CRN-003
July 26, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Commission

In the Matter of	)	
	)	Docket No. 52-047-ESP
Tennessee Valley Authority	)	
	)	
Clinch River, Early Site Permit	)	

TENNESSEE VALLEY AUTHORITY'S RESPONSES TO PRE-HEARING QUESTIONS

In accordance with the Notice of Hearing and the Nuclear Regulatory Commission's (Commission) Order (Transmitting Pre-Hearing Questions) (July 12, 2019), Tennessee Valley Authority ("TVA") submits the following responses to each of the questions posed to it by the Commission.

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

The [Final Safety Evaluation Report ("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 the 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?

Response 1: The depths of the CRBRP permanent groundwater wells range from approximately 115 feet to approximately 156 feet below the ground surface. The CRBRP investigative boring depths ranged between approximately 100 feet below ground surface to 381 feet below ground surface.

Response 2: Documentation of the disposition of wells and borings have not been located for the CRBRP, and therefore the status is unknown.

Response 3: Any wells and borings associated with the canceled CRBRP that have not been dispositioned prior to construction are not expected to pose any safety-related risks or other risk-significant impacts. First, any such remaining CRBRP well or boring within the excavation footprint will be removed during excavation of the power block area at the Clinch River Nuclear ("CRN") Site to the bottom of the excavation. As discussed in Site Safety Analysis Report ("SSAR") section 2.5.4.5.1, construction of the safety-related structures requires excavation depths of up to 138 feet below the existing grade dependent on the final site location and selected Small Modular Reactor ("SMR") design. Second, any geologic feature, including old CRBRP wells and boreholes, encountered within the excavation will be mapped in accordance with Permit Condition 2.5-1 (Permit Condition 3) and grouted if deemed necessary. Third, the relatively small diameters of any wells and borings (normally less than 6 inches in diameter) would not affect the bearing capacity of the rock supporting safety-related or risk-significant structures, systems, and components ("SSCs"). Analysis presented in SSAR Section 2.5.4.13 indicates that cavities of this size would not pose a risk to small modular reactor (SMR)

foundations.

Response 4: The presence of any abandoned CRBRP wells or borings that have the potential to channel shallow groundwater flow into lower levels of the aquifer has already been addressed in SSAR Section 2.4.13. In evaluating an accidental release of liquid effluents to ground and surface waters, it is assumed that radioactive liquid effluent is released directly to the saturated zone at a depth of approximately 140 feet below ground surface. As described in TVA Letter CNL-17-115, which provided supplemental information related to groundwater hydrology in support of the Early Site Permit Application ("ESPA") (Information Needs 25b and 31), this assumption is considered reasonable because an accidental liquid effluent release could flow vertically downward through the backfill surrounding the SMR subgrade structure (granular backfill will be used from site grade to the top of rock, while concrete backfill will be used from the top of rock to the bottom of the excavation). Alternatively, liquid effluent may enter the saturated zone via a short-circuit pathway in potential shallow or deep boreholes that were improperly abandoned or unidentified in historical CRBRP site characterization studies.

Question 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 (MCL-DC) 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?

Response 1: According to FSER Section 2.4.12.3.4.2, the NRC Staff confirmed that radionuclides present in groundwater are consistent with ORR operations and waste disposal practices that commenced in the 1940s. This confirmation was based on the Staff's review of studies conducted by TDEC and the U.S. Department of Energy ("DOE"). Therefore, TVA defers to the NRC Staff in responding to Part 1 of Question 4.

Response 2: Regarding the stability of source(s) and associated groundwater contamination plume(s), DOE has implemented a number of remedial actions within the ORR with the objectives of removing and isolating sources and reducing contaminant concentrations in groundwater. The results of these efforts are summarized annually in Remediation Effectiveness Reports published by DOE, with the most recent report being the 2017 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, DOE/OR/01-2731&D2, issued in September 2017. Additional groundwater monitoring results are summarized in Annual Site Environmental Reports published by DOE. The most recent report was issued in September 2018, DOE/ORR-2511, Oak Ridge Reservation Annual Site Environmental Report 2017, for the 2017 monitoring year. If a Construction Permit Application ("CPA") or Combined License Application ("COLA") is docketed in the future, the NRC Staff will provide their expectations for how the baseline for background groundwater concentrations of the contaminants of concern will be established in accordance with COL Action Item 2.4-3.

Response 3: Distances from the CRN Site to documented ORR groundwater contamination plumes range from 1.2 to 4.7 miles, as shown on Figure 2 of the CRN Site, Groundwater Quality Monitoring Report, Revision 3, dated May 9, 2017.

Question 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?

Response 1: TVA defers to NRC for response on NRC's oversight and inspection responsibilities.

Response 2: The SMR Project has no plans to perform any additional work at the 422 well cluster at this time. The 422 well cluster remains in place, locked, and under TVA control. Future monitoring may be performed to provide additional information that may be requested by TDEC, although no requests have been received to date. TVA will work closely with the DOE and TDEC regarding all future groundwater monitoring to ensure a consistent approach and shared groundwater monitoring results.

Question 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.

Response 1: Precipitation amounts reported for Oak Ridge, Tennessee by Oak Ridge National Laboratory are summarized in SSAR Section 2.4.12C.3.7. The average annual precipitation is given as 50.91 inches (1981-2010 period of record), while the annual precipitation for 2013 is 67.37 inches.

Response 2: SSAR Section 2.4.12C.8 concludes that "Pre-construction groundwater model simulated heads closely matched the observed maximum groundwater heads at observation wells near the proposed location of the SMRs for this modeling exercise." The simulated groundwater levels of the groundwater model generally overestimated the observed groundwater levels. Considering that groundwater levels at the CRN Site are the direct result of precipitation events, the observed groundwater levels at the CRN Site would be higher than average considering the observed data included above average precipitation.

Question 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]

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?

Response 1: As provided in the application, numerous field studies, as well as input from knowledgeable SMEs were utilized to develop a "karst model" for the site, based on data and observations from the site and within the regional area. Input from the previous CRBRP excavation and investigations was also considered in the development of the model. Further

[1] When the prehearing questions refer to a future COL application referencing the ESP for the CRN Site, those references could also apply to a future construction permit application referencing the ESP and the CRN Site.

characterization of the karst features at the CRN Site would require excavation of the site. Because excavation of the safety-related foundation is not scheduled during the ESPA stage, full characterization of the karst features in the excavation would occur at a potential COLA or CPA stage, in conformance with Permit Condition 2.5-1(3).

Response 2: As stated in SSAR Section 2.5.1.2.5.1.2, "Direct evidence of hypogene dissolution processes is not documented at the CRN Site or within the Oak Ridge Reservation (ORR). Most evidence is consistent with dissolution by epigenetic processes in the vadose and phreatic zones. This evidence includes the decrease in frequency of fractures and dissolution cavities with depth in boreholes, phreatic passage geometry and morphology of known caves and solution conduits within the ORR, and the lack of secondary minerals characteristic of hypogene processes. Springs in the ORR have water chemistry typical of meteoric water, rather than warm, mineral-rich waters of hypogene springs. Finally, seismic reflection profiles across the site show continuous, uninterrupted bedding at depth beneath the site suggesting that large hypogenic karst collapse features are not present, at least along the two dimensional profile lines."

A complete understanding of the extent and spatial distribution of potential voids contains some uncertainty, however, the significant amount of data collected at the CRN Site during this investigation, as well as past investigations and excavations for the CRBRP, provides a comprehensive understanding of the karst activity and potential within approximately 300 feet of the ground surface.

Further work to characterize the site is described in SSAR section 2.5.1.2.6.10, "The presence of cavities at and below the level of the foundations within the power block area may affect the bearing capacity of the foundation rock mass and groundwater flow. A mitigation

plan, including detailed geologic mapping of the excavation floor, a potential grouting program and geophysical surveys to address possible cavities at and below the foundation levels of safety-related structures would be developed based on the technology chosen, described in the COLA, and executed during construction. The geophysical surveys would be designed to detect cavities below the foundation elevation that could adversely affect foundation performance and are dependent on the technology chosen for the CRN Site. A PLAXIS or similar analysis would provide the information on potential critical subsurface cavity size.

Response 3: A PLAXIS 2-D model was performed based on a generic design that simulated the placement of a safety-related foundation at various depths, along with associated "unknown" voids at various depths and lateral placements. The results of this analysis are provided in SSAR Section 2.5.1.2.3. A design specific void analysis will be performed at the selected location and the specific design parameters of the chosen technology, to include depth, dimension, bearing values, and safety-related foundation parameters. After excavation and geological characterization of the excavation is complete, and in concert with the design specific analysis, boreholes and geophysical surveys will be performed to detect voids below the foundation level that are larger than the minimum postulated by the analysis that could adversely affect foundation performance.

Response 4: Based on the technology selected, a regulatorily approved grouting program will be developed at the potential future COLA or CPA stage to mitigate any karst voids identified during excavations in the construction phase. SSAR Section 2.5.1.2.6.10 outlines actions to be taken for the potential COLA or CPA, as well as Permit condition 2.5-1(3).

Question 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?

Response 1: The inclusion of updated information from 2009 thru 2013 did not materially change the results of the SSHAC Level 2 assessment previously performed for CRN. Due to the inclusion of the 2011 Mineral, Virginia earthquake data (E(M)5.7), the Mmax distribution for the ECC-AM areal source zone was modified, with insignificant effects on results previously provided, based on several sensitivity analyses. The Technical Integrator (TI) team for the CRN SSHAC reviewed all updated data and analyses. All data including the Mmax update is included in SSAR Section 2.5.2.2.6.1.2.

Response 2: The original (1568-2008) catalog by itself provides stable seismicity estimates, given its duration and number of earthquakes. The updated catalog is considered to provide an even higher confidence in data estimates, based on the inclusion of new data, which were compiled using the same methodology as the original catalog. This is reinforced by the small changes in the activity rates in the vicinity of the site, as indicated in SSAR Section 2.5.2.1.3. At such time when a new SSHAC effort for the Central Eastern United States is completed, validation of this work will be performed per regulation.

Question 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.

Response 1: As stated in SSAR Section 2.5.2.6, two finite element meshes were developed for the 2D calculations, a fine and coarse mesh, established through the computational zone. The coarse mesh model was developed to have a transmission capability limited to 10 Hz, the fine model to 50 Hz. Detailed information is provided in SSAR Section 2.5.2.6, along with the associated figures.

As described in Section 2.5.2.6 of the SSAR, the purpose of the 2D calculations was to (1) evaluate how simplifying the dipping stratigraphy beneath the CRN site to a 1D model for site response impacts the GMRS and (2) assess whether sufficient epistemic uncertainty had been incorporated in the 1D analysis to address potential 2D effects. The 2D modeling was performed as a sensitivity analysis since 2D effects on ground motions were expected to be insignificant because of the lack of strong impedance contrasts between the dipping stratigraphic layers. The analysis confirmed this observation.

The input horizontal time history is defined at the top of the Precambrian basement as an outcrop motion. Hence, SV wave (vertically-polarized shear waves) transmission was used as input motions. Vertical motions were not considered in the 2D analysis because potential effects on the vertical component are expected to be less than the horizontal as the compressional-wave velocities are significantly greater than the shear-wave velocities. No horizontal wave passage effects are considered in the calculations again because of the 1D and 2D comparisons.

Response 2: As described in Section 2.5.2.6 of the SSAR, two finite-element meshes were

developed for the 2D calculations, a fine and coarse mesh developed throughout the large computational zone (20,000 feet wide by 14,800 feet deep). The computational zone consisted of multiple layers having interfaces at various dip angles. The fine mesh provides a 50 Hz transmission capability but results in significant computer capacity. The coarse mesh was used to have a transmission capability limited to about 10 Hz. The comparisons of results at low frequency (less than 10 Hz) are used to provide support and verification to the fine mesh solutions. This coarse mesh calculation is especially appropriate where the most significant 2D effects are expected to be most pronounced at lower frequencies (less than 10 Hz).

Due to the dipping stratigraphy beneath the CRN Site (about 33 degrees) potential two-dimensional (2D) effects on ground motions were evaluated using an expanded version of the computer code SASSI (System for Analysis of Soil Structure Interaction). The 2D effects were addressed through a sensitivity analysis. A geologic cross-section at the site that illustrates the depth to Precambrian rock, drawn perpendicular to the strike direction, is shown on SSAR Figure 2.5.1-63. Planned surface grade at the site is at Elevation 821 feet. The Plant Parameter Envelope (PPE) conservatively bounded the planned bottom of the foundation for Reactor Service Building ("RSB") is taken at Elevation 683 feet. The top of competent rock varies across the areas of Locations A and B as shown on SSAR Figure 2.5.4-2. Based on the data to the top of unweathered rock from the suspension data, competent rock ranges from about Elevation 749 to 770 feet at Location A and Elevation 738 to 758 feet at Location B. Given that no specific technology has been selected, the elevation of the ground motion response spectra ("GMRS") is chosen to be Elevation 683 feet, corresponding to the bottom of the RSB foundations below the top of unweathered rock. All elevations cited in this subsection are based on the North American Vertical Datum of 1988 ("NAVD88").

Recognizing the assessment of epistemic uncertainty must necessarily reflect a significant degree of judgment and the range in basecase shear-wave velocities ("Vs") at CRN Site must necessarily accommodate two separate aspects of the site conditions: (1) for the depth ranges for which measured velocities were available, the dipping structure (Figure 2.5.4-13) results in the same unit and associated dynamic material properties occurring at different depths across each site footprint; and (2) broad-band resonance or amplification effects due to the dipping structure, such as a basin edge. However, as discussed further, impedance contrasts beneath the CRN Site are small and so 2D resonance and amplification effects are not expected to significantly exceed (SSAR Reference 2.5.2-169) one-dimensional (1D) resonances (SSAR Reference 2.5.2-169), particularly if they are broadened through the use of multiple basecases. Extending epistemic uncertainty through the shallow portion of the profile (approximately 300 feet) where sufficient measurements exist to constrain a single basecase profile was considered essential to accommodate the both potential effects of the shallow dipping structure.

Response 3: No inclined wave transmission effects were considered in the 2D analysis since the purpose was to compare the 1D and 2D results. As described above, Vs transmission was considered in the 2D analysis.

Question 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.

Response 1: PGA was taken as equal to 100 Hz, as per EPRI (2013; EPRI 2013-TN6143) ground-motion model, which is the ground motion model adopted for the hard-rock PSHA (as indicated in SSAR Section 2.5.2.4.2).

Response 2: The frequency associated with the spectral peak is determined by the spectral-shape interpolation procedure used, which is the interpolation procedure recommended in NUREG/CR-6728 (McGuire et al. 2001-TN5861). Inputs to this interpolation procedure consist of the following: (1) the UHS spectral accelerations at 10, 25, and 100 Hz calculated by the PSHA; and (2) the magnitude and distance associated with the high-frequency controlling earthquake, which are calculated following RG 1.208 (NRC 2007-TN5858).

Response 3: The magnitudes and distances that control the high frequencies are given in SSAR Table 2.5.2-18. They are M 5.9 at 16 km, M 6.1 at 12 km, and M 6.3 at 11 km, for 10^{-4}, 10^{-5}, and 10^{-6}, respectively. Generally, the controlling magnitudes and distances are the same for all high frequencies (approximately 5 Hz and higher), because all these frequencies scale the same way with magnitude and distance for distances less than approximately 50 km.

Response 4: The spectral shapes in EPRI (2013; EPRI 2013-TN6143) and in NUREG/CR-6728 (McGuire et al. 2001-TN5861) are consistent with the ensemble of spectral shapes recorded at hard rock sites in the CEUS and Eastern Canada.

Response 5: The aleatory variability and epistemic uncertainty for high frequency spectral acceleration are given in EPRI (2013; EPRI 2013-TN6143). In particular, the model for aleatory variability is given in Section 7.10 and displayed in Figure 7.10.2-2; the epistemic uncertainty at

the magnitudes and distances of interest is given in Appendix G and displayed in Figures 7.12.1-22 and 7.12.1-23.

Question 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 (1.64 ft) 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.

Response 1: 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 meters (1.64 feet) intervals. TVA processed the data and grouped the velocity measurements to the stratigraphic unit based on their recorded mid-point depth in the boring and the stratigraphic contacts identified for each unit. The compilation of the profiles does not include velocity measurements from the inclined borings or from boring MP-420 that was considered too far from the power block area, and measurements within the weathered rock were also not included.

The suspension P-S velocity logging data showed that the Newala Formation exhibits the highest average Vs and Vp values of 3,292 m/s (10,800 fps) and 6,066 m/s (19,900 fps), respectively. The Rockdell Formation and Eidson Member exhibit similar velocities with an average Vs of 2,743 m/s (9,000 fps) and average Vp of about 5,182 m/s (17,000 fps). The Benbolt and Blackford Formations also exhibit similar Vs and Vp with an average Vs of 2,438 and 2,499 m/s (8,000 and 8,200 fps) and average Vp of 4,694 and 4,785 m/s (15,400 and 15,700 fps), respectively. The Fleanor Member exhibits the lowest average Vs and Vp of 2,195 and 4,420 m/s (7,200 fps and 14,500 fps), respectively.

TVA also presented the minimum, maximum, and average Vs and Vp obtained for the Clinch River Breeder Reactor Project (CRBRP), for the Fleanor and Eidson Members, and for the Blackford Formation. The CRBRP data showed seismic velocity values similar to those for the CRN Site. The velocity profiles, as presented in SSAR Figure 2.5.4-5 and SSAR Figure 2.5.4-6, show that the Vs and Vp do not vary significantly with depth for each inclined rock formation.

The purpose of the suspension P-S velocity logging was to characterize shear-wave and compression-wave structure at a fine scale of meters beneath the CRN site. The measurements are taken at 0.5 m intervals and hence are not sensitive to large scale changes in the stratigraphy beneath the site. The transit time is measured over the short distance between the receiver to receiver or source to receiver and hence the standard assumption of vertically propagating horizontally polarized shear and compressional waves is valid for any site.

Response 2: As stated above, the purpose of the suspension logging was to characterize the fine Vs and Vp structure beneath the site and not to evaluate larger scale wave transmission effects.

Question 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)?

Response 1: There are no differences between the criteria for Emergency Planning Zone ("EPZ") sizing described in NUREG-0396 and the criteria for EPZ sizing described in the TVA CRN Site ESPA, Part 2, SSAR, Section 13.3, *Emergency Preparedness*. The NUREG-0396 task force identified the bounds of the parameters for which planning is recommended based on knowledge of the potential consequences, timing, and release characteristics of a spectrum of accidents, tempered by probability considerations. Consistent with this recommendation, TVA's methodology for determining the plume exposure pathway ("PEP")EPZ size described in the ESPA is risk-informed and analyzes a spectrum of accidents, both design basis and severe accidents. The NUREG-0396 task force concluded that the objective of emergency plans should be to provide dose savings for a spectrum of accidents that could produce offsite doses in excess of the EPA PAGs. Consistent with this NUREG-0396 conclusion, the risk-informed methodology utilizes the EPA PAGs as its dose criteria.

Response 2: TVA is committed to protecting public safety and health. During the ESPA development, TVA reached out to the local counties and cities to discuss the CRN project and the unique emergency preparedness approach. As a result of these numerous discussions, letters of support for the project and the emergency preparedness approach were received from the State of Tennessee, Roane County, Anderson County and City of Oak Ridge.

NUREG-0396 concludes that the objective of emergency response plans should be to provide dose savings for a spectrum of accidents that could produce offsite doses in excess of the EPA PAGs. The SMR designs considered in the ESPA have significantly improved safety and design features compared to large light water reactors. SMRs have significantly reduced risk of radiological release and offsite consequences, they have smaller radionuclide inventory and

source terms; with slower projected rate of progression of postulated accidents; and various design features that eliminate several otherwise considered design-basis accidents; and the significantly less likely beyond-design-basis accidents.

Question 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?

Response 1: Assessment of multi-module events is design specific and if consideration of multi-module events is required by the design selected, TVA will evaluate multi-module events and an appropriate licensing strategy would be pursued in future applications.

The ESPA does not specifically evaluate or preclude collocation with other nuclear or industrial facilities at the CRN Site. The PPE approach, which is based on a surrogate plant of up to 800 MWe for the Site, provides flexibility for potential collocation options in the future. If TVA decides to collocate at the CRN Site, impacts of collocation will be evaluated and justified in a future application.

Response 2: Consistent with the NUREG-0396 recommendation, TVA's EPZ methodology considers consequences from a spectrum of accidents, including both design basis and beyond design basis accidents. As described in ESPA SSAR Section 13.3.3.1.1 and 13.3.3.1.2, beyond design basis scenarios are evaluated in TVA's methodology under the technical criteria for "The EPZ should encompass those areas in which consequences of less severe core melt accidents

could exceed the EPA PAG." and "The 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." Assessment of multi-module events, and the specific assumptions for multi-module events, is design specific and if consideration of multi-module events is required by the design selected in a future application, they will be evaluated utilizing TVA's EPZ methodology.

Response 3: As discussed in response to question 18-2, assessment of multi-module events is design specific and if consideration of multi-module events is required by the design selected in a future application, they will be fully evaluated.

Question 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?

Response 1: A non-design-specific bounding source term was developed based on NRC staff's request for additional information ("RAI") and audits of the emergency preparedness information in the ESPA. Discussions with NRC staff during the audit indicated a need for establishing a plant parameter specifically applicable only to Part 6 of the ESPA for EPZ exemption requests that will ensure the appropriate application of the exemption requests to support a Site Boundary PEP EPZ at the CRN Site.

Response 2: There could be unintended consequences of specifying a bounding source term at the ESPA phase. As the ESPA is not design specific and source terms are highly design specific,

one potential unintended consequence could be that the selected SMR design adequately meets the dose criteria as discussed in ESPA SSAR Section 13.3, but has release characteristics and radionuclides that are not bounded by the non-design-specific plant parameter.

Response 3: TVA's intent as discussed in RAI response CNL-18-046, dated March 30, 2018, is to implement the PEP EPZ methodology for the selected SMR reactor design in a future application to determine the EPZ size for the Site and treat any potential exceedances from the non-design-specific plant parameter source term in a manner consistent with ESPA SSAR Chapter 2, *Plant Parameter Envelope* variances.

TVA anticipates that the designs considered in the ESPA PPE would be bounded by the newly developed non-design-specific plant parameter source term. However, upon design specific implementation of the PEP EPZ methodology in a future application, if the selected SMR reactor design meets the acceptance dose criteria consistent with the methodology, but is not enveloped by the non-design-specific plant parameter source term, then TVA would provide adequate justification to support a variance for the NRC staff's review. As long as the PEP EPZ methodology implementation shows the dose criteria are met, potential source term exceedances from Permit Condition 5 values would not preclude granting a license.

Question 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?

Response 1: As discussed in response to question 19-1, a bounding source term was developed based on NRC staff's RAIs and audits of the emergency preparedness information in the ESPA.

Response 2: TVA's methodology for determining the PEP EPZ described in ESPA, SSAR, Section 13.3 is consistent with NUREG-0396 sizing rationale and consists of the same dose criteria as the EPA PAGs. The methodology takes into consideration various SMR safety and design advancements which significantly reduced risk of radiological release and offsite consequences. Although the likelihood of an accident or event resulting in offsite doses exceeding the EPA PAGs beyond the site boundary is extremely remote for SMR designs, TVA's complete and integrated emergency plan to be developed in a potential future application would describe the capabilities to determine if a radiological release is occurring to Offsite Response Organizations ("OROs") for their considerations. Each ORO is responsible for deciding what, if any, protective actions should be taken. Consistent with the principles of the EPA PAG manual, protective actions should balance protection with other facts and ensure that protective actions result in more benefit than harm. Public evacuations, if conducted at doses below the EPA PAGs, would not adhere to this fundamental EPA principle and could have the potential to cause more harm to the public, particularly for vulnerable populations, such as those with disabilities, older populations, and young children.

TVA is committed to protecting public safety and health. For the CRN Site, TVA will maintain agreements with surrounding emergency response organizations and continue to work with State and local support organizations to ensure the emergency preparedness planning is commensurate with the potential risk to the public.

Question 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.

Response: The impacts and consideration of threats, such as those described in the question, are design specific. SMR designs are expected to have smaller radionuclide inventory and source terms, the projected rate of progression of postulated accidents is anticipated to be slower, various design features are expected to eliminate several historically considered design-basis events, and the occurrence of severe accidents are projected to be significantly less likely. These expectations support that the likelihood and consequences of an event, regardless of its initiating event, would be reduced. In a future design specific application, TVA would assess required threats to the proposed facility.

Question 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?

Response 3: Granting the requested exemptions at the ESP stage is important to reducing regulatory uncertainty associated with the licensing and operation of a SMR at the CRN Site. TVA's approach to this matter is consistent with the intent of the phased licensing approach

provided for under 10 C.F.R Part 52 (i.e., to reduce regulatory uncertainty). The Emergency Plans presented in Part 5A and Part 5B of the ESPA rely upon the requested exemptions contained in Part 6. Without the regulatory exemptions presented in Part 6 of the ESPA, Part 5 of the ESPA would not meet current regulatory requirements. TVA developed the CRN ESPA to move a step closer to implementing SMR technology in the United States. To this end, the unique emergency preparedness approach described in the ESPA plays a vital role. Absence of these exemptions draws into question the value of the significant safety improvements inherent in advanced reactor designs, adversely impacts the financial estimates and viability of new nuclear at the CRN Site, and likely erodes confidence in new nuclear deployment in the U.S. The exemptions would allow TVA to move towards implementation of SMR technology with increased confidence in regulatory requirements and cost estimates, which would benefit not only the Tennessee Valley communities and commerce, but also the larger U.S. nuclear industry.

Question 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 description of the 2 [mile] PEP EPZ. TVA is not requesting approval of the application 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 1.3 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?

Response 1: The exemptions are necessary at this time because the Emergency Plans presented in Part 5A and Part 5B of the ESPA consider the requested exemptions contained in Part 6 of the ESPA. Without the regulatory exemptions presented in Part 6 of the ESPA, Part 5 of the ESPA would not be adequate, because Part 5 would need to consider all regulatory requirements of 10 CFR 50.33(g), 50.47(b) and (c)(2), and Appendix E to 10 CFR 50, including the requirement that the plume exposure pathway EPZ consist of an area about 10 miles (16 kilometers) in radius. Therefore, without the exemptions contained in Part 6 of the ESPA, Part 5 of the ESPA would need to consider the one-size-fits-all approach used for large light-water reactors ("LWRs") with no consideration given to the significantly reduced risk of radiological release and offsite consequences expected for the SMR designs under consideration for the CRN Site, including the smaller radionuclide inventory and source terms; the slower projected rate of progression of postulated accidents; and the various design features that will eliminate several normally considered design-basis accidents; and the significantly less likely beyond-design-basis accidents.

TVA intends to include one complete and integrated Emergency Plan in a future application that incorporates by reference the major features of either Part 5A or Part 5B, as applicable. This Emergency Plan will demonstrate that the design of the facility falls within the design parameters postulated in the ESPA. The Emergency Plan submitted as part of the future application will based on either Part 5A or Part 5B of the ESPA with additional information or revisions as required to address specific details of the selected reactor technology. The complete and integrated Emergency Plan will reflect the appropriate regulatory exemptions based on the risk-informed dose-based methodology presented in the ESPA. The exact size and configuration

of the CRN Site EPZ will be determined at the next stage based on the dose consequences of the selected reactor technology.

Question 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, "Licenses 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 government."

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?

Response: The CRN ESPA Part 5 describes two major features emergency plans. Part 5A describes a major features emergency plan for a site boundary EPZ and Part 5B describes a major features emergency plan for a 2-mile EPZ. The ESPA is not design specific and an EPZ size for the CRN Site would be determined in a future application when a SMR design is selected. If a site boundary EPZ is established at the site boundary in the future for CRN Site. TVA will maintain the capability to assess, classify, and declare an emergency condition and notify offsite governmental organizations within times specified in the emergency plan. TVA maintains contracts with State and local authorities that support the current operating nuclear fleet. There are semi-annual meetings held with these organizations where, in part, exercise and drill schedules are discussed. TVA intends to augment the existing contracts with State and local support organizations to include support for the CRN Site. CRN Site exercises and drills would be discussed at a minimum during the semi-annually scheduled meetings. Further, although smaller, the site boundary is the PEP EPZ boundary which intersects with state and local

governments. If State and/or local governments touching the EPZ boundary request to participate, 10 CFR Part 50, appendix E.IV.F.2.e requirement would apply, therefore a permit condition is not required.

Question 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.

Response: In the COL application, irrespective of the CRN Site EPZ size, TVA anticipates certain license conditions related to EP. For example, license conditions related to the development of Inspections, Tests, Analyses, and Acceptance Criteria ("ITAAC") for EP are anticipated. The CRN Site ESPA describes the PEP EPZ methodology in SSAR Section 13.3.3.1. As ESPA SSAR Section 13.3.3.2 states, the ingestion exposure pathway EPZ for the CRN Site will be described in a future COL application.

Question 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?

Response: The attributes in Table 3 were not used to calculate the doses in Table 4 for the CRN Largest Core. The Table 4 doses for the CRN Largest Core are calculated using ratio of the X/Q methodology per NEI 10-01 Industry Guideline for Developing a Plant Parameter Envelop in Support of an Early Site Permit. Detailed information found in Table 3, such as time to initial uncovering of the core, long-term cooling capability, and core recovery, is not needed for this analysis method.

Question 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?

Response: CRN Site ESPA Part 5A and Part 5B content is based on the generic part of the TVA Nuclear Power Radiological Emergency Plan (REP), which is approved by NRC and currently used for the TVA nuclear fleet. For the current fleet, changes to the REP and analysis to determine impact of the changes on the effectiveness of the plan are conducted in accordance with the requirements of 10.C.F.R. 50.54(q). A significant change means a reduction in effectiveness and is handled consistent with the requirements of 10.C.F.R. 50.54(q) for NRC review and approval of plan changes. The process for analyzing changes to CRN Site emergency plan, either site boundary or 2-mile, would be conducted consistent with the TVA REP and the requirements of 10.C.F.R. 50.54(q) requirements governing NRC review and approval of plan changes.

Question 30: Section 16.2.3, "EPIP Changes," of ESPA Part 5A and Part 5B states that emergency plan implementing procedures (EPIPs) will receive a review in accordance with 10 C.F.R. § 50.54(q) consistent with screening plan changes to the radiological emergency plan (REP). Paragraph 3.5c of Regulatory Guide 1.219 states that "[o]rdinarily, sub-tier documents such as emergency plan implementing procedures (EPIPS) are not considered to be part of an emergency plan for the purpose of evaluating proposed changes."

Please clarify the relationship between the CRN REP and EPIPs. Specifically, what is the rationale for applying a 10 C.F.R § 50.54(q) screening to changes to EPIPs?

Response: CRN Site ESPA Part 5A and Part 5B content is based on the generic part of the TVA Nuclear Power Radiological Emergency Plan (REP), which is approved by NRC and currently used for the TVA nuclear fleet. Certain EPIPs and sub-tier documents implement the REP. Changes to the REP are screened for impact on effectiveness in accordance with the requirements of 10 C.F.R 50.54(q). The EPIPs or any sub-tier documents that implement the

REP are considered an extension of the REP and therefore are subjected to the 10 C.F.R 50.54(q) screening requirements.

Question 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 or larger retention times that are not accounted for in the assumptions for this analysis" used to conclude the source term for the PPE is "representative and not unreasonable."

Response: SSAR Section 15.2 states that, "The activity release associated with the worst 2-hour time period of the scaled down AP1000 is approximately 25 percent greater than that for the surrogate plant (as provided in the PPE). This difference is reasonable given that SMR designs contain additional safety features that will result in general improvements over the AP1000 design." As described in SSAR Section 15.1 release pathways, release rates, and removal mechanisms for the transport of radionuclides through the plant are design specific; that "Different reactor designs have different release pathways, and each pathway has different release rates and different radionuclide removal mechanisms." In a design specific application, specific removal mechanisms and engineering features would be evaluated. Common design features of SMRs that provide enhanced removal mechanisms and larger retention times include integral vessel and coolant system layouts, large coolant volume to power ratios, large containment surface area to volume ratios, submerged containments, and high pressure containments.

Question 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?

Response: The Clinch River Early Site Permit application was submitted in accordance with 10 C.F.R. § 52 Subpart A- Early Site Permits. The application content requirements do not include the adoption of 10 C.F.R. § 50.69 risk categorization for structures, systems or components. 10 C.F.R. § 50.69, Risk-informed categorization and treatment of structures, systems and components for nuclear power, applicability includes:

1. a holder of a license to operate a light water reactor (LWR) nuclear power plant under this part;
2. a holder of a renewed LWR license under part 54 of this chapter;
3. an applicant for a construction permit
4. an applicant for operating license under this part; and
5. an applicant for a design approval, a combined license, or manufacturing license under part 52 of this chapter;

If TVA pursues additional licensing actions at the Clinch River Site, the adoption of 10 C.F.R. § 50.69 risk categorization will be evaluated as part of future licensing actions.

Question 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.

Response: If TVA decides to submit a CPA or COLA, TVA will use a methodical, comprehensive review process to catalog any new and significant information that it would include as part of a supplemental environmental report ("ER") on those issues that NRC resolved in the NRC ESP Final Environmental Impact Statement ("FEIS"). TVA is developing project procedures and a database to identify and document any such new and significant information, as part of project planning for a potential, future CPA or COLA. TVA anticipates that NRC staff will audit its periodic reviews of new and significant information during its review of a CPA or COLA. New and significant information will be updated with each revision of the CPA or COLA.

Question 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?

Response: The water source for the CRN site is the Clinch River Arm of the Watt's Bar Reservoir. A future design of the CRN makeup water intake would take into account the water levels of the reservoir. No adverse impacts to the intake due to lower flow velocities through Melton Hill Dam are anticipated during construction or operations.

Question 42: In Section 2.7.3, the Final EIS (FEIS) states that the Applicant's efforts relating to compliance with the Native American Graves Protection and Repatriation Act (NAGPRA) includes a commitment by the Applicant to develop a cultural resources management plan, but that completion of this plan has been deferred until the Applicant completes an integrated cultural resources database. The FEIS further states that the Applicant is in the process of developing a comprehensive agreement in consultation with federally-recognized Tribes outlining a process for dealing with "post-1990 unintentional discoveries of NAGPRA cultural items." The FEIS bases this information on a 2017 letter from the Applicant providing supplemental information related to historic and cultural resources.

Please provide an update on the status of these two efforts.

Response: TVA completed the initial Integrated Cultural Database ("ICD") version 1.0 in 2015. TVA continues to compile the large dataset of legacy records which will support the development of a cultural resources management plan.

TVA continues to work with federally recognized Tribes to develop a comprehensive agreement regarding post-1990 unintentional discoveries of NAGPRA cultural items. TVA completed two rounds of consultations prior to the May 15, 2019 face-to-face NAGPRA consultation with Tribal representatives, at which they and TVA discussed and revised the current draft comprehensive agreement. The parties now are reviewing a final draft of this

agreement.

Question 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?

Response: The water law system in Tennessee is based on the riparian doctrine. Even assuming that Tennessee water law applies to TVA's water withdrawals from the Clinch River for purposes of operating the SMR, TVA owns property that is contiguous to the Clinch River, and would therefore have the right to reasonable use of that water. Tennessee is also a regulated riparian state in that the system of water rights has been modified by statutory requirements. However, the state only regulates interbasin transfers at this time. See T.C.A. §§ 69-7-201 to 69-7-212 (Inter-Basin Water Transfer Act). The water withdrawals for the Clinch River SMR would not involve any interbasin transfer. Tennessee also requires water users to register annually under the Water Resources Information Act if the withdrawal of water is in excess of 10,000 gallons per day. See T. C. A. § 69-7-304. While this registration requirement does not apply to TVA under federal supremacy, TVA voluntarily files registration reports in Tennessee to assist the state in tracking water use. TVA would continue to provide such registration reports to Tennessee for the water withdrawals associated with operation of the Clinch River SMR. In sum, while state law does not prevent or restrict TVA from using water from the Clinch River to help achieve its congressionally prescribed mission to provide electricity at rates as low as feasible, TVA expects its use of water from the Clinch River for the CRN demonstration site to be consistent with state law.

As to the "associated" authorizations for use of the water, TVA would obtain a permit from the U.S Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (CWA) for the construction of a water intake structure if such construction would result in the discharge of dredge or fill material into waters of the United States. The State of Tennessee

would need to issue a water quality certification under Section 401 of the CWA prior to USACE's issuance of a Section 404 permit. Tennessee has provided this certification through the issuance of a permit under the Aquatic Resource Alteration Program (ARAP). Tennessee has a General ARAP Permit for water intake structures. However, this General ARAP Permit authorizes only the construction of the intake structure itself. Withdrawal of the water through the intake must be separately authorized under the Tennessee Water Quality Control Act.

Question 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.

Response: ER Table 4.6-1 lists specific measures and controls that are considered reasonable from a practical, engineering, and economic view. Where the specific measures and controls are covered by existing regulation or permit requirements, interagency management of sensitive species, or a part of a formal agreement between TVA and a specific agency, the controls described would be binding (e.g., requirements in a Storm Water Pollution Prevention Permit or requirements resulting from interface with United States Fish and Wildlife Service under the Endangered Species Act, or requirements under a Programmatic Agreement for cultural and historic resources with the State of Tennessee, State Historic Preservation Office). Some of the controls listed in ER Table 4.6-1 are best management practices, which may need to be modified at the time of project implementation based on TVA policies/procedures, current conditions in the field, and interactions with other agencies.

Question 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?

Response 2: In identifying alternative (candidate) sites, TVA considered the presence of the following sensitive land features:

- Habitats for important terrestrial plant and wildlife species
- Wetlands
- Land use and land rights
- Flooding
- Topography

TVA ranked these and other criteria in the site selection report.

Response 3: The evaluation is based on the compatibility of a new nuclear plant with existing land uses, including existing and future land uses and zoning ordinances, as well as the potential for impact on any significant historic resources. Historic resources include those currently listed on the National Register of Historic Places ("NRHP"), or known (active) archaeological sites or Native American lands. TVA assigned ratings based on a qualitative evaluation of the sensitivity of existing land uses, compatibility of existing land uses (for SMR development), and cultural resources, and on its best professional judgment regarding the unique combination of each of these existing features at each potential site.

Response 4: The ORR potential sites were similar in the evaluations and scoring. TVA selected the top three sites to represent this location. The top ranked Redstone Arsenal

Site, Site 12, was included as an alternative site for further evaluation to allow for geographical and environmental diversity in the detailed comparison of alternative sites.

Question 52: The FEIS notes that the Staff "expects that the actual footprint of disturbance for any site TVA might actually select would be substantially greater than the 120 ac that TVA used for identifying potential sites. The footprint of disturbance identified for the CRN [S]ite was not 120 ac but was 357 ac." The FEIS also notes, "The review team also recognizes that the 120-ac estimate likely does not account for optimal construction laydown, road improvements, and new transmission line construction."

Why was 120 acres the size used for identification of potential sites instead of a larger acreage, such as the 300-400 acres used by the review team?

Response: SMRs allow a greater flexibility in the site layout vs traditional large light water reactors. At the site selection stage 120 acres was used as the minimum reasonable area needed to site an SMR. This was based on information from potential SMR vendor designs. TVA did not want to rule out any obviously superior sites by using a larger acre requirement as screening criteria.

Question 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 this 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?

Response 2: Redstone Arsenal and the Oak Ridge Reservation are federal facilities with long term missions. Actions taken at these facilities are subject to review under the National Environmental Policy Act ("NEPA"), including environmental assessments and land use planning. As such, the available information was adequate to inform a reconnaissance level review of the proposed sites without performing additional field studies, consistent with guidance in NUREG-1555.

Respectfully submitted,

/signed (electronically) by Ryan C. Dreke/

Ryan C. Dreke, Esq.
David A. Codevilla, Esq.
Office of the General Counsel
Tennessee Valley Authority
400 W. Summit Hill Drive, WT 6A-K
Knoxville, TN 37902
Telephone: (865) 632-8960
Fax: 865-632-6147
E-mail: rcdreke@tva.gov
E-mail: dacodevilla@tva.gov

Counsel for Tennessee Valley Authority

Dated: July 26, 2019

Certification

I, Daniel Stout, certify that the testimony above was prepared by me or under my direction, and I adopt this testimony as my sworn testimony in this proceeding. I hereby certify under penalty of perjury that the testimony above is true and correct to the best of my knowledge, information, and belief.

Executed in Accord with 10 C.F.R. § 2.304(d)

Director, Nuclear Technology Innovation Tennessee Valley Authority
1101 Market Street Chattanooga, TN 37402 dpstout@tva.gov
(423)751-7642

Dated at Chattanooga, TN
this 26th day of July, 2019

July 26, 2019

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Commission

In the Matter of	)	
	)	Docket No. 52-047-ESP
Tennessee Valley Authority	)	
	)	
Clinch River, Early Site Permit	)	

CERTIFICATE OF SERVICE

I certify that, on July 26, 2019, a copy of "Tennessee Valley Authority's Responses to Pre-Hearing Questions" was served electronically through the E-Filing system on the participants in the above- captioned proceedings.

/signed electronically by/
Ryan C. Dreke