CHAPTER 6

ENGINEERED SAFETY FEATURES

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6.2.2-2R	Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements

ACRONYMS AND ABBREVIATIONS

ASME	American Society of Mechanical Engineers
COL	Combined License
CPNPP	Comanche Peak Nuclear Power Plant
CRE	control room envelope
CSS	containment spray system
DCD	Design Control Document
ECCS	emergency core cooling system
ESF	engineered safety features
HVAC	heating, ventilation, and air conditioning
IDLH	Immediately dangerous to life and heaith
ISI	inservice inspection
MCR	main control room
NaTB	sodium tetraborate decahydrate
NEI	Nuclear Energy Institute
NPSH	net positive suction head
NRC	U.S. Nuclear Regulatory Commission
RCS	reactor coolant system
RG	Regulatory Guide
RWSP	refueling water storage pit
SI	safety injection
SIS	safety injection system
SSC	structures, systems, and components
TBE	thin bed effect

6.0 ENGINEERED SAFETY FEATURES

This section of the referenced Design Control Document (DCD) is incorporated by reference with no departures or supplements.

6.1 ENGINEERED SAFETY FEATURE MATERIALS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

6.1.1.1 Materials Selection and Fabrication

STD COL 6.1(2) Replace the fourth sentence of the fifth paragraph in DCD Subsection 6.1.1.1 with the following.

An augmented inservice inspection (ISI) program will be developed to ensure the structural integrity of such components during service and will be implemented in accordance with Table 13.4-201.

6.1.1.2.1 Compatibility of Construction Materials with Core Cooling Coolants and Containment Sprays

STD COL 6.1(3) Replace the fourth sentence of the second paragraph in DCD Subsection 6.1.1.2.1 with the following.

A program to maintain an inventory of all acids and bases within the containment to aid in control of the pH of the recirculating water will be developed prior to initial fuel load. An as-built tabulation of acids and bases will be prepared to assist in the control of pH during accident conditions. The tabulation will include inventories of acids/bases in the reactor coolant system (RCS), Accumulators, refueling water storage pit (RWSP), NaTB containers and acid generated during accident conditions (e.g., hydriodic acid, nitric acid, hydrochloric acid).

STD COL 6.1(4) Replace the fifth sentence of the second paragraph in DCD Subsection 6.1.1.2.1 with the following.

A list of materials within the containment that would yield hydrogen gas by corrosion from the emergency cooling or containment spray solutions will be prepared prior to initial fuel load.

6.1.1.2.2 Controls for Austenitic Stainless Steel

STD COL 6.1(1) Replace the fifth and sixth sentences of the first paragraph in DCD Subsection 6.1.1.2.2 with the following.

Programs that support the cleaning of materials and components, cleanliness control, and pre-operational flushing for systems that contain austenitic stainless steel components will be developed and implemented under the quality assurance program referenced in Sections 17.1, 17.2, 17.3 and 17.5 prior to initial fuel load.

6.1.2 Organic Materials

CP COL 6.1(5) Replace the last two sentences of the first paragraph in DCD Subsection 6.1.2 with the following.

An as-built list of organic materials will be prepared prior to initial fuel load. Organic materials that exist in significant amounts within the containment building are identified and quantified. Such organic materials include plastics, lubricants, paint or coatings, and electrical cable insulation.

6.1.3 Combined License Information

Replace the content of DCD Subsection 6.1.3 with the following.

STD COL 6.1(1) ***6.1(1)*** *Cleanliness control program for austenitic stainless steel*

This Combined License (COL) item is addressed in Subsection 6.1.1.2.2.

STD COL 6.1(2) ***6.1(2)*** *Augmented ISI program for cold-worked austenitic stainless steel components*

This COL item is addressed in Subsection 6.1.1.1.

STD COL 6.1(3) ***6.1(3)*** *Control program of pH within a post-LOCA environment*

This COL item is addressed in Subsection 6.1.1.2.1.

STD COL 6.1(4) ***6.1(4)*** *Identification of materials that would yield hydrogen gas*

This COL item is addressed in Subsection 6.1.1.2.1.

CP COL 6.1(5) ***6.1(5)*** *Identification and qualification of all organic materials in the containment*

This COL item is addressed in Subsection 6.1.2.

6.1(6) *Deleted from the DCD.*

6.2 CONTAINMENT SYSTEMS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

6.2.1.1.3.4 Description of Containment Analyses

STD COL 6.2(1) Replace the second sentence of the fourteenth paragraph in DCD Subsection 6.2.1.1.3.4 with the following.

The verification of passive heat sink data will be provided to confirm that the data based on as-built information is bounded by the data assumed in the maximum containment pressure analyses for postulated primary or secondary system rupture and the minimum containment pressure analyses. A report will be prepared to document the results of the verification for U.S. Nuclear Regulatory Commission (NRC) review. This report will be prepared prior to initial fuel load.

6.2.1.5.7 Passive Heat Sinks

STD COL 6.2(1) Replace the second sentence of the first paragraph in DCD Subsection 6.2.1.5.7 with the following.

The verification of passive heat sink data will be provided to confirm that the data based on as-built information is bounded by the data assumed in the maximum containment pressure analyses for postulated primary or secondary system rupture and the minimum containment pressure analyses. A report will be prepared to document the results of the verification for NRC review. This report will be prepared prior to initial fuel load.

6.2.2.3 Design Evaluation

STD COL 6.2(9) Replace the seventh paragraph of DCD Subsection 6.2.2.3 with the following.

Administrative programs which address the selection, procurement, and installation of insulation will be developed and implemented prior to the procurement phase.

STD COL 6.2(5) Replace the first sentence of the tenth paragraph in DCD Subsection 6.2.2.3 with the following.

Administrative procedures implement the containment cleanliness program.

Procedures to remove foreign materials and minimize the amount of debris that might be left in containment following refueling and maintenance outages address the following:

- Frequency of cleanliness control and inspection activities for operation and maintenance
- Restriction of materials introduced into the containment
- Accounting for materials introduced into and out of the containment (e.g., scaffold, tape, labels, plastic film, paper, cloth, keys, and pens)
- Cleaning of maintenance outage area, including areas associated with removal or replacement of insulation
- Cleanliness inspections and removal of debris/foreign material, including operation and maintenance areas, RWSP, debris interceptors, RWSP vent and drain lines (available for inspection), and strainer debris
- Preparation and review of entry/exit logs and inspection records

The containment cleanliness program including administrative procedures will be developed and implemented prior to initial fuel load.

6.2.4.2 System Design

STD COL 6.2(6) Replace the last sentence of the forth paragraph in DCD Subsection 6.2.4.2 with the following.

A list of as-built pipe run distances from the outer containment isolation valves to the containment penetrations will be prepared prior to initial fuel load.

6.2.5.2 System Design

STD COL 6.2(7) Replace the last paragraph in DCD Subsection 6.2.5.2 with the following.

The operating principle and accuracy of the hydrogen monitor (combustible gas analyzer) will be provided in procurement specifications and vendor supplied documentation prior to the procurement phase.

6.2.6.1 Containment Integrated Leakage Rate Testing

STD COL 6.2(8) Replace the first sentence of the first paragraph in DCD Subsection 6.2.6.1 with the following.

The containment leakage rate test program requirements are defined by Technical Specifications Subsection 5.5.16. Implementation milestone of the containment leak rate tests program is provided in Table 13.4-201.

6.2.8 Combined License Information

Replace the content of DCD Subsection 6.2.8 with the following.

STD COL 6.2(1) ***6.2(1)*** *Provision for as-built information of heat sinks*

This COL item is addressed in Subsections 6.2.1.1.3.4 and 6.2.1.5.7

6.2(2) *Deleted from the DCD.*

6.2(3) *Deleted from the DCD.*

6.2(4) *Deleted from the DCD.*

STD COL 6.2(5) ***6.2(5)*** *Preparation of a cleanliness, housekeeping and foreign materials exclusion program*

This COL item is addressed in Subsection 6.2.2.3 and Table 6.2.2-2R.

STD COL 6.2(6) ***6.2(6)*** *As-built pipe run distances from outer containment isolation valve to the containment penetration*

This COL item is addressed in Subsection 6.2.4.2.

STD COL 6.2(7) ***6.2(7)*** *Operating principle and accuracy of the hydrogen monitor*

This COL item is addressed in Subsection 6.2.5.2.

STD COL 6.2(8) ***6.2(8)*** *Containment leakage rate testing program*

This COL item is addressed in Subsections 6.2.6.1.

STD COL 6.2(9) ***6.2(9)*** *Administrative program for controlling selection, purchase, and installation of specific insulation products*

This COL item is addressed in Subsection 6.2.2.3 and Table 6.2.2-2R.

6.2(10) *Deleted from the DCD.*

Table 6.2.2-2R (Sheet 6 of 21)
Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements

	No.	Regulatory Position	US-APWR Design
	1.1.1.14	All drains from the upper regions of the containment building, as well as floor drains, should terminate in such a manner that direct streams of water, which may contain entrained debris, will not discharge downstream of the sump screen, thereby, bypassing the sump screen.	The US-APWR design of engineered safety features (ESF) structures, systems, or components (SSCs) does not include a containment spray system (CSS) or safety injection system (SIS) suction flow path that bypasses the RWSP suction strainers.
	1.1.1.15	Advanced strainer designs (e.g., stacked disc strainers) have demonstrated capabilities that are not provided by simple flat plate or cone-shaped strainers or screens. For example, these capabilities include built-in debris traps where debris can collect on surfaces while keeping a portion of the screen relatively free of debris. The convoluted structure of such strainer designs increases the total screen area, and these structures tend to prevent the condition sometimes referred to as the TBE. It may be desirable to include these capabilities in any new sump strainer/screen designs. The performance characteristics and effectiveness of such designs should be supported by the appropriate test data for any particular intended application.	An advanced strainer design is planned for the US-APWR. Thin Bed Effects (TBE) are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).
	1.1.2	**Minimizing Debris** The debris (see Regulatory Position 1.3.2) that could accumulate on the sump screen should be minimized.	**Design Features and Capabilities** The design features and capabilities employed to minimize debris are presented below.
STD COL 6.2(5)	1.1.2.1	Cleanliness programs should be established to clean the containment on a regular basis, and plant procedures should be established for the control and removal of foreign materials from the containment.	Cleanliness programs are addressed in Subsection 6.2.2.3.

Table 6.2.2-2R (Sheet 7 of 21)
Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements

STD COL 6.2(9)

No.	Regulatory Position	US-APWR Design
1.1.2.2	Insulation types (e.g., fibrous and calcium silicate) that are sources of debris known to readily transports to the sump screen and cause higher head losses may be replaced with insulation (e.g., reflective metallic insulation) that transports less readily and causes less severe head losses once deposited onto the sump screen. If insulation is replaced or otherwise removed during maintenance, abatement procedures should be established to avoid generating debris or its residue in the containment.	Particulate (e.g., Min-K-based) insulation is excluded from the containment by design. Selection, purchase, and installation of specific insulation products are addressed in Subsection 6.2.2.3.
1.1.2.3	To minimize potential debris caused by chemical reaction of the pool water with metals in the containment, exposure of bare metal surfaces (e.g., scaffolding) to containment cooling water through spray impingement or immersion should be minimized, either by removal or by chemical-resistant protection (e.g., coatings or jackets).	The principal measures taken by the US APWR design to preclude adverse chemical effects include the use of a buffering agent, NaTB, and minimizing the use of aluminum.
1.1.3	**Instrumentation** If relying on operator action to mitigate the consequences of the accumulation of debris on the ECC sump screens, safety-related instrumentation that provides operators with an indication and audible warning of impending loss of NPSH for ECCS pumps should be available in the MCR.	**Design Features and Capabilities** Containment spray and safety injection (SI) pump operating information is available in the main control room (MCR) to assist in net positive suction head (NPSH) evaluation and includes flow, suction, discharge pressure, and pump motor current.

Table 6.2.2-2R (Sheet 15 of 21)
Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements

	No.	Regulatory Position	US-APWR Design
STD COL 6.2(5)	1.3.2.5	The cleanliness of the containment during plant operation should be considered when estimating the amount and type of debris available to block the ECC sump screens. The potential for such material (e.g., thermal insulation other than piping insulation, ropes, fire hoses, wire ties, tape, ventilation system filters, permanent tags or stickers on plant equipment, rust flakes from unpainted steel surfaces, corrosion products, dust and dirt, latent individual fibers) to impact head loss across the ECC sump screens should also be considered.	The cleanliness of the containment during plant operation will be done with programs addressed in Subsection 6.2.2.3.
	1.3.2.6	In addition to debris generated by jet forces from the pipe rupture, debris created by the resulting containment environment (thermal and chemical) should be considered in the analyses. Examples of this type of debris would be disbondment of coatings in the form of chips and particulates or formation of chemical debris (precipitants) caused by chemical reactions in the pool.	Principal measures taken by the US APWR design to preclude adverse chemical effects include the use of the buffering agent, NaTB, and minimizing the use of aluminum.
	1.3.2.7	Debris generation that is due to continued degradation of insulation and other debris when Subjected to turbulence caused by cascading water flows from upper regions of the containment, or near the break overflow region should be considered in the analyses.	Break properties and debris production considerations are based on Nuclear Energy Institute (NEI) 04-07 methodology and are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).

6.3 EMERGENCY CORE COOLING SYSTEMS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

6.3.2.2.4 ECC/CS Strainers

STD COL 6.3(4) Replace the last paragraph in DCD Subsection 6.3.2.2.4 with the following.

Technical Specifications Subsection 3.5.4 establishes the OPERABILITY requirements for the RWSP water chemistry, and Technical Specifications Subsection 3.5.5 establishes other chemical requirements to ensure proper water chemistry for post-accident conditions. Additionally, the RWSP water chemistry control procedures address chemical requirements. Implementation of the surveillances and chemistry control procedures minimizes adverse chemical effects. A program to maintain RWSP water chemistry including surveillance test procedures will be developed and implemented prior to initial fuel load.

6.3.2.4 Material Specifications and Compatibility

STD COL 6.3(6) Replace the second paragraph in DCD Subsection 6.3.2.4 with the following.

An as-built list of materials (by their commercial names, quantities [estimated where necessary], and chemical composition) used in or on the emergency core cooling system (ECCS) will be prepared. The list is evaluated based on the as-procured, as-built system to determine potential adverse radiolytic or pyrolytic decomposition product interactions with the ESF systems. This evaluation, based on the as-procured, as-built system, will be prepared prior to initial fuel load.

6.3.2.8 Manual Actions

STD COL 6.3(3) Replace the first sentence of the last paragraph in DCD Subsection 6.3.2.8 with the following.

Station operating procedures for normal, abnormal, and emergency operation of the SI pumps, accumulators, and emergency letdown, including feed-and-bleed operation, will be developed and implemented in accordance with Section 13.5 prior to initial fuel load.

6.3.6 Combined License Information

Replace the content of DCD Subsection 6.3.6 with the following.

6.3(1) *Deleted from the DCD.*

6.3(2) *Deleted from the DCD.*

STD COL 6.3(3) ***6.3(3)*** *ECCS operating procedure*

This COL item is addressed in Subsection 6.3.2.8.

STD COL 6.3(4) ***6.3(4)*** *RWSP water chemistry including surveillance test procedures*

This COL item is addressed in Subsection 6.3.2.2.4.

6.3(5) *Deleted from the DCD.*

STD COL 6.3(6) ***6.3(6)*** *Preparation of an as-built list of material used in or on the ECCS*

This COL item is addressed in Subsection 6.3.2.4.

6.4 HABITABILITY SYSTEMS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

6.4.2.2.1 Main Control Room Emergency Filtration Unit

CP COL 6.4(4) Replace the last paragraph in DCD Subsection 6.4.2.2.1 with the following.

The type of charcoal adsorber is type III impregnated charcoal adsorber. The adsorber weight and distribution are provided in the final design in conjunction with vendor selection, as part of the procurement process. The design will be completed prior to initial fuel load.

6.4.3 System Operational Procedures

STD COL 6.4(2) Replace the second paragraph in DCD Subsection 6.4.3 with the following.

Operating procedures for normal, abnormal, and emergency operation of the MCR HVAC system are developed and implemented in accordance with Section 13.5. These procedures and associated training address the applicable operating and training aspects of Regulatory Guide (RG) 1.196. The procedures will be developed and implemented prior to initial fuel load.

6.4.4.2 Toxic Gas Protection

CP COL 6.4(1) Replace the second paragraph in DCD Subsection 6.4.4.2 with the following.

The control room habitability analyses consider postulated releases of toxic chemicals from mobile and stationary sources in accordance with the requirements of RG 1.78. Chemicals, including chemicals in Comanche Peak Nuclear Power Plant (CPNPP) Units 1 and 2, are identified and screened as described in Subsection 2.2.3.1.3.

Several hazardous chemicals exceed the screening criteria provided in RG 1.78 and an analysis is required to determine control room concentrations. 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. RG 1.78 specifies the use of HABIT 1.1 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 heating, ventilation, and air conditioning (HVAC) intake for the MCR. CHEM is then applied by HABIT to model chemical exposure to control room personnel, based on EXTRAN output and MCR design parameters.

The meteorological conditions assumed for these cases are conservatively set at G stability and 2.5 m/s wind speed, or slightly 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 analyses are thus bounding. Lower concentrations are calculated on average using F stability and 1 m/s wind speed.

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 well below the IDLH level. Values of IDLH for various chemicals are found in NUREG/CR-6624 (Reference 6.4-201).

The most limiting case, or the one that leads to the highest control room concentration relative to the IDLH, is the tanker truck release of chlorine on Highway FM 56, at a distance of closest approach to CPNPP Units 3 and 4 MCR intake of 1.4 miles. Chlorine is used for this case because it is one of the most hazardous Department of Transportation approved chemicals, and bounds other chemicals by toxicity, dispersibility, and quantity that may use public transportation such as Highway FM 56. Using the methodology prescribed by RG 1.78, the concentration remains below 5.2 ppm at equilibrium in the MCR. This concentration (5.2 ppm) is less than the IDLH concentration for chlorine (10 ppm). The concentration at the MCR HVAC intakes, that is the concentration of outside, will exceed the IDLH (10 ppm) at about 2.5 minutes, remain elevated until approximately 7 minutes, and then start decreasing slowly on a scale based on the volume and ventilation rates in the MCR.

RG 1.78 states that it is expected that a control room operator will don a respirator and protective clothing, or take other mitigating action within two minutes after detection. The concentration in the MCR reaches the human detection threshold for chlorine (3.5 ppm) at approximately 9 minutes and reaches the maximum concentration (5.2 ppm) in approximately 13 minutes. Also during a toxic gas emergency, the control room operators have the option of manually actuating the emergency isolation mode of the MCR HVAC System.

6.4.6 Instrumentation Requirement

CP COL 6.4(5) Replace the last paragraph in DCD Subsection 6.4.6 with the following.

Instrumentation to detect and alarm a hazardous chemical release in the vicinity of CPNPP Units 3 and 4, 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.

6.4.7 Combined License Information

Replace the content of DCD Subsection 6.4.7 with the following.

CP COL 6.4(1) ***6.4(1)*** *Toxic chemicals of mobile and stationary sources and evaluation of the control room habitability*

This COL item is addressed in Subsection 6.4.4.2.

STD COL 6.4(2) ***6.4(2)*** *Normal, abnormal, and emergency operating procedures for the MCR HVAC system*

This COL item is addressed in Subsection 6.4.3.

6.4(3) *Deleted from the DCD.*

CP COL 6.4(4) ***6.4(4)*** *Charcoal adsorber weight, type, and distribution*

This COL item is addressed in Subsection 6.4.2.2.1.

CP COL 6.4(5) ***6.4(5)*** *Toxic gas detection requirements necessary to protect the CRE*

This COL item is addressed in Subsection 6.4.6.

6.4.8 References

Add the following reference after the last reference in DCD Subsection 6.4.8.

6.4-201 U.S. Nuclear Regulatory Commission, *Recommendations for Revision of Regulatory Guide 1.78*, NUREG/CR-6624, Washington, DC, 1999.

6.5 FISSION PRODUCT REMOVAL AND CONTROL SYSTEMS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

6.5.1.7 Materials

STD COL 6.5(4) Replace the second sentence in DCD Subsection 6.5.1.7 with the following.

An as-built list of materials by their commercial names, quantities (estimated where necessary), and chemical composition used in or on the Annulus Emergency Exhaust System and MCR HVAC System will be prepared. The list is evaluated based on the as-procured, as-built system to confirm that there are no adverse radiolytic or pyrolytic decomposition product interactions with the ESF systems. This evaluation will be prepared prior to initial fuel load.

6.5.6 Combined License Information

Replace the content of DCD Subsection with the following.

6.5(1) *Deleted from the DCD.*

6.5(2) *Deleted from the DCD.*

6.5(3) *Deleted from the DCD.*

STD COL 6.5(4) ***6.5(4)*** *Provision for an as-built list of material used in or on the ESF filter systems*

This COL item is addressed in Subsection 6.5.1.7.

6.6 INSERVICE INSPECTION OF CLASS 2 AND 3 COMPONENTS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

STD COL 6.6(1) Replace the second sentence of the second paragraph in DCD Section 6.6 with the following.

A preservice inspection program (non-destructive base line examination) and an Inservice inspection program for American Society of Mechanical Engineers (ASME) Code Section III Class 2 and 3 systems, components (pumps and valves), piping, and supports will be developed and implemented in accordance with Table 13.4-201.

6.6.8 Augmented ISI to Protect Against Postulated Piping Failures

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STD COL 6.6(2) Replace the first sentence of the second paragraph in DCD Subsection 6.6.8 with the following.

The non-destructive examination method is 100 percent volumetric examination of circumferential and longitudinal welds in the affected piping during each 10-year inspection interval, except as exempted by ASME Code, Section XI, IWC-1220. Implementation milestones of the augmented ISI program are the same as that specified for inservice inspection of Class 2 and 3 components provided in Table 13.4-201.

6.6.9 Combined License Information

Replace the content of DCD Subsection 6.6.9 with the following.

STD COL 6.6 (1) ***6.6(1)*** *Preparation of a preservice inspection program and an inservice inspection program*

This COL item is addressed in Section 6.6.

STD COL 6.6(2) ***6.6(2)*** *Preparation of an augmented inservice inspection program for high-energy fluid system piping*

This COL Item is addressed in Subsection 6.6.8.