



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS
RELATED TO AMENDMENT NOS. 114 AND 113
TO THE COMBINED LICENSE NOS. NPF-91 AND NPF-92, RESPECTIVELY
SOUTHERN NUCLEAR OPERATING COMPANY, INC.
GEORGIA POWER COMPANY
OGLETHORPE POWER CORPORATION
MEAG POWER SPVM, LLC
MEAG POWER SPVJ, LLC
MEAG POWER SPVP, LLC
CITY OF DALTON, GEORGIA
VOGTLE ELECTRIC GENERATING PLANT UNITS 3 AND 4
DOCKET NOS. 52-025 AND 52-026

1.0 INTRODUCTION

By letter dated July 28, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17209A185), the Southern Nuclear Operating Company (SNC) requested that the Nuclear Regulatory Commission (NRC) amend Vogtle Electric Generating Plant (VEGP) Units 3 and 4, Combined License (COL) Numbers NPF-91 and NPF-92, respectively. The License Amendment Request (LAR) 17-025 proposed changes to the Updated Final Safety Analysis Report (UFSAR) information, and also proposed changes to plant-specific (PS) Tier 1 information (and associated COL Appendix C information) relating to update Reactor Coolant System (RCS) requirements for reactor vessel head vent (RVHV) mass flow rate.

Pursuant to 52.63(b)(1) of Title 10 of the *Code of Federal Regulations* (10 CFR), SNC also requested an exemption from the provisions of the Commission's regulations in 10 CFR Part 52, Appendix D, "Design Certification Rule for the AP1000 Design," Section III.B, "Scope and Contents." The requested exemption would allow a departure from the corresponding portions of the certified information in Tier 1 of the generic AP1000 Design Control Document (DCD).¹ In

¹ While the licensee describes the requested exemption as being from Section III.B of 10 CFR Part 52, Appendix D, the entirety of the exemption pertains to proposed departures from Tier 1 information in the generic AP1000 DCD. In the remainder of this evaluation, the NRC will refer to the exemption as an

order to modify the UFSAR Tier 1 information, the NRC must find SNC's exemption request included in its submittal for the LAR to be acceptable. The staff's review of the exemption request, as well as the LAR, is included in this safety evaluation.

2.0 REGULATORY EVALUATION

The LAR summarizes the changes as follows: The RVHVs are used to provide emergency letdown and avoid long term pressurizer overfill during events which increase inventory in the RCS. VEGP COL Appendix C and the corresponding PS Tier 1 give the required RVHV mass flow rate to accomplish this safety-related function. A revised plant safety analysis based on the AP1000 design pressure of 2500 pounds per square inch absolute (psia) has been performed and identified the need to update the RVHV mass flow rate to reflect the flow required at this higher AP1000 design pressure. The updated analysis has the RVHV opening at a different RCS pressure and requires a higher minimum mass flow rate through the RVHV line to accomplish the emergency letdown function. SNC proposes changes to the VEGP COL Appendix C Table 2.1.2-4, Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) No. 2.1.02.08e, UFSAR Subsection 5.4.12.4.1, "Flow Testing," and UFSAR Table 5.4-18, "Reactor Vessel Head Vent System Design Parameters," to reflect the required RVHV mass flow rate of 9.0 pounds mass per second (lbm/sec) at a pressure of 2500 psia, consistent with the current AP1000 plant safety analysis.

The NRC staff considered the following regulatory requirements in reviewing the proposed LAR:

Appendix D, Section VIII.A.4 to 10 CFR Part 52 states that exemptions from Tier 1 information are governed by the requirements in 10 CFR 52.63(b)(1) and 10 CFR 52.98(f). It also states that the Commission will deny such a request if it finds that the design change will result in a significant decrease in the level of safety otherwise provided by the design.

Appendix D, Section VIII.B.5.a allows an applicant or licensee who references this appendix to depart from Tier 2 information, without prior NRC approval, unless the proposed departure involves a change to or departure from Tier 1 information, Tier 2* information, or the Technical Specifications, or requires a license amendment under paragraphs B.5.b or B.5.c of the section.

10 CFR 52.63(b)(1) allows the licensee who references a design certification (DC) rule to request NRC approval for an exemption from one or more elements of the certification information. The Commission may only grant such a request if it determines that the exemption will comply with the requirements of 10 CFR 52.7, which, in turn, points to the requirements listed in 10 CFR 50.12, "Specific Exemptions," and the special circumstances present outweigh any decrease in safety that may result from the reduction in standardization caused by the exemption. Therefore, any exemption from the Tier 1 information certified by Appendix D to 10 CFR Part 52 must meet the requirements of 10 CFR 50.12, 52.7, and 52.63(b)(1).

10 CFR 52.98(f) requires NRC approval for any modification to, addition to, or deletion from the terms and conditions of a COL. These activities involve a change to COL Appendix C ITAAC information, with corresponding changes to the associated plant specific (PS)-DCD Tier 1 information. Therefore, NRC approval is required prior to making the PS proposed changes in this license amendment request.

exemption from Tier 1 information to match the language of Section VIII.A.4 of 10 CFR Part 52, Appendix D, which specifically governs the granting of exemptions from Tier 1 information.

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 15, "Reactor Coolant System Design," requires the RCS and associated auxiliary, control, and protection systems to be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences.

3.0 TECHNICAL EVALUATION

3.1 EVALUATION OF EXEMPTION

The regulations in Section III.B of Appendix D to 10 CFR Part 52 require a holder of a COL referencing Appendix D to 10 CFR Part 52 to incorporate by reference and comply with the requirements of Appendix D, including certified information in Tier 1 of the generic AP1000 DCD. Exemptions from Tier 1 information are governed by the change process in Section VIII.A.4 of Appendix D of 10 CFR Part 52. Because SNC has identified changes to PS Tier 1 information, with corresponding changes to the associated COL Appendix C information resulting in the need for a departure, an exemption from the certified design information within PS Tier 1 material is required to implement the LAR.

The Tier 1 information for which a PS departure and exemption was requested relates to RCS requirements for the RVHV mass flow rate. Specifically, the revision was to the PS Tier 1 Table 2.1.2-4 Item 8.e) for the required RVHV mass flow rate from 8.2 lbm/sec at an RCS pressure of 1250 psia to 9.0 lbm/sec at an RCS pressure of 2500 psia to align with the events evaluated in the current AP1000 safety analysis. The result of this exemption would be that SNC could implement modifications to UFSAR Tier 1 information and associated COL Appendix C information. Pursuant to the provisions of 10 CFR 52.63(b)(1), an exemption from elements of the design as certified in the 10 CFR Part 52, Appendix D, DC rule is requested for the involved Tier 1 information described and justified in LAR 17-025. This exemption is a permanent exemption limited in scope to the particular Tier 1 information specified.

As stated in Section VIII.A.4 of Appendix D to 10 CFR Part 52, an exemption from Tier 1 information is governed by the requirements of 10 CFR 52.63(b)(1) and 52.98(f). Additionally, Section VIII.A.4 of Appendix D to 10 CFR Part 52 provides that the Commission will deny a request for an exemption from Tier 1 if it finds that the requested change will result in a significant decrease in the level of safety otherwise provided by the design. Pursuant to 10 CFR 52.63(b)(1), the Commission may grant exemptions from one or more elements of the certification information, so long as the criteria given in 10 CFR 52.7, which, in turn, references 10 CFR 50.12, are met and that the special circumstances, which are defined by 10 CFR 50.12(a)(2), outweigh any potential decrease in safety due to reduced standardization.

Pursuant to 10 CFR 52.7, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 52. As 10 CFR 52.7 further states, the Commission's consideration will be governed by 10 CFR 50.12, which states that an exemption may be granted when: (1) the exemptions are authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security; and (2) special circumstances are present. Specifically, 10 CFR 50.12(a)(2) lists six special circumstances for which an exemption may be granted. It is necessary for one of these bases to be present in order for the NRC to consider granting an exemption request. SNC stated that the requested exemption meets the special circumstances of 10 CFR 50.12(a)(2). The staff's analysis of these findings is presented below.

3.1.1 AUTHORIZED BY LAW

This exemption would allow SNC to implement changes to elements of the PS Tier 1 DCD to depart from the AP1000 certified design (Tier 1) information. Specifically the exemption would allow SNC to implement changes to the VEGP COL Appendix C Table 2.1.2-4 ITAAC No. 2.1.02.08e to reflect the required RVHV mass flow rate of 9.0 lbm/sec at a pressure of 2500 psia, consistent with the current AP1000 plant safety analysis. This exemption is a permanent exemption limited in scope to particular Tier 1 information. Subsequent changes to this PS Tier 1 information, and corresponding changes to Appendix C, or any other Tier 1 information would be subject to the exemption process specified in Section VIII.A.4 of Appendix D to 10 CFR Part 52 and the requirements of 10 CFR 52.63(b)(1). As stated above, 10 CFR Part 52, Appendix D, Section VIII.A.4 allows the NRC to grant exemptions from one or more elements of the Tier 1 information. The NRC staff has determined that granting of SNC's proposed exemption will not result in a violation of the Atomic Energy Act of 1954, as amended, or the Commission's regulations. Therefore, as required by 10 CFR 50.12(a)(1), the exemption is authorized by law.

3.1.2 NO UNDUE RISK TO PUBLIC HEALTH AND SAFETY

The underlying purpose of Appendix D to 10 CFR 52 is to ensure that a licensee will construct and operate the plant based on the approved information found in the DCD incorporated by reference into a licensee's licensing basis. The changes proposed by SNC do not add or delete systems or equipment as described in Tier 1 of the generic DCD. These changes will not impact the ability of the systems or equipment to perform their design function. Because they will not alter the operation of any plant equipment or systems, these changes do not present an undue risk from existing equipment or systems. These changes do not add any new equipment or system interfaces to the current plant design. The description changes do not introduce any new industrial, chemical, or radiological hazards that would represent a public health or safety risk, nor do they modify or remove any design or operational controls or safeguards intended to mitigate any existing on-site hazards. Furthermore, the proposed changes would not allow for a new fission product release path, result in a new fission product barrier failure mode, or create a new sequence of events that would result in significant fuel cladding failures. Accordingly, these changes do not present an undue risk from any new equipment or systems. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that there is no undue risk to public health and safety.

3.1.3 CONSISTENT WITH COMMON DEFENSE AND SECURITY

The proposed exemption would allow changes to the VEGP COL Appendix C, Table 2.1.2-4 ITAAC No. 2.1.02.08e, to reflect the required RVHV mass flow rate consistent with the current AP1000 plant safety analysis, thereby departing from the AP1000 certified Tier 1 design information. The change does not alter or impede the design, function, or operation of any plant structures, systems, or components (SSCs) associated with the facility's physical or cyber security and, therefore, does not affect any plant equipment that is necessary to maintain a safe and secure plant status. In addition, the changes have no impact on plant security or safeguards. Therefore, as required by 10 CFR 50.12(a)(1), the staff finds that the common defense and security is not impacted by this exemption.

3.1.4 SPECIAL CIRCUMSTANCES

Special circumstances, in accordance with 10 CFR 50.12(a)(2), are present, in part, whenever 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. The underlying purpose of the Tier 1 information is to ensure that a licensee will safely construct and operate a plant based on the certified information found in the AP1000 DCD, which was incorporated by reference into the VEGP Units 3 and 4 licensing basis. The proposed changes would allow changes to the VEGP COL Appendix C Table 2.1.2-4 ITAAC No. 2.1.02.08e to reflect the required RVHV mass flow rate of 9.0 lbm/sec at a pressure of 2500 psia, consistent with the current AP1000 plant safety analysis. The changes do not impact the ability of any SSCs to perform their functions or negatively impact safety.

Special circumstances are present in the particular circumstances discussed in LAR 17-025 because the application of the specified Tier 1 information is not necessary to achieve the underlying purpose of the rule. The proposed changes do not affect any function or feature used for the prevention and mitigation of accidents or their safety analyses, and no safety-related SSC or function is involved. This exemption request and associated revisions to the Tier 1 information and corresponding changes to Appendix C demonstrate that the applicable regulatory requirements will continue to be met. Therefore, for the above reasons, the staff finds that the special circumstances required by 10 CFR 50.12(a)(2)(ii) for the granting of an exemption from the Tier 1 information exist.

3.1.5 SPECIAL CIRCUMSTANCES OUTWEIGH REDUCED STANDARDIZATION

This exemption would allow the implementation of changes to Tier 1 information in the PS DCD and corresponding changes to Appendix C that are being proposed in the LAR. The justification provided in LAR 17-025, the exemption request, and the associated licensing basis mark-ups demonstrate that there is a limited change from the standard information provided in the generic AP1000 DCD, and that information is unnecessary to achieve the underlying purpose of the rule. The design functions of the system associated with this request will continue to be maintained because the associated revisions to the Tier 1 information support the required RVHV mass flow rate consistent with the current AP1000 plant safety analysis. Consequently, the safety impact that may result from any reduction in standardization is minimized, because the proposed design change does not result in a reduction in the level of safety. Based on the foregoing reasons, as required by 10 CFR Part 52.63(b)(1), the staff finds that the special circumstances outweigh any decrease in safety that may result from the reduction of standardization of the AP1000 design.

3.1.6 NO SIGNIFICANT REDUCTION IN SAFETY

This exemption would allow the implementation of changes to changes to the VEGP COL Appendix C Table 2.1.2-4 ITAAC No. 2.1.02.08e consistent with the current AP1000 plant safety analysis. The exemption request proposes to depart from the certified design by allowing changes to update the ITAAC to reflect the required RVHV mass flow rate consistent with the current AP1000 plant safety analysis. The changes for consistency will not impact the functional capabilities of this system. The proposed changes will not adversely affect the ability of the RVHV, and the level of safety provided by the current systems and equipment therein is unchanged. Therefore, based on the foregoing reasons and as required by 10 CFR 52.7, 10 CFR 52.98(f), and 10 CFR Part 52, Appendix D, Section VIII.A.4, the staff finds that granting the exemption would not result in a significant decrease in the level of safety otherwise provided by the design.

3.2 TECHNICAL EVALUATION OF PROPOSED CHANGES

In LAR 17-025, SNC summarizes its proposed changes to the COL and UFSAR for VEGP Units 3 and 4 related to changes to update RCS requirements for RVHV mass flow rate to be tested from 8.2 lbm/sec at 1250 psia to 9.0 lbm/sec at 2500 psia. This includes proposed changes to ITAAC 2.1.02.08e and UFSAR information in two locations. The staff conducted a detailed audit of the documentation and calculations supporting the changes proposed in LAR 17-025, including telephone conferences with SNC personnel. The staff describes the audit of the LAR 17-025 documentation and calculations in its audit plan dated October 30, 2017 (ADAMS Accession No. ML17303A665). In this safety evaluation report, the staff summarizes the results of the audit of the LAR 17-025 documentation and calculations, and reaches a conclusion on the acceptability of the changes proposed in LAR 17-025.

The AP1000 RVHV capacity is sized to perform the following functions:

- Provide an emergency letdown path that can be used to prevent long-term pressurizer overfill following loss of heat sink events, and
- Normal RCS venting and filling operations during startup

Based on information provided by SNC, the staff reviewed four calculations that support the RCS requirements for the ITAAC 2.1.02.08e acceptance criteria.

As part of the AP600 design certification, document RCS-M3C-025, Rev. 0, "AP600 Calculation for Head Vent Flow at 1250 psia (RCS Head Vent Line Sizing)," calculated the allowable resistance criteria for RVHV piping and fittings to relieve enough RCS coolant to prevent the pressurizer from overflowing following actuation of the Core Makeup Tanks (CMTs) for a non-loss-of-coolant accident event (CMT water-solid recirculation mode) and to size the head vent inlet and discharge line. The analysis was based on a CMT net injection flow rate of 8.2 lbm/sec at RCS pressure of 1250 psia (the acceptance criteria of ITAAC 2.1.02.08e) as the flow rate the RVHV vent valves must be designed to accommodate. The staff found the AP600 RVHV system to be acceptable as provided in Section 5.4.12.1, "Reactor Vessel Head Vent System," of NUREG-1512, "Final Safety Evaluation Report Related to Certification of the AP600 Standard Design," published in September 1998.

For the AP1000 design certification, document APP-RCS-M3C-025, Rev. 0, "AP1000 Head Vent Flow at 2500 psia," applied the same computer code model of the RVHV system (and the same flow areas and flow resistances for the RVHV flow path) as was used for the AP600 DC review (i.e., RCS-M3C-025, Rev. 0). This calculation demonstrated that the AP600 RVHV sizing was adequate for the AP1000 design (see AP1000 DC review request for additional information 440.048 response Rev. 1, dated March 13, 2003, ADAMS Accession No. ML030760701). The staff found the AP1000 RVHV system to be acceptable as described in Section 5.4.12.1, "Reactor Vessel Head Vent System," of NUREG-1739, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," published in September 2004.

The current required RVHV flow capacity is analyzed in Rev. 3 of APP-RCS-M3C-067, "AP600 Orifice Calculation," to demonstrate the 8.2 lbm/sec at 1250 psia sizing basis is consistent with the LOFTRAN base deck for the AP1000 safety analyses provided in calculation file APP-RCS-M3C-025, Rev. 0. Subsequently, SNC determined the actual RVHV computer code model used for the AP600 and AP1000 analyses may not directly correspond to the sizing basis of 8.2 lbm/sec at 1250 psia. Therefore, to ensure consistency with the analysis of APP-RCS-M3C-025, Rev. 0, SNC reassessed the RVHV orifice size to the ITAAC acceptance criteria conditions

of 9 lbm/sec at 2500 psia in Rev. 4 of APP-RCS-M3C-067, "AP1000 Orifice Calculation." The revised calculation applies the conditions corresponding to the 9 lbm/sec at 2500 psia conditions in support the ITAAC No. 2.1.02.08e change with the resulting expected mass flow rate of 12.34 lbm/sec as presented in Section 2 of Enclosure 1 to LAR 17-025. Thus, Rev. 4 of APP-RCS-M3C-067 verifies the RVHV orifice is sized to meet or exceed the ITAAC No. 2.1.02.8e flow requirement. Based on its review, the staff finds that the proposed changes to ITAAC No. 2.2.02.8e and UFSAR Subsection 5.4.12.4.1 information to be acceptable.

Additionally, the staff confirmed that UFSAR Tier 2, Subsection 5.4.12.4.1 specifies the initial verification of the capacity of the RVHVs to be performed during the plant initial test program. The low pressure flow test and associated analysis is conducted to determine the capacity of each RVHV flow path. As discussed in the audit report, SNC confirmed that the normal residual heat removal pumps are used to provide injection flow into the RCS, discharging through the RVHV valves, and they will confirm that the flow corresponds to a flow resistance that would result in exceeding the flow rate of 9.0 lbm/sec at 2500 psia. Based on its review, the staff found the description of the low pressure test in UFSAR Tier 2, Subsection 5.4.12.4.1 continues to be acceptable.

3.3 SUMMARY OF TECHNICAL EVALUATION

Based on the information provided in the supporting calculation files along with the staff's assessment of the RVHV system in the AP600 and AP1000 final safety evaluation reports, the staff finds the changes proposed in LAR 17-025 supports the requirements of 10 CFR 50.46a for high point vents for the reactor vessel head. Additionally, the staff also finds the requirements of 10 CFR Part 50 Appendix A, GDC15, are met for the RCS and associated auxiliary, control, and protection systems to have sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences such as a loss of heat sink.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations in 10 CFR 50.91(b)(2), on February 7, 2018, the Georgia State official was consulted regarding the proposed issuance of the amendment. The State official had no comment.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20, "*Standards for Protection Against Radiation.*" The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite. Also, there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (82 FR 42844, published on September 12, 2017). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

Because the exemption is necessary to allow the changes proposed in the license amendment, and because the exemption does not authorize any activities other than those proposed in the

license amendment, the environmental consideration for the exemption is identical to that of the license amendment. Accordingly, the exemption meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment needs to be prepared in connection with the issuance of the exemption.

6.0 CONCLUSION

The NRC staff has determined that pursuant to Section VIII.A.4 of Appendix D to 10 CFR Part 52, the exemption (1) is authorized by law, (2) presents no undue risk to the public health and safety, (3) is consistent with the common defense and security, (4) presents special circumstances, and (5) does not reduce the level of safety at SNC's facility. Therefore, the staff grants SNC an exemption from the Tier 1 information as requested in the LAR.

The staff has reviewed the changes associated with the license amendment and concluded, based on the considerations discussed in Section 3.2 that there is reasonable assurance that: (1) the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public. Therefore, the staff finds the changes proposed in this license amendment acceptable.

7.0 REFERENCES

1. Southern Nuclear Operating Company, Vogtle Electric Generating Plant Units 3 and 4, "Request for License Amendment and Exemption: Reactor Vessel Head Vent Capacity (LAR 17-025)," July 28, 2017 (ADAMS Accession No. ML17209A185).
2. Vogtle Units 3 and 4 Updated Final Safety Analysis Report, Revision 6 and Tier 1, Revision 5, March 12, 2017 (ADAMS Accession No. ML17172A218).
3. AP1000 Design Control Document, Revision 19, June 13, 2011 (ADAMS Accession No. ML11171A500).
4. Combined License NPF-91 for Vogtle Electric Generating Plant Unit 3, Southern Nuclear Operating Company (ADAMS Accession No. ML14100A106).
5. Combined License NPF-92 for Vogtle Electric Generating Plant Unit 4, Southern Nuclear Operating Company (ADAMS Accession No. ML14100A135).
6. Westinghouse Electric Company, LLC, APP-RCS-M3C-067, Rev. 3, "AP600 Orifice Calculation," September 16, 2014, Westinghouse Proprietary Class 2.
7. Westinghouse Electric Company, LLC, APP-RCS-M3C-067, Rev. 4, "AP1000 Orifice Calculation," September 19, 2016, Westinghouse Proprietary Class 2.
8. Westinghouse Electric Company, LLC, RCS-M3C-025, Rev. 0, "AP600 Calculation for Head Vent Flow at 1250 psia (RCS Head Vent Line Sizing)," March 8, 1995, Westinghouse Proprietary Class 2.

9. Westinghouse Electric Company, LLC, APP-RCS-M3C-025, Rev. 0, "AP1000 Head Vent Flow at 2500 psia," February 23, 2004, Westinghouse Proprietary Class 2.
10. U.S. Nuclear Regulatory Commission," Final Safety Evaluation Report Related to Certification of the AP600 Standard Design," NUREG-1512, Vol. 2, Chapters 5 to 14, September 1998 (ADAMS Accession No. ML081080320).
11. U.S. Nuclear Regulatory Commission," Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design," NUREG-1793, Vol. 1, Chapter 5, September 2004 (ADAMS Accession No. ML043450354).