Part 12

South Carolina Electric and Gas
V. C. Summer Nuclear Station, Units 2 & 3
COL Application

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V. C. Summer Nuclear Station, Units 2 and 3

COL Application

Part 12

COLA Enclosure 2 —
Seismic Technical Advisory Review Letter

Revision 0

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SUBJECT: *SEISMIC TECHNICAL ADVISORY GROUP REVIEW REPORT FOR THE SOUTH CAROLINA ELECTRIC & GAS COMPANY COMBINED OPERATING LICENSE APPLICATION FOR THE VIRGIL C. SUMMER NUCLEAR STATION UNITS 2 & 3*

Dear Mr. Clary:

The Seismic Technical Advisory Group (TAG) for preparation of the South Carolina Electric & Gas Company (SCE&G) Combined Operating License Application (COLA) for the Virgil C. Summer Nuclear Station (VCSNS) Units 2 & 3 has completed its review. We want to express our appreciation for the opportunity to participate in the very important VCSNS Units 2 & 3 COLA preparation. This letter report describes our participation and states our review conclusions.

TAG REVIEW PROCESS

We understand that to a significant degree seismic safety assurance is obtained through implementation of current standards of practice and our advice and recommendations for preparation of the VCSNS Units 2 & 3 COLA reflect this understanding. We participated in the preparation of the COLA as "participatory peer reviewers". Budnitz, et al., 1997[1] (now referred to as the SSHAC process) defined participatory peer review and contrasted this process to the historically more common practice of "late-stage peer review". In a participatory peer review process the reviewers interact frequently with the project throughout the work performance period. For the VCSNS Units 2 & 3 COLA preparation there was frequent interaction between the TAG and the COLA preparation team and the subject matter experts who provided inputs for the COLA. The process focused on providing timely TAG recommendations on scientific, technical, and regulatory aspects of the COLA preparation as well as on aspects of the project implementation. The very significant value of frequent TAG review is that problems are identified early when they can be corrected without the need to substantially redo work. The Nuclear Regulatory Commission (NRC) has recognized the significant benefit of a participatory review and has accepted this review process as part of the SSHAC process

[1] Budnitz, R. J., G. Apostolakis, D. M. Boore, L. S. Cluff, K. L. Coppersmith, C. A. Cornell, and P. A. Morris, 1997. *Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and the Use of Experts.* NUREG/CR-6372, U. S. Nuclear Regulatory Commission, Washington, DC

for assessing probabilistic seismic hazard and determination of the required site-specific seismic design basis parameters[2] [3].

Our review for the VCSNS Units 2 & 3 COLA preparation occurred primarily in four TAG review meetings, which were scheduled to coincide with specific completion stages of the work. Sequencing the review meetings in this way allowed the TAG to stay current with implementation of the work plan and to make timely recommendations. The schedule for the interactive reviews also allowed the Project and the TAG to fully consider evolving seismic practice and the seismic regulatory guidance that was being updated to reflect that practice. Activities to update seismic regulatory guidance involved Industry (through the Nuclear Energy Institute (NEI)) and NRC interactions for the purpose of updating NRC's seismic regulatory guidance with current technologies and the AP1000 Certified Design Design-Centered Working Group activities under NuStart to resolve generic seismic issues related to the AP1000 site-foundation interface. Also, we were aware that several COLA preparation activities for sites located in the Southeast were proceeding in parallel. We considered it necessary to establish a structure to manage active coordination with these important activities in order to provide fully informed recommendations for preparation of the VCSNS Units 2 & 3 COLA. Accordingly, in order to establish and maintain the needed level of coordination we recommended that SCE&G should seek to establish a formal structure that would implement broad coordination among the relevant activities.

SCE&G initiated discussions with Duke Energy, Progress Energy, Southern Nuclear Company, TVA, and NuStart for the purpose of establishing an appropriate coordination structure. These discussions resulted in formation of the AP1000 Seismic Review Committee (APSRC), a management and technical entity chartered to implement the needed coordination. APSRC established the process of combined TAG review meetings for the several affected AP1000 COLA preparation activities: Bellefonte Nuclear Station (BNS), William States Lee Nuclear Station (WSLNS), and Virgil C. Summer Nuclear Station (VCSNS). The Grand Gulf Nuclear Station (GGNS), although considering another reactor technology, also participated in these generic discussions. Through the participation of NuStart (BNS and GGNS), we were able to remain current with progress toward generic resolution foundation interface issues.

APSRC additionally established through the Nuclear Energy Institute (NEI), coordination with the New Plant Seismic Issues Resolution Program managed by the Electric Power Research Institute (EPRI). Progress toward resolution of generic seismic issues occurred in technical meetings between Industry (represented by NEI/EPRI, NuStart, and APSRC) and the NRC's seismic review staff. As resolution was reached, the NRC's meeting reports provided interim staff guidance for implementation of updated technical

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[2] NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants*, Section 2.5.2, "Vibratory Ground Motion", U.S. Nuclear Regulatory Commission, Washington, DC

[3] Regulatory Guide 1.208, *A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion*, U.S. Nuclear Regulatory Commission, Washington, DC

procedures acceptable to the NRC. Through this multi-layered coordination we were able to participate in the resolution of technical issues related to implementation of current seismic hazard assessment and seismic design methods in regulatory practice and to factor these developments into our specific recommendations for preparation of the VCSNS Units 2 & 3 COLA. Our review of the VCSNS Units 2 & 3 COLA preparation significantly benefited from the APSRC's very effective coordination of these activities.

TAG REVIEW MEETINGS

In the first TAG meeting (June 7 - 8, 2006) we were able to review compilations and preliminary evaluations of geological, geophysical, and seismological information for the VCSNS site and region together with the planned additional site and region investigations and analyses for completing preparation of the COLA. We were able to visit the VCSNS site and observe the locations selected for the planned AP1000 units. Additionally, we were able to review the preliminary site geotechnical investigations, borehole core drills, and preliminary analysis results, together with the planned additional investigations and analysis for completing the geotechnical characterization for preparation of the COLA. Also during the first meeting we were able to review a number of technical issues related to the AP1000 foundation interface and to discuss SCE&G's planned use of a number of advances in seismic hazard and seismic analysis technologies that were then being considered by the NRC for generic updating seismic regulatory practice.

We made the following recommendations.

1. The performance goal-based method described in American Society of Civil Engineers (ASCE) Standard 43-05 is appropriate for determination of the site-specific Safe Shutdown Earthquake (SSE) ground motion for VCSNS Units 2 & 3. The performance goal-based method is a significant advancement that combines site-specific seismic hazard results with seismic design criteria to achieve a target seismic performance goal. Although not yet implemented at that time in NRC's seismic regulatory guidance, we considered the performance goal-based method to be current state of practice for determination of site-specific SSE ground motion. Also, we were aware that Exelon had recently used the performance goal-based method for determination of the site-specific SSE ground motion for the Clinton Early Site Permit (ESP) application. The NRC review staff and the Advisory Committee on Reactor Safeguards (ACRS) had accepted the method for the Clinton ESP and had recommended that the NRC initiate development of a new regulatory guide to provide guidance for generic implementation of the method.
2. Evaluation and characterization of seismic sources for the computation of probabilistic seismic hazard for the VCSNS Units 2 & 3 site should be coordinated with other utilities that are developing ESPs or COLAs for sites located in the Southeast. The goal of the coordination should be to develop consensus characterizations of seismic sources that contribute to the hazard at more than one of these sites. The consensus characterization should then be used for computation of seismic hazard at each of the affected sites.

3. The EPRI 04 Ground Motion model should be used for site-specific seismic hazard computation. This model has been used for recent ESP applications and NRC has accepted it on a site-specific basis. In addition, we expect the updated NRC regulatory guidance will include this model for generic application.
4. Rock level uniform hazard spectra should be computed for 10^{-4}, 10^{-5}, and 10^{-6} mean annual non-exceedance probabilities for use in site response analysis and for determining performance goal-based SSE ground motion at the free ground surface and the nuclear island foundation level.
5. NUREG/CR-6728 site response analysis Approach 2A/3 should be used to develop site response transfer functions. [The NRC subsequently accepted the more analytically accurate Approaches 3, and 4 for site response analysis, allowing this recommendation to be modified accordingly.]
6. Observations of microseismicity associated with the Monticello Reservoir impoundment should be updated. Microseismicity began shortly after the start of filling of the Monticello Reservoir late in 1977 and was monitored and documented through 1996. Using compilations and evaluations provided by SCE&G, the NRC had previously evaluated the safety significance of this microseismicity and found it to be negligible. We concur that microseismicity associated with the Monticello Reservoir has negligible safety significance. We recommend updating the compilation only for the purpose of continuity of documentation of the process to date.
7. SCE&G should initiate discussions with other utilities that are currently preparing COLAs for sites located in the Southeast for the purpose of establishing active formal coordination to achieve consistent implementation of updated technical methods. The coordination should ensure that momentum in addressing current generic technical issues is maintained and that closure of the issues with the NRC is achieved in a time frame that supports preparation of the COLA. The NuStart AP1000 Design-Centered Working Group is addressing many of the same generic issues and should participate in the coordination. We identified the following technical and implementation issues

    - Coordinated treatment of seismic source models for PSHA across sites
    - Consistent approaches for site geotechnical investigations and characterization
    - Consistent use of SSE ground motion response spectra for development of site control response spectra and response spectra for foundation levels of structures
    - Development of consistent approaches for treatment of high spectral amplitude values at high response spectra frequencies on structures and equipment
    - Consistent location of seismic instrumentation that will be used for determining Operating Basis Earthquake exceedance – compliance with regulatory requirements and guidance.

Based on our initial recommendations, the VCSNS TAG review meetings No. 2, 3 and 4 were held in combination with TAG meetings for the BNS, WSLNS, GGNS COLA preparations. In these meetings we were able to review progress toward preparation of the COLA together with progress toward resolution of AP1000 foundation interface

issues as well as progress toward resolving foundation interface issues for the ESBWR, the certified design technology selected for the GGNS COLA.

During TAG review meeting No 2 held on January 30, 2007, we were able to review the results of the site geotechnical characterization and the layout of the two units, the excavation and backfill plan, and presentations of draft Safety Analysis Report Sections 2.5.1 and 2.5.2. We additionally discussed plans for updating reservoir-induced microseismicity observations and documentation of shear fractures expected to be found in the Units 2 and 3 foundations based the results of the geotechnical site characterization and the shear fractures found in the existing VCSNS Unit 1 foundation. We observed that the Project team had satisfactorily implemented our prior recommendations as well as the NRC staff interim guidance on use of updated technical methods provided in their summaries of Industry-NRC staff generic issue resolution meetings held on September 12, 2006 and December 14, 2006.

Also during TAG review meeting No. 2 we were able to review progress toward resolution of foundation-site interface generic issues for the AP1000 Certified Design technology. Westinghouse proposed to perform an analysis using a recently developed site-specific ground motion response spectrum (GMRS[4]) for the BNS site and to use the analysis for the three hard rock sites: BNS, VCSNS, and WSLNS. The AP1000 units at these three sites will be founded on hard rock with very nearly the same seismic shear-wave velocity profiles, approximately 9200 fps at the foundation level. The BNS GMRS was selected for the analysis because it was determined to be the bounding spectra for the three sites. We agreed with the proposal to perform a generic analysis for the three hard rock sites, but we recommended that Westinghouse should perform the analysis using the GMRS more recently derived for the BNS COLA. We observed that while the three sites have nearly the same shear-wave velocity profiles there are some variations. We recommended that a sensitivity analysis should be performed to determine whether the variations are significant. We also observed that a number of AP1000 foundation interface generic issues remain open pending further planned interactions with the NRC staff.

During TAG meeting No. 3 on June 21, 2007, we were able to review content presentations of the geology, seismology, and geotechnical engineering sections of the COLA Safety Evaluation Report (SRP) Sections 2.5.1 through 2.5.5. We observed that the assessments described in these sections appropriately implement NRC's updated seismic regulatory guidance (Regulatory Guide 1.208 and SRP Chapter 2.5) and the TAG implementation recommendations, and we endorse the proposed presentations of these sections and the conclusions. For determination of Operating Basis Earthquake (OBE)

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[4] In the Industry-NRC staff meeting on New Plant Seismic Issues Resolution on December 14, 2006, NRC agreed with the need for a distinction between the performance goal-based site-specific ground motion and site-independent certified seismic design response spectra (CSDRS) that have been approved for standard design certification. The GMRS satisfies the site-specific SSE Ground Motion requirements of 10 CFR Part 100.23.

exceedance based on CAV, appropriate seismic instrumentation placed in a light structure within the controlled area of the plant adequately meets the NRC's regulatory guidance as well as the interim guidance provided by the staff following the Industry-NRC generic seismic issue resolution meeting on May 31, 2007 for free-field instrumentation. We noted that several items remain to be completed: dynamic testing of soil samples, foundation input response spectra (FIRS) for the Annex Building, and sensitivity of the GMRS to the New Madrid Seismic Source.

During the fourth (and final) TAG review meeting on August 31, 2007, we were able to review the several incomplete items from TAG meeting No. 3. We concur with the results developed to complete these items for preparation of the COLA. The sensitivity study showed that the New Madrid Seismic Source has a non-negligible contribution to the GMRS at the VCSNS site and the source was included in the analysis. We consider the planned number of dynamic soil tests for the site to be sufficient. We recommend however, that these site-specific testing results should be compared with Industry generic test results..

CONCLUSIONS

- Preparation of the VCSNS Units 2 & 3 COLA properly implemented state of practice technical methods and procedures in compliance with NRC's updated seismic regulatory guidance and interim staff guidance.

- Coordination of the VCSNS Units 2 & 3 COLA preparation with concurrent preparation of COLA for Bellefonte Nuclear Station (BNS), William States Lee Nuclear Station (WSLNS), and Grand Gulf Nuclear Station (GGNS) and with Industry-NRC generic seismic issue resolution activities was particularly effective and productive.

- We concur with the results and conclusions presented in the Safety Analysis Report supporting the COLA and consider them to be appropriately and adequately supported by the data and analysis presented.

Sincerely,

C. Allin Cornell

Martin C. Chapman

Robert P. Kennedy

Donald P. Moore

J. Carl Stepp