methodology to support its requested exemptions. The staff has found that TVA's methodology could, if approved, be used in a future COL or construction permit (CP)

application that references a specific design to justify a site-boundary or 2-mile PEP EPZ. The staff evaluated the reasonableness of TVA's proposed methodology and found it maintains the same level of protection (i.e., dose savings) in the environs of the CRN Site as that which exists for the 10-mile PEP EPZ for large light water reactors (LLWRs). As discussed in SECY-19-0064, the staff based this conclusion on the following:

- TVA developed technical criteria for design basis accidents (DBAs), less severe core melt accidents, and more severe core melt accidents that are consistent with the technical criteria in NUREG-0396, *Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants*. NUREG-0396 provides the basis for the 10-mile PEP EPZ requirement in the current regulations.
- TVA derived dose criteria from the technical criteria for each of the accident categories. These dose criteria are similar to the dose criteria used in the analyses in NUREG-0396 and are based on the same reasoning (dose savings) used as the technical basis for the PEP EPZ distance codified in NRC regulations.
- Similar to the analysis in NUREG-0396, the applicant's proposed method to determine PEP EPZ size relies on consequence analyses for a range of potential accidents, including DBAs and severe accidents. The staff reviewed the applicant's description of the consequence analyses and found it to be reasonable and consistent with the analyses described in NUREG-0396.

TVA's methodology provides reasonable assurance that any radiation exposures beyond the PEP EPZ would be highly unlikely to exceed the Environmental Protection Agency (EPA) early phase Protective Action Guides (PAGs) and that there would be a substantial reduction in early health effects for more severe accidents. Based on the above, the proposed methodology maintains the same level of protection (i.e., dose savings) in the environs of the CRN Site, as that which exists for the 10-mile PEP EPZ for LLWRs.

3. Numerous wells and borings were made at the CRN Site during the previous investigation and development of the site for the canceled Clinch River Breeder Reactor Project (CRBRP).

The FSER at p. 2-141 states, "The applicant noted that many of the CRBRP wells and borings would have been removed or destroyed during the site excavation. During the April 24–27, 2017 audit . . . the applicant indicated that the disposition of the CRBRP wells and borings installed is unknown. During 2018 site walk down activities and subsequent searches, the applicant identified three of these wells. The applicant is currently investigating their disposition and evaluating [these wells] for closure in accordance with TVA and [Tennessee Department of Environment and Conservation (TDEC)] requirements."

1. **Please describe the depths of the identified wells and borings.**
2. **How many wells and borings currently have an unknown disposition?**
3. **Considering both the complex geology and hydrogeology (e.g., inclined strata containing fractures, faults, and carbonate bedrock joints and cavities), what are the potential safety-related or risk-significant impacts of wells and borings that are not found?**
4. **With regard to abandoned wells that have the potential to channel shallow groundwater flow into lower levels of the aquifer (termed "short-**

circuiting"), how would liquid effluents be addressed for those wells and borings that may not be found?

Staff Response: (1) As stated in the staff's SER, the applicant identified three CRBRP wells during 2018 site walkdown activities and in subsequent searches. The staff does not know the depths of the identified wells. In addition, to the staff's knowledge, no CRBRP borings were identified.

(2) With the exception of the three CRBRP wells identified in the SER, the disposition of the remaining wells and borings are unknown. The staff does not have the information necessary to identify how many wells and borings remain or deduce their disposition.

(3) As stated in the staff's SER, improperly abandoned wells have the potential to channel shallow groundwater flow into lower levels of the aquifer system. The staff did not identify any other potential safety-related or risk significant impacts associated with undiscovered wells and borings. The staff's evaluation of the potential for short-circuiting caused by unidentified wells and borings is addressed in the response below.

(4) The staff evaluated short-circuiting with respect to groundwater pathways potentially leading to radiological exposure to receptors. As discussed below, groundwater channeling through undiscovered CRBRP wells or borings into deeper aquifers poses no safety exposure risks. The NRC staff evaluated CRN Site and regional studies as described in FSER Section 2.4.12.3.4. The applicant determined that groundwater at the CRN Site circulates shallowly and ultimately discharges to the Clinch River based on the following factors: (1) low and decreasing fracture occurrence and permeabilities with depth; (2) total dissolved solid measurements in monitoring wells which indicate that site groundwater occurs as a shallow system; and, (3) groundwater gradients indicate that the groundwater discharges to the Clinch River. The applicant used this conceptual model to evaluate the impacts of a postulated accidental effluent release scenario, which is described in FSER Section 2.4.13. The applicant concluded that a radionuclide release would discharge to the Clinch River adjacent to the CRN Site.

Conservatisms included an instantaneous release to groundwater with no consideration of any containment barrier, radionuclide decay, or dilution as a result of wet periods. Additionally, the applicant assumed that all radionuclide concentrations (including daughter products) occur coincidentally at their peak. Based on the site conceptual model and the results of this release scenario, the staff concluded that onsite groundwater would circulate near the surface and discharge into the Clinch River and that undiscovered wells and borings would not have an impact on this flow path. Therefore, undiscovered CRBRP wells or borings pose no potential safety exposure risks which would result from channeling or short-circuiting groundwater through these wells into deeper aquifers.

4. **As noted in the FSER, groundwater contamination containing legacy radionuclides has been observed in well OW-422L. According to the FSER, "Past TDEC sampling results (TDEC 2016-TN5350) from the applicant's wells have indicated that radionuclides are present at or below detection limits and drinking water Maximum Contaminant Level-Derived Concentration (MCLDC) levels in CRN Site wells PT-PW and OW-422L," and the Staff "confirmed that the radionuclides present are consistent with [Oak Ridge Reservation (ORR)] operations and waste disposal practices that commenced in the 1940s. The extent of the resulting legacy contamination in the vicinity of the ORR is being characterized by ongoing [U.S. Department of Energy] remediation and monitoring studies."**

1. **What is the basis for the conclusion that radionuclides present in groundwater are consistent with ORR operations and waste disposal practices that commenced in the 1940s?**
2. **How stable are the source and associated plume of contamination, and what are the Staff's expectations for how baseline for background groundwater concentrations of the contaminants of concern will be established in accordance with COL Action Item 2.4-3?**
3. **What is the distance between the resulting legacy contamination and the proposed site?**

Staff Response: (1) The TDEC (TDEC 2016-TN5350) sampling results indicate the presence of anthropogenic fission products including Strontium-90 and Technetium-99. Based on a review of historical documents, the NRC staff determined that these fission products appear to be characteristic of the ORR operations and waste streams that commenced in the 1940s (DOE 2017-TN6170). As a result, the staff concluded that groundwater containing these radionuclides was influenced by ORR operations and waste disposal practices that commenced in the 1940s.

(2) The radionuclides detected are consistent with past waste disposal infiltration and injection practices at ORR that affected contaminant movement and resulted in the current extent of legacy contamination as described in the response above. With the termination of past waste disposal practices at ORR, the groundwater flow system has returned to ambient conditions. Therefore, the staff conservatively assumed that concentrations of existing radionuclides will remain stable on the CRN Site. The presence of pre-existing radionuclide concentrations on the CRN Site would make determination of a potential accidental release inconclusive or indeterminate without initial background concentrations to differentiate existing concentrations from accidentally released radionuclide concentrations. COL Action Item 2.4-3 provides for the establishment of initial concentration baselines to evaluate elevated concentrations of radionuclides from a potential release. The future applicant would have a number of options to address the COL item, and the NRC staff will evaluate the chosen method at the COL or CP stage.

(3) The ORR site is adjacent to the CRN Site and within a few miles of various former ORR waste discharge areas. The extent of the contamination emanating from the ORR is not yet completely characterized, and the Department of Energy (DOE) continues to study the extent of the legacy contamination and waste streams resulting from the past waste disposal practices at the ORR (DOE 2017-TN6170).

5. The FSER states that "the groundwater contamination and associated monitoring and sampling of [well OW-422L] continues to be under the purview of TDEC in cooperation with the applicant."

1. **What, if any, role will the NRC have with respect to oversight and inspection of this monitoring and sampling?**
2. **How has the potential for duplicative or conflicting requirements for the well been addressed?**

Staff Response: (1) If the ESP is issued, the NRC will have no role in the oversight and inspection of monitoring and sampling of well OW-422L because the ESP does not authorize licensed activities. There are no current NRC requirements for the well, and monitoring is under the purview of TDEC in cooperation with the applicant.

A future CP or COL applicant may include this well as part of its groundwater monitoring program and/or radiological environmental monitoring program. If the well is included in either or both of these programs, the monitoring and sampling activities described in the COL or CP safety analysis report (SAR) would be subject to NRC regulatory authority, which extends to radiological health and safety issues; TDEC's authority would remain unchanged.

(2) Currently, well monitoring is under the purview of TDEC in cooperation with the applicant. As discussed above, a future COL or CP applicant could include this well in its groundwater monitoring program or radiological environmental monitoring program (or both). If so, the future applicant's SAR would describe the applicant's approach to assuring timely detection and effective response to situations involving inadvertent radiological releases relative to groundwater to prevent migration of licensed radioactive material off-site, assess the source of the material, and quantify impacts on decommissioning. In these circumstances, the NRC staff will coordinate oversight of monitoring and sampling activities with TDEC, as necessary. The applicant's cooperation with TDEC would remain unaffected by participation in these programs at the COL or CP stage.

6. FSER Section 2.4.12.3.9.2 concludes that the maximum groundwater level established by the Applicant was reasonable, in part based on water level measurements that took place over the period of September 2013 to March 2014. That period "includes the relatively wet year of 2013 when the total annual rainfall was approximately 37 percent higher than the area's average annual rainfall." The FSER concludes that the "maximum observed ground levels during the September 2013 to August 2015 monitoring period would be relatively high and near an overall maximum for the CRN Site because of the relatively high precipitation during the monitoring period."

1. **The conclusion that precipitation during the measurement period was "relatively high" is drawn from comparison to average annual rainfall. Over what period was the average annual rainfall calculated?**
2. **Please explain why the groundwater model used to establish maximum groundwater level is conservative.**

Staff Response: (1) The period of time considered for the calculation of average annual rainfall was 1981-2010 (University of Tennessee Institute of Agriculture, Climate Data for Tennessee).

(2) The objective of the groundwater modeling was to determine maximum groundwater levels after plant construction that could be used to establish the PPE value. The NRC staff considered this PPE value to be conservative because the model used input that included water level observations over a monitoring period of higher-than-average rainfall. The amount of rainfall and resulting rainfall infiltration directly influence groundwater level elevations at the CRN Site. The applicant's groundwater modeling results are consistent with hydraulic parameters and observations from the CRN Site and CRBRP studies discussed in Section 2.4.12 of the FSER.

7. SSAR Section 2.5.1.1.5.1 states that carbonate rock dissolution and karst formation are the dominant non-seismic geologic hazard in the CRN Site region. According to FSER Section 2.5.1.3.2.5, there is "a lack of definitive evidence for present-day active hypogene karst development"; however, that "does not indicate hypogene processes were inactive in the past or could not occur in the future." Thus, "for a future [COL application], detailed geologic mapping and a

subsurface exploration program would be implemented to characterize the excavations for safety-related structures at the CRN Site with regard to the presence or absence of karst features in and below the floor of those excavations. These activities are captured by Permit Condition 2.5-1 (Permit Condition 3), as discussed in FSER Section 2.5.3.4."

1. **Why is the karst hazard not more fully characterized at the ESP stage?**
2. **Please discuss the potential for hypogenic dissolution to develop voids underground and explain what methods or technologies would be used to further characterize the site.**
3. **In the context of groundwater conduit flow as well as the construction, operation and associated activities (e.g., monitoring) for the proposed site, describe the safety-related or risk-significant impacts of any undetected significant joints, fractures, and limestone cavities.**
4. **What mitigating strategies or engineered solutions might be available at a later stage to deal with karst features that may be found?**

Staff Response: (1) The staff determined that the applicant's initial characterization of karst hazard, which was provided in the ESP application and based on data and observations performed by the applicant, meets the regulatory requirements for an ESP as specified in 10 CFR 52.17(a)(1)(vi) and described in detail in Sections 2.5.1 and 2.5.3 of NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition* (SRP). The applicant did not select either a reactor design or a specific location for the plant at the CRN Site, as will be necessary for a COL or CP applicant. Consistent with the requirement in 10 CFR 52.17(a)(1)(v), the Clinch River ESP application therefore describes the proposed general location of each facility on the site, which includes for this application two slightly different optional locations for the plant. For a COL or CP application referencing this ESP, the specific location of the plant footprint and foundation grade level rock units will be particularly important to obtain a more complete characterization of potential karst hazard at the specific plant location than is possible at the ESP stage. Completion of detailed geologic mapping of the excavations for safety-related structures under Permit Condition 2.5-1 (Permit Condition 3) and geophysical testing and boring programs under COL action items 2.5-3 and 2.5-16 will further characterize the presence or absence of potential hazard from karst at the selected plant location in foundation grade level rock units at the CRN Site.

(2) Based on results of the ESP site characterization and previous investigations in the site area, evidence from the site area is consistent with dissolution by movement of water derived from epigenic processes in the unsaturated (vadose) zone above the water table and the saturated (phreatic) zone below the water table, rather than from water derived from deeper upwelling sources characteristic of hypogenic dissolution. Based on borehole data and field observations, the frequency of subsurface fractures and dissolution cavities decrease with depth, and secondary minerals characteristic of hypogene processes were not found. Additionally, similar water levels from the 1973/1974 CRBRP study observations, as compared to the 2013/2014 CRN study observations, indicate that the groundwater level is not likely to rise significantly during the life of the licensed facility. Therefore, the potential for hypogenic dissolution to develop voids in the site subsurface that might have an adverse effect on the CRN Site is minimal.

(3) As discussed above under part (1) of Question 7, methods and technologies related to the geologic mapping effort and the subsurface exploration program will provide the opportunity to directly and more fully assess the presence or absence of karst features at the selected plant

location in foundation grade level rock units at the CRN Site and to characterize any observed geologic features in and beneath the excavation floors. The subsurface exploration program may include confirmatory drilling or borehole testing, geophysical surveys, and other site-specific analyses to further characterize the specific site location at the COL or CP stage.

In the context of groundwater conduit flow, as discussed in SSAR Section 2.4.12.4 and as consistent with the industry's groundwater protection initiative that is documented in NEI 07-07, "Industry Ground Water Protection Initiative – Final Guidance Document," the applicant committed to establishing an onsite groundwater monitoring program at the COL or CP stage. This program will assure timely detection and effective management of contaminant movement in the groundwater flow system at the CRN Site, which may be affected by undetected joints, fractures, or dissolution cavities. Undetected joints, fractures, and dissolution cavities could have safety-related and risk-significant impacts at the CRN Site by affecting the engineering properties of the foundation rock materials, if such geologic features exist and are significant but not detected. However, Permit Condition 2.5-2 (Permit Condition 4) requires excavation of the upper 80 ft of the materials in areas underlying safety-related structures to minimize the adverse effects of discontinuities, weathered and shear-fracture zones, and karst features on the stability of subsurface materials and foundations. Permit Condition 2.5-1 (Geologic Mapping) and COL Action Item 2.5-16 (Subsurface Investigations and Remediation Methods) will result in additional information on the presence of joints, fractures, and dissolution cavities in the zone of influence for foundations of safety-related structures. Furthermore, COL Action Item 2.5-3 addresses the need for an applicant referencing this ESP to conduct additional geophysical surveys, characterize geophysical anomalies, and implement a grouting program with an associated ITAAC, if needed. Staff will review the safety-related and risk-significant impacts of any newly identified features, as well as the proposed mitigation strategies or engineered solutions, to reduce the potential adverse effects at the COL or CP stage.

(4) The choice of mitigating strategies or engineered solutions to be used for dealing with subsurface karst features at the CRN Site will be determined by the COL or CP applicant referencing the ESP once there is a more complete characterization of the extent of the karst hazard, including karst features that were not detected at the ESP stage. This work will be completed as part of the geologic mapping of excavations for safety-related engineered structures at the selected plant location in foundation grade level rock units at the CRN Site. These strategies and solutions will be reviewed by the staff. A systematic borehole grouting program to seal dissolution features could provide a viable approach to acceptably reduce the safety-related and risk-significant impacts of any karst dissolution features. The need to identify an appropriate mitigating strategy or engineered solution for any identified karst features found in the excavations for safety-related structures during the subsequent site investigations is addressed in COL Action Item 2.5-16.

8. The earthquake catalog in NUREG-2115 (2012), which covers earthquakes in the Central and Eastern United States (CEUS) region from 1568 through 2008, was used to analyze seismic hazards for the site, along with a separate earthquake catalog developed by the Applicant, which covered earthquakes from 2009 through mid-September 2013. The Applicant merged the two catalogs and used the updated catalog in its seismic hazard evaluation at the CRN Site.

1. How did inclusion of earthquakes occurring over the relatively short time span between 2009–2013 affect the determination of magnitude and distance distributions and why?

2. **What confidence is there that the combined catalog will achieve a stable seismicity estimate at the CRN Site over time?**

Staff Response: (1) The inclusion of **M**2.9 – **M**4.17 earthquakes occurring within the site region between 2009 and 2013 had a minor impact on seismicity rates and magnitude-frequency relations. Nine earthquakes occurred during the period of the catalog updates, resulting in minor changes in overall seismicity rates within the site region. Specifically, the applicant calculated a 3.3 percent increase in the seismicity rate for the quarter degree by quarter degree area around the ESP site. Despite no earthquakes occurring within this area, this 3.3 percent increase reflects small earthquakes occurring in the region surrounding the ESP site. The applicant provided a graphical representation of this effect in SSAR Figure 2.5.2-27. The staff's review of the applicant's updates and confirmatory analysis, which did not use updated seismicity rates, shows that the impact of the updated catalog on final seismic hazard curves for the site is minor.

(2) The longer an earthquake record extends, the more confident scientists can be in stating that the record reflects the long-term seismicity rates and that the record adequately accounts for the natural variability in the timing and location of seismicity. The earthquake catalog in NUREG-2115 covers a time period of over 400 years. The updated catalog added an additional five years to the record. Based on the minor impact the addition had on NUREG-2115's seismicity rates and magnitude-frequency distributions for the region surrounding the ESP site, the staff is confident in the stability of that model and its representation of the long-term seismicity rates and magnitude-frequency relations. The staff is confident that the combined catalog represents a stable seismicity estimate at the CRN Site over time because the model accounts for uncertainty in the location, timing, and magnitude of earthquakes by incorporating multiple alternatives for seismicity rates. Further, the staff's confirmatory analysis using the published NUREG-2115 seismicity rates results in hazard curves with similar results to those developed by the applicant using updated rates. In sum, the addition of five years of data to the catalog demonstrated the stability of the model in NUREG-2115 because of the minor impact the new data had on the seismicity rates. This addition, together with the uncertainty accounted for in the NUREG-2115 model, demonstrates reasonable confidence that the combined catalog represents a stable model of seismicity over time.

9. FSER Section 2.5.2.1.6 suggests that the potential complexity of seismic wave propagation at the site could not be fully captured by a one-dimensional propagation model because the site strata is composed of non-horizontal layers dipping more than 30 degrees. Therefore, the Applicant performed a two-dimensional sensitivity analysis using Structural Dynamics Engineering-System for Analysis of Soil Structure Interaction (SDE SASSI) Version 2.0.

Please explain:

1. **What wave compositions the 2-D SDE SASSI analysis assumed and why;**
2. **How the SDE SASSI modeled the essentially global dipping stratigraphic units at the site given that the underlying method requires modeling a localized region embedded in a horizontally stratified half-space; and**
3. **Whether the SDE SASSI analysis considered potential inclined wave transmission effects and what wave forms were identified to impact the ground motion response spectrum and why.**

Staff Response: (1) The applicant's SDE SASSI model is run with vertically propagating shear waves that are polarized in the plane of the 2-D model, consistent with the assumptions used in calculating the 1-D site response model. The staff determined that this assumption allows for the direct comparison of the 1-D results used in the development of the site GMRS with the 2-D results generated by SDE SASSI.

(2) The applicant's SDE SASSI model extends for 20,000 ft in the horizontal direction and over the entire sedimentary section (14,800 ft) in the vertical direction. Below the sedimentary section lies the granitic basement rock that forms the crust of the central and eastern United States. The applicant's model introduces 20 layers to the base of the model to adequately address the impact of the upper crust on site response. In addition, the applicant incorporates boundary conditions along the vertical and horizontal boundaries of the model that ensure that energy propagating out of the model is not artificially reflected back into the model. The staff reviewed the applicant's SDE SASSI model and determined that the area of the subsurface modeled was sufficiently large to adequately account for 2-D site effects because it encompasses the entire sedimentary section vertically and is wide enough to adequately capture the effect of refraction at layer interfaces.

(3) The input ground motion for the SDE SASSI analysis is a vertically propagating shear wave, as discussed in part (1) of this response. The analysis allows for the incoming wave to reflect from and refract at interfaces where layers on either side have different seismic characteristics. These refractions allow waves to focus and defocus across the analysis region. As shown by the applicant in SSAR Figures 2.5.2-107 through 2.5.2-110, these refractions and reflections result in amplification due to the sedimentary structure that is lower than that calculated for a 1-D case at the majority of frequencies. In addition, FSER Figure 2.5.2-8 shows a comparison of the applicant's GMRS, the staff's confirmatory GMRS, and a surface response spectrum for a hard rock site. The staff's confirmatory analysis was performed by making different assumptions about how potential 2-D site effects might be modeled using a 1-D approach. All three surface response spectra are similar, indicating that the site is essentially a very firm to hard rock site with relatively small differences in seismic characteristics between layers. Based on the results of the applicant's 2-D sensitivity study and the staff's confirmatory analysis, the staff concluded that, for this specific site, any 2-D effects due to the dipping structure in the subsurface are minor compared to the overall similarity in the seismic properties of the layers themselves.

10. FSER Section 2.5.2.1.4.2 states that the Probabilistic Seismic Hazards Analysis (PSHA) calculations were performed for the peak horizontal ground acceleration (PGA), and spectral accelerations at frequencies of 0.5, 1.0, 2.5, 5, 10, and 25 Hz. FSER Figure 2.5.2-2 shows calculated mean uniform hazard response spectra (UHRS) at annual frequencies of exceedance of 1E-4, 1E-5, and 1E-6. These UHRS showed the same trend of a monotonic increase between frequencies in the range of 0 Hz and somewhere between 30 and 40 Hz and then a monotonic decrease between frequencies after the peak up to 100 Hz.

Please explain:

1. **At what frequency the PGA was anchored and why;**
2. **How the peak for UHRS was determined considering that the calculations were performed for frequencies of 25 Hz or less;**
3. **What magnitude and distance earthquakes excite the large amplitude of the peak spectral accelerations at the high frequencies in the UHRS and why;**

4. **Whether recorded earthquakes in the CEUS or around the world either singularly or collectively embody the spectral shape of the UHRS as predicted by the PSHA, and why; and**
5. **What aleatory variability and epistemic uncertainty are associated with the estimate of high frequency spectral accelerations.**

Staff Response: (1) The peak ground acceleration, or PGA, represents the maximum absolute acceleration due to an earthquake. It is an instantaneous measure of how hard the earth shakes due to an earthquake at a site. Because PGA represents an instantaneous measure of earthquake intensity, it is placed at the maximum frequency that is typically able to be accurately recorded by or interpreted from strong motion instrumentation. For the purposes of performing PSHA, staff places the PGA at 100 Hz because it represents the highest frequency of engineering interest.

(2) The shape of the UHRS is determined using guidance in NUREG/CR-6728, *Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-consistent Ground Motion Spectra Guidelines* (ADAMS Accession No. ML013100232). The values for the UHRS are anchored at the frequencies for which the PSHA is conducted, including PGA (100 Hz), and interpolated between those points using guidance in NUREG/CR-6728 for a rock site. This provides a spectral shape that is consistent with both the PSHA and earthquake data used in the development of NUREG/CR-6728.

(3) Typically, smaller magnitude, local earthquakes excite high frequency vibrations due to the damping effect the earth has on high frequency energy as a function of distance. Following guidance in NUREG-0800, SRP Section 2.5.2 (ADAMS Accession No. ML13316C066) and RG 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion" (ADAMS Accession No. ML070310619), the applicant performed an analysis (deaggregation) of its PSHA to determine the magnitude-distance pairs that have the greatest impact on the final hazard curves for the site. The magnitude and distance pair that excites the high frequency spectral accelerations for the 10^{-4} UHRS is a **M**5.8 at a distance of 16 km (9.9 mi). These values are determined by calculating the mean earthquake magnitude and distance that contribute to the 5 to 10 Hz spectral accelerations. The staff reviewed the applicant's deaggregation analysis and determined that the applicant had followed the appropriate guidance for determining the magnitude and distance of earthquakes significant to hazard at high frequencies.

(4) As discussed in part (2) above, the spectral shape of the ESP site UHRS are consistent with earthquake recordings in the CEUS at rock sites. At frequencies for which ground motion models (GMM) exist for the CEUS, the UHRS is anchored to those values. The GMMs are based on earthquake recordings in the CEUS and modeling earthquakes using similar crustal structure to the CEUS. The UHRS shape is controlled by the equations in NUREG/CR-6728 which are based on earthquake recordings in the CEUS.

(5) Aleatory variability and epistemic uncertainty in spectral accelerations, including at high frequencies, are incorporated in the logic tree and uncertainty models in the GMM. The staff endorsed "EPRI (2004, 2006) Ground Motion Model (GMM) Review Project" (ADAMS Accession No. ML13170A385) (EPRI 2013) model, which incorporates epistemic uncertainty directly by using a logic tree approach to the GMM, where each branch receives a weight based on expert judgement and statistical analysis regarding the branch's fit to recorded earthquake data. Aleatory variability in ground motions is also incorporated in the EPRI 2013 model through observations of ground motion variability. Because the epistemic uncertainty and

aleatory variability in the GMM are explicitly factored into the PSHA for the site, the resulting final hazard curves and GMRS adequately capture variability in spectral shape as observed in the CEUS.

11. FSER Section 2.5.4.1.4.2 described downhole geophysical testing for obtaining properties for the CRN Site profile. FSER Section 2.5.4.1.4.2.1 states, "Suspension P-S velocity logging was used to obtain in situ measurements of vertically propagating horizontally polarized shear and compressional wave velocities at 0.5 m (1.64ft) intervals."

Considering the non-horizontal layers of the CRN Site with dipping stratigraphic units, please explain:

1. **Why the normal assumption of vertically propagating horizontally polarized shear and compressional waves for the CRN Site is valid; and**
2. **Whether the potential effect of inclined wave forms has been investigated and how the wave properties associated with these wave forms are characterized and why.**

Staff Response: (1) The staff evaluated the validity of the normal assumption of vertically propagating horizontally polarized shear and compressional waves for the CRN Site, which consists of inclined stratigraphic units with an inclination angle greater than 20 degrees. For this site, the staff focused on: (a) whether the general assumption is valid for the methods used to determine stratigraphic unit material properties related to wave propagations; and (b) whether the general assumption is valid for the whole site. With respect to part (a), FSER Section 2.5.4.1.4.2.1 describes how the horizontal component of shear wave (SH), and compressional wave (P) were measured by this method. The FSER states, "Suspension P-S velocity logging was used to obtain in situ measurements of vertically propagating horizontally polarized shear and compressional wave velocities at 0.5 m (1.64ft) intervals." Since the Suspension P-S Logging method measures the average wave velocities over 1.64 ft vertical distance, when both vibration source and receiver are placed in the same stratum, it will measure the in-situ material properties of that stratum regardless of the orientation of the layer. When the source and receiver are placed at two different strata (at the interface), the measurement will reflect the properties of the two layers and the interface condition, but the measured data will provide indication of such condition, and those measurements will not be used to determine the properties of that stratigraphic unit. Although the CRN Site consists of inclined stratigraphic units, the staff determined that it is reasonable to use the Suspension P-S logging method to obtain in-situ shear wave velocity for each stratigraphic unit with thicknesses ranging from more than 30 ft to over 300 ft. With respect to part (b), the testing data showed that the shear wave velocities at the CRN Site do not vary significantly between stratigraphic units. This indicates that the impedances of the strata at this site do not vary significantly either, which will greatly reduce the effects of the dipping layers on wave propagation. Additionally, the applicant performed a 2-D site seismic response sensitivity analysis to investigate the effect of inclined wave form and compared the results with that obtained from 1-D model response analysis. The two analyses provided similar results. The staff evaluated the analyses and results and determined that the use of the 1-D model or treating the site as a non-dipping site but with site specific considerations, is reasonable.

(2) The applicant investigated, and the staff evaluated, the potential effect of inclined wave forms and how the site and subsurface material properties associated with these wave forms were characterized at the CRN Site. First, the staff noted that the applicant conducted various

geophysical surveys, including seismic refraction and reflection, and P-S suspension logging at the CRN Site to characterize the dynamic properties of the site and subsurface materials. The seismic refraction and reflection geophysical surveys do not use any assumptions regarding the strata orientation at the CRN Site; therefore, the effect of inclined wave form caused by the inclination of strata was included. Second, the applicant performed a 2-D site seismic response sensitivity analysis to investigate the effect of inclined wave form on the site seismic response. Third, because of the inclined stratigraphy of the site, various stratigraphic units may be exposed at the foundation level at different locations. Therefore, the applicant analyzed two separate possible new reactor locations. For each location, the subsurface material strata profile consists of different rock formations and was determined based on boring data obtained in that specific area, to capture the actual site geologic conditions. Those site profiles were used for site seismic response and a 2-D sensitivity study to include the effect of inclined layers on the responses of the site. Fourth, all subsurface material properties related to wave propagation were determined statistically by providing mean and standard deviation values to account for uncertainties that include the effect of wave forms. Last, when the applicant conducted the site seismic response analysis, a randomization procedure, with a plus or minus 25 percent variation about the mean base case shear wave velocity profiles, was used to include the potential complexity of seismic wave propagation associated with the dipping stratigraphy at the site.

COL Action Item 2.5-11 states that an applicant for a COL or CP referencing this ESP should develop seismic wave velocity profiles for the locations where the safety-related structures will be built, based on sufficiently detailed site investigation data and with consideration of uncertainties and variability. This information is needed because the actual locations of the safety-related structures may differ from the analyzed locations in this ESPA, and additional site investigations may be needed to update seismic wave velocity profiles and other dynamic properties of the subsurface materials to account for the dipping stratigraphy at the site.

12. FSER Section 13.3.3.1 at p. 13-9 states that there are "approximately 186,500 permanent residents within 14 [miles] of the proposed CRN Site." Should this instead say "15 miles" as stated in the Clinch River Evacuation Time Estimate report?

Staff Response: Yes. The FSER has a typographical error and should say "15 miles." This error will be corrected for the NUREG publication of the FSER.

13. According to both the Staff and the Applicant, the technical criteria for establishing the PEP EPZ for the CRN Site would be:

- **The PEP EPZ should encompass those areas in which projected dose from design basis accidents could exceed the U.S. Environmental Protection Agency (EPA) early phase protective action guides (PAGs).**
- **The PEP EPZ should encompass those areas in which consequences of less severe core melt accidents could exceed the EPA early phase PAGs.**
- **The PEP EPZ should be of sufficient size to provide for substantial reduction in early severe health effects in the event of more severe core melt accidents.**

Please answer the following:

1. **Are there differences between the criteria for EPZ sizing described in the FSER and the technical criteria described in NUREG-0396?**
2. **How do public perception considerations discussed in NUREG-0396 relate to the development of the bases for the proposed exemption from the 10-mile EPZ generally specified in 10 C.F.R. § 50.33(g)?**

Staff Response: (1) There are no differences between the criteria for PEP EPZ sizing described in the FSER and the technical criteria described in NUREG-0396. These criteria are discussed on pages 15 to 17 of NUREG-0396.

(2) The basis for EPZ sizing in the NUREG is set out in technical terms. Specifically, page 15 of NUREG-0396 states that the EPZ sizing rationale was based "on a full spectrum of accidents and corresponding consequences tempered by probability considerations." Based on this rationale, NUREG-0396 included technical criteria that are the same as those in TVA's methodology. At the time the criteria in NUREG-0396 were developed, public perception was taken under consideration in a general sense. The staff's review was based on the same rationale and resulting technical criteria in NUREG-0396. As such, while the staff did not include public perception as a standalone consideration for the proposed exemption, public perception is accounted for by virtue of its consideration in the development of the NUREG-0396 criteria.

14. 10 C.F.R. § 52.17(b)(2)(i) requires the NRC Staff to consult with the Federal Emergency Management Agency (FEMA) during its review of any proposed "major features" of the emergency plan, which includes EPZs.

According to the FSER, the Staff requested that FEMA review the application and provide the following determinations:

- **Whether there is a significant impediment to the development of offsite emergency plans for the 2-mile PEP EPZ (for ESP Plan 5B), pursuant to 10 C.F.R. §§ 52.17(b)(1) and 52.18; and**
- **Whether the proposed major features of ESP Plan 5B, specifically related to the exact size and configuration of the 2-mile PEP EPZ, are acceptable.**

Please discuss any consultation with FEMA regarding ESP Plan 5A, which describes a site-boundary EPZ.

Staff Response: The NRC staff requested FEMA's determinations regarding the matters described in the question, which FEMA provided in its January 24, 2018 letter (ADAMS Accession No. ML18031B055). Consultation under 10 CFR 52.17(b)(2)(i) was limited to these matters.

More generally, the NRC has frequently engaged FEMA during the review process for the Clinch River ESP application through the FEMA/NRC Steering Committee on Emergency Preparedness in accordance with the "Memorandum of Understanding Between the Department of Homeland Security/Federal Emergency Management Agency and Nuclear Regulatory Commission Regarding Radiological Response, Planning and Preparedness" (ADAMS Accession No. ML15344A371). The Steering Committee serves as the focal point for coordination of radiological emergency planning and preparedness issues. Also, the Director of the Division of Preparedness and Response in the NRC's Office of Nuclear Security and Incident Response (NSIR), as co-chair of the FEMA/NRC Steering Committee, maintains an

ongoing dialog with his FEMA co-chair (Director, Technological Hazards Division). The NRC staff discussed the Clinch River ESP application and a scalable EPZ approach with FEMA on multiple occasions throughout the application review.

In addition to bilateral discussions with FEMA, the NRC staff has participated in discussions with FEMA that involved other parties. For example, the NRC staff has held government-to-government discussions with the Tennessee Emergency Management Agency (TEMA) staff on several occasions to discuss the ESP application, including the proposed Site Boundary PEP EPZ described in ESP Plan 5A. FEMA participated in these discussions.

15. Please briefly summarize the major concerns raised by FEMA and how those concerns were resolved.

Staff Response: FEMA's concerns regarding the Clinch River ESP application were provided in its letter dated July 8, 2019, to the Office of the Secretary and are summarized below. In general, FEMA's letter conveys concerns about the risk-informed emergency planning approach proposed by the ESP applicant and found acceptable by the NRC staff. The specific concerns and the NRC staff's response to those concerns are as follows:

FEMA concern: "FEMA does not currently endorse establishment of a Site-Boundary PEP EPZ or a 2-mile PEP EPZ for any SMR/[Other New Technology] absent the integration of the full spectrum of threats (Insider Threat, Cyber, Nation-State National Security Emergency, Electromagnetic Pulse etc.) and their associated impacts into the Accident Analyses and the [PRA]. The full threat spectrum must be integrated into the risk assessment to provide a comprehensive view of EP requirements."

NRC Staff Response: The underlying purpose of the EPZ sizing requirements in 10 CFR 50.33(g) and 10 CFR 50.47(b) and (c)(2), is set forth in NUREG-0396, a report prepared by an NRC and Environmental Protection Agency (EPA) task force on emergency planning. In developing NUREG-0396, the task force considered the views of interested federal agencies and some state and local government emergency preparedness representatives. NUREG-0396 introduced the concept of generic emergency planning zones as a basis for the planning of response actions to protect people and the environment in the area surrounding a nuclear facility from radiation in the unlikely event of a significant release of radioactive material.

To determine a generic PEP EPZ size, NUREG-0396 considered various rationales for establishing an emergency planning basis, including risk, probability, cost effectiveness, and consequence spectrum, as well as a spectrum of accidents, including rapidly evolving events, that could produce offsite doses in excess of EPA PAGs. A number of accident descriptions were considered in the development of NUREG-0396, including the core melt accident release categories of the NRC's Reactor Safety Study.[1] After September 11, 2001, the NRC conducted vulnerability studies that revealed that the timing and magnitude of releases related to hostile action would be no more severe than in the other accident sequences considered in the EP basis. For credible accident sequences, the initiating event may change how an accident starts (e.g., terrorist attack, insider threat, cyber, etc.), but it does not change the source term, how fast fuel melts, or potential offsite consequences, as discussed in more detail in the response to Question 21.

[1] NUREG-75/014 (WASH-1400), *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants* (Oct. 1975).

The NRC recognizes that if offsite emergency response is necessary to respond to a security-initiated event at a nuclear facility, some aspects of this response may be different, as compared to other events. For example, in a security emergency the decision may be to shelter the population in place, rather than evacuate, until offsite conditions are such that it is safe to evacuate. However, the principles used in setting PEP EPZ size remain the same.

TVA has requested two sets of exemptions from various EP requirements in 10 CFR 50.33(g), 10 CFR 50.47(b) and (c)(2), and Appendix E to 10 CFR Part 50, which consider a smaller PEP EPZ at the CRN Site than the current 10-mile PEP EPZ requirement specified in 10 CFR 50.47(c)(2). One set of exemptions is associated with a site boundary PEP EPZ, and the other set is associated with a 2-mile PEP EPZ. TVA requested these exemptions under 10 CFR 50.12 on the basis that a 10-mile PEP EPZ may not be necessary, considering the reduced risks associated with SMR technology, to achieve the underlying purposes of the EP requirements.

In support of its exemption requests, TVA provided a methodology for determining the appropriate PEP EPZ for SMRs at the CRN Site. TVA's methodology is based on the same approach and technical criteria in NUREG-0396 and, if approved as part of the ESP, could be used in a future COL or CP application referencing the ESP to justify a site-boundary or 2-mile PEP EPZ for a specific SMR design. The staff reviewed TVA's methodologies and exemption requests as part of its review of Chapter 13.3 of the SSAR. The staff's review determined that TVA's methodology provides the same level of protection as the 10-mile PEP EPZ requirement provides for large light-water reactors. Based on its review of the applicant's exemption requests, the staff has determined that the applicant has satisfied the criteria for exemptions under 10 CFR 50.12.

FEMA concern: "[B]ecause of the 'uniqueness' of radiological emergency preparedness (EP), we believe that State, Local, Tribal and Territorial (SLTT) stakeholders must play a central role in managing and mitigating the risk by determining the appropriate offsite radiological EP requirements."

NRC Staff Response: The NRC agrees that the views of federal, state, local, and Tribal stakeholders should be considered as part of the NRC's process for determining emergency preparedness requirements for NRC-regulated facilities. When reviewing EP information in applications, the NRC seeks and considers the views of stakeholders, including FEMA, states, local and Tribal authorities, and others. The staff recognizes that FEMA, state, local and Tribal authorities provide valuable perspectives on matters within the scope of their authority, and the NRC staff has engaged extensively with FEMA, TEMA, and others throughout the reviews of this ESP application. The NRC values its federal, state, local, and Tribal partners and works closely with them to carry out its safety and security mission, which includes determining the appropriate emergency planning requirements at the facilities it regulates. But, the NRC staff disagrees with FEMA's view that State, local, tribal and territorial stakeholders should "*determin[e]* the appropriate offsite radiological EP requirements" (emphasis added). Regulation of commercial nuclear reactor safety resides solely with the NRC, as required by the Atomic Energy Act of 1954, as amended. Thus, it is the NRC's responsibility to determine the appropriate offsite radiological EP requirements. For decades, the NRC has determined the appropriate radiological EP requirements for power reactors and the NRC and FEMA have worked together cooperatively, each within the scope of its own statutory authority and mission.

FEMA concern: "Offsite Radiological EP is not sufficiently addressed within the All Hazard's framework – radiological EP is unique. In a Worst-Case scenario, [offsite response

organizations] could be challenged to effectively protect the public health and safety using an Ad Hoc EP construct." "[I]t appears the NRC may be assuming a massive, immediate coordinated federal response should the need arise for offsite response. FEMA remains concerned that relying on such a massive and immediate federal response to a radiological accident/incident would be problematic in the event of multiple catastrophic disasters or a broader nation-state/national security emergency."

NRC Staff Response: The NRC staff did not rely on offsite response action, even if an unlikely event occurs, and did not use the all-hazards framework to review TVA's methodology for determining the appropriate size of a PEP EPZ at the CRN Site, or to reach a finding that the methodology is acceptable. Instead, the NRC staff used the technical criteria from NUREG-0396 to determine the extent to which formal offsite radiological plans should be required for SMRs at the CRN Site.

If a COL or CP applicant referencing the ESP cannot demonstrate that a site boundary PEP EPZ is justified, then a formal offsite radiological plan for the facility would be required. If the COL or CP applicant demonstrates that a site boundary PEP EPZ is justified, however, then the need for offsite actions would be highly unlikely, and the NRC staff's determination that a site boundary PEP EPZ is acceptable would not be based on prompt offsite response actions being taken. This approach is consistent with the long-standing regulatory treatment of radiological hazards by the NRC. If, despite the staff's risk-informed conclusion that offsite emergency response would not be expected to be necessary at the CRN Site, a highly unlikely release of radioactive material occurs and offsite response is necessary, the NRC staff acknowledges that such a response would occur in the context of an all-hazards framework, consistent with how such a release would currently be handled for NRC licensees other than power reactors.

The NRC staff's view is that the response to a nuclear hazard is similar to the response to other hazards. This view is consistent with FEMA guidance. For example, FEMA published Comprehensive Preparedness Guide (CPG) 101, "Developing and Maintaining Emergency Operations Plans," in November 2010 to address all-hazards planning. CPG 101 states, "Planning considers all hazards and threats. While causes of emergencies can vary greatly, many of the effects do not." In addition, CPG 101 recognizes that "planners can address common operational functions in their basic plans instead of having unique plans for every type of hazard or threat." The document further recognizes that while each hazard's characteristics (e.g., speed of onset, size of affected area) are different, the general tasks for conducting an evacuation and shelter operations are the same.

FEMA concern: "FEMA remains concerned with the use of the Protective Action Guide (PAG) for evacuation as the principal threshold to determine if a formal offsite EP program or an EPZ is needed. According to the January 2017 EPA PAG Manual, EPA-400/R-17/001, this is an inappropriate application of the EPA PAG, as a PAG is defined as the projected dose to an individual from a release of radioactive material at which a specific protective action to reduce or avoid that dose is recommended. (See January 2017 PAG Manual p. 12). PAGs do not establish an acceptable level of risk for normal, non-emergency conditions, nor do they represent the boundary between safe and unsafe conditions. (see January 2017 PAG Manual p. 12). Advanced planning - such as provided by an EPZ – reduces the complexity of the decision-making process during an incident. (See January 2017 PAG Manual p. 58)."

NRC Staff Response: The NRC staff used the EPA PAGs to review this ESP application in a manner consistent with EPA guidance, as discussed below. The NRC staff agrees with FEMA that a PAG is the projected dose to an individual from a release of radioactive material at which

a specific protective action to reduce or avoid that dose is recommended. The NRC staff also agrees that PAGs do not establish an acceptable level of risk for normal, non-emergency conditions, nor do they represent the boundary between safe and unsafe conditions. However, the NRC staff disagrees with FEMA's interpretation of the PAG Manual. Given that the PAG represents the decision point for taking protective action, it follows that if the dose is below the PAG then no specific action is necessary. The EPZ concept was developed in response to a request by the Conference of Radiation Control Program Directors (CRCPD) in 1976 to establish bounds on planning so that offsite response organizations could understand the extent of necessary planning for cases where doses exceed the PAGs and protective actions are required. If the offsite doses do not exceed the PAGs, then no specific protective actions would be necessary and offsite planning would therefore not be necessary. The NRC and EPA both support this use of the PAG as a threshold, as documented by the joint NRC/EPA Task Force in NUREG 0396/EPA-520, as well as in the 1992 EPA-400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents" and the 2017 EPA PAG manual update. EPA-400-R-92-001 states: "If PAGs cannot be exceeded offsite, EPZs need not be established for such cases." The 2017 update to the PAG manual acknowledges that "the size of the EPZ is based on the maximum distance at which a PAG might be exceeded …."

16. Section 657 of the Energy Policy Act of 2005 requires the NRC, "before issuing a license for a utilization facility," to "consult with the [Department of Homeland Security (DHS)] concerning the potential vulnerabilities of the location of the proposed facility to terrorist attack."

In SECY-19-0064, the Staff states, "[b]y email dated May 30, 2019, DHS confirmed that it will conduct consultation once the COL application has been received by NRC. As part of its environmental review in accordance with the National Environmental Policy Act (NEPA) and other applicable statutes . . . the staff consulted with and obtained input from the appropriate Federal, State, local, and Tribal organizations."

If DHS has not yet provided input, what is the basis for the Staff's conclusion that it has "obtained input" from the appropriate Federal organizations?

Staff Response: In SECY-19-0064, the staff's consultations are described on page 6. The DHS consultation on security matters pursuant to Section 657 of the Energy Policy Act of 2005 was conducted independently from the environmental consultations; both are described in this paragraph. The statement that the staff "obtained input" is specific to the environmental consultations and was not intended to apply to the DHS consultation.

Although the NRC has not yet obtained input from DHS, the NRC has complied with Section 657 of the Energy Policy Act of 2005 because it contacted DHS to initiate consultation. DHS chose to defer engaging in consultation until a future COL application is received. This is consistent with prior DHS practice for ESP reviews.

17. Is radiological emergency preparedness unique for small modular reactors (SMRs), and how does such preparedness fit into an all hazards approach?

Staff Response: Radiological emergency preparedness for SMRs is unique in comparison to EP for large light water reactors (LLWRs) to the extent that a small reactor has a potentially lower source term hazard based on the size of the core, credible accident scenarios, and

accident progression. However, emergency preparedness for SMRs and LLWRs is similar in that EP for both types of reactors has the same goal of reasonable assurance of adequate protection of the public health and safety and is based on the same technical considerations.

The response to Question 15 discusses the relationship between the NRC's risk-informed approach and the all-hazards framework.

18. The Staff refers to SECY-11-0152, "Development of an Emergency Planning and Preparedness Framework for Small Modular Reactors," dated October 28, 2011, in which the Staff discussed the need to address both modularity "to determine whether emergency planning (EP) requirements should be based on the maximum number of reactor modules onsite or whether the requirements should vary when modules are added" and collocation with different SMR types "to consider the impacts of SMRs of the same type being collocated with large reactors, industrial facilities, different SMR types, or any combination of these."

1. **How did the Staff and Applicant assess both modularity and collocation for the Clinch River ESP?**
2. **What, if any, beyond design basis assumptions were used for scenarios to evaluate the EPZ for multi-module unit designs?**
3. **Were multiple reactors assumed to have accidents for multi-module designs that share common systems?**

Staff Response: (1) The applicant's PEP EPZ sizing methodology provides that TVA will address modularity and collocation, as needed, when implementing the methodology. The staff will evaluate the COL or CP applicant's implementation of the methodology, including the use of design-specific information in the selection of accidents for the evaluation. This would include evaluation of the potential for multi-module or multiple unit events, in accordance with NUREG-0800, SRP Section 19.0, and the impact of collocation (if applicable). This evaluation was not performed during the ESP review because TVA has not yet selected a specific design; therefore, sufficiently detailed information is not yet available.

(2) The ESP application did not propose a specific PEP EPZ size. Therefore, neither the applicant nor the staff performed a specific calculation using the applicant's methodology, which requires design- and site-specific information on potential accidents. During the COL or CP review, the staff will evaluate the implementation of the methodology, including any beyond-design-basis assumptions used for the selection of accident scenarios for multi-module designs.

(3) The COL or CP applicant will be responsible for identifying credible accident scenarios. Depending on the plant design, multiple reactor accidents for multi-module designs may or may not be included in the spectrum of accidents used for the PEP EPZ size determination. The staff will evaluate the COL or CP applicant's implementation of the methodology, including the potential for multiple unit accidents.

19. Permit Condition 5 would require an applicant for a COL or construction permit (CP) that references the ESP to demonstrate that the source term for the selected SMR design "is bounded by the non-design-specific plant parameter source term information" in Table 13.3-1, "Plant Parameter Accident Releases for Determining Emergency Planning Zone (EPZ) Size in Support of Emergency Planning Exemptions."

1. **Why is it necessary to specify a bounding source term as proposed by Permit Condition 5?**
2. **Are there any potential unintended consequences of specifying a bounding source term as a Permit Condition in this case?**
3. **If a COL applicant selected a design, applied the calculation methodology for EPZ sizing proposed in this case, and met the acceptance criteria, would Permit Condition 5 preclude granting a license if the source term for the selected design were not enveloped by the Permit Condition?**

Staff Response: (1) It is necessary to specify a bounding source term in Permit Condition 5 to provide a factual basis to support the findings to issue the ESP and the requested exemptions. For example, in accordance with 10 CFR 52.17(b)(1), the NRC must find either that the site characteristics do not pose significant impediments to the development of emergency plans or that the application must identify measures to mitigate or eliminate the significant impediment. TVA's application addressed this requirement to a distance of 2-miles from the center of the site, but did not address this requirement out to 10 miles. For the NRC to find that 10 CFR 52.17(b)(1) is met, the NRC must have a factual basis for approving the exemptions from the 10-mile PEP EPZ requirement. TVA's proposed source term provides a factual basis for this finding, similar to how the NRC bases other ESP findings on design parameters in a PPE. For example, the SSAR Chapter 15 analysis of siting dose factors is based on PPE values in SSAR Table 2.0-3. SSAR Table 2.0-3 provides values for accident release source terms that are similar to the source term in Permit Condition 5. Including source term values in the PPE is an established part of the ESP review process.

(2) The staff believes that it adequately considered the consequences of specifying a bounding source term as a permit condition. TVA provided a source term that would meet the dose criteria in its methodology at the site boundary and would be conservative at the 2-mile distance reflected in ESP Plan 5B. The staff reviewed the source term TVA developed using the principles for accident source term reviews as outlined in NUREG-0800, SRP Section 15.0.3. If issues are identified in a future COL or CP application that references a specific design that differs from the source term in Permit Condition 5, they can be addressed through existing processes, such as a variance from the ESP. If a variance is requested, the COL or CP applicant would have a number of options. One option would be to provide alternative information to support whichever PEP EPZ size is requested in the COL or CP application and any associated exemptions. In this case, the staff's review would be limited to how the variance affects the basis for the NRC's original approval of the exemptions and would not reopen the entirety of the ESP review. Another alternative would be to provide information supporting the 10-mile PEP EPZ size in the NRC's regulations.

(3) No. A failure to meet Permit Condition 5 would not preclude issuance of the COL or CP, but to use the exemptions granted in the ESP, a variance would have to be requested and approved.

20. The planning basis for the existing EPZ requirements in 10 C.F.R. Part 50 was established in NUREG-0396 and was based on the objective that emergency response plans should provide dose savings for a spectrum of accidents that could produce offsite doses in excess of the EPA early phase PAGs. In EPA-400/R-17/001, "PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents," EPA provided recommended numerical PAGs for the

principal protective actions available to public officials during a radiological accident, including guidance for early phase protective actions for projected doses ranging from 1 to 5 rems during the first 96 hours of an accident.

1. **Please explain why it is necessary to develop a bounding source term (for potential credible accidents for the facility) in order to establish a PEP EPZ boundary that would provide public protection from dose levels in excess of the guidelines of the EPA PAGs?**
2. **If evacuation is conducted at doses below the EPA PAG Guidelines, what are the potential risks to the public for evacuation?**

Staff Response: (1) As explained in the response to Question 19, specifying the bounding source term is necessary to provide a factual basis for the findings to issue the ESP and the requested exemptions, consistent with the process for developing PPE values for ESPs. It is not necessary to develop a bounding source term to establish a PEP EPZ boundary that would provide public protection from dose levels in excess of the EPA early phase PAGs for the ESP at the CRN Site. Instead, TVA's proposed methodology and criteria for use by a future CP or COL applicant referencing a specific design provides reasonable assurance of adequate protection of the public health and safety. TVA's methodology and criteria include evaluation of a spectrum of credible accidents to determine a PEP EPZ that encompasses areas where the projected dose from accidents could be expected to exceed the EPA early phase PAGs.

(2) The general principle to be followed is that the risk to health from a protective action (including evacuation) should not itself exceed the risk to health from the dose that would be avoided. This is a consideration for any public evacuation. The PAGs are not limits but represent a decision point where the risk of not evacuating is considered against the risk of evacuation. This decision is the responsibility of state, local, and Tribal officials. The EPA PAGs are used for EPZ sizing to avoid the negative impacts of evacuations when they are not exceeded by the positive result of the evacuation (i.e., reduced radiation exposure and thus reduced stochastic risk). As Section 2.2.2 of EPA-400-R17-001 (January 2017) states, "When dose projections are at levels less than 1 rem (10 mSv) over the first four days, evacuation is not recommended due to the associated risks of moving large numbers of people."

Negative impacts of any evacuation may include (1) potential deaths and/or injuries resulting from traffic accidents or related mishaps; (2) potential emotional stress due to an individual's separation from family or home; (3) financial impacts on evacuees and the community in general; and (4) adverse health effects to institutionalized patients (in hospitals and nursing and retirement homes) and to elderly, disabled and/or ill persons that are more vulnerable, and less resilient, to hazardous events, such as natural and man-made disasters. EPA-400-R17-001 establishes an early phase PAG of 1 to 5 rem (10 to 50 mSv) projected dose over four days. The upper guide of 5 rem projected dose over a four-day period was established in recognition that those persons who are not readily mobile are at a higher risk from evacuation than are average members of the population.

21. Regarding the assessment of different threats (insider threat, cyber, national security emergencies, such as those experienced after 9-11, etc.) and associated impacts for the proposed facility, please describe how the source term would change or how fast a core melt would change based on the introduction or variation of an external threat (e.g., a national security threat)? Please explain how the various threats have been considered in the development of the methodology for emergency preparedness.

Staff Response: External threats, including those identified in the question, would not affect the accident progression, timing, or source term for a given accident scenario, as described below.

Interim Staff Guidance (ISG) NSIR/DPR-ISG-01, "Emergency Planning for Nuclear Power Plants," November 2011 (ADAMS Accession No. ML113010523), states the following on pages 1 and 2:

> Following the events of September 11, 2001, the NRC staff reviewed the [emergency planning (EP)] basis for nuclear power plants (NPPs) considering the impact of hostile action contingencies unanticipated at the time the basis was established. The staff concluded that the EP basis remains valid.
>
> Vulnerability studies revealed that the timing and magnitude of releases related to hostile action would be no more severe than in the other accident sequences considered in the EP basis.

Further detail is given on page 26 of the ISG:

> Vulnerability studies revealed that the timing and magnitude of releases related to hostile action events are no more severe than the shortest timing or largest magnitude sequences considered in the EP basis. The EP basis accounts for the shortest timing and largest magnitude from a spectrum of accidents.

More detailed discussion of this topic, including the results of the vulnerability studies, is given in SECY-03-0165, "Evaluation of Nuclear Power Reactor Emergency Preparedness Planning Basis Adequacy in the Post-9/11 Threat Environment," September 22, 2003 (ADAMS Accession No. ML031960020, NONPUBLIC).

TVA's proposed methodology and criteria for determining the appropriate size of the PEP EPZ at the CRN Site considers a range of design basis and severe accidents. The staff evaluated TVA's proposed methodology and criteria for determining the appropriate PEP EPZ size for the CRN Site and determined that the consideration of hazards is reasonable and consistent with the NRC's current EP basis.

22. In SSAR § 13.3 the Applicant requests approval of a methodology and radiological dose-related criteria that could be used by a future COL or CP applicant to support a specific PEP EPZ size in the COL or CP application. The Applicant does not ask for approval of a specific PEP EPZ as part of the ESP application, but rather the methodology and criteria, and limits on the maximum megawatts thermal per unit and the total number of megawatts thermal onsite as discussed in Appendix A of the FSER, Table A.4, "Bounding Design Parameters Specified in the ESP."

For context and in order to fully understand the implications of the Applicant's methodology and radiological dose-related criteria, and without consideration of the specifics in FSER Appendix A, Table A.4, please apply these criteria and methodology to the following operating units:

1. **R.E. Ginna Nuclear Power Plant**

2. **Three Mile Island Nuclear Station, Unit 1**
3. **Indian Point Nuclear Generating, Unit 2**
4. **Diablo Canyon Nuclear Power Plant, Unit 1.**

What would be the resulting EPZs?

Staff Response: The staff does not have sufficient information to apply TVA's proposed PEP EPZ size methodology to the identified operating units. To perform the analyses described in the applicant's methodology, the staff would need to obtain from the licensees both DBA radiological release information and probabilistic risk assessment (PRA) Level 2 and 3 information for each of the listed operating units. After obtaining this information, the staff would require substantial time and resources to perform the evaluations. These evaluations would entail multiple steps performed separately for each unit, including: development of appropriate assumptions (including consideration of uncertainties), selection of accident scenarios (DBAs and severe accidents), development of source terms, acquisition/development of other input data (e.g., at least a year of hourly weather data, a calculation grid to determine doses at multiple locations, and modeling of appropriate dose quantities and exposure periods), comparison of calculated dose results for each accident category, and appropriate peer review.

23. 10 C.F.R. § 50.33(g) states, in part, "Generally, the plume exposure pathway EPZ for nuclear power reactors shall consist of an area about 10 miles (16 km) in radius . . . The size of the EPZs also may be determined on a case-by-case basis for gas-cooled reactors and for reactors with an authorized power level less than 250 MW thermal." In the statement of considerations for the 1980 EP rule (45 FR 55406, dated August 19, 1980), that established this requirement, the Commission stated that smaller planning zones can be evaluated on a case-by-case basis for these facilities because of the lower potential hazard and longer times to release significant amounts of activity.

The information provided to support an exemption to the general requirement for a 10-mile EPZ (for large light water reactors) would also seem to support the rationale for a case-by-case request for EPZ size (i.e., lower potential hazard and longer times to release).

1. **(Staff) What would the consequences be of an exemption from the conditions for a case-by-case consideration of EPZ size?**
2. **(Staff) What would the consequences be of an exemption from part of the regulation that "in general" requires a 10-mile EPZ?**
3. **(Applicant) What would the consequences be of not granting an EPZ exemption at the ESP stage?**

Staff Response: (1) The regulations allow case-by-case consideration of EPZ size if one of the following two conditions is met: the reactor is "gas-cooled," or the reactor has "an authorized power level less than 250 MW thermal." 10 CFR 50.33(g). If, in acting on this ESP application and TVA's exemption requests, the NRC were to grant an exemption from these conditions (e.g., gas-cooled or less than 250 MW thermal) instead of TVA's requested exemptions, a COL or CP applicant referencing the ESP could establish the PEP EPZ size on a case-by-case basis regardless of reactor type or size.

(2) As stated in Part 6, Revision 2, of TVA's application, the applicant requested an exemption from specific requirements in 10 CFR 50.33(g) for both the site boundary and 2-mile PEP EPZ

emergency plans. If approved and granted, the exemptions would mean that a CP or COL applicant referencing the ESP would not have to meet the lined-out requirement shown in the following quote of 10 CFR 50.33(g) for both the site boundary and 2-mile PEP EPZ emergency plans: "Generally, ~~the plume exposure pathway EPZ for nuclear power reactors shall consist of an area about 10 miles (16 km) in radius and~~ the ingestion pathway EPZ shall consist of an area about 50 miles (80 km) in radius." If the applicant had requested an exemption from the word "Generally" *in addition to* the struck-out language in TVA's exemption request, this would have removed flexibility in the ingestion pathway EPZ requirement for the CRN Site. If the applicant had requested an exemption from the word "Generally" *in lieu of* the struck-out language in TVA's exemption request, then the CRN Site would be subject to a 10-mile PEP EPZ and a 50-mile ingestion pathway EPZ.

24. 10 C.F.R. § 52.17(b)(1) requires that the SSAR submitted by the Applicant set forth physical features of the site that could pose "a significant impediment" to the development of emergency plans. 10 C.F.R. § 52.17(b)(2) states that the SSAR "may also" either "[p]ropose major features of the emergency plans . . . such as the exact size and configuration" of the EPZs or "[p]ropose complete and integrated emergency plans."

In this case, the SSAR proposes "major features," but the Staff has not determined the "exact size and configuration" of the EPZs. For example, according to a footnote in FSER Section 13.3.3.5.1, "TVA is requesting NRC approval of the [ESP application]'s <u>description</u> of the 2 [mile] PEP EPZ. TVA is not requesting approval of the <u>application</u> of the 2 [mile] PEP EPZ to the CRN Site, because this would be addressed in a [COL application]. The extent of NRC approval of the description of the 2 [mile] PEP EPZ is limited to whether that description reflects such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries, in accordance with Section I.3 of Appendix E to 10 CFR Part 50."

1. **(Staff and Applicant) Please clarify why exemptions from EPZ and related requirements in 10 C.F.R. § 50.33(g) and elsewhere would be necessary at this time if the "exact size and configuration of the emergency planning zones" is not being approved now.**
2. **(Staff) If the exemptions are approved now, is this conclusion—that either a 2-mile or site-boundary EPZ would be appropriate for a COL application that references a design within the PPE—final? What further review of EPZ size, if any, would occur at the COL stage?**

<u>Staff Response</u>: (1) Although the PEP EPZ size and configuration are not being established now, TVA's application includes information related to a PEP EPZ size smaller than 10 miles (for example, the information on site impediments to emergency plans discussed in response to Question 19). If the proposed exemptions are not approved, the NRC would not be able to make the findings to issue the ESP, unless TVA modified those portions of its application that rely on the proposed exemptions.

Also, the exemptions are necessary to provide finality for TVA's risk-informed approach to PEP EPZ sizing that it seeks to implement in a future application that incorporates the ESP, if granted. The finality granted at the ESP stage is for the methodology and the major features in Part 5A and Part 5B of the application, not for the PEP EPZ size that might result from use of the methodology. The exemptions, if approved, would allow the COL or CP applicant to use the

approved methodology to support a site boundary or 2-mile PEP EPZ if the COL or CP applicant demonstrates that the selected reactor design meets the applicable dose criteria and Permit Condition 5.

(2) Neither the 2-mile PEP EPZ nor a site boundary PEP EPZ is being approved in the ESP. As discussed above, the staff proposes to approve in the ESP the methodology to determine the appropriate PEP EPZ size in a future COL or CP application. If the exemptions are approved, the future applicant may use the applicable exemptions, as long as all conditions on use of the exemptions are satisfied.

The future COL or CP applicant would use the source term for the selected design and the ESP-approved methodology to develop a dose assessment. The result of that assessment will be compared with the approved dose criteria to determine whether a site boundary or 2-mile PEP EPZ is justified. The future applicant will also have to show that Permit Condition 5 is met or provide the basis for a variance from the source term listed therein. Finally, if the future COL or CP applicant seeks a site boundary PEP EPZ, the applicant would have to specify the exact boundary for the site boundary PEP EPZ because the ESP applicant has not done this. The NRC staff would review these matters, as applicable, when the COL or CP application is submitted.

25. 10 C.F.R. § 50.33(g) states, in part, "If the application is for an early site permit that, under 10 CFR 52.17(b)(2)(i), proposes major features of the emergency plans describing the EPZs, then the descriptions of the EPZs must meet the requirements of this paragraph." For the site-boundary EPZ, the requested exemption would still leave in place the requirement that, "The exact size and configuration of the EPZs surrounding a particular nuclear power reactor shall be determined in relation to the local emergency response needs and capabilities as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries." This statement is repeated in 10 C.F.R. § 50.47(c)(2).

Please discuss the effect that language in the regulations would have on the proposed site-boundary EPZ. Would this part of the regulations impose any requirements for determining EPZ size that differ from (or add to) the risk-informed, dose-based, consequence-oriented methodology proposed for approval in this case?

Staff Response: The quoted language from 10 CFR 50.33(g) and 50.47(c)(2) relates to conditions beyond the site boundary and, thus, would have no effect on a site boundary PEP EPZ because for the site boundary PEP EPZ, no offsite needs and capabilities are necessary. Therefore, this part of the regulations would not impose any requirements for determining PEP EPZ size that differ from (or add to) the risk-informed, dose-based, consequence-oriented methodology proposed for this ESP.

26. Section 14.2 of the ESPA Part 5A, "Emergency Plan (Site Boundary EPZ)," states, in part, "TVA offers State and local authorities and support organizations the opportunity to participate in drills and exercises to the extent their assistance would be expected during an emergency at the CRN Site; however, participation is not required." This statement is consistent with the exercise requirements for other NRC-licensed facilities with site-boundary EPZs including independent spent fuel storage installations under 10 C.F.R. § 72.32(a)(12) and the EP

exemption requests for decommissioning nuclear power plants as described in NSIR/DPR-ISG-02. However, the requirement in 10 C.F.R. Part 50, Appendix E.IV.F.2.e., states, "Licensees shall enable any State or local government located within the plume exposure pathway EPZ to participate in the licensee's drills when requested by such State or local governments."

Please clarify how this requirement would apply to a site-boundary EPZ emergency plan for an SMR. Would a permit condition related to and/or an exemption from the phrase "located within the plume exposure pathway EPZ" be needed to ensure that such participation is made available to State and local governments by the licensee?

Staff Response: Should a COL or CP be issued with a site boundary PEP EPZ, the existing rule would require the licensee to enable state and local participation in onsite drills when requested. No exemption or permit condition is needed to ensure that such participation is made available.

27. Is it expected at this time that any license conditions related to EP and/or exemptions from EP regulations will be needed at the COL stage if a site-boundary EPZ is established? If so, please briefly describe the license conditions and exemptions that are expected to be needed.

Staff Response: With respect to the PEP EPZ, the staff has determined that additional exemptions would not be necessary if a site boundary PEP EPZ is justified at the COL or CP stage. Whether license conditions or additional exemptions related to emergency planning may be necessary in a future COL or CP application would depend on the specific contents of the future application and whether the applicant makes additional requests that bear upon emergency planning.

28. In CNL-18-046 (letter response to additional requests for additional information), dated March 30, 2018, Table 4 shows a dose at the exclusion area boundary (EAB) of 4.35 rem total effective dose equivalent for the CRN Largest Core. Table 3, "Comparison of Design Basis Accident Progression Between SMRs and Large LWRs," states that no data is available for the CRN Largest Core for parameters including time to the initial uncovering of the core, long-term cooling capability, and core recovery. How was this EAB dose calculated for Table 4 if accident data is not available?

Staff Response: In response to staff requests for additional information (ADAMS Accession Nos. ML17209A401 and ML17345B126), the applicant provided information from vendors for the four preliminary SMR designs that TVA used to develop the ESP PPE. Apparently, the vendor for the design with the largest core provided information on the calculated dose at the EAB, but did not provide specific details about the accident scenario(s) for its design, including accident progression and accident mitigation capabilities.

However, these details are not necessary for the staff to assess the reasonableness of the dose results reported in Table 4 of the applicant's response letter. The ESP application provided information on the releases for the largest core design. The design basis LOCA dose of 4.35 rem TEDE for the "CRN Largest Core" given in Table 4 of the applicant's letter is the same as the vendor dose reported in SSAR Table 15.1. The source term for this design basis LOCA is listed in SSAR Table 2.0-3. When the source term in SSAR Table 2.0-3 and the vendor-

supplied atmospheric dispersion factors in SSAR Table 15-1 are used as input to the dose analysis, the result is the vendor dose reported in SSAR Table 15-1.

29. Section 16.0, "Plan Maintenance," of ESPA Part 5A and Part 5B describes the change process for revisions to the CRN emergency plan. Specifically, the determining factor for whether NRC review and approval is required for a plan change is whether the change is a "significant change" as determined by a "Plan Effectiveness Determination."

How does the "Plan Effectiveness Determination" define a "significant change"? Does "significant change" mean the same thing as a "reduction in effectiveness," which is defined in the requirements of 10 C.F.R. § 50.54(q) governing NRC review and approval for plan changes?

Staff Response: "Plan Effectiveness Determination" refers to the process under 10 CFR 50.54(q) where a licensee shall evaluate a proposed change to its emergency plan to determine whether the change would reduce the effectiveness of the plan if implemented. As stated in Figure 16-1 of ESP Plan 5A and ESP Plan 5B, the plan effectiveness determination will be made in accordance with 10 CFR 50.54(q). While the term "significant change" is not defined in TVA's emergency plans, the staff understands that the term, in context, refers to a change that results in a reduction in effectiveness.

31. As the Staff notes in FSER § 15.0.3.2.1, to assess the reasonableness of the source terms used in the ESP PPE, the Staff and Applicant conducted comparisons of the most limiting unit (800 MWt) to that of a scaled down Westinghouse Advanced Passive 1000 reactor design. The Applicant acknowledged approximately a 25-percent greater total activity release for the scaled-down AP1000 source term than that of the surrogate plant analyzed for the PPE. The independent Staff evaluation resulted in a higher activity release using the same scaled-down ratio.

Please describe the "SMR design enhanced removal mechanisms and advanced engineering features for larger retention times that are not accounted for in the assumptions for this analysis" used to conclude the source term for this PPE is "representative and not unreasonable."

Staff Response: Because the SMR design is conceptual in nature, it is not known whether there are additional engineering features that would enhance fission product transport, retention, and removal, or whether there are other mechanisms and phenomena that can be assumed to have the same relative effect as in the AP1000 consequence analyses. The PPE was based on available information for four conceptual SMR designs that are still being developed; as such, the DBA source term information provided to the applicant by the vendors is not based on a complete design. The staff's evaluation determined that the PPE information provided by the applicant (in this case, assumed release from DBAs for an 800 MWt SMR) is reasonable for use as surrogate plant information for siting analysis in review of the ESP application. Because the AP1000 is a certified design with known systems and accident characteristics evaluated by the staff, the staff chose to evaluate whether the bounding DBA releases to the environment included in the PPE were generally consistent with releases for a version of the plant that would be scaled down on a core power basis. Because the fuel design is similar between the AP1000 and the conceptual 800 MWt SMR, core inventory can generally be assumed to scale with thermal power.

As such, the releases scaled down from the AP1000 information are an adequate approximation to the SMR DBA releases, and this approach is, therefore, representative and reasonable. Further, an SMR design vendor may choose to use a more realistic mechanistic modeling of the source term for DBAs, which may result in smaller or delayed releases from the fuel into the containment.

32. In Appendix A of the FSER, the Staff notes that it "identified the COL Action Items listed in Table A.2 to ensure that particular significant issues are tracked and considered during the review of a later COL or CP application referencing the ESP, if granted, for the CRN Site."

How did the Staff determine which items were "particular significant issues"? Meteorological issues (item 2.3-1) are captured in the Table A.2, but "effects of potential explosion events caused by onsite storage" (as discussed on page 2-17, chapter 2 of the FSER) are not. Should the latter have been included in Appendix A?

Staff Response: If the information in the ESP needs to be verified in the COL or CP application, then the staff considers this confirmation to be a significant issue that should be captured as a COL action item. A COL action item can also be used for significant matters covered by regulatory requirements for a COL or CP application if the staff or the applicant considers it would be appropriate to emphasize the need for the COL or CP applicant to meet the requirement, but this is a matter of judgment. COL action items help ensure that significant issues are tracked and considered during the review of a later COL or CP application referencing the ESP, if granted, for the CRN Site. For example, in the case of COL Action Item 2.3-1, the staff evaluated cooling tower impacts on local meteorology in the FSER based on the operation of two linear mechanical draft cooling towers at the site, as provided in the SSAR. A cooling tower design submitted for a COL or CP application, however, could utilize a different system and configuration, which could change cooling tower plume characteristics and potentially affect the plant switchyard and safety-related air intakes. As such, the COL or CP applicant is instructed by COL Action Item 2.3-1 to verify that the cooling-tower plume characteristic assumptions described in the ESPA are accurate for whichever design is chosen.

A COL action item is not needed to capture the "effects of potential explosion events caused by onsite storage" (as discussed on page 2-1, chapter 2 of the FSER) because no assumptions regarding these matters were made in the ESP application. Also, the information required by 10 CFR 100.20(b) for man-made hazards, including explosion impacts, is addressed in detail by NUREG-0800, SRP Sections 2.2.1-2.2.2 (Revision 3, 2007), SRP Section 2.2.3 (Revision 3, 2007) and Regulatory Guide 1.91 (Revision 2, 2013).

33. The permit conditions, COL action items, site characteristics, and bounding design parameters tables reference Regulatory Guides, NUREGs, Interim Staff Guidance, and Nuclear Energy Institute (NEI) documents, but do not always specify the date or revision number associated with the document.

What was the Staff's rationale for omitting the date or the revision number for some of the key documents referenced in the Appendix A tables?

Staff Response: Entire citations to all RGs, NUREGs, ISGs and NEI documents, complete with dates and revision numbers, are provided in the FSER sections in which they are

discussed. For this reason, and for the purposes of streamlining the document, the staff did not repeat the specific dates and revision numbers of these documents in the Appendix A tables.

34. Sections A.2 and A.4 specify that the items included in the subsequent tables were for future applicants referencing the ESP for either a COL or CP. However, Section A.3 only refers to information in a COL application.

What is the rationale for the Staff's referencing only a COL in the introduction paragraph to Section A.3?

Staff Response: In the introduction paragraph to Section A.3, the Staff only included a reference to a COL applicant; however, the text should have included both COL and CP applicants. This was an inadvertent omission, and the staff will correct it prior to NUREG publication of the FSER.

35. Table A.4, "Bounding Design Parameters Specified in the ESP," presents the bounding value for "plant megawatts thermal" as the maximum thermal power generated by one unit and the maximum thermal power for the site. The bounding design parameters do not specify that the reactors must be of the same type or that there should be a maximum number of reactor cores onsite.

Should the Staff specify in Appendix A whether the reactor cores must be of the same type?

Should the Staff specify in Appendix A whether there should be a maximum number of total reactors onsite?

Staff Response: The applicant did not specify a reactor type or the number of reactors as a design parameter for the PPE. The NRC staff determined that parameters for these matters were not necessary because the PPE (which included parameters for thermal power, accident source term, etc.) was sufficient to support the staff's review. A COL or CP applicant that references the ESP will have to show that each specific technology selected for the COL or CP application is within the PPE, regardless of reactor type, consistency, or number.

36. Some Permit Conditions (e.g., 2.5-1) and COL Action Items (e.g., 2.4-1) use the term "safety-related" when discussing requirements for certain structures, systems, and components (SSCs). Did the Staff consider the impact of a COL or CP applicant opting to use 10 C.F.R. § 50.69, which contains four safety classes, rather than the traditional two (i.e., "safety-related" and "non-safety-related")? For example, would the provisions discussed in Permit Condition 2.5-1 apply to Risk-Informed Safety Class (RISC)-3 structures?

Staff Response: The staff did not consider the impact of a COL or CP applicant opting to use 10 CFR 50.69, which defines four safety classes, because it was unnecessary to do so. SSCs of all safety classes could be located in those excavations covered by Permit Condition 2.5-1, and if surface deformation occurred at a site, it could affect all SSCs located on the nuclear island whether they are low or high safety-significant SSCs. The provisions discussed in Permit Condition 2.5-1 apply to structures that fall in RISC Classes 1 and 3. The permit conditions and COL action items in the draft permit do not preclude a COL or CP applicant from applying 10 CFR 50.69.

37. Several COL Action Items (e.g., 2.5-2, 2.5-5) direct the Applicant to perform an analysis (e.g., "conduct further evaluation of the shear-fracture zones"), but they do not state that the results of the analysis need to be included or even summarized in a future COL or CP.

Other COL Action Items (e.g., 2.3-1) direct the Applicant to perform an analysis and include the results in a future COL application.

Did the Staff intend to require the Applicant to perform an analysis for some COL Action Items but not to include the results of the analysis in a future COL application?

Staff Response: No. As stated in Condition 3.C. on page 2 of the draft permit referenced in SECY-19-0064 (ADAMS Accession No. ML19107A241), the "COL action items identify certain matters that an applicant submitting a construction permit (CP) or COL application that references this ESP shall address in the safety analysis report (SAR)." Thus, an applicant for a COL or CP referencing the CRN Site ESP must address each of these items in its application, whether or not the COL action item explicitly states this. Also, as stated in Condition 3.C. of the draft permit, COL action items establish information requirements, but the applicant may depart from or omit these items provided that the COL or CP application identifies and justifies the departure or omission.

38. Permit Condition 2.2-1 states that a COL applicant shall evaluate the potential Heritage Center Industrial Park Airport to determine whether an aircraft impact should be considered a design basis event. What methodology and acceptance criteria for completing this evaluation (e.g., what is the threshold probability that defines a design basis event?) are acceptable to the Staff? Would a COL Applicant be required to use the same approach that was used for existing airports as described in FSER § 3.5.1.6?

Staff Response: A design-basis event is defined in NUREG-0800, SRP Section 2.2.3, as an event that has a probability of occurrence on the order of magnitude of 10^{-7} per year or greater with potential consequences serious enough to affect the safety of the plant to the extent that the dose guidelines referenced in 10 CFR Part 100 could be exceeded. NUREG-0800, SRP Section 3.5.1.6, establishes a methodology and acceptance criteria acceptable to the staff in determining whether an aircraft accident is a design-basis event. If the aircraft event is determined by a COL applicant not to be a design-basis event, the risks of aircraft hazards would have to be sufficiently low, as described in SRP Sections 2.2.3 and 3.5.1.6. A COL applicant is required to evaluate aircraft hazards in accordance with 10 CFR 100.20(b). A COL applicant could use an approach that is the same as, or different from, the one described in FSER Section 3.5.1.6, so long as the regulation is satisfied.

39. Please describe the Staff's and the Applicant's methodology and process for tracking and accounting for new and significant information that may arise between the ESP (if issued) and any submission of a CP or COL application.

Staff Response: Consistent with the Commission's requirements stated in 10 CFR 51.45 and 51.50(a) and (c)(1)(iii) and (iv), an application for a COL or CP that references an ESP must provide an Environmental Report (ER) containing any new and significant information for issues related to the impacts of construction and operation of the facility that were resolved in the ESP proceeding as well as a description of the process used to identify new and significant

information regarding the NRC's conclusions in the ESP EIS. Section 51.50(c)(1)(iv) states that the process must use a reasonable methodology for identifying such new and significant information.

Further, the Statement of Considerations for the NRC's August 2007 rule revising 10 CFR Part 52 (72 FR 49352) states that the applicant's documentation related to the search for new information and its determination about the significance of the new information should be maintained in an auditable form by the applicant. That Statement of Considerations also states that for new information to be considered "significant", it must be material to the issue being considered; that is, it must have the potential to affect the finding or conclusions of the NRC staff's evaluation of the issue in the ESP environmental impact statement (EIS).

Consistent with the Commission's requirements stated in 10 CFR 51.75(c)(1) and 51.92(b) and (e)(7) and NEPA, in a proceeding for a COL or CP application referencing an ESP, the NRC staff must evaluate in a supplement to the final EIS for a referenced ESP the impacts of construction and operation of the facility that were resolved in the ESP proceeding for which new and significant information has been identified. In its review of an application for a COL or CP referencing an ESP, the staff will verify that the applicant's process to identify new and significant information is effective in ensuring that the applicant becomes aware of new and significant information that may affect the earlier NRC conclusions described in an EIS for the referenced ESP. During the review of a COL or CP application, the staff will also independently identify new and significant information and would use the environmental scoping process for this effort.

The Commission's requirements in 10 CFR Parts 51 and 52 do not require the ESP holder or the NRC staff to perform continuous or periodic updating of ESP information prior to receipt of a COL or CP application referencing that ESP. Because new environmental information, if any, would be identified at the time a license application referencing the ESP is submitted to the NRC, there is no requirement that the ESP holder (or the staff) track new information in the interim between ESP issuance and the time the applicant begins to prepare a COL or CP application.

40. Please highlight major themes from the comments on the Draft Environmental Impact Statement (EIS), and generally describe the Staff's responses to those comments.

Staff Response: The staff issued the draft EIS in April 2018 for public comment. Two public meetings were held in Kingston, TN, on June 5, 2018, which was transcribed, to collect comments from interested stakeholders in the communities near the proposed site. Approximately 115 people attended the meetings and numerous participants provided oral comments at each meeting. During the 75-day comment period, the staff received over 2500 letters and emails, the vast majority of which were received as form letters from individuals through the web sites of two environmental advocacy groups. All comments and their responses are included in Appendix E of the final EIS.

The two advocacy groups' form letters expressed concerns regarding the following: the cost of the project; whether there is a need for the electricity; the NRC's regulatory process allowing ESP applicants to defer the discussion of the project's benefit-cost balance and to defer the consideration of energy alternatives; and TVA's request for exemptions from certain NRC regulatory requirements related to emergency planning. Other comments were received which

expressed concerns for the impacts to water and wetlands, impacts to cultural resources, legacy contaminants, and whether any of the other alternative sites should be the preferred alternative. Regarding issues relating to analyses which TVA chose to defer at the ESP stage, the staff's responses referenced the regulations which allow TVA to defer those analyses and explained that TVA would be required to provide those analyses and address any related issues in a COL or CP application that references the CRN Site ESP. For example, pursuant to 10 CFR 51.50(b)(2) and (c), an ESP applicant may defer its assessment of the benefit-cost balance of the project (including a demonstration of the need for power) and an evaluation of alternative energy sources.

For those comments related to emergency planning, the staff's response explained that the evaluation of the exemption requests and TVA's proposed methodology for establishing the size of the PEP EPZ in a future application that references the CRN Site ESP is part of the safety review. Therefore, these comments were considered out of scope of the environmental review. Because these comments addressed aspects of the safety review, comment responses referenced the FSER, which provides the staff's evaluation of the proposed major features of the emergency plans and the related exemption requests.

With respect to the other comments on topics covered in the ESP environmental review, the review team's responses directed the commenters to the section of the draft EIS where the issue raised in the comment was evaluated and indicated whether that section had been revised as a result of the comment. Most responses included a brief explanation of how a section of the EIS was revised, or why a section was not revised.

41. "A new nuclear power plant at the CRN [S]ite would withdraw most of the water needed for building and operations from the Clinch River arm of the Watts Bar Reservoir." Melton Hill Dam is one of two dams located on the Clinch River upstream of the CRN Site. "Because the river at the [CRN Site] is part of the Clinch River arm of the Watts Bar Reservoir, Clinch River flow velocity at the CRN [S]ite may be low when no water is being released from Melton Hill Dam."

How does this impact intake for the CRN Site? Does this impact present a concern from a construction or operations perspective?

Staff Response: Low flow velocities in the Clinch River are not expected to impact the CRN Site intake for construction or operation. The NRC staff evaluated potential fluctuations in reservoir water elevations at the intake location and determined that under TVA's current river management policy, the availability of water for construction and operation at the CRN Site would not be significantly affected by the expected variation in releases from Melton Hill Dam. Because the Clinch River at the CRN Site is part of the Watts Bar Reservoir, which extends from the Watts Bar Dam upstream in the Clinch River to the Melton Hill Dam, water-surface elevations at the location of the CRN Site intake are controlled primarily by releases from Watts Bar Dam (*See* Figures 2-12 and 2-13 of the final EIS). When no water is being released from Melton Hill Dam, flow velocity downstream of the dam will be significantly reduced, but water surface elevations at the CRN Site intake location (5 miles downstream from Melton Hill Dam) will not be significantly affected.

43. What is the process to acquire water rights and associated authorizations for the use of water from the Clinch River arm of the Watts Bar Reservoir?

Staff Response: The processes to acquire water rights and associated authorizations for the use of water from the Clinch River arm of the Watts Bar Reservoir are governed by State and Federal statutes and regulations. The separate authorizations likely to be necessary in connection with building and operating a nuclear plant on the CRN Site are listed in Sections 4.2 and 5.2 of the final EIS.

The principal authorization associated with water use is from the State. The Tennessee Water Quality Control Act establishes waters of Tennessee as the property of the state that are regulated to protect water quality (T.C.A. § 69-3-102). Withdrawal from the Clinch River arm of the Watts Bar Reservoir would be regulated under this Act as a physical alteration to the water resource and would require an Aquatic Resource Alteration Permit from TDEC's Division of Water Resources. The Aquatic Resource Alteration Permit may establish conditions for the withdrawal that are protective of the resource value (Rules of the TDEC Chap. 0400-40-07).

44. In Section 4.4.4.1 of the FEIS, the Staff states that four traffic intersections were identified that would deteriorate by 2024, due to "peak construction employment," and would be below acceptable standards for State traffic thresholds. The Staff notes that several potential mitigation strategies were identified as improvements to nearby infrastructure. In Section 4.4.4.6 of the FEIS, the Staff concludes that adverse impacts to traffic for routes near the CRN Site would be LARGE for routes without mitigation, and MODERATE to LARGE if mitigation measures are implemented. Please clarify whether the Staff's analysis of traffic impacts to these routes accounts for the four deteriorating traffic intersections described in Section 4.4.4.1 of the FEIS.

Staff Response: Yes. The staff's analysis of traffic impacts accounts for the four deteriorating traffic intersections in reaching the impact conclusions stated in Sections 4.4.4.6 and 4.4.5 of the final EIS. Taking these intersections into account, the staff found that adverse impacts to traffic for routes near the CRN Site during peak construction employment would be LARGE for routes without mitigation and MODERATE to LARGE if mitigation measures are implemented.

45. The Staff bases its findings on impacts to cultural and historic resources in part on the NRC's ongoing consultation with twenty American Indian Tribes and the Tennessee Historical Commission (THC). Please explain whether this consultation is ongoing and, if so, describe any new information received relevant to the Staff's findings on impacts to historic and cultural resources and how such information could affect the Staff's findings.

Staff Response: The completion of consultation was documented in a letter to the THC on November 13, 2018, following an October 3, 2018, teleconference (ADAMS Accession No. ML18267A315). In accordance with 36 CFR 800.8(c), submission of the final EIS to THC (ADAMS Accession No. ML19053A649), the Advisory Council on Historic Preservation (ADAMS Accession No. ML19053A751), and American Indian Tribes in April 2019 documents completion of the NRC's National Historic Preservation Act (NHPA) Section 106 compliance requirements for the Clinch River ESP. For this reason, the language in Section 4.6.3 and 5.6.3 should have been updated to remove the word "ongoing."

46. Does the Staff's evaluation of impacts to air quality account for the contribution of traffic exhaust emissions from idling vehicles due to the increase in traffic jams associated with the construction and pre-construction phases of the project?

Staff Response: Yes. The staff's evaluation of impacts to air quality accounts for the contribution of traffic emissions as part of its evaluation in accordance with NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan* (ESRP) (Sections 2.7 and 4.4.1), and Attachment 1 of NRC Interim Staff Guidance COL/ESP-ISG-26, "Interim Staff Guidance on Environmental Issues Associated with New Reactors" (ISG-26). As stated in Section 4.7.1 of the final EIS, the staff evaluated air emissions from a list of potential activities, which included the workforce commute. The staff's evaluation of air emissions from the workforce commute in Section 4.7.1 of the final EIS covers emissions produced by idling vehicles in traffic jams. Section 4.7.2 of the final EIS specifically discusses the potential impacts of increased traffic on emissions. Air emissions from equipment and vehicles, including commuter vehicles, would contain carbon monoxide, oxides of nitrogen, volatile organic compounds, oxides of sulfur to a lesser extent, and particulate matter during vehicular traffic over recently disturbed or cleared areas. In addition, construction and preconstruction activities, such as operation of on-road construction vehicles, commuter vehicles, nonroad construction equipment, and marine engines, would also result in greenhouse gas (GHG) emissions, principally carbon dioxide (CO2), which was also considered in the staff's analyses in Section 4.7.

The staff found that the impact from increased traffic volume and congestion would be localized and temporary. While emissions will vary throughout the life of the project, the peak commuter emissions would occur for approximately 6 months of the 72 months during the estimated building period.

47. Table 4-13 of the FEIS lists specific measures and controls to limit impacts from building a new SMR at the CRN Site. Table 4-13 was based on Table 4.6-1 in the environmental report (ER) and "other information provided by the applicant." The FEIS states that the Staff considered these measures and controls in its evaluation of the impacts of building two or more SMRs at the site. Please explain whether the measures identified in Table 4-13 are intended to be binding.

Staff Response: Given that the non-radiological mitigation measures outlined in Table 4-13 are not under NRC jurisdiction, the ESP does not include these as permit conditions, nor would the NRC enforce these mitigation measures as part of a future COL or CP should one be issued. However, many of these measures are expected to be required by other Federal, state or local permits or authorizations that would be required in order for TVA to perform those building activities that are outlined in the ER.

Measures and controls to limit any adverse impact are identified and evaluated for feasibility and adequacy in limiting such impacts. Staff guidance for addressing mitigating measures that are identified during the course of its review of an ESP or COL application is found in ISG-26. ISG-26 outlines the circumstances in which the staff may rely upon mitigation measures and controls to determine impact levels. ISG-26 explains that the staff may rely on mitigation measures proposed by the applicant if the mitigation can be considered reasonably foreseeable. ISG-26 provides that the staff may rely on mitigation measures when they are expected to be required by another Federal, state, or local permitting agency or when it can be shown that the measures are standard industry construction practices. The staff may also rely on those mitigations that are integral parts of the project. If the available information does not clearly demonstrate whether the mitigation measure is reasonably foreseeable and the non-implementation of that mitigation would result in a change in an impact level, then the staff should provide two impact levels; one with and one without mitigation.

48. The Staff evaluated the potential for severe accident risks associated with a surface-water pathway (i.e., hypothetical accidents resulting in radioactive material deposited on open bodies of water) and concluded that the doses associated with ingestion of aquatic food in surface waterbodies would be equivalent to or lower than the doses associated with the atmospheric pathway. The Staff's conclusion was based on the evaluation performed in "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, and the Staff referenced interdiction measures as part of the basis for its conclusion in Section 5.11.2.2 of the FEIS. Please summarize the interdiction measures that would be used to limit the risk associated with the hypothetical release of radioactive material to the aquatic food pathway.

Staff Response: Section 5.3.3.3.2 of the 1996 version of NUREG-1437 identifies the interdiction measures that could be used to reduce or limit the risk to human health, if necessary, by preventing use of the water or making contaminated food difficult to obtain. Limiting people's contact with contamination would be through such measures as:

- Preventing or confiscating catches of recreational and commercial fish and shellfish,
- Prohibiting water-based recreation, and
- Eliminating surface-water as a drinking-water source

Additional consideration could be given for long term interdiction due to radionuclide residence times in the surrounding ecology that could be lengthy for certain aquatic environmental situations. The aquatic food pathway's physical transport mechanisms could be complex where many of the important recreational and commercial aquatic organisms are highly mobile. Thus, the ability of humans to obtain these organisms would also need to be controlled.

49. As noted in FEIS § 6.3, applicants are not required to submit information regarding decommissioning at the ESP stage. Nonetheless, § 5.9 of TVA's ER included information supporting a conclusion that the environmental impacts of decommissioning the SMR reactor designs proposed in TVA's application would be bounded by the decommissioning generic environmental impact statement (Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities: NUREG-0586, Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors (Decommissioning GEIS). In the FEIS, the review team stated that it "has no reason to believe that the impacts discussed in [the Decommissioning GEIS] are not bounding for reactors deployed after 2002 . . . including the SMR designs included in TVA's PPE."

How did the review team reach this conclusion?

Staff Response: In reaching the conclusion discussed above, the staff reviewed NUREG-0586, Supplement 1, *Regarding the Decommissioning of Nuclear Power Reactors* (Decommissioning GEIS). Chapter 3 of the Decommissioning GEIS describes the types of licensed reactors that are considered in the Decommissioning GEIS (light water reactors, fast breeder reactors and high-temperature gas-cooled reactors) as well the types of structures and systems at a nuclear power facility. The staff considered whether the PPE values referenced in TVA's ESP application for the CRN Site reflected the same characteristics as described in the Decommissioning GEIS. The PPE was developed from information provided from four vendors, namely BWXT mPower™ (Generation mPower LLC), SMR-160 (Holtec SME, LLC), NuScale (NuScale Power, LLC) and Westinghouse SMR (Westinghouse Electric Company, LLC). The

four designs are pressurized water reactors (PWRs), and PWRs larger than these SMRs were considered in the Decommissioning GEIS. In addition, the types of structures and systems represented in the PPE are similar to those described in the Decommissioning GEIS. Because TVA's ESP application references a PPE based on information from SMR reactor designs that have characteristics similar to those considered in the Decommissioning GEIS, the staff concluded in Section 6.3 of the final EIS for the CRN Site ESP that the impacts from decommissioning of the SMRs would be bounded by the environmental impacts discussed in the Decommissioning GEIS.

50. Was the vicinity defined in the beginning of Chapter 7 applied to all the resource areas or was it defined and delineated for each resource area? Were all of those past, present, and reasonably foreseeable projects listed in Table 7-1 taken into account for the impacts analysis for each resource area?

Staff Response: The cumulative impact analysis for each resource area in Chapter 7 was based on the "geographic area of interest," which was defined and delineated for each resource area. The geographic area of interest is generally different for each resource area, as different resources have different impact areas. The projects listed in Table 7-1 were taken into account in the impacts analysis if the project affected the specific resource being evaluated. If a project listed in Table 7-1 did not affect the resource being evaluated, then it was not considered in that resource evaluation. Therefore, not all the projects listed in Table 7-1 were considered in the impact analysis for each resource area.

51. The Staff evaluated the process the Applicant used to identify alternative sites for the proposed action. To identify the CRN Site and three alternative sites, TVA: (1) defined the region of interest; (2) applied exclusionary or inclusionary criteria to define candidate areas within that region; and (3) applied exclusionary or inclusionary criteria to identify potential sites within those areas. This resulted in the identification of fifteen potential sites, which were then ranked using general siting criteria to identify candidate sites. The CRN Site was selected as the proposed site and the top candidate sites were then evaluated as potential alternatives.

1. **(Staff) Did the Staff perform a sensitivity analysis on the Applicant's ranking scheme or otherwise verify the results to ensure that a potential alternative site was not overlooked?**
2. **(Staff and Applicant) What are the sensitive land features that helped define the alternative sites?**
3. **(Applicant) How were impacts to cultural resources considered in TVA's site selection process? (Staff) How were they considered in the Staff's evaluation of alternative sites?**
4. **(Staff and Applicant) Given that the ORR potential sites all had higher composite scores than the Redstone Arsenal site, why was it reasonable to include Redstone Arsenal Site 12 as an alternative site?**

Staff Response: (1) The staff verified the Applicant's ranking scheme in accordance with NUREG-1555, ESRP Section 9.3. This review consisted of an independent comparison of the proposed and potential sites. While TVA considered both environmental criteria and technical criteria in its scoring of the sites, the ESRP guidance directs the staff to consider only environmental factors in the comparison of the sites to determine whether any is environmentally preferable. The staff compared scores which resulted from its analysis for each

of the candidate sites based only on the numerical scores for the environmental issues and concluded that the scores of all the ORR sites, including the CRN Site (ORR Site 3) were similar (including environmental factors for ecology and socioeconomics).

In Section 9.3.1.4 of the final EIS, the staff also examined the numerical values of the important weighting factors that were applied by TVA to each of the 35 site characteristics and concluded that no single one of these weighting factors was by itself sufficient to significantly skew the total score obtained by TVA for any one site or to alter the ranking for the top two sites.

(2) The sensitive land features that helped define the alternative sites included: (a) seismology considerations, (b) population density, (c) cooling-water availability, (d) proximity to targeted customers, (e) the requirement for a contiguous 120-ac site, (f) the percent of the forest cover, and (g) the amount of undeveloped versus previously disturbed land. TVA identified the TVA Power Service Area as the Region of Interest (ROI). The ROI is the geographic area considered in searching for candidate sites, which in this case includes most of Tennessee and portions of six adjacent states (Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia). It consists of the Tennessee River watershed, the Cumberland River watershed, and areas surrounding these watersheds. The environment within the ROI is diverse, ranging from riparian habitat along the rivers and lakes to rugged mountain ranges to lowlands.

(3) While there are more recorded historic and cultural resource sites located on the proposed CRN Site than on the alternative sites, it is still unknown, particularly at the ESP stage, how many will be impacted if a COL or CP applicant referencing the ESP proceeds with the project. For the alternative sites considered in the final EIS, rather than relying upon the collection of new data or field studies, the NRC's analysis of impacts on historic and cultural resources typically relies on available information obtained from published reports, public records, public and private agencies, and individuals knowledgeable about the locality of a potential site (referred to as reconnaissance-level information). Reconnaissance-level information is discussed in Section 9.3.1.5 of the final EIS. Therefore, there are greater unknowns for the three alternative sites.

(4) It is reasonable to include the Redstone Arsenal Site 12 as an alternative site because although this site had lower overall environmental scores than all ORR potential sites according to the staff's ranking, it was included as an alternative site for geographical diversity, which the NRC staff finds acceptable and is consistent with the process described in NUREG-1555, ESRP Chapter 9.

53. In discussing the Building Impacts for the alternative sites, the Staff notes that the acreages in Table 9-3 do not include corridors that would need to be cleared for the intake and discharge pipelines at ORR Sites 2 and 8, or for the new offsite buried 69-kV transmission line, and that clearing such corridors would "impact primarily an unquantified additional amount of forest habitat at each site." The Staff also notes that the burial of the 69-kV transmission lines would "affect artificially maintained right-of-way habitat and may affect any wetlands in these corridors for each site."

Did the absence of the information related to "total acreage needed" along with associated impacts to forest habitats and possible wetlands influence the Staff's alternatives analysis?

Staff Response: No. The staff was able to evaluate the ORR alternatives and reach its impact level conclusions with respect to land use and ecological impacts without needing acreage data for the offsite corridors or for forest cover or wetlands within those corridors. Using sketches included with the application, the staff estimated that building pipeline and access roads would use approximately 8.5 ac on ORR Site 2 and approximately 25 ac for ORR Site 8 (final EIS, page 9-20). Based on the position of the sites close to usable cooling water sources, the staff estimated that the corridors would be situated mostly, but not necessarily completely, within the site boundaries (final EIS, page 9-20). The staff likewise assumed that delivering power from Sites 2 or 8 to the ORR would require building an underground 69-kV transmission line to the same developed areas served by the new underground transmission line for the CRN Site (final EIS, page 9-21). The staff's MODERATE conclusions for land use impacts at each of ORR Sites 2 and 8 (final EIS, page 9-23) account for the possible routing for the offsite corridors. The primary basis for the MODERATE conclusions is the extent of Federal land dedicated to the project (final EIS, page 9-23). The staff was able to ascertain that the extent of dedicated land on the ORR would be noticeable without needing to know a precise acreage.

In its evaluation of terrestrial impacts, the staff acknowledged that some additional terrestrial habitat, including wetlands, outside of ORR Sites 2 or 8 could be affected by building within offsite corridor lands (final EIS, pages 9-38 and 9-39). The staff concluded that terrestrial impacts from use of either site would be LARGE because of the loss and fragmentation of broad contiguous tracts of deciduous forest used in long-term ecological research (final EIS, page 9-42). When drawing this conclusion, the staff accounted for possible loss and fragmentation of additional forest cover by building the offsite facilities. The staff was able to determine that the forest losses and fragmentation on the sites could be potentially destabilizing to terrestrial resources without needing precise quantification of additional offsite impacts.

54. The FEIS indicates that no field studies were conducted at the Redstone 12 Site, and no new field studies have been conducted at Oak Ridge Reservation Site 2 or Site 8. The FEIS states: "The presence or absence of Federally listed, State-listed and State-ranked species and communities in the project footprints cannot be ascertained without field studies."

1. **(Staff) Did the absence of the information impact the Staff's alternative site analysis? If so, how?**
2. **(Applicant) Why did TVA not conduct any new field studies for the alternative candidate sites?**

Staff Response: No. The absence of field survey data did not compromise the staff's ability to evaluate and compare ecological impacts and reach impact level conclusions for the alternative sites. As indicated in the question, the staff considered it necessary to acknowledge that the presence or absence of important species cannot be confirmed without field surveys (final EIS, pages 9-34 and 9-38). However, the staff reviewed state databases of published information regarding important species for the ORR sites (final EIS, pages 9-34 to 9-37) and Redstone Site 12 (final EIS, page 9-38). That information indicates the presence of Federally listed, State-listed, and State-ranked species and communities. Comparing similar information for each site under consideration enabled the staff to meaningfully consider possible impacts to those species. Reliance on reconnaissance-level information rather than field surveys when evaluating environmental impacts to alternative sites is consistent with guidance in ESRP Section 9.3.

55. In determining the alternatives to the proposed action, did the Staff consider alternate transmission line pathways as an alternative system design?

Staff Response: No. The staff did not consider alternative transmission line pathways as an alternative system design. As discussed in Section 1.1.4 of the final EIS, erection of transmission lines and associated activities are a preconstruction activity not within the regulatory purview of the NRC. ISG-26 states that because transmission lines are not within the definition of construction in 10 CFR 50.10 and 10 CFR 51.4, the staff will no longer consider alternative transmission systems.

However, the NRC staff discussed impacts related to transmission lines in sections of Chapters 4, 5, and 7 dealing with resources affected by the lines, as part of its evaluation of cumulative impacts from use of each alternative site. The staff believes that the applicant's proposed routes are reasonable, appearing to minimize length and impacts to sensitive geographic features while taking advantage of existing transmission line corridors. The staff therefore does not see a potential for reasonable routing alternatives that might substantially reduce adverse environmental impacts. Additionally, as noted in Section 5.12 of TVA's siting study (ADAMS Accession No. ML16188A075) and on page 9-5 of the final EIS, proximity to existing transmission lines was one of the principal considerations used by the applicant in the selection of potential alternative sites.

56. Section 10.6 of the FEIS states, "certain issues are not resolved because of a lack of information. An applicant for a COL (or CP/[operating license]) referencing an ESP for the CRN Site would need to provide the necessary information to resolve these issues if the proposed licensing action ultimately would affect the resources associated with these issues."

Please provide a summary of the issues that were not resolved in the FEIS due to a lack of information.

Staff Response: There were two unresolved issues in the final EIS due to lack of information. As discussed in Sections 5.11.2.4 and 5.11.3, the staff's evaluation of Severe Accident Mitigation Design Alternatives (SAMDA) is unresolved in the ESP EIS as the input for this evaluation requires information from a chosen reactor design. In addition, TVA's ER did not include information to evaluate water treatment alternatives and stated that specific methods are to be defined in a future COL or CP application when a final SMR design is selected. (See Section 9.4.3 of the final EIS). Pursuant to 10 CFR 51.50(c), the SAMDA evaluation and an evaluation of any identified water treatment alternatives would be resolved during the environmental review of any COL or CP application.

57. In its letter dated April 18, 2019, THC found that the CRN Site ESP "as currently proposed, may adversely affect properties that are eligible for listing in the National Register of Historic Places."

1. **Did the Staff have any further interactions with THC?**
2. **What were THC's specific concerns about properties eligible for listing in the National Register of Historic Places?**

Were THC's concerns addressed? If so, how were they addressed?

Staff Response: (1) No.

(2) The THC did not raise specific concerns about properties eligible for listing in the National Register of Historic Places (NRHP) beyond stating by letter dated May 16, 2018, that the proposed project may adversely affect historic properties (ADAMS Accession No. ML18194A388). This statement is consistent with the staff's finding in Section 4.6.3 of the final EIS that "the combined impacts from construction and preconstruction activities on historic and cultural resources located within the onsite and offsite direct- and indirect-effects APE [Area of Potential Effects] would be MODERATE TO LARGE," based, in part, on the possible damage to eligible and potentially eligible NRHP sites and deeply buried historic and cultural resource-bearing deposits. Preconstruction activities constitute the primary contribution to the staff's impact determination.

Prior to the issuance of the final EIS, NRC staff conducted a teleconference with the THC on October 3, 2018, and summarized the details of this teleconference in a letter dated November 13, 2018, to the THC (ADAMS Accession No. ML18267A315). In this correspondence, the NRC staff explained to THC that the NRC's undertaking is to consider TVA's application for an ESP, which, if approved, would result in the approval of a site as suitable for future deployment of two or more SMRs with the characteristics presented in the application. The staff further explained that the issuance of an ESP does not authorize construction and operation of a nuclear power plant. The staff clarified that it expects TVA will consult with the THC and Tribes, in accordance with their Programmatic Agreement, to resolve potential adverse effects prior to TVA moving forward with the project and applying for a COL or a CP. This Programmatic Agreement was executed between 2015 and 2016 among TVA, THC, and Tribes to address how TVA would comply with its ongoing NHPA Section 106 requirements and is described in Section 2.7 of the final EIS. The Programmatic Agreement outlines a process by which TVA will comply with NHPA Section 106 as plans are finalized and specific onsite and offsite project areas associated with these plans are identified. The staff informed THC that TVA has committed to keeping the NRC informed of any updates concerning its NHPA Section 106 consultations (ADAMS Accession No. ML17234A003). Finally, the NRC staff explained that should TVA pursue a COL or CP in the future, it would constitute a separate NRC undertaking and would require the NRC to prepare a Supplemental EIS and complete a separate NHPA Section 106 review and consultation.

58. Has the Staff satisfied the requirements of NHPA section 106? If not, please explain what remains to be done.

Staff Response: Yes. In accordance with 36 CFR 800.8(c), the NRC elected to use the NEPA process to comply with Section 106 of the NHPA. NHPA Section 106 compliance was documented and completed through the NRC's issuance of the final EIS and its submission to the THC (ADAMS Accession No. ML19053A649), the Advisory Council on Historic Preservation (ADAMS Accession No. ML19053A751), and American Indian Tribes.