6.0 ENGINEERED SAFETY FEATURES

This section of the Comanche Peak Nuclear Power Plant (CPNPP), Units 3 and 4, Combined License (COL) Final Safety Analysis Report (FSAR) itemizes the engineered safety features (ESFs) designed to reduce the consequences of postulated accidents, summarizes the regulatory requirements associated with these ESFs, and evaluates how these ESFs satisfy the applicable regulatory requirements.

Section 6.0, "Engineered Safety Features," of the CPNPP, Units 3 and 4, COL, Revision 3, FSAR incorporates by reference, with no departures or supplements, Section 6.0, "Engineered Safety Features," of the United States - Advanced Pressurized Water Reactor (US-APWR) Design Control Document (DCD), Revision 3. The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the application and checked the referenced DCD to ensure that no issues relating to this section remained for review. The NRC staff's review confirmed that there are no outstanding issues related to this section.

The staff is reviewing the information in DCD Section 6.0 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information related to the ESFs incorporated by reference in the CPNPP, Units 3 and 4, COL FSAR will be documented in the staff's safety evaluation report (SER) for the design certification (DC) application for the US-APWR design. The SER on the US-APWR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update Section 6.0 of this SER to reflect the final disposition of the DC application design.

6.1 Engineered Safety Feature Materials

6.1.2 Organic Materials

6.1.2.1 Introduction

Organic materials in containment mainly consist of protective coatings applied to steel and concrete surfaces, and polymeric materials used for electrical cable insulation. Other organic materials that may potentially be found in containment include wood, plastics, lubricants, paint or coatings, and asphalt.

6.1.2.2 Summary of Application

In the CPNPP, Units 3 and 4, COL, Revision 3, FSAR Section 6.1, "Engineered Safety Feature Materials," the applicant incorporated by reference Section 6.1 of the US-APWR DCD, Revision 3, "Engineered Safety Features Materials."

US-APWR COL Information Item

- STD COL 6.1(7)

The applicant provided additional information in 6.1.2, "Protective Coating Systems (Paints) - Organic Materials," to address COL Information Item 6.1(7) in Section 6.1 of the US-APWR DCD, which states:

> The COL Applicant is responsible for identifying the implementation milestones for the coatings program.

6.1.2.3 **Regulatory Basis**

The regulatory basis of the information incorporated by reference is documented in Section 6.1.2 of the US-APWR Final Safety Evaluation Report (FSER) related to the DCD. In addition, the associated acceptance criteria are given in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition," (SRP) Section 6.1.2, "Protective Coating Systems (Paints) - Organic Materials."

Acceptance criteria for this review are also contained in Regulatory Guide (RG) 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition), dated June 2007.

6.1.2.4 **Technical Evaluation**

The NRC staff reviewed Section 6.1.2 of the CPNPP, Units 3 and 4, COL FSAR and the referenced DCD to ensure that the information contained therein satisfies the requirements of 10 CFR 52.79(d) and that any supplemental information to be provided by the COL applicant has been addressed in the COL application (COLA). The staff reviewed Section 6.1.2 of the CPNPP COL FSAR, using the guidance in RG 1.206, Section C.III.1, Chapter C.III.6.1.2, "Organic Materials." The NRC staff's review of Section 6.1 of the CPNPP, Units 3 and 4, COL FSAR, Revision 3 finds that it incorporates by reference Section 6.1.2 of the US-APWR DCD, Revision 3. The NRC staff's technical evaluation of the information incorporated by reference related to organic materials is documented in Section 6.1.2 of the US-APWR FSER.

US-APWR COL Information Item

In addition, the applicant included supplemental information to address COL Information Item 6.1(7) from the US-APWR DCD, Table 1.8-2, "Compilation of All Combined License Applicant Items for Chapters 1-19."

COL Information Item 6.1(7): *The COL Applicant is responsible for identifying the implementation milestones for the coatings program.*

In Revision 3 of the CPNPP, Units 3 and 4, COLA, the applicant addressed COL Information Item 6.1(7) as follows:

> "Coatings program will be developed and implemented prior to procurement phase."

The staff finds that the applicant has adequately addressed COL Information Item 6.1(7), because by developing and implementing the coatings program prior to the procurement phase, the applicant will ensure appropriate programmatic controls with respect to the procurement,

application, inspection and maintenance of protective coatings. The protective coatings program is addressed in DCD Section 6.1.2.

RG 1.206, Section C.I.6.1.2, recommends the following:

> Identify and quantify all organic materials that exist within the containment building in significant amounts. Such organic materials include wood, plastics, lubricants, paint or coatings, electric insulation, and asphalt. The applicant should classify plastics, paints and other coatings and list its references. Coatings not intended for 40 year service without overcoating should include total coating thicknesses expected to be accumulated over the service life of the substrate surface.

In Revision 1 of the US-APWR DCD, Comanche Peak (CP) COL Information Item 6.1(5) required the COL applicant to address this information. CP COL 6.1(5) was eliminated from Revision 2 of the US-APWR DCD as part of a comprehensive review by Mitsubishi Heavy Industries, Ltd. (MHI) of all the COL information items in the DCD (Reference 1). The justification for elimination of the COL item is that the information on organic materials that exist in significant amounts in the containment is in DCD Section 6.2.2.3, "Design Evaluation." The staff has verified that this information is addressed adequately in the DCD as part of the staff's review of DCD Tier 2, Subsections 6.1.2, "Organic Materials," and 6.2.2, "Containment Heat Removal Systems." Therefore, the staff finds that this information does not need to be included in the CPNPP, Units 3 and 4, COL FSAR.

6.1.2.5 Post Combined Operating License Activities

There are no follow-up actions identified for the COL applicant or the NRC staff during the construction stage related to this topic.

6.1.2.6 Conclusion

The staff is reviewing the information in US-APWR DCD Section 6.1 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information related to the ESF Materials incorporated by reference in the CPNPP, Units 3 and 4, COL FSAR will be documented in the staff's SER for the US-APWR DC. The SER for the US-APWR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update Section 6.1 of this SER to reflect the final disposition of the DC application.

On the basis of its review of the CPNPP COLA and the referenced DCD, the NRC staff finds that Section 6.1.2 of the US-APWR DCD pertaining to organic materials is completely incorporated by reference in the CPNPP, Units 3 and 4, COLA with no departures or supplements. The staff also concludes that the information provided in the COLA FSAR to address COL Information Item 6.1(7) is acceptable because it will ensure appropriate programmatic controls are applied to the coatings program and the information meets the guidance described in SRP 6.1.2. Additionally, since the information recommended by RG 1.206 to be included in Section 6.1.2 of the COL FSAR was addressed in the DCD, the staff finds that the applicant has met the guidance described in RG 1.206.

References

1. Letter from Yoshiki Ogata, MHI, to Mr. Jeffrey A. Ciocco, NRC, dated November 7, 2008; Subject: Transmittal of COL Information Update for US-APWR Design Control Document Revision 1; Docket No. 52-021 MHI Ref: MHI Ref: UAP-HF-08259 (ADAMS Accession No. ML083170228)

6.2 Containment Systems

6.2.1 Introduction

The containment is designed as an essentially leak-tight barrier that will safely and reliably accommodate calculated temperature and pressure conditions resulting from the complete size spectrum of piping breaks, up to and including a double-ended, guillotine-type break of a reactor coolant or main steam line. The following ESF systems are directly associated with containment: 1) containment structure (vessel), including subcompartments; 2) containment spray system; 3) containment isolation system; and 4) containment hydrogen monitoring and control system.

6.2.2 Summary of Application

Section 6.2, "Containment Systems," of the CPNPP, Units 3 and 4, COL FSAR, Revision 3, incorporates by reference Section 6.2 "Containment Systems," of the US-APWR DCD, Revision 3. Section 6.2 of the DCD includes Sections 6.2.1, "Containment Functional Design";" 6.2.2, "Containment Heat Removal Systems;" 6.2.3, "Secondary Containment Functional Design;" 6.2.4, "Containment Isolation System;" 6.2.5, "Combustible Gas Control in Containment;" 6.2.6, "Containment Leakage Testing;" and 6.2.7, "Fracture Prevention of Containment Pressure Vessel."

In addition, in CPNPP, Units 3 and 4, COL FSAR Section 6.2.2 and 6.2.6, the COL applicant provided the following:

US-APWR COL Information Items

- Standard (STD) COL 6.2(5)

The applicant provided additional information in STD COL 6.2(5) to address COL Information Item 6.2(5), which states:

> Preparation of a cleanliness, housekeeping and foreign materials exclusion program is the responsibility of the COL applicant. This program will be established to limit 200 lbm (90.7 kg) of latent debris, and to limit the allocated 200 ft^2 (18.6 m^2) of miscellaneous debris per sump.

- STD COL 6.2(6)

The applicant provided additional information in STD COL 6.2(6) to address COL Information Item 6.2(6), which states, in part:

> Preparation of administrative procedures is the responsibility of the COL applicant. The procedures will ensure that reflective metal insulation (RMI) and fiber insulation debris within zone of influence will be consistent with the design basis debris specified in the Table 6.2.2-4, and will ensure that the aluminum in containment exposed to water in

containment in post-LOCA condition (i.e., spray and blowdown water) is limited to equal or less than 810 ft^2 (75.25 m^2).

- STD COL 6.2(8)

The applicant provided additional information in STD COL 6.2(8) to address COL Information Item 6.2(8), which states:

> The COL applicant is responsible for identifying the implementation milestone for the containment leakage rate testing program described under 10 CFR 50, Appendix J.

6.2.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in Section 6.2 of the FSER related to the US-APWR DCD.

The relevant requirements of the Commission's regulations for containment heat removal systems, and the associated acceptance criteria, are given in Section 6.2.2, “Containment Heat Removal Systems,” of NUREG-0800, “Review of Safety Analysis for Nuclear Power Plants.”

The applicable regulatory requirements for COL Information Items 6.2(5) and 6.2(6) are as follows:

1. General Design Criterion (GDC) 39, “Inspection of Containment Heat Removal System,” as it relates to the design of the containment heat removal system to permit appropriate periodic inspection of important components.

2. GDC 40, “Testing of Containment Heat Removal System,” as it relates to the design of the containment heat removal system to permit appropriate periodic pressure and functional testing.

3. Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50.46(b)(5), “Long-term cooling,” as it relates to requirements for long-term cooling, including adequate net positive suction head margin in the presence of loss-of-coolant accident (LOCA) generated and latent debris.

In conducting its review of COL Information Items 6.2(5) and 6.2(6), the NRC staff used the following guidance:

1. RG 1.82, Revision 3, “Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors,” dated November 2003,

2. Nuclear Energy Institute (NEI) 04-07, “Pressurized Water Reactor Sump Performance Evaluation Methodology,” Revision 0, Volume 1, as supplemented

by the NRC in the "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02," Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004, in NEI 04-07, Revision 0, Volume 2, dated December 2004.

The relevant requirements of the Commission's regulations for containment leakage testing, and the associated acceptance criteria, are given in Section 6.2.6, "Containment Leakage Testing," of NUREG-0800.

The applicable regulatory requirements for COL Information Item 6.2(8) are as follows:

1. GDC 52, "Capability for Containment Leakage Rate Testing," states that the reactor containment and other equipment, which may be subjected to containment test conditions, shall be designed so that periodic integrated leakage rate testing can be conducted at containment design pressure.

2. GDC 53, "Provisions for Containment Testing and Inspection," states that the reactor containment shall be designed to permit (1) appropriate periodic inspection of all important areas such as penetrations, (2) an appropriate surveillance program, (3) periodic testing at containment design pressure of the leaktightness of penetrations which have resilient seals and expansion bellows.

3. GDC 54, "Piping Systems Penetrating Containment," which states that piping systems penetrating primary reactor containment shall be provided with leak detection, isolation, and containment capabilities having redundancy, reliability, and performance capabilities which reflect the importance to safety of isolating these piping systems.

4. 10 CFR Part 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors," which discusses the containment leakage test requirements for primary reactor containments.

5. 10 CFR Part 52.79, "Contents of applications; Technical Information in Final Safety Analysis Report," as it relates to the primary containment leakage rate testing program and its implementation to ensure that the containment meets the requirements of 10 CFR Part 50, Appendix J.

In conducting its review of COL Information Item 6.2(8), the NRC staff used the following guidance:

1. RG 1.163, "Performance-Based Containment Leak-Test Program," dated September 1995.

2. RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," dated June 2007.

3. RG 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," Revision 3, dated November 2003.

4. Office of the Secretary (SECY) 05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria," dated October 28, 2005.

6.2.4 Technical Evaluation

The NRC staff reviewed Section 6.2 of the CPNPP, Units 3 and 4, COL FSAR and the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to the containment systems. Section 6.2 of the US-APWR DCD is being reviewed by the staff. The NRC staff's technical evaluation of the information incorporated by reference related to containment systems will be documented in the staff safety evaluation report on the DC application for the US-APWR design.

The staff reviewed the information contained in the COL FSAR:

US-APWR COL Information Items

- STD COL 6.2(5)

The NRC staff reviewed STD COL 6.2(5) related to the COL Information Item 6.2(5) included in Subsection 6.2.2.3.2, "Debris Source Term," of the CPNPP, Units 3 and 4, COL FSAR. The applicant replaced the last sentence of the first bullet of seventh paragraph in DCD Subsection 6.2.2.3.2 with several paragraphs and bulleted items in CPNPP, Units 3 and 4, COL FSAR Section 6.2.2.3.2.

In the COL FSAR Subsection 6.2.2.3.2, the COL applicant provided additional information on the containment cleanliness program and procedures that limit debris within containment. The applicant states that the containment cleanliness program including administrative procedures will be developed and implemented prior to initial fuel load. The applicant also states that guidance documents used to develop the cleanliness program sampling/survey methods will include NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," Revision 0, dated December 2004; Volume 1 (Pressurized Water Reactor Sump Performance Evaluation Methodology) and Volume 2 (Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, Revision 0, dated December 6, 2004). The applicant's program also includes reporting requirements for degraded conditions or non-conforming results.

The staff determined that the resulting cleanliness program is consistent with the RG 1.82 guidance that procedures be in place to regularly clean the containment and to control and remove foreign materials from containment. The sampling approach included in COL FSAR

Subsection 6.2.2.3.2 is required to demonstrate that latent debris found in containment is within the US-APWR DCD specified limits of 200 lbm (90.7 kg), of which, up to 30 lbm (13.6 kg) may be fibrous material. The DCD specified limits were demonstrated to be acceptable through scale testing and analysis. Thus, COL FSAR Subsection 6.2.2.3.2 (COL 6.2(5)) is consistent with RG 1.82 guidance that the cleanliness program be correlated to the amount of debris used in the long-term cooling analysis.

In Request for Additional Information (**RAI) 6997, Question 06.02.02-06**, the staff requested that the applicant address inconsistencies related to the COL item descriptions in FSAR Chapter 1, "Introduction and General Description of the Plant," and Chapter 6. It appeared that these inconsistencies were introduced as part of an effort to incorporate interim (future) changes to US-APWR DCD Revision 3, into the COL FSAR, that the DC applicant has communicated to the NRC staff in DCD docketed correspondence, such as tracking reports or in DCD RAI responses. On this basis, the staff, in **RAI 6997, Question 06.02.02-06,** requested the COL applicant clearly identify what additional docketed DCD correspondence (in addition to US-APWR DCD, Revision 3) was being used to support the COLA regarding Section 6.2, "Containment Systems." In its response to **RAI 6997, Question 06.02.02-06**, dated March 4, 2013, the applicant addressed the inconsistencies between COL item descriptions in FSAR Chapters 1 and 6 and provided proposed FSAR changes of Tables 1.8-201, "Resolution of Combined License Items for Chapters 1-19," and 6.2.2-2R, "Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements." The applicant also identified that the CPNPP FSAR, Revision 3 was based on all docketed DCD correspondence up to and including Tracking Report MUAP-11021, "US-APWR DCD Revision 3 Tracking Report," Revision 2, dated April 6, 2012. In addition, the applicant identified DCD interim changes that directly impact FSAR Subsection 6.2.2.3.2. Because the applicant addressed the FSAR inconsistencies, provided appropriate FSAR markups, and identified the specific DCD interim changes used to support FSAR Subsection 6.2.2.3.2, the staff finds the response to **RAI 6997, Question 06.02.02-06** is acceptable and this question is resolved. The staff will confirm the FSAR changes have been incorporated in the next revision of the COL FSAR. Accordingly, **RAI 6997, Question 06.02.02-06, is being tracked as Confirmatory Item 06.02.02-06.**

Conformance to guidance contained in NEI 04-07, Volumes 1 and 2, is appropriate because these documents contain the most recent NRC-approved evaluation methodology for cleanliness programs. In **RAI 6997, Question 06.02.02-07**, the staff requested that the applicant provide additional information regarding conformance to cleanliness program guidance documents, inspection (survey/sampling) frequency, and evaluation of sampling results. In its response to **RAI 6997, Question 06.02.02-07**, dated March 4, 2013, the applicant revised FSAR Subsection 6.2.2.3.2 and identified that the containment sampling program will be developed consistent with the guidance in NEI 04-07 and the associated NRC safety evaluation. However, the applicant took exception to staff guidance related to the latent debris sampling (survey) frequency. The applicant's sampling program for latent debris is conducted prior to initial plant start-up following the completion of construction and pre-operational testing and sampling results are evaluated prior to initial start-up. Following refueling outages, the applicant plans to perform inspections and walk downs. Sampling is not conducted unless visual observation indicates abnormal build-up or if invasive or extended maintenance activities have been performed.

For the purpose of latent debris characterization in containment, the staff's safety evaluation (SE) on NEI 04-07 indicates that surveys should be taken after every second outage. The applicant bases their survey frequency exception (i.e., periodic sampling is not conducted unless visual observation indicates abnormal build-up) on generic pressurized-water reactor (PWR) operating plant experience. The operating experience (provided by the applicant) lists latent debris survey results for several large dry PWR's. The applicant highlights the fact that the resultant latent debris amounts are representative of PWRs and, in general, the total amount of the latent debris is less than the US-APWR design basis limit of 200 lbm (90.7 Kg). Based on this operating experience and expected margin to design limits, the applicant considers periodic sampling to be unnecessary.

Operating PWR latent debris survey results provide useful information on plant-specific latent debris loads and margin to design basis limits. The staff values operating plant experience and encourage its use. However, the staff recognizes that the latent debris load is plant-specific and dependent on the how well a particular plant implements their cleanliness program. The NEI 04-07 guidance recommends that a survey of containment be performed with the objective of determining the quantity of latent debris. As stated in the safety evaluation for NEI 04-07, the staff found the NEI 04-07 guidance with respect to the overall evaluation of latent debris to be acceptable, provided some additional provisions were incorporated. In addition, as stated in the SE for NEI 04-07, for the purposes of latent debris characterization, the staff finds that surveys should be taken after every second outage or after any invasive or extended maintenance. The applicant's approach to conducting visual observation during inspections and walk downs should provide useful information regarding containment debris. However, the staff finds that visual observation is not a sufficient means to periodically demonstrate compliance with the latent debris design limits, i.e., determining the quantity of latent debris. Therefore, the staff finds the applicant's response to **RAI 6997, Question 06.02.02-07**, to be unacceptable because the applicant's proposed alternative to staff guidance, that is using visual observation in lieu of periodic surveys, is not adequately justified through the use of generic operating experience. Use of generic operating experience does provide a level of confidence that latent debris amounts less than the design limits can be achieved; however, it is dependent on the effectiveness of the plant-specific cleanliness program. Therefore, it is incumbent upon the applicant to perform periodic surveys (e.g., as part of outage efforts) to confirm that there has been no significant change in the latent debris load inside containment.

In a supplemental response to **RAI 6997, Question 06.02.02-07**, dated June 19, 2013, the applicant revised the containment cleanliness program by removing the sample frequency exception and replacing with periodic surveys, consistent with guidance in NEI 04-07 and the associated staff's SE. Because the applicant conforms to staff guidance, the staff finds the supplemental response to **RAI 6997, Question 06.02.02-07,** acceptable and this question is resolved. The staff will confirm that the proposed changes to the FSAR, Section 6.2 are incorporated into the next revision of the CPNPP, Units 3 and 4 COLA FSAR. **RAI 6997, Question 06.02.02-07, is being tracked as Confirmatory Item 06.02.02-07.**

- STD COL 6.2(6)

The NRC staff reviewed STD COL 6.2(6) related to the COL Information Item 6.2(6) summarized in Section 6.2.8, "Combined License Information," of the CPNPP, Units 3 and 4, COL FSAR.

The applicant did not discuss STD COL Information Item 6.2(6) in Section 6.2.2, "Containment Heat Removal Systems." Therefore, the staff issued **RAI 6965, Question 06.02.02-05**, requesting that the COL applicant address STD COL Information Item 6.2(6) in its application. In its response to **RAI 6965, Question 06.02.02-05,** dated January 17, 2013, the applicant revised FSAR Subsection 6.2.2.3.2 to address STD COL Information Item 6.2(6). Specifically, the applicant clarified STD COL Information Item 6.2(6) by modifying FSAR Subsection 6.2.2.3.2 to add a statement referencing the administrative procedures in FSAR Subsection 13.5.1, "Administrative Procedures." These procedures implement design change and configuration management controls to ensure that quantities of RMI, fiber insulation, and aluminum are consistent with the design basis debris limits. Because the applicant addressed STD COL Information Item 6.2(6) in the FSAR and refers to administrative procedures to ensure consistency with the design basis, the staff finds that the response to **RAI 6965, Question 06.02.02-05**, is acceptable and this question is resolved. The staff will confirm that the FSAR changes have been incorporated in the next revision of the COL FSAR. Accordingly, **RAI 6965, Question 06.02.02-05, is being tracked as Confirmatory Item 06.02.02-05.**

- STD COL 6.2(8)

The NRC staff reviewed STD COL Information Item 6.2(8) related to the COL Information Item 6.2(8) included under Section 6.2.6.1, "Containment Integrated Leakage Rate Testing," of the CPNPP, Units 3 and 4, COL FSAR. The applicant replaced the first and second sentences of the first paragraph in DCD Subsection 6.2.6.1 with a paragraph in CPNPP, Units 3 and 4, COL FSAR Section 6.2.6.1, "Containment Integrated Leakage Rate Testing."

In the CPNPP, Units 3 and 4, FSAR, Section 6.2.6.1, the applicant states that the milestone for implementing the containment leak rate testing program is given in Table 13.4-201, "Operational Programs Required by NRC Regulation and Program Implementation," of the FSAR. The staff reviewed Table 13.4-201 and found that Item No. 7, "Containment Leakage Rate Testing Program," committed to a milestone date for implementation as prior to initial fuel load. The staff finds this milestone date to be acceptable as it is in accordance with 10 CFR 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors," and the guidance of NUREG-0800, SRP 13.4, "Operational Programs." The milestone is consistent with the guidance from RG 1.206 and SECY-05-0197, because it provides a schedule that supports planning and conducting NRC inspections of the applicant's primary containment leakage rate testing program. Consequently, the staff finds that the applicant has provided sufficient information for satisfying the requirements of 10 CFR 52.79 as it relates to required information to be submitted in a COLA on the primary containment leakage rate testing program.

6.2.5 Post Combined License Activities

There are no post COL activities related to this section.

6.2.6 Conclusion

The staff is reviewing the information in US-APWR DCD Section 6.2 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information related to the Containment Systems incorporated by reference in the CPNPP, Units 3 and 4, COL FSAR will be documented in the staff's SER for the US-APWR DC. The SER for the US-APWR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update Section 6.2 of this SER to reflect the final disposition of the DC application.

The staff finds that the information pertaining to CPNPP, Units 3 and 4, COL FSAR Section 6.2 is within the scope of the DC and adequately incorporates by reference Section 6.2 of the US-APWR DCD, Revision 3. The staff has compared the information contained within STD COL Information Item 6.2(5) to the relevant NRC regulations and acceptance criteria defined in NUREG-0800, Section 6.2.2, as supplemented by guidance contained in RG 1.82 and NEI 04-07, Volume 1 and 2, and finds that the applicant provided acceptable information for satisfying the requirements of GDC 38 and 10 CFR 50.46(b)(5), as it relates to requirements for long-term cooling capability, pending resolution to **RAI 6997, Questions 06.02.02-07 and 06.02.02-06 as Confirmatory Items 06.02.02-07 and 06.02.02-06.**

The staff has compared the information contained within STD COL Information Item 6.2(6) to the relevant NRC regulations and acceptance criteria defined in NUREG-0800, Section 6.2.2, as supplemented by guidance contained in RG 1.82 and NEI 04-07 Volume 1 and 2, and finds that the applicant has provided sufficient information for satisfying the requirements of GDC 38 and 10 CFR 50.46(b)(5), as it relates to requirements for long-term cooling capability, pending resolution to **RAI 6965, Question 06.02.02-05, which is being tracked as Confirmatory Item 06.02.02-05.**

The staff finds that the information pertaining to CPNPP, Units 3 and 4, COL FSAR Section 6.2.6 is within the scope of the DC and adequately incorporates by reference Section 6.2.6 of the US-APWR DCD Revision 3, and is, thus, acceptable.

The staff has compared the information contained within STD COL Information Item 6.2(8) to the relevant NRC regulations, acceptance criteria defined in NUREG-0800, Section 6.2.6, and finds that the applicant has provided sufficient information for satisfying the requirements of 10 CFR 52.79 as it relates to required information to be submitted on operational programs by COL applicants.

6.3 Emergency Core Cooling Systems

Section 6.3, Emergency Core Cooling Systems," of the CPNPP, Units 3 and 4, COL , Revision 3, FSAR incorporates by reference, with no departures or supplements, Section 6.3, "Emergency Core Cooling Systems," of the US-APWR DCD, Revision 3. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issues relating to this section remained for review. The NRC staff's review confirmed that there is no outstanding issues related to this section.

The staff is reviewing the information in DCD Section 6.3 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information related to the emergency core cooling system, incorporated by reference in the CPNPP, Units 3 and 4, COL FSAR, will be documented in the staff's SER on the DC application for the US-APWR. The SER for the US-APWR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update Section 6.3 of this SER to reflect the final disposition of the DC application design.

6.4 Habitability Systems

6.4.1 Introduction

The habitability systems for the Main Control Room (MCR) allow operators to remain safely inside the control room envelope (CRE) and take the actions necessary to manage and control the plant under normal and abnormal plant conditions, including a LOCA. The MCR habitability systems protect operators against a postulated release of radioactive material, natural phenomenon induced missiles, radioactive shine, smoke, and toxic gases. The MCR habitability systems enable operators and technical staff to occupy the CRE safely for the duration of accidents analyzed in DCD Chapter 15, "Transient and Accident Analyses." These systems include the following:

- MCR heating, ventilation, and air conditioning (HVAC) system.
- MCR emergency filtration system.
- Radiation monitoring system.
- Radiation shielding.
- Lighting system.
- Fire protection system.

The CRE includes the MCR and is served by the MCR HVAC system during normal and abnormal conditions, as well as during control room smoke purge operations. Personnel occupying the CRE are protected from the respiratory effects and eye irritation of smoke.

6.4.2 Summary of Application

Section 6.4, "Habitability Systems," of the US-APWR DCD includes the Tier 1 and Tier 2 information. Section 6.4, "Habitability Systems," of the CPNPP, Units 3 and 4, COL FSAR, Revision 3, incorporates by reference Section 6.4 "Habitability Systems," of the US-APWR DCD, Revision 3, with the supplements described below.

For CPNPP, Units 3 and 4, COL FSAR Section 6.4, the staff considered the following CPNPP COL information and STD COL information.

COL Information Item

US-APWR COL 6.4(1): "*The COL Applicant is responsible to provide details of specific toxic chemicals of mobile and stationary sources within the requirements of RG 1.78 and evaluate the control room habitability based on the recommendation of RG 1.78.*"

CPNPP Information Item CP COL 6.4(1) provides the CPNPP site specific COL information to resolve DCD Combined License information item US-APWR COL Information Item 6.4(1). Information Item CP COL Information Item 6.4(1) reads: "*Toxic chemicals of mobile and stationary sources and evaluation of the control room habitability.*"

The COL applicant replaced the second paragraph of DCD Subsection 6.4.4.2, "Toxic Gas Protection," with the results of the applicant's control room habitability analyses. The applicant performed habitability threat analyses in accordance with the requirements of RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," for both stationary and mobile sources of toxic chemicals. This population of toxic chemical sources included chemicals located at the licensed CPNPP, Units 1 and 2. The applicant identified and screened chemicals described in COL FSAR Subsection 2.2.3.1.3, "Toxic Chemicals."

Using conservative assumptions and input data for chemical source term, the COL applicant analyzed CPNPP, Units 3 and 4, control room parameters, site characteristics, and meteorology inputs, postulated chemical releases for the maximum value concentration to the MCR using the HABIT Code, Version 1.1. RG 1.78 specifies the use of HABIT software for evaluating control room habitability. HABIT software includes modules that evaluate radiological and toxic chemical transport and exposure. For this analysis of chemical release concentrations, EXTRAN, and CHEM modules are utilized in the code. EXTRAN models toxic chemical transport from the selected release point to the HVAC intakes of the MCR. CHEM is then applied by HABIT to model chemical exposure to control room personnel, based on EXTRAN output and MCR design parameters.

For all the cases analyzed, the COL applicant determined that all postulated releases led to CPNPP, Units 3 and 4, control room concentrations that are below the threshold level of Immediately Dangerous to Life and Health (IDLH), as discussed in RG 1.78.

COL Information Item

US-APWR COL Information Item 6.4(2): "*The COL Applicant is responsible to discuss the automatic actions and manual actions for the MCR HVAC system in the event of postulated toxic gas release.*"

CPNPP Information Item CP COL 6.4(2) reads: "*Automatic and manual action for the MCR HVAC system that are required in the event of postulated toxic gas release.*" The applicant replaced the third paragraph of DCD Subsection 6.4.3, "System Operational Procedures", with a paragraph that concluded that based on the analyses described in DCD Subsection 6.4.4.2, that

for CPNPP, Units 3 and 4, no specific automatic action of MCR HVAC system is required to protect operators within the CRE against toxic gas release event.

In addition, in FSAR Subsection 6.4.4.2, the applicant concluded that based on the results of the analyses that there will be no procedures prescribing specific operator actions. More specifically, there will be no procedure requiring operator action, either to don respirators and protective clothing or to manually isolate the CRE. Both of these actions will be considered discretionary in the event of a toxic gas event.

COL Information Item

US-APWR COL Information Item 6.4(5): "*The number, locations, sensitivity, range, type, and design of the toxic gas detectors are COL items. Depending on proximity to nearby industrial, transportation, and military facilities, and the nature of the activities in the surrounding area, as well as specific chemicals onsite, the COL Applicant is responsible to specify the toxic gas detection requirements necessary to protect the CRE.*"

CPNPP Information Item STD COL 6.4(5) reads: "*Toxic gas detection requirements necessary to protect the CRE,"* and provides COL information that addresses the requirements of DCD Combined License information item US-APWR COL Information Item 6.4(5). In accordance with information item US-APWR COL 6.4(5), CPNPP is to specify the toxic gas detection requirements necessary to protect the CRE.

In Section 6.4.6, "Instrumentation Requirement," of the COLA, the applicant concluded that toxic gas instrumentation to detect, alarm and isolate the CRE is not required based on the analyses described in FSAR Subsection 6.4.4.2. Succinctly, based on analysis and the guidance of RG 1.78, the applicant did not identify any hazardous chemical that could cause the CRE environment to exceed its respective IDLH threshold value.

Supplemental Information Item

CP SUP 6.4(1), the COL applicant added the following text to DCD Subsection 6.4.4.1:

> The impact of a post-accident release on the maximum control room dose for the same US-APWR unit at CP has been evaluated and addressed in the DCD. The DCD analysis credits operation of the MCR HVAC system in the pressurization mode. The dose to the control room operation at an adjacent US-APWR unit due to a radiological release from the other US-APWR unit is bounded by the dose to control room operators in the affected unit. While it is possible that the other US-APWR unit may be downwind in an unfavorable location, the dose at the downwind unit would be bounded by what has already been evaluated for a single US-APWR unit in the DCD. In addition, because the shortest distance between existing CPNPP, Unit 1 or Unit 2, and US-APWR, Unit 3 or Unit 4, is several times the separation between Unit 3 and Unit 4, the dose to either US-APWR unit control room from either existing operating unit would be bounded by a release at the same US-APWR Unit. Simultaneous post-accident radiological releases from multiple units at a single site are not considered to be credible.

6.4.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed in Section 6.4 of the FSER related to the DCD.

The relevant requirements of the Commission regulations for the habitability systems for the MCR, and the associated acceptance criteria, are given in Section 6.4, "Control Room Habitability System," of NUREG-0800.

The applicable regulatory requirements for the habitability systems for the MCR are as follows:

GDC 19, "Control room." A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including LOCAs. GDC 19 applies to this SRP section because the reviewer verifies that adequate protection from hazardous chemical releases will be provided to permit access to and occupancy of the control room under accident conditions.

The related acceptance criteria are as follows:

1. RG 1.52, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," Revision 3, dated June 2001.

2. RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," Revision 1, dated December 2001, present methods acceptable to the staff for meeting control room occupancy protection requirements.

3. RG 1.196, "Control Room Habitability at Light-Water Nuclear Power Reactors," Revision 1, dated January 2007.

4. RG 1.197, "Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors," dated May 2003, provides acceptable guidance for meeting control room habitability requirements.

5. RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," dated June 2007.

RG 1.78 and RG 1.196 provide the regulatory basis for acceptance of the resolution to CPNPP STD CP COL Information Item 6.4(2). RG 1.78 Regulatory Position C.5, "Emergency Planning," provides criteria for procedural emergency response guidance. The Regulatory Positions 2.2.1, "Comparison of System Design, Configuration, and Operation with the Licensing Bases," and 2.7.1, "Periodic Evaluations and Maintenance," of RG 1.196 provides criteria for normal operation procedural guidance.

For Information Item STD COL Information Item 6.4(5), the Regulatory Positions 4.1, "Detection System," 4.2, "Isolation System," and 4.3, "Protection System" of RG 1.78 provide the guidance and acceptance criteria with respect to the issues of number, locations, sensitivity, range, type and design of toxic gas detectors.

6.4.4 Technical Evaluation

The staff reviewed Section 6.4 of the CPNPP, Units 3 and 4, COL FSAR and checked the referenced DCD to ensure that the combination of the DCD and the information in the COL represent the complete scope of information relating to this review topic. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to the Habitability Systems. Section 6.4 of the US-APWR DCD is being reviewed by the staff. The staff's technical evaluation of the information incorporated by reference related to the Habitability Systems will be documented in the staff's SER on the DC application for the US-APWR. The SER on the US-APWR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update Section 6.4 of this SER to reflect the final disposition of the DC application.

The staff reviewed the following information contained in the COL FSAR:

COL Information Item

- CP COL 6.4(1): "The COL Applicant is responsible to provide details of specific toxic chemicals of mobile and stationary sources within the requirements of RG 1.78 (Ref 6.4-4) and evaluate the control room habitability based on the recommendation of RG 1.78 (Ref 6.4-4*)."*

RG 1.206 provided guidance regarding the information that is needed to ensure potential hazards in the site vicinity are identified and are evaluated as meeting the siting criteria in 10 CFR 100.20 and 10 CFR 100.21. The Radiation Protection and Accident Consequences Branch (RPAC) of the Division of Site Safety and Environmental Analysis is responsible for the review of COL FSAR Section 2.2, "Nearby Industrial, Transportation and Military Facilities." The RPAC staff performs this review in accordance with the direction provided by SRP 2.2.1 - 2.2.2, "Identification of Potential Hazards in Site Vicinity" and SRP 2.2.3 "Evaluation of Potential Accidents." Through RPAC's review, potential toxic gas threats to control room habitability are identified. Threats that are determined to be credible, are analyzed further.

The Containment and Ventilation Branch staff used the results of RPAC's review in conjunction with the CHEM module of Habit Version 1.1, to perform confirmatory analyses that establish the integrity of the applicant's toxic gas analyses and conclusions.

The applicant determined that chemicals stored at or transported through eight locations within the five mile radius of the nearest CPNPP, Units 3 and 4, MCR Inlet posed a potential hazardous chemical threat to control room habitability. These locations and chemicals are listed in FSAR Table 2.2-214, "Toxic Chemicals that do not meet the RG1.78 Screening Criteria."

The following excerpts from FSAR Subsection 6.4.4.2, "Toxic Gas Protection," provide a synopsis of the applicant's RG 1.78 control room habitability evaluation:

> …using conservative assumptions and input data for chemical source term, CPNPP Units 3 and 4 control room parameters, site characteristics, and meteorology inputs, postulated chemical releases are analyzed for maximum value concentration to the MCR using the HABIT code, version 1.1….
>
> The meteorological conditions assumed for these cases were initially set at G stability and 2.5 m/s wind speed, which is more extreme than 95th percentile for the CPNPP site. The 2.5 m/s wind speed is higher than would be expected for G stability but is conservative in that it introduces the chemical gas into the intakes faster than at lower speeds. …
>
> The HABIT-based analysis determines the peak concentration in the MCR and compares this level to the RG 1.78 criterion, the specific chemical listed immediately dangerous to life and health (IDLH). In the cases that were analyzed, all postulated releases led to concentrations that are below the IDLH level.

The applicant determined that the most limiting and bounding threat to control room habitability was from the release of chlorine from a tanker truck traveling on roadway Farm to Market (FM) 56. The tanker truck had a capacity to hold 42,500 lbs (19.0 Kg) of chlorine. The closest distance that FM 56 gets to the CPNPP, Units 3 and 4, MCR fresh air intakes is 1.4 miles (2.25 Km). The applicant determined that the potential for a chlorine release from this source exceeds RG 1.78's stated threshold frequency of occurrence of 10^{-6} per year. The COL applicant then performed an analysis consistent with the guidance of RG 1.78, for this chlorine release event.

The staff performed confirmatory analyses using the guidance of RG 1.78 and the HABIT EXTRAN and CHEM code to determine the impact on control room habitability. The staff used the site specific information contained in FSAR Table 2.2-214, "Toxic Chemicals that do not Meet the RG 1.78 Screening Criteria," for stationary and transitory chemicals in support of these confirmatory actions. This table lists chemicals determined to pose a potential threat to CPNPP, Units 3 and 4, control room habitability. To establish the scope and breadth of the applicant's habitability review, the staff accessed information contained in the applicant's document 4CS-CP34-200800074, "CPNPP Units 3 & 4 Control Room Habitability Analysis Following Postulated Toxic Chemical Release (Support Document)." The goal of the staff was to understand the applicant's approach. The staff's review focused on maximum concentration accidents and maximum concentration-duration accidents consistent with the guidance of Section 3.2 of RG 1.78. For the confirmatory dispersion models, the staff adhered to the guidance of the RG in that the values used in the derivation of the atmospheric dilution factor (i.e. between the release point and the control room intakes) were values that were exceeded only five percent of the time.

During the staff's comparison of its own HABIT code analyses' results to those contained in 4CS-CP34-200800074, the staff noted significant differences in the initial mass values used for the onsite chemicals of sulfuric acid, ammonia, hydrazine and morpholine. This observation

was documented in **RAI 5652, Question 06.04-13**. In particular that for the onsite chemicals of sulfuric acid, ammonia, hydrazine and morpholine, the staff noted significant differences in its own calculated initial mass values from those listed in the EXTRAN Input Files of the applicant's document. The applicant responded to **RAI 5652, Question 06.04-13** (ADAMS No. ML11152A239), document dated May 31, 2011, stating that FSAR Table 2.2-214, "Toxic Chemicals that do not Meet the Regulatory Guide 1.78 Screening Criteria," needed to be revised to indicate the weight percentages of the chemicals of concern. The applicant included a proposed change to FSAR Table 2.2-214. Upon another review of portions of 4CS-CP34-200800074, the staff found that the applicant did document how the mass values of these three chemicals were derived. Therefore, the applicant's revision of Table 2.2-214, which was included in FSAR Revision 3, resolved the deficiencies captured in **RAI 5652 Question 06.04-13**. Based on this, the staff considers **RAI 5652, Question 06.04-13**, to be resolved and closed.

In **RAI 3451, Question 06.04-4**, the staff requested additional information from the applicant to support performing confirmatory calculations with respect to the applicant's conclusions. In particular, the staff requested that the COL applicant provide the requisite input parameters used in the HABIT EXTRAN and CHEM models and any significant intermediate values. The staff also requested that the applicant describe all relevant assumptions used in the applicant's analyses. In its response (ADAMS No. ML093510531), dated November 12, 2009, the applicant explained that the MCR input parameters were obtained from DCD Table 15.6.5-5, "US-APWR Major Input Parameters Used in the MCR and TSC Consequence Analysis for the LOCA," and provided the EXTRAN input values used for the most bounding case of the assumed truckload of chlorine on Highway FM 56. For further clarification of the response, the staff issued RAI **4678, Question 06.04-10**. In its RAI, the staff explained that the EXTRAN inputs cited a MCR height of 46.9 ft (14.3 meters), while the US-APWR DCD Chapter 6 listed the height of the MCR fresh air intakes as between 50 ft 2 in (50.166 meters) and 65 ft (19.8 meters); and the staff questioned the applicant's use of an EXTRAN input parameter of 25 °C (77 °F) for the storage and air temperature. Finally, the applicant's response to **RAI 3451, Question 06.04.04** included an intake flow rate of 1800 cfm (0.8495 m3/second) and an infiltration rate of 120 cfm (0.05663 m3/second). The staff wanted to know if the 120 cfm (0.05663 m3/second) is the correct value to use in the event of a toxic gas response and whether operator action would be needed.

The applicant responded to **RAI 4678, Question 06.04-10** (ADAMS No. ML102810224) on October 6, 2010. Specifically, the applicant stated that the in-leakage flow rate of 120 cfm (0.05663 m3/second) was utilized as the worst case additional in-leakage flow rate and was added to the unfiltered bypass flow. These values were consistent with the worst case accident flow rates in the US-APWR DCD Chapter 15, Table 15.6.5-5 and no operator action was credited. In addition, the applicant stated the value of 46.9 ft (14.3 meters) was utilized as a bounding value and did not directly correspond to any physical property. The elevation of the MCR fresh air intake specified as an input of the EXTRAN and CHEM is 46.9 ft (14.3 meters), including an additional conservatism because the lower the elevation of the MCR fresh air intake, the more conservative the analysis for EXTRAN and CHEM. Finally, in its response, the applicant added that the temperature of 25 °C (77 °F) used in the original HABIT calculation, is the US-APWR 1 percent exceedance coincident wet bulb temperature (US-APWR DCD Table 2.0-1, Sheet 1). The new sensitivity analyses utilized a higher ground temperature of 115 °F

(46.1 °C) which is the US-APWR DCD 0 percent exceedance dry bulb temperature, to calculate the most conservative concentrations for CPNPP, Units 3 and 4. The sensitivity analysis comparison results obtained with 0 percent exceedance dry bulb temperature yield slightly higher concentrations inside the control room compared with the other temperatures. As such, the 0 percent exceedance dry bulb value is the most conservative value for the air and ground temperature. The results of this sensitivity analysis demonstrate that the resulting MCR concentrations are acceptable, since the IDHL values from RG 1.78 for chlorine are not exceeded. The staff reviewed the applicant's analysis input and determined that the staff could confirm the applicant's FSAR conclusions for the bounding case. Based on this, the staff closed **RAI 4678, Question 06.04-10.**

In **RAI 4678, Question 06.04-9**, the staff asked the following four part question that prompted the applicant to perform a sensitivity analysis to justify and show the effects of changes to the original analysis described in FSAR Subsection 6.4.4.2 (i.e. the bounding case above).

- In FSAR Section 6.4.4.2, do any of the calculations credit design features, such as an elevated control room intake, to keep the chemical concentration in the control room below the IDLH (Immediately Dangerous to Life and Health) levels? If so, provide a description in the FSAR of design features credited in the design basis analysis.

- Justify the data used in HABIT analysis, specifically, the solar radiation that will represent the site, while air and ground temperatures, to be consistent with the temperature as shown in the site characteristics table (FSAR Table 2.0-1 R, "Key Site Parameters").

- FSAR Section 6.4.4.2, states that the meteorological condition assumed for the analysis is conservatively set at G stability and 2.5 m/s (8.2 feet/sec) wind speed. Provide HABIT run results to demonstrate that the selected data set is conservative.

- FSAR Section 6.4.6, concludes that no instrumentation to detect and alarm is required. This conclusion is based on the HABIT run that no hazardous chemical concentrations will exceed the IDLH. To demonstrate that the IDLH has not been exceeded, it is important to verify that the HABIT calculation has not terminated before the peak concentration has occurred. Please verify that the HABIT calculations show the concentration has peaked and is decreasing (or has leveled-off) before the calculation has terminated. Provide the numeric output of the portion of HABIT run that demonstrates the peak chemical concentration in MCR has been calculated.

The applicant responded to **RAI 4678, Question 06.04-9**, (ADAMS No. ML102810224), dated October 6, 2010, with the following information.

> The only design feature in the original analyses described in the FSAR Subsection 6.4.4.2 was a control room intake height of 14.3 m. The control room concentration with this intake height was below its limiting values (IDLH). A HABIT sensitivity analysis comparison was performed with a change in intake height from 14.3 m to 0 m (the same as the assumed release height). The

results showed that there is a small increase in concentration, but the concentrations are still well below the limiting values (IDLH). Therefore, the original analyses do not rely on any design features to meet a value less than the limit.

The original HABIT analyses in the FSAR used a solar radiation value of 600 W/m2 for the CPNPP site. The sensitivity analysis comparison referred to above was performed using solar radiation values ranging from 600 W/m2 to 1150 W/m2 and showed no significant deviation from the original analyses results. The HABIT sensitivity analysis utilized the DCD 0% exceedance maximum dry bulb temperature of 115^0F as a worst-case temperature scenario. The temperature of 115° F is shown in DCD Table 2.0-1 Sheet 1 and in FSAR Table 2.0-1 R Sheet 2.

The HABIT sensitivity analysis compared results at Classes E, F and G stability and demonstrated that the use of Class G stability is the most conservative. However, as Class G stability occurs less than 5% of the time at the CPNPP site (see Table 06.04-9-1 below), Class F stability is utilized in the HABIT sensitivity analysis per Appendix A of RG 1.78. HABIT sensitivity analyses for Class F stability and a range of wind speeds from 1 m/s to 6 m/s was performed to determine the worst wind speed. A summary of these results are located in Figure 06.04-9-1, which are the results from CHEM (a determination of the chemical concentration inside the control room) and Figure 06.04-9-2, which are the results from EXTRAN (a calculation of the chemical concentration outside the control room at the air intake). The worst-case wind speed was 6 m/s as shown in Figures 06.04-9-1 and 06.04-9-2, below.

The new HABIT CHEM analysis results demonstrate that the calculation is asymptotically approaching a maximum for the worst case 6 m/s wind speed (see Figure 06.04-9-1). For lower wind speeds with lower calculated control room concentration curves that have not peaked, the results are analyzed in terms of the 0.08 ppm odor threshold (from NUREG/CR-6624) for chlorine. In each case, the time between the 0.08 ppm odor threshold limit and the calculated highest concentration is well in excess of the RG 1.78 value of 2 minutes to don SCBAs. As the IDLH value for chlorine is 10 ppm, there is no threat to CRH.

All results of the original and new sensitivity analyses were acceptable. FSAR Subsection 6.4.4.2 has been revised to reflect the new analysis results with Class F stability and the most conservative parameters identified from the sensitivity analyses.

The applicant also included proposed changes to the FSAR Chapter 6. The staff verified that Revision 2 of RCOLA FSAR Subsection 6.4.4.2, contained the outcomes of these sensitivity analyses. As indicated above, staff performed confirmatory modeling for all the applicant's findings of FSAR Table 2.2-214 and replicated the sensitivity analysis described above.

In addition, the staff performed HABIT modeling for extended runs beyond the applicant's HABIT models which were programmatically limited by timing out (e.g. 12.5 mins for chlorine). The results of the staff's HABIT modeling of the chlorine accident yielded a MCR concentration still below the IDHL limits but not substantially below. In particular, for the extended run modeling of the chlorine event the staff used an elevated MCR intake of 14.3 ms (46.9 feet) and a five percent exceedance temperature. This model resulted in a maximum peak MCR concentration equal to 8.8 ppm which occurred at 28.25 mins into the event. This lack of significant margin prompted further review by the staff.

The staff notes that the ALOHA manual defines a heavy gas as "*A gas that has a molecular weight greater than that of air (the average molecular weight of air is about 29 kilograms per kilomole) will form a heavy gas cloud if enough gas is released.*" Chlorine with a molecular weight of 70.9 grams/mole fits the definition of a heavy gas. Based on this, the staff modeled in ALOHA the chlorine event as a heavy gas based on a five percent exceedance temperature and other parameters similar to the HABIT modeling. There is one limitation of the ALOHA model in that MCR intake elevations cannot be factored into the model. The ALOHA heavy gas model for the chlorine event yielded a peak internal building concentration of 46.5 ppm occurring at approximately 25 mins into the event. Internal building concentration for this chlorine model exceeded the IDHL limit of 10 ppm at approximately 18 mins into the event.

In light of the comparative results of the HABIT versus ALOHA modeling for chlorine, the staff produced ALOHA heavy gas models for a 40 percent by weight dimethlylamine solution and for a 93 percent by weight sulfuric acid solution. The molecular weight of a dimethylamine solution equals 45.08 gms/mole with an IDHL of 500 ppm. The molecular weight of a sulfuric acid solution equals 98.1 gms/mole with an IDHL of 15 mg/m^3.

The heavy gas model for dimethlylamine solution assumed a continuous release over 60 mins and used a five percent exceedance temperature and a stability class consistent with RG 1.78 guidance. This ALOHA heavy gas model yielded an internal building concentration 12.8 ppm at 60 mins with concentration still slowly rising. A HABIT model was also run using values of five percent exceedance temperature and stability class "F" consistent with RG 1.78 guidance. The staff assumed an elevated control room intake and a "Liquid Tank Burst". The staff's Habit run timed out at 19.75 min with the MCR internal concentration at 32.14 ppm but slowly rising. Based on both the ALOHA model and the HABIT model for a 40 percent by weight dimethlylamine solution, the staff concluded from this modeling that this chemical solution did not constitute a realistic threat to control room habitability.

For sulfuric acid the staff modeled a spill in ALOHA assuming a continuous release over 60 mins and ambient conditions consistent with RG 1.78 guidance. From this model it appeared to the staff that the IDLH within the building at ground level (i.e. not representative of an elevated MCR) could be exceeded at about five minutes after the event (i.e. sulfuric tank rupture). This observation caused the staff to further question the applicant in **RAI 6158, Question 06.04-15**, about the threat to control room habitability from a sulfuric acid spill. The applicant responded (ADAMS No. ML12167A291), dated June 13, 2012, by stating that 10 torr is the vapor pressure threshold that determines the need for consideration of flashing and boil off in a liquid spill release determination. In particular and consistent with RG 1.78 guidance, chemicals with such low vapor pressure (< 10 torr) do not result in significant atmospheric gaseous releases. The

vapor pressure of a sulfuric acid solution at normal temperatures is approximately 0.001 torr.

Based on this vapor pressure, the staff then established a more realistic evaporation rate for use the ALOHA model. With this revised model the staff confirmed that potential sulfuric acid spills do not constitute a realistic threat to control room habitability.

As a follow-up to **RAI 4678, Question 06.04-9**, the staff issued **RAI 6158, Question 06.04-15.** In this RAI, the staff noted that both the applicant's and the staff's HABIT modeling illustrate the sensitivity of the EXTRAN results to the parameter of MCR intake height. The staff requested that the MCR HVAC intake height used in the habitability analyses be captured as a plant attribute in FSAR 6.4.4.2, "Toxic Gas Protection". In addition in **Question 06.04-15**, the staff posited that since chlorine clearly fits ALOHA's definition of a heavy gas as captured above, that ALOHA modeling is the more appropriate program (i.e. as opposed to HABIT) to use for determining MCR habitability. More specifically, the use of the HABIT Gaussian model may be producing non-conservative results for these two heavy gases. The staff requested that the applicant re-evaluate their findings of FSAR 6.4.4.2, based on the fact that chlorine is a heavy gas and that the applicant provide a comprehensive justification for why the results are appropriate and conservative.

The applicant responded (ADAMS No. ML12167A291), dated June 13, 2012, with a thorough response that used a combination of ALOHA and HABIT models to reflect the fact that from a tanker spill, chlorine behaves initially as a heavy gas and ultimately transitions to a neutrally buoyant gas (i.e. Gaussian) well before (i.e. on its path to) encountering the main control room air intakes. In essence, the applicant in its modeling created a "virtual point" where heavy gas behavior had abated and Gaussian gas behavior dominated (i.e. HABIT analysis again became an acceptable modeling technique). With this approach the applicant recreated its sensitivity analysis plot for different wind speeds and RG 1.78 worst case (i.e. five percent of the time) ambient conditions. The plot indicated that the time available for a control room operator to detect a chlorine release at the odor threshold (i.e. 0.08 ppm) and then take protective measures before the IDLH of a MCR concentration of 10 ppm is reached is always over 12 mins. This is well over the two minutes considered by RG 1.78 as adequate time before the IDLH of a MCR concentration of 10 ppm is reached. To establish a comfort level with the applicant's hybrid modeling approach, the staff performed a set of confirmatory calculations that replicated the essential portions of the applicant's analyses. These confirmatory calculations left no residual staff concerns. The applicant agreed to amend the FSAR Subsection 6.4.4.2, to indicate the use of both ALOHA and HABIT modeling in its analysis of the chlorine tanker spill event. The applicant also agreed to amend Subsection 6.4.4.2, to emphasize that a MCR intake height of 14.3 meters (46.9 feet) above ground level was used in all the HABIT analyses.

Based on the foregoing, the staff concluded that the applicant had comprehensively analyzed the chlorine tanker spill event and found the applicant's response **to RAI 6158, Question 06.04-15**, acceptable. The staff will confirm that the proposed changes to the FSAR, Section 6.4 are incorporated into the next revision of the CPNPP, Units 3 and 4 COLA FSAR. Accordingly, **RAI 4678, Question 06.04-9 is resolved and closed, and RAI 6158, Question 06.04-15 is listed as Confirmatory Item 06.04-15.**

In **RAI 3968, Question 06.04-7**, the staff noted that neither COLA FSAR Subsection 2.2.3.1.3.2, "Source Evaluation," nor Table 2.2-214 "Toxic Chemicals discusses refrigerants that fail to meet the RG 1.78 Screening Criteria," lists the particular refrigerants used throughout the US-APWR plant. The staff requested that the applicant provide a RG 1.78 evaluation in the FSAR for the refrigerants to be used at CPNPP, Units 3 and 4. The applicant responded (ADAMS No. ML100550345), dated February 22, 2010, with a conclusion that was based on analysis that an entire maximum theorized chiller refrigerant R-134a charge of 2570 lbs (1165.7 kg) could be discharged directly to the CRE without creating an asphyxiation hazard. The applicant also noted that R-134a has a low acute inhalation toxicity threshold.

The applicant indicated that plant design also included several barriers that prevented refrigerant from reaching the MCR fresh air intakes including a dedicated ventilation purge system for each chiller. The applicant also stated that the rooms containing the chillers and the chiller units are designed in accordance with American National Standards Institute/American Society of Heating, Refrigeration and Air Conditioning Engineers (ANSI/ASHRAE) Standard 15 "Safety Standard for Refrigeration Systems". The applicant committed to amend Table 2.2-214 to include the refrigerant R-134a "as typical" and to the limit the quantity to a value of less than 2570 lbs (1165.7 kg) per chiller. The staff verified that Revision 2 of RCOLA Table 2.2-214 contained the committed changes to the COLA FSAR that pertained to refrigerant R-134a.

In follow-up **RAI 4678, Question 06.04-11**, the staff requested that the following information from the applicant:

- The staff found that the applicant's response to Question 06.04-7 included an analysis of the CRE asphyxiation hazard (i.e. toxic gas) from the refrigerant charge only. However, the potential for toxic chemicals in the refrigerant oil was not addressed. The applicant is requested to amend its response to reflect this threat to the CRE habitability from the aspect of a toxic gas hazard to the Control Room operators.

- The staff noted that the applicant's response implies that the US-APWR DCD design will include; (1) a dedicated ventilation purge exhaust system to remove a massive freon/refrigerant oil dump directly to the room from the housed chiller; and (2) pressure relief device to safely relieve pressure buildup due to a fire or other abnormal conditions and the relief discharge is piped outside the system. The applicant implied that both the non-essential chillers in the Auxiliary Building (A/B) and the essential chillers in the Power Source Building will have these dedicated systems. However in US-APWR DCD RAI 338-2325 Question 06.04-6, the DCD applicant, MHI, only commits to add these plant design enhancements for the nonessential chillers of the A/B. The staff requests that the COL applicant provide an amended response to correct this error and address the staffs concerns about public health and safety from a massive refrigerant release laced with refrigerant oil.

The COLA applicant responded (ADAMS No. ML102810224), dated October 6, 2010, that the typically-used refrigerant (R-134a) uses R-134a PAG (Polyalkylene Glycol) Oil Charge. The Material Safety Data Sheet shows "None Known" for any hazardous exposure limits and "Not

Determined" for vapor pressure for this chemical. Hence it was screened out for the control room habitability analysis and the response does not require amendment. In addition, ANSI/ASHRAE Standard 15 is still being invoked in the design of the chillers and chiller rooms but that a dedicated ventilation purge system will not be part of the design for each chiller.

Rather the A/B HVAC system would be relied upon to exhaust from the Essential Chilled Water chiller rooms and the Non-Essential Chilled Water chiller area any accumulation of refrigerant due to leaks or a line ruptures of the system.

Based on a detailed review of ANSI/ASHRAE Standard 15-2007, the staff issued **RAI 5411**, **Question 06.04-12**, as a follow up to **RAI 4678, Question 06.04-11**, regarding the evolving design direction for the machinery rooms that house the non-essential chillers and the essential chillers. Specifically, the applicant was asked why a dedicated ventilation and compliance with ANSI/ASHRAE Standard 15-2007 was not necessary for all chiller configurations described in the COLA FSAR. The applicant, in its response (ADAMS No. ML110800596), dated March 18, 2011, stated:

> The design of the essential chilled water system (ECWS), non-ECWS chillers, and chiller equipment rooms is within the scope of the standard plant contained in the US-APWR Design Control Document (DCD). The applicable sections of the DCD related to ECWS, non-ECWS chillers, and chiller equipment rooms are incorporated by reference into the FSAR.

The staff found the applicant's answer acceptable in that any issue with respect to toxic gas analysis and MCR habitability, had been adequately addressed in the applicant's response to **RAI 3968, Question 06.04-7**, where the applicant committed to limit the amount of refrigerant R-134a to 2750 lbs (1165.7 kg) per chiller. Based on this, the staff considers **RAI 3968, Question 06.04-7; RAI 4678, Question 06.04-11; and RAI 5411, Question 06.04-12** to be resolved and closed.

Based on the foregoing review, the staff concluded that the applicant had fulfilled the requirements of CP COL Information Item 6.4(1), since the applicant's response to COL Information Item 6.4(1) was consistent with the guidance described in RGs 1.78 and 1.206.

COL Information Item

- CP COL 6.4(2): "The COL Applicant is responsible to discuss the automatic actions and manual actions for the MCR HVAC system in the event of postulated toxic gas release."

For Information Item CP COL Information Item 6.4(2), the COL applicant will replace the third paragraph of DCD Subsection 6.4.3 "System Operational Procedures" with the following:

> The analyses of control room habitability during postulated release of toxic chemicals described in Subsection 6.4.4.2 identify no hazardous chemical that exceeds the IDLH criteria of RG 1.78, so that no specific automatic action of MCR HVAC system is required to protect operators within the CRE against toxic gas release event. The

emergency isolation mode may be initiated by manual action as described in Subsection 6.4.4.2.

The staff noted that both CP COL Information Item 6.4(2) and STD COL Information Item 6.4(2) first appeared in Revision 2 of RCOLA FSAR Section 6.4.7 was listed against Information Item 6.4(2). In **RAI 6158, Question 06.04-14**, the staff indicated that US-APWR DCD Subsection 6.4.3 contained wording that is application specific.

In particular, the Reference COLA applicant could not draw the conclusions of DCD Subsection 6.4.3 for each subsequent COLA applicant. The applicant responded to **RAI 6158 Question 06.04-14** (ADAMS No. ML12093A002), dated March 29, 2012, and agreed with the staff's observation and replaced STD COL Information Item 6.4.2 with CP COL Information Item 6.4.2 from FSAR Revision 3, Sections 6.4.3, "System Operational Procedures," and 6.4.7, "Combined License Information." Based on this the staff has resolved and closed **RAI 6158, Question 06.04-14**.

In **RAI 3451, Question 06.04-5,** the staff noted that the applicant's initial analysis of FSAR Revision 2, Subsection 6.4.4.2, indicated that the projected chlorine concentrations within the CRE peak out at 5.2 ppm (i.e. well below the IDHL). Given the effects of donning respirators (e.g. poor communications, increased risk of operator error, etc.), the staff requested that the applicant clarify what operator actions that would be captured in the plant's toxic gas response procedures.

The applicant responded to **RAI 3451, Question 06.04-5** (ADAMS No. ML093510531), dated November 12, 2009, that all of the FSAR Table 2.2-214 assumed chemical releases analyzed with the HABIT code produced maximum control room concentration values well below the IDLH. Therefore, there will be no procedure requiring operator action. Either donning respirators and protective clothing or manually isolating the control room HVAC system, will be considered at the discretion of the operators in the event of a toxic gas release. The CPNPP Units 3 and 4, Emergency Plan (ADAMS No. ML082680315) includes provisions for maintaining self-contained breathing apparatuses in the control room. The staff notes that the essence of this response has been included in FSAR Subsection 6.4.4.2, Revision 2.

Also in **RAI 3451, Question 06.04-5**, the staff noted that all the chemicals of FSAR Table 2.2-214 screened in as potential threats to the control room. The staff asked the applicant: (a) whether the control room concentrations of any of these toxic chemicals would reach levels perceptible to the MCR operator and (b) whether the procedural response to this these toxic gases would differ from that for chlorine.

The applicant responded to **RAI 3451, Question 06.04-5** on November 12, 2009 (ADAMS No. ML093510531), stating that in addition to chlorine, the accident sources of hydrogen sulfide, morpholine, and ammonia could produce maximum control room concentrations below the respective chemical's IDHL but nonetheless perceptible to operators. This conclusion was based on the applicant's analyses and on the American Industrial Hygiene Association odor detection thresholds values included in Appendix B of NUREG/CR-6624, "Recommendations for Revision of Regulatory Guide 1.78." The discretionary operator response to the release of these and any chemical will not differ from those for the release of chlorine.

The staff found the applicant's response to all parts of **RAI 3451, Question 06.04-5** acceptable, since the planned procedural response is consistent with regulatory guidance of Section 4.0 of RG 1.78. Based on this, the staff considers **RAI 3451, Question 06.04-5** to be resolved and closed.

The staff could find neither a commitment by the applicant nor a mechanism in the COL FSAR that will direct the COL applicant to perform future surveys of stationary and mobile sources of hazardous chemicals on a periodic basis consistent with Regulatory Position 2.5, "Hazardous Chemicals," of RG 1.196. In **RAI 3451, Question 06.04-1**, the staff requested additional information as to how the COL applicant intended to satisfy the intent of this regulatory guidance during the life cycle of CPNPP, Units 3 and 4.

The applicant responded, dated November 12, 2009 (ADAMS No. ML093510531), that the CPNPP potential offsite chemical hazards are reviewed annually as part of the Land Use Census required by the Offsite Dose Calculation Manual. These requirements and instructions for conducting the annual chemical hazard survey are described in CPNPP procedures for CPNPP, Units 1 and 2.

The applicant also noted that the provisions of CPNPP procedures for CPNPP, Units 1 and 2, requires prior to their use and storage, a Control Room Habitability assessment for all halogenated gas or liquid products in quantities of 100 lbs (45.3 Kg) or greater. The CPNPP procedures for CPNPP, Unit 3 and 4, will be modeled after those of CPNPP, Unit 1 and 2. The applicant agreed to revise COL FSAR Subsection 6.4.4.2, to reflect the periodic surveys discussed in RG 1.78 and RG 1.196. The applicant also noted that the FSAR includes commitment to all RG 1.196 regulatory positions as indicated in DCD Table 1.9.1-1.

The staff found the applicant's response acceptable since the COL FSAR binds the applicant to satisfy all RG 1.196 regulatory positions and since the applicant agreed to amend FSAR Subsection 6.4.4.2 with wording that addresses the issues identified in **RAI 3451, Question 06.04-1**. The staff verified that RCOLA Revision 2, FSAR Subsection 6.4.4.2 contained the requisite wording to satisfy all RG 1.196 regulatory positions. Based on this, the staff considers **RAI 3451 Question 06.04-1** as closed and resolved.

COL FSAR Subsection 13.5.1.2 reads that "…*preparation of plant procedures takes place in approximately the same period as the preparation of preoperational and initial startup test procedures*." Therefore, for this SER evaluation the staff could not review the operating procedures for normal, abnormal and emergency operation against the review criteria contained in:

- Regulatory Position C.5, "Emergency Planning" of RG 1.78;
- Regulatory Position 2.5, "Hazardous Chemicals" of RG 1.196;
- Regulatory Position 2.2.1, "Comparison of System Design, Configuration, and Operation with the Licensing Bases" of RG 1.196; and

- Regulatory Position 2.7.1, "Periodic Evaluations and Maintenance" of RG 1.196.

The staff notes that COL FSAR Subsection 13.5.2.1, "Operating and Emergency Operating Procedures," reads that "*Operating procedures for all anticipated conditions affecting reactor safety are written prior to initial fuel loading*." These procedures include the grouped classifications of: System Operating Procedures; General Plant Procedures; Abnormal Condition Procedures; Emergency Operating Procedures; and Alarm Response Procedures. Given this absence of procedures for review, the staff requested in **RAI 3451, Question 06.04-6,** that the applicant provide, in the FSAR, the essential elements of the training and procedures necessary to ensure that the regulatory positions listed above will be met. In the second part of the RAI, the staff requested that the applicant include in its response, a discussion of any arrangements that will be in place with local and state authorities for notification of the control room when an offsite toxic gas release has occurred.

The applicant responded, in document dated November 12, 2009 (ADAMS No. ML093510531), that the FSAR 6.4 endorses RG 1.196 and RG 1.78 and includes commitments to all applicable regulatory positions contained therein, including regulatory positions 2.5, 2.2.1, 2.7.1 of RG 1.196 and C.5 of RG 1.78 and any periodic survey recommendations.

As a follow up to **RAI 3451, Question 06.04-6**, the staff issued **RAI 4678, Question 06.04-08**. The applicant was requested to discuss any arrangements that will be in place for notifying the control room when a release has occurred, provide a FSAR change that includes a description of how the procedures and training will address RGs 1.78 and 1.196. The applicant responded, dated October 6, 2010 (ADAMS No. ML102810224), with a comprehensive response and agreed to revise the FSAR Subsections 6.4.4.2, 13.2.1.1.3, "Hazards Awareness Training," and 13.5.2.2, "Maintenance and Other Operating Procedures," to capture the cited regulatory positions of RG 1.78 and RG 1.196. The staff reviewed the applicant's planned subsection revisions to the FSAR and concluded that the applicant's FSAR commitments will ensure that the subject regulatory positions are included in the CPNNP operating procedures before initial fuel load.

To the second part of the RAI, the applicant responded that local emergency plans are included in Part 5 of the COLA and that:

> Within the plant, it is part of the training provided to all plant employees to inform the control room of any abnormal or adverse condition that occurs. Both Hood County and Somervell County require prompt notification of CPNPP of any accidents involving hazardous chemicals that have occurred within five miles of the plant. The Unit 3 and 4 control rooms' interface with the Unit 1 and 2 control rooms as described in FSAR Subsection 13.3.2 via the Emergency Plans and would keep each other informed if a toxic gas event were to occur.

The staff found the applicant's response to this RAI series acceptable since the FSAR will include endorsements of the guidance of Regulatory Position C.5 of RG 1.78 and to the Regulatory Positions of 2.2.1, 2.5 and 2.7 of RG 1.196. The staff verified that Revision 2 of the RCOLA FSAR contained the requisite changes for Subsections 6.4.4.2, 13.2.1.1.3 and 13.5.2.2. Based on this the staff considers **RAI 3451, Question 06.04-6, and RAI 4678, Question 06.04-**

8 to be resolved and closed.

Based on the review as documented above, the staff concluded that the applicant had fulfilled the requirements of CP COL Information Item 6.4(2), since the applicant's response to COL Information Item 6.4(1) was consistent with the guidance described in RGs 1.78 and 1.196.

COL Information Item

- STD COL Information Item 6.4(5): "The number, locations, sensitivity, range, type, and design of the toxic gas detectors are COL items. Depending on proximity to nearby industrial, transportation, and military facilities, and the nature of the activities in the surrounding area, as well as specific chemicals onsite, the COL Applicant is responsible to specify the toxic gas detection requirements necessary to protect the CRE."

The last paragraph of DCD Subsection 6.4.6 is replaced in the COL FSAR with the following:

> "Instrumentation to detect and alarm a hazardous chemical release in the vicinity, and to automatically isolate the control room envelope (CRE) from such releases is not required based on analyses described in Subsection 6.4.4.2. No hazardous chemicals concentrations in the MCR exceeded the IDLH criteria of RG 1.78."

In FSAR Subsection 6.4.6, "Instrumentation Requirement," of the COLA, the applicant concluded that toxic gas instrumentation to detect, alarm and isolate the CRE is not required based on the analyses described in Subsection 6.4.4.2 of the COLA. Succinctly, based on analysis and the guidance of RG 1.78, the applicant did not identify a single hazardous chemical that could cause the CRE environment exceed its respective IDLH threshold value.

Based on the staff's review of the adequacy of the applicant's assessment of toxic gas threats as described above for STD COL Information Item 6.4(1), the staff concludes that toxic gas monitoring instrumentation is not required. Accordingly, the staff concludes that the applicant has fulfilled the requirements of STD COL Information Item 6.4(5), since the applicant's response to COL Information Item 6.4(1) was consistent with the guidance described in RG 1.78.

Control Room Radiological Habitability

Compliance with the control room habitability radiological requirements of GDC-19 requires that the applicant show that, for a plant located at the CPNPP site, the control room provides adequate radiation protection to ensure that radiation exposures shall not exceed 0.05 Sv (5 rem) total effective dose equivalent (TEDE) to permit access and occupancy of the control room under accident conditions for the duration of the accident.

The applicant did not provide site-specific doses in the control room for the design basis accidents (DBAs) referenced in the US-APWR DCD, but instead incorporated by reference the analysis of the control room radiological habitability from the US-APWR DCD, Revision 2, Section 6.4.4, "Design Evaluations." US-APWR DCD Chapter 6.4 referred to US-APWR DCD

Chapter 15 to provide the results of the analysis of the control room radiological consequences for the DBAs analyzed for offsite radiological consequences. The details and assumptions used in modeling the radiological consequences to control room operators were described in detail in US-APWR DCD Section 15.6.5. These analyses show that the dose requirements of GDC-19 are met for the US-APWR control room, given analysis inputs for a hypothetical site.

The DBA control room radiological consequences analyses in the US-APWR DCD used design reference values for the control room atmospheric dispersion factors (χ/Q values) in place of site-specific values. The atmospheric dispersion factors are the only input to the DBA radiological consequences analyses that are affected by the site characteristics. The applicant discussed the CPNPP, Units 3 and 4, site-specific short-term (accident) χ/Q values in Section 2.3.4 of the CPNPP, Units 3 and 4, COL FSAR.

The staff's review of the CPNPP, Units 3 and 4, incorporation of the US-APWR DCD DBA radiological consequences analyses, including control room radiological habitability, is discussed in Section 15.0.3, "Design Basis Accident Radiological Consequences Analyses for Advanced Light Water Reactors," of this report. The staff finds that by appropriately incorporating the US-APWR DCD DBA analyses by reference, the applicant has sufficiently shown that the DBA control room radiological consequences meet the regulatory requirements of GDC-19.

Supplemental Information:

CPNPP Units 3 and 4 FSAR, Revision 1, included supplemental information CP SUP Information Item 6.4(1) to address the radiological impact on the CPNPP, Unit 3 or 4, MCR habitability due to a DBA at the adjacent US-APWR unit or at either of the currently operating CPNPP, Units 1 and 2.

As part of the staff's evaluation of the incorporation by reference of the US-APWR design analyses, the staff has determined that the CPNPP, Units 3 and 4, control rooms are designed to meet the GDC-19 control room habitability dose limits for a DBA occurring at the US-APWR unit which includes the control room. The control room at the US-APWR unit on the CPNPP site that is not experiencing an accident is located further away from the accident release point than the control room at the unit experiencing the accident. Because of this increase in distance, the atmospheric dispersion is greater and the radioactive material concentration at the unaffected control room is reduced compared to the concentration at the affected unit's control room. Given that the control room design is identical at both US-APWR units, the resulting dose in the unaffected unit's control room is reduced, and also meets the GDC-19 dose criterion. Therefore, the staff finds that the CPNPP, Units 3 and 4, control rooms are each also designed appropriately to maintain habitability for a DBA at the adjacent US-APWR unit.

Considering the relative radioactive release source terms and locations for DBAs at CPNPP, Units 1 and 2, compared to the releases and locations from the CPNPP, Unit 3 or 4, units to the associated Units 3 and 4, control rooms, and by using similar logic as stated above for the evaluation of control room radiological habitability for a DBA at an adjacent US-APWR unit, the staff has reasonable assurance that the CPNPP, Units 3 and 4, control room habitability

systems would be able to mitigate the release from a DBA at CPNPP, Unit 1 or 2, to meet the requirements of GDC-19.

6.4.5 Post Combined License Activities

There were no "Post Combined License Activities" identified during the staff's review.

6.4.6 Conclusion

The staff is reviewing the information in US-APWR DCD Section 6.4 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information related to Habitability Systems incorporated by reference in the CPNPP, Units 3 and 4, COL FSAR will be documented in the staff's SER for the US-APWR DC. The SER for the US-APWR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update Section 6.4 of this SER to reflect the final disposition of the DC application.

On the basis of its review of the CPNPP COLA and the referenced DCD, the NRC staff finds that Section 6.4 of the CPNPP COLA adequately incorporates by reference Section 6.4 of the US-APWR DCD. In addition, the staff has determined that the information presented within FSAR Section 6.4, including the COL information items and supplemental information, is acceptable and meets the acceptance criteria of RGs 1.78, 1.196, 1.206 and the requirements of GDC-19, with the exception of the confirmatory item below.

RAI 6158, Question 06.04-15, is listed as a Confirmatory Item 06.04-15.

6.5 Fission Product Removal and Control Systems

Section 6.5, "Fission Product Removal and Control Systems," of the CPNPP, Units 3 and 4, COL, Revision 3, FSAR incorporates by reference, with no departures or supplements, Section 6.5, "Fission Product Removal and Control Systems," of the US-APWR DCD, Revision 3. The NRC staff reviewed the application and checked the referenced DCD to ensure that no issues relating to this section remained for review. The NRC staff's review confirmed that there is no outstanding issues related to this section.

The staff is reviewing the information in DCD Section 6.5 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information related to the fission product removal and control system, incorporated by reference in the CPNPP, Units 3 and 4, COL FSAR, will be documented in the staff's SER on the DC application for the US-APWR. The SER on the US-APWR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update Section 6.5 of this SER to reflect the final disposition of the DC application design.

6.6 Inservice Inspection of Class 2 and 3 Components

6.6.1 Introduction

Inservice inspection (ISI) programs are based on the requirements of 10 CFR 50.55a, "Codes and Standards," in that Code Class 2 and 3 components, as defined in Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (ASME Code), meet the applicable inspection requirements set forth in Section XI of the ASME Code, "Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components." ISI includes preservice examinations prior to initial plant startup as required by IWC-2200 and IWD-2200 of Section XI of the ASME Code.

6.6.2 Summary of Application

In the CPNPP, Units 3 and 4, COL Revision 3, FSAR, Section 6.6, "Inservice Inspection of Class 2 and 3 Components," the applicant incorporated by reference Section 6.6, "Inservice Inspection of Class 2 and 3 Components," of the US-APWR DCD, Revision 3 with supplemental information associated with the development of the preservice inspection (PSI) program and the augmented ISI program.

In addition, in the CPNPP, Units 3 and 4, COL FSAR, Section 6.6, "Inservice Inspection of Class 2 and 3 Components," the COL applicant provided supplementary information to address COL information items as described in the US-APWR DCD Section 6.6.9, "Combined License Information."

US-APWR COL Information Items

- STD COL 6.6(1)

The applicant provided additional information in STD 6.6(1) to address COL Information Item 6.6(1) which states:

The COL applicant is responsible for identifying the implementation milestone for ASME Section XI inservice inspection program for ASME Code Section III Class 2 and 3 systems, components (pumps and valves), piping, and supports, consistent with the requirements of 10 CFR 50.55a(g).

- STD COL 6.6(2)

The applicant provided additional information in STD 6.6(2) to address COL Information Item 6.6(2) which states:

The COL applicant is responsible for identifying the implementation milestone for the augmented inservice inspection program.

6.6.3 Regulatory Basis

The regulatory basis of the information incorporated by reference is documented in Section 6.6 of the staff's FSER related to the US-APWR DCD. In addition, the regulatory bases for acceptance of the resolution to the departures and supplementary information on ISI of Class 2

and 3 components are established in 10 CFR 50.55a as it pertains to specification of the preservice and periodic inspection and testing requirements of the ASME Code for Class 2 and 3 systems and components. In addition, the associated acceptance criteria are given in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition," (SRP) Section 6.6, "Inservice Inspection and Testing of Class 2 and 3 Components."

Acceptance criteria for this review are also contained in RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition), dated June 2007.

6.6.4 Technical Evaluation

The staff's evaluation of the operational program aspects of the ASME Code Class 2 and 3 PSI/ISI program is addressed with Class 1 components in Section 5.2.4, "Inservice Inspection and Testing of the RCPB," of this FSER. Accordingly, the staff's evaluation of this section focuses on the acceptability of the COL applicant's supplemental information and responses to US-APWR DCD COL information items and action items as they relate to PSI/ISI of ASME Code Class 2 and 3 components and the augmented ISI program for high-energy fluid system piping.

The staff reviewed conformance of Section 6.6 of the CPNPP, Units 3 and 4, COL FSAR, to the guidance in RG 1.206, Section C.III.1, Chapter 6, C.I.6.6, "Inservice Inspection of Class 2 and 3 Components." The NRC staff's review of the CPNPP, Units 3 and 4, COL FSAR, Section 6.6, finds that it incorporates by reference Section 6.6 of the US-APWR DCD. However, neither the referenced DCD nor the COL FSAR indicated the applicable ASME Code/Addenda for Class 2 and 3 components, as Table 5.2.1-1, "Applicable Code Addenda for RCS Class 1 Components," indicates for Class 1 components. Based on the above, the staff requested the information above from the COL applicant in **RAI 2970, Question 06.06-1**.

The COL applicant responded, in its document dated October 19, 2009, that as a result of RAI 232-2114 for the US-APWR DCD, the US-APWR DCD has been revised to include the 2001, edition and the 2003, addenda of ASME Section XI. Furthermore, the CPNPP, Units 3 and 4, FSAR incorporates the US-APWR by reference. As a result, the staff finds that the COLA as it relates to ISI is consistent with the DCD, meets the acceptance criteria of SRP 6.6, and **RAI 2970, Question 06.06-1,** is considered resolved and closed.

US-APWR COL Information Items

- STD COL 6.6(1)

The staff reviewed CPNPP, Units 3 and 4, COL FSAR Information Item STD COL 6.6(1), which states that a PSI/ISI program for the ASME Class 2 and 3 systems, components, piping, and supports will be developed and implemented in accordance with Table 13.4-201, "Operational Programs Required by NRC Regulation and Program Implementation." The subject information item proposes to replace a portion of Section 6.6 of the US-APWR DCD, which states that the COL applicant is responsible for the preparation of the PSI/ISI programs. Table 13.4-201, "Operational Programs Required by NRC Regulation and Program Implementation," states that

the PSI program implementation milestone will be prior to initial fuel load and that the ISI program implementation milestone will be prior to commercial service. At the COLA stage, the PSI/ISI programs were not developed, but rather will be developed after the COL is issued. Although Section 6.6 applies to Class 2 and 3 components, these components comprise portions of the total PSI/ISI program, which includes Class 1 components. Therefore, RG 1.206, Section C.III.1, Chapter 5, C.I.5.2.4.1, for the reactor coolant pressure boundary applies. It states that the detailed procedures for performing the examinations may not be available at the time of the COLA, and the COL applicant should make a commitment to provide sufficient information to demonstrate that the procedures meet ASME Code standards.

In order for the staff to make a reasonable assurance finding of the acceptability of the PSI/ISI operational programs, it must be able to inspect the construction of the plant for conformance to the regulations and the ASME Code of record. Therefore, the staff intends to impose the following license condition below:

- **License Condition (6-1)** – No later than 12 months after issuance of the COL, the licensee shall submit to the Director of the Office of New Reactors a schedule that supports planning for, and the conducting of, NRC inspections of the preservice inspection and ISI programs. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until either the PSI or ISI programs have been fully implemented.

As discussed in SECY-05-0197, "Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, tests, Analyses, and Acceptance Criteria," a COL applicant should provide schedules for implementation milestones for operational programs. The staff intends to impose this license condition to support its plans to inspect operational programs and their implementation as they are developed to ensure these programs are being implemented consistent with the COLA FSAR. As stated in SECY-05-197, "…recognizing that maintaining NRC inspection schedules will be critical to ensuring that the Commission has timely information on operational readiness."

The staff has determined that the applicant's response to STD COL Information Item 6.6-(1) is acceptable to the staff as it is consistent with the guidance described in SRP 6.6.

US-APWR COL Information Items

- STD COL 6.6(2)

The staff reviewed CPNPP, Units 3 and 4, COL FSAR, COL Information Item STD COL 6.6(2), which states that the implementation milestones of the augmented ISI program are the same as that specified for ISI of Class 2 and 3 components provided in Table 13.4-201. The subject information item proposes to replace a portion of the US-APWR DCD, Section 6.6.8, "Augmented ISI to Protect against Postulated Piping Failures," which states that the COL applicant is responsible for preparing an augmented ISI program for high-energy fluid system piping. RG 1.206, Section C.III.1, Chapter 6, C.I.6.6.8 and SRP 6.6, "Inservice Inspection and Testing of Class 2 and 3 Components," provide acceptance criteria for an augmented ISI program, which include accessibility, extent of examination, use of inspection ports, and areas

subject to examination. The information provided by the COL applicant did not provide sufficient detail for the staff to make a reasonable assurance finding regarding this operational program. Based on the above concern, the staff requested additional information in **RAI 2971, Question 06.06-2**.

In its response, dated October 19, 2009, the COL applicant stated that additional information was provided to MHI for incorporation into the DCD Section 6.6.8. The COL applicant stated that its ISI program contains information addressing areas subject to inspection, method of inspection, extent, and frequency in accordance with the requirements of IWC-2000 for examination of Category C-F welds. The inservice examination completed during each inspection interval is a 100 percent volumetric examination of circumferential and longitudinal pipe welds within the boundary of these portions of piping. The access provisions incorporated into the design of the US-APWR provide access for personnel and equipment to inspect the affected welds. In addition, the staff reviewed the changes to the US-APWR DCD, Section 6.6.8, Revision 3, and found that the additional level of detail had been incorporated into the DCD, and is therefore, acceptable. The staff concludes that the information provided by the applicant provides sufficient detail to reach a reasonable assurance finding on the acceptability of operational program for augmented ISI and is, therefore, acceptable.

6.6.5 Post Combined Operating License Activities

As discussed in FSAR Table 13.4-201, the applicant described the ISI and PSI programs and the implementation milestones.

As discussed above, the staff plans to impose the following license condition below:

- **License Condition (6-1)** – No later than 12 months after issuance of the COL, the licensee shall submit to the Director of NRO a schedule that supports planning for, and the conducting of, NRC inspections of the preservice inspection and ISI programs. The schedule shall be updated every 6 months until 12 months before scheduled fuel loading, and every month thereafter until either the PSI or ISI programs have been fully implemented.

The NRC staff will inspect the CPNPP, Units 3 and 4, PSI and ISI program plans during construction to verify compliance with 10 CFR 50.55a requirements prior to fuel load.

6.6.6 Conclusion

The staff is reviewing the information in US-APWR DCD Section 6.6 under Docket Number 52-021. The results of the NRC staff's technical evaluation of the information related to the Inservice Inspection of Class 2 and 3 components incorporated by reference in the CPNPP, Units 3 and 4, COL FSAR will be documented in the staff's SER for the US-APWR DC. The SER for the US-APWR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update Section 6.6 of this SER to reflect the final disposition of the DC application.

The NRC staff concludes that the information pertaining to the CPNPP, Units 3 and 4, COL FSAR, Section 6.6 is within the scope of the DC and adequately incorporates by reference the US-APWR DCD, Section 6.6, “Inservice Inspection of Class 2 and 3 Components.”

In addition, the staff concludes that the COL applicant’s proposed resolution to COL Information Items under Section 6.6.9 of the CPNPP, Units 3 and 4, COL FSAR, Revision 1, meets the relevant guidelines in SRP Section 6.6 and RG 1.206, Section C.III.1, Chapter 6, C.I.6.6 and, is, thus, acceptable. Conformance with these guidelines provides an acceptable basis for satisfying in part, the requirements of 10 CFR 50.55a. On the same bases, the staff concludes that the COL applicant has adequately closed out COL Information Items COL 6.6(1) and 6.6(2).

Furthermore, the staff finds that the plant specific information provided under STD COL Information Item 6.6(2) meets the relevant guidelines in SRP Section 6.6 and RG 1.206, Section C.III.1, Chapter 6, C.I.6.6.8, and, is thus, acceptable. The staff further concludes that the CPNPP, Units 3 and 4, COL FSAR, PSI, ISI, and augmented ISI programs and implementation milestones are consistent with the policy established in SECY-05-0197. Conformance with these guidelines and policy provides an acceptable basis for satisfying in part, the requirements of 10 CFR 50.55a.