

CHAPTER 15 - TRANSIENT AND ACCIDENT ANALYSIS

15.0 Introduction - Transient and Accident Analyses

This chapter describes the U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of the plant's responses to postulated equipment failures or malfunctions. These analyses are used to determine the limiting conditions for operation, limiting safety system settings, and design specifications for safety-related components and systems.

Chapter 15 of the Comanche Peak Nuclear Power Plant (CPNPP), Units 3 and 4, Combined License (COL) application, Part 2, Final Safety Analysis Report (FSAR), Revision 2, incorporates by reference Chapter 15, "Transient and Accident Analyses," of the U.S. Advanced Pressurized-Water Reactor (US-APWR) Design Control Document (DCD), Revision 3, with no departures and supplements, except as provided in Section 15.0.3, "Design Basis Accident Radiological Consequence Analyses for Advanced Light Water Reactors," specifically, the site-specific atmospheric dispersion factors, as discussed below. The regulatory basis of the information from the US-APWR DCD incorporated by reference in Chapter 15 of the CPNPP, Units 3 and 4 COL FSAR is addressed within Chapter 15 of the NRC's Final Safety Evaluation Report (FSER) related to the US-APWR design certification (DC) application.

The NRC staff reviewed Chapter 15 of the CPNPP, Units 3 and 4 COL FSAR and checked the referenced US-APWR DCD chapter to ensure that the combination of the DCD information and the information in the COL application represent the complete scope of information relating to this review topic. The NRC staff's review confirmed that the information contained in the COL application and incorporated by reference addresses the required information relating to this section. Chapter 15 of the USAPWR DCD is being reviewed by the staff under Docket No. 52-021. The NRC staff reviewed the supplemental information contained in CPNPP, Units 3 and 4 COL FSAR Subsection 15.0.3, as discussed below.

15.0.3 Design-Basis Accident Radiological Consequence Analyses for Advanced Light Water Reactors

15.0.3.1 Introduction

Design-basis accidents (DBAs) that have radiological consequences are evaluated in this section.

15.0.3.2 Summary of Application

Section 15.0.3 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference Section 15.0.3 of the US-APWR DCD, Revision 3. In addition, in FSAR Subsection 15.0.3, for STD COL Information Item 15.0(1), the applicant replaced the last paragraph of US-APWR DCD Subsection 15.0.3.3 with the following information:

"The site-specific χ/Q values in Subsection 2.3.4 are bounded by the χ/Q values in Tables 15.0-13 and 15A-18 through 15A-24 of the DCD."

Although Section 15.0.3 of the US-APWR DCD discusses the DBA radiological consequences analyses in general, detailed discussion of the radiological consequences analyses for each DBA are included in additional sections of the remainder of US-APWR DCD Chapter 15. The DBAs evaluated for radiological consequences, and the associated US-APWR DCD Chapter 15 subsections discussing the analyses are:

15.1.5.5	Steam System Piping Failure (Main Steam Line Break)
15.3.3.5	Reactor Coolant Pump Rotor Seizure (Locked Rotor)
15.4.8.5	Rod Ejection Accident
15.6.2	Failure of Small Lines
15.6.3	Steam Generator Tube Rupture
15.6.5.5	Loss-of-Coolant Accident
15.7.4	Fuel Handling Accident

The CPNPP, Units 3 and 4 COL FSAR also incorporates by reference the DBA radiological consequence analyses discussed in these US-APWR DCD Chapter 15 sections.

15.0.3.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the US-APWR DCD. In addition, the relevant requirements of the Commission's regulations for the radiological consequences of DBAs, and the associated acceptance criteria are given in Section 15.0.3, "Design Basis Accident Radiological Consequence Analyses for Advanced Light Water Reactors," of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition."

The applicable regulatory requirements are as follows:

1. Title 10 of the *Code of Federal Regulations* (10 CFR) 50.34, "Contents of Applications; Technical Information," Paragraph 50.34(a)(1), as it relates to the evaluation and analysis of the offsite radiological consequences of postulated accidents with fission product release.
2. 10 CFR 52.79, "Contents of Applications; Technical Information in Final Safety Analysis Report," Paragraph 52.79(a)(1), as it relates to the evaluation and analysis of the offsite radiological consequences of postulated accidents with fission product release.
3. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 19, "Control Room," as it relates to maintaining the control room in a safe condition under accident conditions by providing adequate protection against radiation.
4. Section 100.21 of 10 CFR Part 100, "Non-seismic siting criteria," as it relates to the evaluation and analysis of the radiological consequences of postulated accidents for the type of facility to be located at the site in support of evaluating the site atmospheric dispersion characteristics.
5. GDC 19 of Appendix A to 10 CFR Part 50, 19 of Appendix A to 10 CFR Part 50, "Control room," as it relates to maintaining the control room in safe condition under accident conditions by providing adequate protection against radiation.

6. Paragraph IV.E.8 of Appendix E to 10 CFR Part 50, "Emergency Planning and Preparedness for Production and Utilization Facilities," as it relates to adequate provisions for an onsite technical support center (TSC) from which effective direction can be given and effective control can be exercised during an emergency. The related acceptance criteria are as follows:
7. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," with respect to acceptable analysis methods and dose acceptance criteria.

15.0.3.4 Technical Evaluation

The staff reviewed Section 15.0.3 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2, and reviewed the US-APWR DCD FSAR, Revision 3, Section 15.0.3 and related Chapter 15 subsections that discuss DBA radiological consequence analyses, including Appendix 15A to ensure that the combination of the DCD and the information in the COL represent the complete scope of information related to this review topic. The details of the DBA radiological analyses are presented in several subsections throughout the US-APWR DCD Chapter 15, which was incorporated by reference in the Comanche Peak FSAR. However, rather than addressing these analyses serially, the staff's evaluation of the DBA radiological analyses will be discussed as a group in this subsection of the SER. The staff's review confirmed that the information contained in the application and incorporated by reference addresses the required DBA information. Chapter 15, including the US-APWR DCD sections on DBA radiological analysis (e.g., Section 15.0.3) incorporated by reference, is being evaluated by the staff under Docket Number 52-021. The staff's technical evaluation of the information incorporated by reference will be documented in the NRC staff's SE of the DC application for the US-APWR.

The NRC staff reviewed the impact of the site characteristics on the radiological consequences of DBAs. The applicant did not provide site-specific doses at the exclusion area boundary (EAB), low population zone (LPZ), control room or TSC for the design basis accidents referenced in the US-APWR DCD, Chapter 15, but instead incorporated by reference the US-APWR DCD, Chapter 15 design basis accident radiological consequence analyses.

The DBA radiological consequence analyses in Chapter 15 of the US-APWR DCD, used design reference values for the offsite, control room and TSC atmospheric dispersion factors (χ/Q values). These design reference χ/Q values are DCD site parameter values given in place of site-specific values. The χ/Q values are the only input to the DBA radiological consequence analyses that are affected by site characteristics. The applicant discussed the CPNPP, Units 3 and 4 site characteristic short-term (accident) χ/Q values in Section 2.3.4 of the CPNPP, Units 3 and 4 COL FSAR. The CPNPP, Units 3 and 4 site characteristic accident EAB and LPZ χ/Q values are given in COL FSAR Table 2.3-337, "Relative Concentration at CPNPP." The site characteristic accident control room and TSC χ/Q values are given in COL FSAR Table 2.3-339, "Main Control Room and TSC Atmospheric Dispersion Factors (χ/Q) for Accident Dose Analysis." CPNPP, Units 3 and 4 FSAR Table 2.0-1R, "Key Site Parameters," also lists the site.

characteristic accident χ/Q values. In Section 2.3 of the NRC staff's SE, the staff discusses its review of the CPNPP, Units 3 and 4 site characteristic short-term χ/Q values.

The estimated DBA dose calculated for a particular site is affected by the site characteristics through the calculated χ/Q values input to the analysis, therefore the resulting estimated site-specific dose would be different than that calculated generically for the US-APWR design.

Because the CPNPP, Units 3 and 4 COL FSAR, Chapter 15, DBA analyses otherwise incorporate the corresponding US-APWR DCD information by reference with no other departures or supplements, all other inputs and assumptions in the radiological consequences analyses, except for the site-specific χ/Q values, remain the same as in the US-APWR DCD. Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. When comparing a DCD site parameter χ/Q value and a site characteristic χ/Q value, the site is determined to be acceptable for the design if the site characteristic χ/Q value is smaller than the DCD site parameter χ/Q value. Such a comparison shows that the site has better dispersion characteristics than that required by the reactor design.

For each time averaging period, the CPNPP, Units 3 and 4 site-specific, accident χ/Q values for the EAB, LPZ, control room and TSC receptor locations are less than the design reference χ/Q values used by Mitsubishi Heavy Industries, Ltd. (MHI) in the US-APWR DCD radiological consequence analyses for each of the DBAs. Since the result of the radiological consequence analysis for a DBA during any time period of radioactive material release from the plant is directly proportional to the χ/Q for that time period, and because the CPNPP, Units 3 and 4 site-specific, accident χ/Q values are less than the comparable US-APWR DCD design reference χ/Q values at the EAB, LPZ, control room and TSC for all time periods and all accidents; the CPNPP, Units 3 and 4 site-specific total dose at the EAB, LPZ and control room for each DBA is therefore less than the US-APWR generic total dose for each DBA. The US-APWR DCD analyses shows that the DBA radiological consequences meet the regulatory dose criteria of 10 CFR 100.21, 10 CFR 50.34(a)(1) and 10 CFR 52.47(a)(2) for offsite doses and also meets 10 CFR Part 50, Appendix A, GDC 19, for the control room doses and the regulatory dose criterion of 5 rem total effective dose equivalent (TEDE) for the TSC doses. The dose reference value of 25 rem TEDE for the offsite consequences of accidents given in 10 CFR 52.47(a)(2) for DC is the same value given in 10 CFR 52.79(a)(1) for combined licenses. Since, by the logic above, the CPNPP, Units 3 and 4 site-specific DBA offsite, control room and TSC radiological consequences are shown to be less than those estimated for the US-APWR design, then the applicant has sufficiently shown that the offsite, control room and TSC radiological consequences of DBAs meet the regulatory requirements stated above in the Section 15.0.3.3 Regulatory Basis. Furthermore, the staff concludes that the applicant has adequately addressed STD COL 15.0(1).

15.0.3.5 Post Combined license Activities

There are no post COL activities related to this section.

15.0.3.6 Conclusions

The US-APWR DCD, Revision 3, Section 15.0.3, "Design-Basis Accident Radiological Consequence Analyses for Advanced Light Water Reactors," and the entirety of Chapter 15 is being reviewed by the staff under Docket Number 52-021. The SE for the US-APWR DCD is not yet complete, and this is being tracked as part of **Open Item 1-1**. As a result of the open

item, the staff is unable to finalize its conclusion on Section 15.0.3 in accordance with the requirements of 10 CFR Part 100, 10 CFR 50.34(a)(1), 10 CFR 52.79(a)(1), GDC 19 and Paragraph IV.E.8 of Appendix E to 10 CFR Part 50. The staff will update Section 15.0.3 of this SE to reflect the final disposition of the DC application.

15.1 Increase in Heat Removal by the Secondary System

Section 15.1 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Section 15.1, "Increase in Heat removal by the Secondary System," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR DCD Section 15.1 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Section 15.1 of this SE to reflect the final disposition of the DC application.

15.2 Decrease in Heat Removal by the Secondary System

Section 15.2 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Section 15.2, "Decrease in Heat removal by the Secondary System," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR DCD Section 15.2 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Section 15.2 of this SE to reflect the final disposition of the DC application.

15.3 Decrease in Reactor Coolant System Flow Rate

Section 15.3 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Section 15.3, "Decrease in reactor Coolant System Flow Rate," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR DCD Section 15.3 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Section 15.3 of this SE to reflect the final disposition of the DC application.

15.4 Reactivity and Power Distribution Anomalies

Section 15.4 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Section 15.4, "Reactivity and Power Distribution Anomalies," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR

DCD Section 15.4 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Section 15.4 of this SE to reflect the final disposition of the DC application.

15.5 Increase in Reactor Coolant Inventory

Section 15.5 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Section 15.5, "Increase in Reactor Coolant Inventory," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR DCD Section 15.5 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Section 15.5 of this SE to reflect the final disposition of the DC application.

15.6 Decrease in Reactor Coolant Inventory

Section 15.6 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Section 15.6, "Decrease in Reactor Coolant Inventory," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR DCD Section 15.6 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Section 15.6 of this SE to reflect the final disposition of the DC application.

15.7 Radioactive Release from a Subsystem or Component

Section 15.7 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Section 15.7, "Radioactive Release from a Subsystem or Component," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR DCD Section 15.7 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Section 15.7 of this SE to reflect the final disposition of the DC application.

15.8 Anticipated Transients Without Scram

Section 15.8 of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Section 15.8, "Anticipated Transients Without Scram," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR DCD Section 15.8 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Section 15.8 of this SE to reflect the final disposition of the DC application.

Appendix 15A Evaluation Models and Parameters for Analysis of Radiological consequences of Accidents

Appendix 15A of the CPNPP, Units 3 and 4 COL FSAR, Revision 2 incorporates by reference, with no departures or supplements, Appendix 15A, "Evaluation Models and Parameters for Analysis of Radiological Consequences of Accidents," US-APWR DCD, Revision 3. The staff is reviewing the information in US-APWR DCD Appendix 15A under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information incorporated by reference in the CPNPP, Units 3 and 4 COL FSAR will be documented in the NRC staff's FSER of the DC application for the US-APWR. The SE for the DC application is not yet complete, and this is being tracked as part of **Open Item 1-1**. The staff will update Appendix 15A of this SE to reflect the final disposition of the DC application.