



ACRS Subcommittee

August 22, 2018

Tennessee Valley Authority (TVA)

Early Site Permit Application (ESPA)

ESPA Site Safety Analysis Report (SSAR) Section 13.3

Emergency Planning

Advanced Safety Evaluation Report (SER) with no Open Items

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13.3 Emergency Planning – TVA Early Site Permit Application

The ESPA requested review of 3 key areas, which consist of:

- Plume exposure pathway (PEP) emergency planning zone (EPZ) sizing methodology (ESPA SSAR, Sec. 13.3)
- 2 Major Features (onsite) Emergency Plans (ESPA Part 5)
 - ESPA Part 5A reflects a Site Boundary PEP EPZ
 - ESPA Part 5B reflects a 2-Mile PEP EPZ (includes an evacuation time estimate)
- 25 Exemption Requests (ESPA Part 6)
 - ESPA proposes 2 sets of exemptions (for the site boundary/2-mile PEP EPZs)
 - ESPA proposes an exemption from the current 10-mile PEP EPZ
 - Exemptions address portions of 10 CFR 50.33(g), 50.47(b) & (c)(2), and Appendix E to 10 CFR Part 50, for onsite and offsite emergency planning (EP)

Part 52 Licensing Process

- Upon issuance of the early site permit (ESP), the applicant acquires approval, with conditions, on:
 - The PEP EPZ sizing methodology
 - The 25 requested exemptions
 - The 2 major features E-plans (site boundary & 2-mi PEP EPZ)
- In the future, a combined license application (COLA) that incorporates by reference the ESP will:
 - Identify a chosen small modular reactor (SMR) technology for the Clinch River Nuclear Site
 - The applicant must demonstrate that the EPZ sizing methodology supports either the site boundary or 2-mile PEP EPZ
 - Provide a complete & integrated emergency plan
 - For the 2-mile PEP EPZ, must provide onsite & offsite emergency plans
 - For the site boundary PEP EPZ, must provide onsite emergency plan (assumes that site boundary, as defined for EP purposes in the COLA, will be within the applicant's owner controlled area)
 - Address identified COL action items and permit conditions

Review of Exemptions (Special Circumstances)

- The NRC reviewed the requested exemptions pursuant to 10 CFR 50.12 (Specific Exemptions)
 - 50.12(a)(2) – The Commission will not consider granting an exemption unless special circumstances are present.
 - Special circumstances are present whenever –
 - (ii) – Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule, or is not necessary to achieve the underlying purpose of the rule.

Special Circumstances (Underlying Purpose of Rule)

- The underlying purpose of 10 CFR 50.33, 50.47, and Appendix E to 10 CFR Part 50, is to:
 - Ensure that licensees maintain effective onsite and offsite radiological emergency response plans,
 - Ensure that there is reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency, and
 - Establish plume exposure and ingestion pathway EPZs.
- The ESPA serves to provide a basis for the establishment (in the COLA) of either a Site Boundary or 2-mi PEP EPZ, which maintains the same level of protection (i.e., dose savings in the event of a radiological emergency) in the environs of the Clinch River Nuclear Site, as that which exists in the basis for a 10-mi PEP EPZ.

TVA PEP EPZ Size Methodology

Technical Criteria

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

TVA PEP EPZ Size Methodology

SSAR Section 13.3.3.1

- Accident scenario selection
 - Use bounding DBA from COLA Final Safety Analysis Report Chapter 15
 - Use COLA site- and design-specific probabilistic risk assessment (PRA) to categorize severe accident scenarios
 - All modes, internal and external events, applicable fuel handling and spent fuel pool accidents, multi-module considerations
 - Assess all sequences with mean core damage frequency (CDF) $> 10^{-8}$ per rx-yr
 - More probable, less severe core melt scenarios
 - Mean CDF $> 10^{-6}$ per rx-yr, intact containment
 - Less probable, more severe core melt scenarios
 - Mean CDF $> 10^{-7}$ per rx-yr, containment bypass or failure
- Determine source term releases to atmosphere
- Calculate dose consequences at distance from plant
- Determine PEP EPZ size that meets the dose-based criteria

TVA Dose-Based PEP EPZ Size Criteria

- Dose to individual from exposure to the airborne plume during its passage and to groundshine, using average atmospheric dispersion characteristics for site
- DBA and more probable, less severe accidents
 - 1 rem total effective dose equivalent (TEDE) from 96-hr exposure
 - Lower end of dose range EPA PAG for early phase protective actions (e.g., evacuation and sheltering)
 - Verify that dose consequences do not exceed the EPA PAG beyond the site boundary (within owner controlled area) and 2-mile PEP EPZs
- Less probable, more severe accidents
 - Calculate the distance at which the conditional probability to exceed 200 rem whole body from 24-hr exposure exceeds 10^{-3} per rx-yr
 - Acute dose at which radiation-induced early health effects may begin to be noted (e.g., nausea)
 - Verify that the PEP EPZ supports substantial reduction in early health effects

Review of PEP EPZ Size Methodology

- Staff compared TVA's methodology and dose criteria to the study used as technical basis for current 10-mile PEP EPZ requirement (NUREG-0396)
 - The features of TVA's methodology are consistent with NUREG-0396
 - Considered a range of accidents
 - Performed accident consequence analyses
 - Determined an area outside of which early protective actions are not likely to be necessary to protect the public from radiological releases
- The staff concludes that the applicant's proposed methodology is reasonable, and consistent with the analyses that form the technical basis for the current regulatory requirement of a PEP EPZ of about 10 miles in radius.

SMR Features that Support the Exemption Requests

- TVA stated that special circumstances exist at the Clinch River Nuclear Site due to the anticipated enhanced safety features of the SMR designs under consideration
 - Smaller radionuclide inventory and source terms
 - Projected accident progression rate is anticipated to be slower
 - Various design features are expected to eliminate several historically considered design basis events
 - Severe accidents are projected to be less likely to occur
 - Advanced design features that would minimize accident consequences

Request for Additional Information

Question 1

- Specific technical support related to the statements on SMR features and comparison to large light water reactors (LLWRs)
- TVA provided tables with several parameters comparing the smallest and largest SMRs (based on unit rated thermal power) in the Clinch River Nuclear ESPA plant parameter envelope (PPE) to large and medium currently operating pressurized water reactors and the AP1000

For example:

- Internal events CDF and large release frequency
- Source term total activity
- Primary coolant liquid mass to power ratio
- Severe accident progression information

Request for Additional Information

Question 2

- Demonstration that the proposed PEP EPZ size criteria could be met at a given EPZ boundary distance for potential reactor facilities that would be represented by the surrogate design in the PPE
- TVA provided an example analysis using design information for a specific SMR design as input to the SSAR 13.3 PEP EPZ size methodology
 - Example analysis showed that design could support a site boundary PEP EPZ
 - Not intended to prove case for ESPA to justify a specific PEP EPZ size
 - Based on preliminary design information for an SMR at the lower end of the rated power (160 MWt) that is part of the basis for the Clinch River Nuclear ESPA PPE
 - Used internal events design PRA only
 - Did not do detailed uncertainty analysis

EP Exemption Plant Parameters

- TVA developed a non-design-specific accident release source term that would meet the PEP EPZ size criteria to be used as plant parameters (SER Table 13.3-1)
 - Same idea as PPE DBA source term to envelope an unknown design
 - Referenced in Permit Condition 1 for adoption of EP exemptions
- Isotopic total release activity over 96 hrs results in TEDE of about 0.9 rem at site boundary
 - 3 core melt, intact containment accidents (2 DBAs and 1 severe accident)
 - From 2 SMRs (160 MWt and 800 MWt)
 - Maximum activity release for a specific radionuclide from any of the 3 accidents over a specific dose averaging period was assumed to be the release activity of that radionuclide for that period
 - 0-8 hrs, 8-24 hrs, 24-96 hrs
 - Added 25% margin
 - Additional adjustment to values for backcalculation

Permit Condition 1

- COL applicant referencing the ESP (if approved) would perform an analysis using the SSAR 13.3 PEP EPZ size methodology, with site- and design-specific input, to justify the PEP EPZ size for the COLA
- The COLA PEP EPZ size analysis output includes the source term releases to the atmosphere
 - Isotopic activity release over time
- If the COLA PEP EPZ size analysis source term releases to the atmosphere are bounded by the non-design-specific plant parameter source term information in SER Table 13.3-1, then the COL applicant can adopt the EP exemptions
 - 4-day total activity release to the atmosphere for 71 isotopes
 - COLA values should be shown to be less than ESP (Table 13.3-1) values to adopt the EP exemptions

Plant Parameter Envelope

- TVA identified 4 SMR designs to develop the PPE
 - BWXT mPower (Generation mPower)
 - NuScale (NuScale Power)
 - SMR-160 (Holtec SMR)
 - Westinghouse SMR (Westinghouse Electric Co.)
- A different reactor design that falls within the following PPE information range may be selected in the COLA
 - 2 or more SMRs with a maximum 800 MWt for a single unit
 - Combined site capacity not to exceed 2420 MWt (800 MWe)



Review Standards/Guidance

- 10 CFR Part 52, Subpart A, Early Site Permits
- 10 CFR 50.47 & Appendix E to Part 50
- 10 CFR 50.12 & 52.7, Specific Exemptions
- NUREG-0800, Standard Review Plan, Sec. 13.3, Emergency Planning
- NUREG-0654/FEMA-REP-1 (Rev. 1), Suppl. 2, NSIR/DPR-ISG-01
- NUREG-0696, Functional Criteria for Emergency Response Facilities
- NUREG/CR-7002, Criteria for Development of ETE Studies
- NUREG-0396, Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants
- EPA PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents



Federal Emergency Management Agency (FEMA) Consultation

- NRC performed its review in consultation with FEMA, pursuant to the FEMA-NRC Memorandum of Understanding (MOU) (12/7/15, ML15344A371)
- FEMA review was limited because:
 - The ESPA did not include offsite emergency plans, and
 - The major features plans only addressed limited onsite EP features.
- FEMA's January 24, 2018, letter (ML18031B055) stated that:
 - Working with TEMA, FEMA did not identify physical characteristic of the proposed site that could pose a significant impediment to the development of emergency plans, including evacuation from the 2-mi EPZ.
 - The boundary established for the proposed 2-mi PEP EPZ was established relative to local emergency response needs and capabilities, as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries.
 - At this time, FEMA's finding does not endorse or determine the adequacy of a proposed 2-mi PEP EPZ for the site if proposed during the licensing process.
- In its June 12, 2017, letter (ML17164A206) FEMA further stated that it did not review or analyze the feasibility and assumptions for the site boundary EPZ, but if requested in the future, would provide comments and recommendations.

COL Action Items vs. Permit Conditions

- The 16 COL Action Items:
 - Track information that is needed before granting a COL, but is not required in the ESPA
 - Reflect the SMR design that may be identified in the COLA
 - Require NRC evaluation as part of the COLA review
- The 4 Permit Conditions:
 - An ESP is granted subject to permit conditions, which address required detailed information that is not yet known, but will be available in the COLA and subject to NRC confirmation

16 COL Action Items

- 13.3-1, Select SMR (EPA PAGs)/PEP EPZ/E-plan
- 13.3-2, Update Letters of Agreement/MOUs
- 13.3-3, SMR facilities & staffing
- 13.3-4, Emergency action level scheme
- 13.3-5, Alert and notification system
- 13.3-6, SMR communications/data links
- 13.3-7, Joint Information Center location/capabilities
- 13.3-8, Onsite monitoring systems/equipment

COL Action Items (cont.)

- 13.3-9, Technical Support Center
- 13.3-10, Operations Support Center
- 13.3-11, Local Recovery Center
- 13.3-12, Central Emergency Control Center
- 13.3-13, Radiation monitoring systems
- 13.3-14, Meteorological tower & monitoring program
- 13.3-15, On-site personnel decontamination facility
- 13.3-16, Communications testing & hostile action exercises

4 Permit Conditions, 1 Confirmatory Item

- Permit Conditions (PC)
 - SMR PPE Accident Consequence Analyses
 - PC 1, Calculation of EPZ Size
 - Fukushima Dai-ichi (near term task force 9.3, Tier 1)
 - PC 2, Multi-Unit Staffing Assessment
 - PC 3, Communications Assessment
 - 2011 Emergency Preparedness Rulemaking
 - PC 4, On-Shift Staffing Analysis
- Confirmatory Item 13.3-1
 - Withdrawal of exemption request Item No. 19 (re: the requirement for remedial exercises)
 - Section IV.F.2.f of App. E to 10 CFR Part 50
 - Can be closed out when ESPA Rev. 2 is submitted



Combined License Application (COLA)

- In the COL Application:
 - The COL applicant will identify an SMR technology, which must meet the PEP EPZ sizing methodology approved in the ESP for either the site boundary or 2-mile PEP EPZ, or may propose a new emergency plan.
 - If the 2-mile PEP EPZ is selected and justified, the NRC will request that FEMA review the offsite emergency plans.
 - If the site boundary PEP EPZ is selected and justified, no formal FEMA-approved offsite radiological plans are required.
 - The COL applicant will still need to address requirements to communicate and coordinate with offsite support organizations and agencies

Staff Review Findings

- No significant impediments to the development of emergency plans (10 CFR 52.17(b)(1))
- Adequate description of contacts and arrangements with Federal/State/local support agencies (10 CFR 52.17(b)(4))
- Proposed exemptions are acceptable (10 CFR 50.12, 52.7)
- Proposed major features emergency plans are acceptable (10 CFR 52.17(b)(2)(i))
- Proposed dose-based, consequence-oriented EPZ sizing methodology is reasonable

Conclusions

- The staff concludes that:
 - The PEP EPZ sizing methodology is acceptable for determining the appropriate size of the PEP EPZ for the Clinch River Nuclear Site because it is consistent with the analyses that form the technical basis for the current 10-mile PEP EPZ.
 - The 2 major features emergency plans are acceptable because they meet the applicable standards of 10 CFR 50.47 and requirements of Appendix E to 10 CFR Part 50.
 - The exemption requests are acceptable because they are authorized by law, will not present an undue risk to the public health and safety, are consistent with the common defense and security, and special circumstances are present.
- Therefore, the staff finds the TVA ESPA acceptable with respect to emergency planning and related exemption requests.

TVA's Request in ESP Application and Method of Implementation (if ESP Application Approved) in COLA			Final Products and Approval Mechanism	
	ESP	COLA	ESP	COLA
Methodology (SSAR 13.3)	Approval of a dose-based methodology for determining the EPZ size, as described in SSAR Section 13.3.	Approval of site-specific implementation of the previously approved methodology in ESP SSAR Section 13.3 to justify EPZ size. EPZ size calculation provided using site- and design-specific information. Approval of final EPZ size.	Final Product: SER and permit Staff relies on NUREG-0396 and EPA PAG Manual. SECY-15-0077: Staff initiated rulemaking for SMRs and ONTs. Prior to establishment of rule, staff should be prepared to adapt approach to EPZs for SMRs under existing exemption processes, in parallel with its rulemaking efforts (case-by-case).	Final Product: SER, license with EPZ size Using the methodology in ESP SSAR Section 13.3, the COL applicant must demonstrate that the selected SMR design meets EPA PAGs for the selected EPZ size.
Exemption Request (Part 6)	Approval for exemptions from the current 10-mile EPZ requirement if certain conditions are met. Approval to use the methodology in ESP SSAR Section 13.3 to determine EPZ size in the COLA. The ESPA requests 2 sets of exemptions, one for a site boundary EPZ and one for a 2 mile EPZ, and proposed major features of emergency plans for each.	The COLA can rely on EP exemptions granted in the ESP, provided site- and design-specific information justify use of one of the sets of exemptions evaluated in the ESPA.	Final Product: SER and permit with exemptions (if approved) and related conditions Staff relies on exemption guidance, NUREG-0396 and EPA PAG Manual	Final Product: SER, license to reflect EPZ size supported in the COLA.
Emergency Plans (Part 5A and Part 5B)	Approval of the major features of the site boundary and 2-mile emergency plans in Part 5.	Approval of complete and integrated emergency plans, including offsite emergency plans if a PEP EPZ other than site boundary is selected. Includes the remaining features of the emergency plan (either site boundary or 2-mile) from the ESP or new emergency plan based on the final dose-based EPZ size.	Final Product: SER and permit Staff relies on existing rules and guidance, except to the extent that they are not applicable because of the requested exemptions.	Final Product: SER, license to reflect EPZ size supported in the COLA.

Abbreviations

- CDF – core damage frequency
- CFR – Code of Federal Regulations
- COL – combined license
- COLA – combined license application
- DBA – design basis accident
- EP – emergency planning
- EPA – U.S. Environmental Protection Agency
- EPZ – emergency planning zone
- ESP – early site permit
- ESPA – early site permit application
- ETE – evacuation time estimate
- FEMA – Federal Emergency Management Agency
- FSAR – Final Safety Analysis Report
- LLWR – large light water reactor
- MOU – memorandum of understanding
- MWe – megawatts electric
- MWt – megawatts thermal
- NTTF – Near-Term Task Force

Abbreviations (cont.)

- PAG – (EPA) protective action guide
- PC – permit condition
- PEP – plume exposure pathway
- PPE – plant parameter envelope
- PRA – probabilistic risk assessment
- RG – Regulatory Guide
- rem – roentgen equivalent man ($1 \text{ rem} = 0.01 \text{ Sv}$)
- rx-yr – reactor-year
- SER – safety evaluation report
- SMR – small modular reactor
- SSAR – site safety analysis report
- TEDE – total effective dose equivalent
- TEMA – Tennessee Emergency Management Agency
- TVA – Tennessee Valley Authority