U.S. NUCLEAR REGULATORY COMMISSION SUMMARY OF THE SEPTEMBER 27, 2022, OBSERVATION PREAPPLICATION PUBLIC MEETING WITH SMR, LLC (A HOLTEC INTERNATIONAL COMPANY) TO DISCUSS SEISMIC ANALYSIS METHODOLOGY TO SUPPORT THE CONSTRUCTION PERMIT APPLICATION OF THE SMR-160 DESIGN

Meeting Summary

The U.S. Nuclear Regulatory Commission (NRC) held a preapplication public meeting on September 27, 2022, with SMR, LLC (SMR), a Holtec International company, to discuss its seismic analysis methodology to support the construction permit application of the SMR-160 design. Specifically, SMR (applicant) requested the meeting to provide an overview of the proposed method of analysis for the seismic design of SMR-160 plant, including the use of a non-linear soil model. Additional topics for discussion include the design basis ground motion for the SMR-160 site and the input soil parameters used to inform the standard plant design.[1]

This virtual preapplication meeting had attendees from SMR, LLC, Holtec International, LLC, NRC staff and members of the public.

- The applicant provided an overview of its presentation that included a discussion of the review procedures in Standard Review Plan Section 3.7.2 and typical soil-structure interaction (SSI) time history analysis methods.[2] The applicant proposed a time-domain nonlinear analysis method for the SMR-160 design that has been used in building and bridge industries and noted that non-linear time domain SSI guidance in ASCE 4-2016 includes provisions to meet 10 CFR Part 50, Appendix B requirements.[3] The applicant noted that its analysis assumes a soil, non-rock foundation and that additional analysis would be needed for a rock site.

- The NRC staff requested whether absorption due to the hysteresis loop considers the sliding and gap conditions. The applicant responded that LS-DYNA models the gap conditions and the soil-material model captures the soil deformation where the SMR-160 plant interface with the soil. In response to the NRC staff's questions about any planned laboratory testing to determine required parameters of these models, the applicant responded that measured data will be relied up on for soil properties and the capabilities in LS-DYNA will be leveraged to simulate contact between two materials. The NRC staff noted that a contact model would have two spring constants and that lab testing would be needed since the surfaces of the soil-structure interface in reality are not smooth. The applicant noted that for shear (soil-structure) interface and sliding, LS-DYNA will define

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1 SMR, LLC, "SMR, LLC Preapplication Meeting Materials for September 27, 2022 (Project No. 99902049)," dated September 23, 2022. Agencywide Documents and Access Management System (ADAMS) Accession No. ML22266A126.

2 U.S. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (NUREG-0800, Formerly issued as NUREG-75/087)," Chapter 3, "Design of Structures, Components, Equipment, and Systems," Section 3.7.2, "Seismic System Analysis," ML13198A223.

3 American Society of Civil Engineers (ASCE), ASCE 4-16, "Seismic Analysis of Safety-Related Nuclear Structures."

the coefficient of friction to capture the interface between two materials, and that parametric studies would be conducted.

- The NRC staff requested additional information on Slide #16, Sub-bullet #5, regarding the second LS-DYNA time history analysis. The applicant described a historical two-step process of informing the LS-DYNA soil properties with SHAKE2000 soil response data. For the SMR-160 design, the applicant is proposing to use the MAT-079 element in LS-DYNA to provide material information in lieu of SHAKE2000 data with the expectation of similar results.

- In response to the NRC staff's request, the applicant clarified that the ground motion response spectra in the left table on Slide #9 represents the horizontal direction(s), that in the right table represents the vertical direction, and that ground motion input in three directions will be included in the analysis.

- For Slide #16, Sub-bullet #2, the applicant clarified for the staff that the slaved boundary condition assumes that the soil behavior is identical at the lateral boundary of the same elevation, essentially simulating an infinite half-space conditions.

- Following the meeting, and in consideration of the presentation and discussion, the NRC staff has a high-level understanding of the SMR (Holtec) proposed non-linear soil analysis method. The NRC staff did not identify any immediate concerns with the approach; however, this does not preclude the staff's evaluation of the methodology, its implementation, and associated conclusions when the details are submitted to support a construction permit application. Additionally, the NRC staff has not previously approved a non-linear soil-structure analysis for licensing a reactor. Since this will be a 'first-of-a-kind' review, the NRC staff may ask additional questions to fully understand the approach and its implementation.