9.1.3 Spent Fuel Pool Cooling and Cleanup System

9.1.3(A) Introduction

The safety function to be performed by the spent fuel pool cooling system (SFPCS) (in conjunction with the spent fuel pool itself) is to assure that the spent fuel assemblies are cooled and remain covered with water during all storage conditions. Other functions performed by the system but not related to safety include water cleanup for the spent fuel pool, refueling canal, in-containment refueling water storage tank, and other equipment storage pools; means for filling and draining the refueling canal and other storage pools; and surface skimming to provide clear water in the storage pool.

9.1.3(B) Summary of Application

DCD Tier 1: In DCD Tier 1, Section 2.7.4.3, "Spent Fuel Pool Cooling and Cleanup System," the applicant states that the SFPCS is a safety-related system and that the spent fuel pool cleanup system (SFPCL) is non safety-related but, as showed in Figure 2.7.4.3-1, "Spent Fuel Pool Cooling and Cleanup System," a portion of the system provides the safety-related functions of containment isolation.

DCD Tier 2: The applicant has provided DCD Tier 2 system description in Section 9.1.3, "Spent Fuel Pool Cooling and Cleanup System" (SFPCCS), which consists of two separate subsystems: the SFPCS and the SFPCL.

The SFPCS consists of two redundant divisions that are independent of each other. The SFPCS, during normal and accident conditions, is designed to remove the decay heat that is produced by the spent fuel assemblies of the newest batch just offloaded from the core and the accumulated assemblies resulting from previous refueling. The SFPCS is shown in DCD Tier 2, Figure 9.1.3-1, "Spent Fuel Pool Cooling and Cleanup System Flow Diagram."

Each of the two cooling divisions is designed to maintain the pool temperature below 48.9 degrees Celsius °C (120 °F) during ~~refueling periods to facilitate operations in the pool area~~ [normal power operation], and a maximum temperature of 60 °C (140 °F) during normal and accident conditions.

Initial Test Program: DCD Tier 2, Section 14.2.12.1.77, "Spent Fuel Pool Cooling and Cleanup System Test," addresses the startup tests for the SFPCCS.

ITAAC: The ITAAC associated DCD Tier 2, Section 9.1.3, are identified in DCD Tier 1, Section 2.7.4.3, "Spent Fuel Pool Cooling and Cleanup System."

Technical Specifications: There are no TSs applicable to the spent fuel pool cooling and ~~purification~~ [cleanup] system; however, related TS information can be found in DCD Tier 2, Chapter 16, Sections 3.7.14, "Spent Fuel Storage Pool Water Level," through 3.7.16, "Spent Fuel Storage"; 4.3, "Fuel Storage"; and Bases 3.7.14, "Spent Fuel Storage Pool Water Level," through Bases 3.7.16, "Spent Fuel Storage." These TSs are reviewed in Section 9.1.2, "New and Spent Fuel Storage," of this report.

The staff confirmed that DCD Tier 2, Section 3 states that the auxiliary building is designed to sustain external missile impact and that the divisional wall in the auxiliary building provides protection from the effects of internally generated missiles. The staff evaluation of the adequacy of missile barriers is addressed in Chapter 3, "Design of Structures, Components, Equipment, and Systems," of this report.

The staff also finds that locating the auxiliary building outside the turbine trajectory hazard zone meets the recommendation of RG 1.13, Regulatory Position C.2, which states that the spent fuel storage facility should be designed to (a) keep extreme winds and missiles generated by those winds from causing significant loss of watertight integrity of the fuel storage pool, and (b) keep missiles generated by extreme winds from contacting fuel within the pool. Therefore, the staff concludes that the SFPCCS design meets the requirements of GDC 4.

9.1.3(D)(c) ***GDC 5, Sharing of structures, systems, and components***

Compliance with GDC 5 requires that SSCs important to safety not be shared among nuclear power units unless it can be shown that such sharing will not impair their ability to perform their safety functions.

The APR1400 design is a single-unit design, and a COL applicant must comply with GDC 5 for a multiple-unit site; therefore, the staff finds that the SFPCCS design satisfies the requirements of GDC 5 as they relate to whether shared SSCs important to safety are capable of performing their required safety functions.

9.1.3(D)(d) ***GDC 61, Fuel storage and handling and radioactivity control***

Compliance with GDC 61 requires that the fuel storage system be designed to assure adequate safety under normal and postulated accident conditions. The system shall be designed with:

- the capability to permit appropriate periodic inspection and testing of components important to safety; suitable shielding for radiation protection;
- appropriate containment, confinement, and filtering capability;
- residual heat removal that reflects the importance to safety of decay heat and other residual heat removal; and
- the capability to prevent a significant reduction in fuel storage coolant inventory under accident conditions.

normal power operation

The SFPCS is a safety-related, seismic category I system designed to provide SFP cooling under normal and accident conditions. The system consists of two redundant, independent, one hundred percent capacity divisions, each capable of maintaining the SFP water below 48.9ºC (120 °F) during ~~normal operations~~ (including one single active failure) or below 60°C (140°F) assuming a full core offload (including one single active failure). The decay heat is transferred from the SFPCS heat exchangers to the CCW. DCD Tier 2 Section 9.1.1 defines a fueling batch as 112 fuel assemblies. The SFP has a total storage capacity of 1,792 fuel assemblies. Tier 2 Table 9.1.3.-2, "Spent Fuel Pool Cooling System Principal Component Design Parameters," presents the design parameters for the SFPCS heat exchanger and the pump.

The staff confirmed that DCD Tier 2, Section 3 states that the auxiliary building is designed to sustain external missile impact and that the divisional wall in the auxiliary building provides protection from the effects of internally generated missiles. The staff evaluation of the adequacy of missile barriers is addressed in Chapter 3, "Design of Structures, Components, Equipment, and Systems," of this report.

The staff also finds that locating the auxiliary building outside the turbine trajectory hazard zone meets the recommendation of RG 1.13, Regulatory Position C.2, which states that the spent fuel storage facility should be designed to (a) keep extreme winds and missiles generated by those winds from causing significant loss of watertight integrity of the fuel storage pool, and (b) keep missiles generated by extreme winds from contacting fuel within the pool. Therefore, the staff concludes that the SFPCCS design meets the requirements of GDC 4.

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- the capability to permit appropriate periodic inspection and testing of components important to safety; suitable shielding for radiation protection;
- appropriate containment, confinement, and filtering capability;
- residual heat removal that reflects the importance to safety of decay heat and other residual heat removal; and
- the capability to prevent a significant reduction in fuel storage coolant inventory under accident conditions.

The 112 is the storage capacity of new fuel storage rack, but not fueling batch.

The SFPCS is a safety-related, seismic category I system designed to provide SFP cooling under normal and accident conditions. The system consists of two redundant, independent, one hundred percent capacity divisions, each capable of maintaining the SFP water below 48.9ºC (120 °F) during normal operations (including one single active failure) or below 60°C (140°F) assuming a full core offload (including one single active failure). The decay heat is transferred from the SFPCS heat exchangers to the CCW. ~~DCD Tier 2 Section 9.1.1 defines a fueling batch as 112 fuel assemblies.~~ The SFP has a total storage capacity of 1,792 fuel assemblies. Tier 2 Table 9.1.3.-2, "Spent Fuel Pool Cooling System Principal Component Design Parameters," presents the design parameters for the SFPCS heat exchanger and the pump.

The applicant's response states that, by designing the refueling pool seal as a seismic Category II component, this maintains the structural integrity of continuous structure without the failure under all postulated design conditions according to the Seismic Category II definition; therefore, the function of the seal will be assured.

The staff evaluated the applicant's response and determined that the applicant has misinterpreted the definition of a seismic Category II component. According to DCD Tier 2, Section 3.3.2, seismic Category II SSCs are designed to preclude a gross structural failure resulting from an SSE that could degrade the ability of an adjacent safety-related SSC to function to an unacceptable level or result in incapacitating injuries to personnel in the MCR. Designing the refueling pool seal as a seismic Category II component does not preclude seal leakage as stated in the applicant's response. Therefore, the staff requested the applicant to revise their response to RAI 7992, Question 9.1.4-1, Item (a). The staff is tracking the resolution of RAI 161-7992, Question 9.1.4-1 Item (a) as Open Item 9.1.4-1.

Refueling Cavity Drainage Paths

In response to RAI 7992, Question 9.1.4-1, Item (b), the applicant discusses the different pathways capable of draining the refueling cavity. The applicant's description states that leakage through the refueling pool seal would not occur since the seal is designed to seismic Category II standards.

As discussed above, the staff does not agree with this conclusion. Classifying a structure as a seismic Category II does not preclude failure of the structure; it, however, precludes catastrophic failure. This limits the amount of leakage through the seal.

The applicant's RAI response also addresses the inadvertent draining due to system misalignments. The applicant identified that the refueling pool is provided with connections to the SFPCCS, the shutdown cooling system (SCS), and the IRWST. All the different connections mentioned in the RAI response are provided with several isolation valves or check valves to reduce the possibility of a draindown event. In addition, the availability of these valves provide the capability of mitigating in case a draindown event occurs.

9.1.4−5 or 9.1.4−6

The staff evaluated the applicant's response and determined that it does not address the drainage caused by failures of non-Seismic Category I SSCs that connect to the refueling pool. In RAI 8588 (ADAMS Accession No. ML16123A212), Question 9.1.4-4, the staff requests the applicant to identify all non-Seismic Category I SSCs that connect to the refueling pool (including their associated elevations), and to evaluate the drain-down scenario caused by failure of these non-Seismic Category I SSCs. The staff is tracking the resolution of RAI 8588, Question 9.1.5-4 as Open Item 9.1.4-2.

9.1.4−5 or 9.1.4−6

Impact and Mitigation of Refueling Cavity Leakage

In RAI 7992, Question 9.1.4-1, Item (b), the staff requested the applicant to provide a refueling cavity drain-down evaluation, as described in SRP 9.1.4.III.3.D.ii. The applicant's response indicates the worst drain-down scenario as the one in which the spent fuel assembly is temporarily stored, in a vertical position, in the fuel carrier upender.

The staff evaluated the applicant's response and determined that additional information is needed. Taking into consideration the refueling operations, the staff would have expected the worst case to occur with fuel already located in the double-capacity upender and another fuel

9.3.1(E) Combined License Information Items

The applicant did not provide a detailed design of the compressed gas systems; therefore, the applicant proposed a COL item requiring a COL applicant to complete the design of the compress gas system.

COL 9.3(4) The COL applicant is to provide the supply systems of the nitrogen gas subsystem, the hydrogen subsystem, the carbon dioxide subsystem, and the breathing air systems.

The staff evaluated the proposed COL 9.3(4) and determined that, since the compressed gas system has no safety-related function other than containment isolation, requiring the COL applicant to address the design details of the compressed gas system is acceptable.

9.3.1(F) Conclusion

Based on the review above, the staff concludes that the SER remains incomplete pending resolution of the identified Open Item. The staff will update Section 9.3.1 of this SER to reflect the final disposition of the DCD.

9.3.2 Process and Post-Accident Sampling Systems

9.3.2(A) Introduction

The Process and Post-Accident Sampling System (PPASS) allows the plant staff to obtain liquid and gaseous samples and determine their physical and chemical characteristics by measurement and analysis. Centralized and local facilities permit samples to be taken of primary and secondary coolant, containment atmosphere, liquid and gaseous waste treatment systems, and the IRWST. The system consists of the normal primary sampling system (NPSS), the post-accident sampling system (PASS), and the secondary sampling system (SSS).

, 9.3.2-1, and 9.3.2-3

9.3.2(B) Summary of Application

DCD Tier 1: In the DCD Tier 1 Document, Section 2.7.2.6, “Process and Post-Accident Sampling Systems” the applicant describes the PPASS sampling functions and the safety-related containment isolation function. The Tier 1 information includes design information and ITAAC related to functional arrangement, ASME Code requirements, seismic design, instrumentation, controls, displays, and alarms.

DCD Tier 2: The applicant has described the sampling systems in DCD Section 9.3.2, “Process and Post-Accident Sampling Systems,” where it is asserted that the process sampling system has no safety function apart from containment isolation. Detailed descriptions of all the sample points and the type of sampling done at each are contained in DCD Tables 9.3.2-1 ~~and 9.3.2-2~~. These descriptions include samples of the primary reactor coolant, gaseous samples from containment, sampling of containment sumps and tanks, and sampling of secondary side water.

ITAAC: The ITAAC related to the PPASS are listed in DCD Tier 1 Subsection 2.7.2.6.

The acceptance criteria are delineated in the SRP Section 9.3.2; in particular, the applicant should demonstrate sampling of the sites mentioned on page 9.3.2-6 of SRP 9.3.2. Also, sampling procedures should adhere to the guidelines of RG 1.21, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste,” (Reference 2), Regulatory Positions C.2, C.6, and C.7, specifically, and the EPRI report, “PWR Primary Water Chemistry Guidelines” (Reference 3).

9.3.2(D) Technical Evaluation

The staff reviewed the information provided in DCD Tier 2, Section 9.3.2, “Process and Post-accident Sampling System,” Revision 0, against the guidance of SRP Section 9.3.2. SRP 9.3.2 contains a number of detailed acceptance criteria that should be met concerning sampling of many fluids and gasses.

, 9.3.2-1, and 9.3.2-3

9.3.2(D)(a) *Sampling Locations*

SRP Section 9.3.2 requires a number of sample locations to be included in order to satisfy regulatory criteria; these are listed in a table on page 9.3.2-6 of SRP 9.3.2. The applicant has listed numerous sample locations in DCD Tables 9.3.2-1 ~~and 9.3.2-2~~. The tables in the DCD also summarize the species that are to be measured at each sample point in accordance to the EPRI PWR Primary and Secondary Water Chemistry Guidelines. The tables in the DCD list many more locations in addition to those required by SRP 9.3.2, indicating a very extensive and thorough sampling system. The staff agrees that these features of the system design and operation are consistent with SRP guidance and, therefore, satisfy the requirements of GDC 13, 14, 26, 40, 60, 63, and 64, as they relate to sampling locations identified in SRP 9.3.2.

9.3.2(D)(b) *Sampling Procedures*

Most samples (including all from the RCS) are collected manually (i.e., “grab samples”). Grab sample instruments are calibrated regularly with known standards. Liquid samples from the RCS are conducted through stainless steel pipe to a common sample room outside of containment. The sample lines from the RCS hot leg include extra length to delay arrival of the sample sufficiently to allow for decay of ^{16}N.

Shielded compartments are available in the sample room to minimize exposure to personnel from potentially radioactive samples. The sample panel is situated in a ventilated, hooded enclosure to further reduce the possibilities of exposure or contamination. Spilled or leaked water is routed to a waste holdup tank for processing. The DCD does not supply information regarding the actual handling of samples, especially those that might contain radioactive materials. The local grab sample ports do use quick-disconnect couplings, but there is no information in the DCD on the time it takes for samples to be analyzed once they are drawn.

In RAI 8464 (ADAMS Accession No. ML16032A392),Question 09.03.02-1, the staff requested that the applicant provide more information on its sample procedures, specifically the handling of the samples and the timing of the analyses. By response dated March 21, 2016 (ADAMS Accession No. ML16081A212), the applicant clarified that the time needed to perform sampling and analysis will be estimated based on operating experience. During normal operation the analysis of the samples will be performed within one hour. This time is appropriate based on the experience of the operating fleet for protecting personnel from excessive radiation exposures and to minimize loss of short-lived radionuclides by decay. The staff finds this

Safety Injection, Chemical and Volume Control, and Sampling System. The program shall include the following:

> a. *Preventive maintenance and periodic visual inspection requirements*

and

> b. *Integrated leak test requirements for each system at least once per 24 months.*

This describes a program intended to fulfill the requirements of NUREG-0737, Item III.D.1.1. This program will be completed by the COL applicant under COL Item 9.3(1) and the initial and periodic tests would be performed by the COL holder. Based on the above, the staff finds the applicant has appropriately described the recommended program to meet NUREG-0737, Item III.D.1.1 as required by GL-80-90, "Post TMI Requirements, NUREG-0737" and 10 CFR 50.34(f)(2)(xxvi).

9.3.2(E) Combined License Information Items

DCD Tier 2, Table 1.8-2, lists the information items that are required of the COL applicant to supply information or action to supplement the certified design.

Item No.	Description
9.3(1)	The COL applicant is to provide the operational procedures and maintenance program as related to leak detection and contamination control.
9.3(2)	The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations.

As described above in Section 9.3.2(D)(c), COL Item 9.3(1) addresses operational procedures and programs to address Three Mile Island action items. The staff finds the COL item acceptable because it is appropriate for COL applicants and holders to provide procedure and program details. The staff finds COL Item 9.3(2) acceptable because it addresses as-built plant information that cannot be provided in the design certification.

9.3.2(F) Conclusion

will

The staff has not been able to make its safety findings for the RPASS relative to GDC 1 and 2 and therefore this section of the SER is incomplete. The staff will revise Section 9.3.2 of the SER following final resolution of these issues.

The staff reviewed the COL items for the EFDS and found them acceptable.

9.3.3(F) Conclusion

Based on the review above, the staff concludes that the SER remains incomplete pending satisfactory resolutionof the open item identified in the staff's technical evaluation in this report. The staff will update Section 9.3,3 of this SER to reflect the final disposition of the DCD.

9.3.4 Chemical and Volume Control System

9.3.4(A) Introduction

The CVCS is designed to maintain the required water inventory, chemistry, and purity in the RCS through its charging and letdown functions, provide flow to the reactor coolant pump seals, and control the boron neutron absorber concentration in the reactor coolant. Section 9.3.4(D) of this SER summarizes the CVCS, which performs both safety and non-safety-related functions.

9.3.4(B) Summary of Application

DCD Tier 1: The Tier 1 information associated with this section is found in Tier 1 Section 2.4.6, "Chemical and Volume Control System."

DCD Tier 2: The applicant provided a Tier 2 system description in Section 9.3.4, "Chemical and Volume Control System (Including Boron Recovery System)," summarized here, in part, as follows.

The DCD provides information regarding the CVCS design as a whole and on a component basis. The CVCS performs the following functions: (1) maintains the coolant inventory in the RCS for all modes of operation; (2) provides seal water flow to the RCS pumps; (3) provides makeup capability for small RCS leaks; (4) regulates the boron concentration in the reactor coolant during normal operation; (5) controls the reactor coolant water chemistry; (6) performs purification by removal of the fission and activation products in the reactor coolant; (7) borates the RCS for cold shutdown; and (8) provides pressurizer auxiliary spray water for depressurization of the RCS when none of the RCS pumps are operating.

The CVCS performs the following safety functions: (1) maintains the integrity of the RCPB; and (2) provides containment isolation of CVCS lines penetrating containment.

In general, the CVCS consists of charging pumps, a regenerative heat exchanger, a letdown heat exchanger, ion exchangers, filters, pumps, tanks, and associated valves, piping, and instrumentation. The system parameters are given in DCD Tier 2, Table 9.3.4-3.

The DCD also provides information regarding the system operation during plant startup, normal operation, plant shutdown, and accident operation. Furthermore, the DCD presents information on the availability and reliability, accident response, provisions for leakage detection and control, and a radiological evaluation of the CVCS.

ITAAC: The ITAAC associated with DCD Tier 2, Section 9.3.4 are given in DCD Tier 1, Section 2.4.6, Table 2.4.6-4, "Chemical and Volume Control System ITAAC."

Changed to Table 9.3.4-2 in DCD rev.1

Changed to Section 3.1.8 in DCD rev.01

Technical Specifications: The TS associated with DCD Tier 2, Section 9.3.4 are given in DCD Tier 2, Chapter 16, and evaluated in Chapter 16 of this report. These include Section 3.1.9, "Charging Flow," Section 3.3.14, "Boron Dilution Alarms," Section 3.9.1, "Boron Concentration," and chemistry-related requirements of DCD Tier 2, Section 3.4.15, "RCS Specific Activity."

9.3.4(C) Regulatory Basis

The relevant requirements of the NRC regulations for this area of review, and the associated acceptance criteria, are given in NUREG-0800, Section 9.3.4, "Chemical and Volume Control System (PWR) (Including Boron Recovery System)," and are summarized below. NUREG-0800, Section 9.3.4also provides review interfaces with other SRP sections.

1. GDC 1, Quality standards and records, as it relates to system components being assigned quality group classifications and application of quality standards in accordance with the importance of the safety function to be performed.

2. GDC 2, Design bases for protection against natural phenomena, as it relates to structures housing the facility and the system itself being capable of withstanding the effects of earthquakes.

3. GDC 5, Sharing of structures, systems, and components, as it relates to shared systems and components important to safety being capable of performing required safety functions.

4. GDC 14, Reactor coolant pressure boundary, as it relates to assuring RCPB material integrity by means of the CVCS being capable of maintaining RCS water chemistry necessary to meet PWR RCS water chemistry TSs.

5. GDC 29, Protection against anticipated operational occurrances, as it relates to the reliability of the CVCS to provide negative reactivity to the reactor by supplying borated water to the RCS in the event of anticipated operational occurrences, if the plant design relies on the CVCS to perform the safety function of boration for mitigation of design-basis events.

6. GDC 33, Reactor coolant makeup, as it relates to the CVCS capability to supply reactor coolant makeup in the event of small breaks or leaks in the RCPB, to function as part of ECCS assuming a single active failure coincident with the loss of offsite power, and to meet ECCS TSs, if the plant design relies on the CVCS to perform the safety function of safety injection as part of ECCS.

7. GDC 55, Reactor coolant pressure boundary penetrating containment, as it relates to the CVCS capability of isolating containment.

8. GDC 60, Control of releases of radioactive materials to the environment, and GDC 61, Fuel storage and handling and radioactivity control, as they relate to CVCS components having provisions for venting and draining through closed systems.

9. 10 CFR 50.34(f)(2)(xxvi), as it relates to the provisions for a leakage detection and control program to minimize the leakage from those portions of the CVCS outside of the containment that contain or may contain radioactive material following an accident.

Changed to Table 9.3.4-1 in DCD rev.01.

Add "a"

auxiliary charging positive displacement pump (ACP), a boric acid batching tank, boric acid storage tank, two boric acid makeup pumps, a holdup tank, a gas stripper, two holdup pumps, a boric acid concentrator, a reactor makeup water tank, two reactor makeup water pumps, and associated piping and valves. The applicant provided flow diagrams and CVCS process and instrumentation diagram (P&ID) in DCD Tier 1, Figure 2.4.6-1, "Chemical and Volume Control System," and DCD Tier 2, Figure 9.3.4-1, "Chemical and Volume Control System Flow Diagram." The staff reviewed the drawings and confirmed that they provide equipment locations along with system interconnections, pressure and temperature ratings, and safety or seismic classifications. The applicant provided the principal component data summary of the CVCS in DCD Tier 2, Table 9.3.4-2, "Principal Component data Summary." The staff reviewed the component data summary, including design pressures and materials, and confirms that the applicant used materials appropriate for the chemical environment of the CVCS.

The staff noted that during normal operation, letdown flow from the RCS passes through the tube side of the regenerative heat exchanger and the letdown heat exchanger. The temperature reduction occurs to cool the letdown water to purification subsystem operating conditions. The applicant stated that it reduced the letdown fluid pressure from RCS pressure to purification subsystem operating conditions in two stages. The first stage occurs at the letdown orifices, and the second occurs at the letdown control valves downstream of the orifices. The letdown flow is then filtered, monitored via a process radiation monitor and a boronometer, purified via the purification ion exchanger, and sprayed into the VCT through the hydrogen overpressure gas. The VCT water is then sucked into the inlet of the charging pumps. From there, the water passes through charging restricting orifices and the charging flow control valves. Finally, an RCP seal injection filter diverts a portion of the charging flow to the RCP injection system. The shell side of the regenerative heat exchanger injects the un-diverted charging fluid back into the RCS.

a portion of the charging flow diverts to the RCP seal injection system through one of two RCP seal injection filters.

The staff confirmed that the design includes a pressurizer level setpoint program that varies as a function of the RCS average temperature, and the pressurizer level control system maintains the reactor coolant inventory. If the VCT level gets to a high-level setpoint, the pre-holdup ion exchanger and gas stripper will divert letdown flow to the holdup tank. If the VCT level gets to a low-level setpoint, normally, with the makeup system set for automatic, the BAST and reactor makeup water tank (RMWT) will provide a preset blend of boric acid and demineralized water to the VCT, respectively. A low-low VCT level signal will cause the VCT outlet valves to close and switch the charging pump suction to the BAST.

switch the charging pump suction to the BAST, and then cause the VCT outlet valves to close.

The staff noted that the design provides two [covered] protection to preclude pump damage under [covered] not safety-related; thus, the staff concluded that the applicant's minimum flow protection for the charging pumps is adequate commensurate with the pump's importance to safety. Additionally, the applicant's CVCS design provides an auxiliary charging pump parallel to the two centrifugal pumps to maintain RCP seal injection if the two centrifugal pumps are unavailable.

The staff noted that the CVCS will remove oxygen from the coolant via hydrazine when the reactor coolant temperature is below 150 °F, and when the reactor is at normal operating power, the hydrogen cover gas in the VCT provides oxygen scavenging. Lithium-7 hydroxide (LiOH, enriched in Lithium-7) maintains the coolant's pH.

The staff noted that the operators normally control the boron concentration via feed and bleed. To change the boron concentration, the makeup system supplies either reactor makeup water

The staff reviewed the required actions and surveillance requirements together with the completion times allotted for corrective action and surveillance frequencies and found that the applicant's proposed TSs are acceptable.

This COL item is related to subsection 9.3.1(Compressed Air and Gas Systems), not 9.3.4(CVCS). The same COL item is already described in page 9-145 of SER.

9.3.4(E) Combined License Information Items

DCD Tier 2, Table 1.8-2 lists the information items that are required of the COL applicant to supply information or action to supplement the certified design. There are four information items contained in this table related to the CVCS; they are:

1. COL 9.3(1) – The COL applicant is to provide operational procedures and maintenance programs as related to leak detection and contamination control;
2. COL 9.3(2) – The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations;
3. COL 9.3(3) – The COL applicant is to prepare the site radiological environmental monitoring program; and
4. ~~COL 9.3(4) – The COL applicant is to provide the supply systems of the nitrogen gas subsystem, the hydrogen subsystem, the carbon dioxide subsystem, and the breathing air systems.~~

The staff identified an additional COL item that the applicant should add to Table 1.8-2 for the CVCS.

4 → ~~5.~~ COL 9.3(5) – The COL applicant is to provide primary side water chemistry threshold values and recommended operator actions for chemistry excursions in compliance with the latest version of the EPRI PWR Primary Water Chemistry Guidelines in effect at the time of COLA Submittal. The COL applicant is to establish the operation water chemistry program six months before fuel load.

The applicant agreed to add COL 9.3(5) to ensure the COL applicant references the latest edition of the EPRI Guidelines and provides threshold values and operator actions for primary water chemistry that are in compliance with the latest version of the EPRI Guidelines. The staff finds this acceptable and will verify the addition of this COL information item in the next revision of the DCD and is tracking RAI 8367, Question 05.02.03-15 as a confirmatory item.

9.3.4(F) Conclusion

The staff finds that the design of the CVCS is acceptable and meets the intent of the SRP Acceptance criteria regarding to GDC 1, 2, 5, 33, 55, 60, 61, 10 CFR 50.34(f)(2)(xxvi), 10 CFR 50.63(a)(2), and 10 CFR 52.47(b)(1). Specifically, with respect to safety functions of the CVCS, the staff concludes that the safety-related system components have appropriate ASME Code Section III classifications. The staff also concludes that the applicant assures the RCPB integrity by designing parts of the CVCS which interact with the RCS to withstand full RCS pressure. In addition, the staff concludes that the APR1400 design includes a containment isolation signal that causes containment isolation valves in the CVCS to close when required by the design. Furthermore, the staff concludes that providing an alternate AC source of power to power the auxiliary charging pump, which maintains RCP seal integrity during a SBO, the requirements of because the APR1400 design utilizes a controlled-leakage building which encloses the fuel to limit the potential release of radioactive iodine and other radioactive materials. The staff review of the ESF filtration trains as they relate to RG 1.52 and GDC 60 is discussed in Section 6.5.1 of this report.

9.4.2(D)(e) ***ITAAC***

The staff reviewed the proposed ITAAC for the Fuel Handling Area HVAC System and its associated safety-related features. The applicant's proposed ITAAC requirements in DCD Tier 1, Tables 2.7.3.2-3, and DCD Tier 2, Section 14.3 were reviewed. The staff finds that sufficient information has been provided to comply with SRP Section 14.3 and SRP Section 14.3.7.

The staff finds that the DCD Tier 1 ITAAC tables adequately address verification of the functional arrangement, physical separation, and seismic qualification of the system. The staff concludes that the design, fabrication, and inspection of the filter systems is in accordance with ASME AG-1 code requirements. The staff also concludes that ITAAC tables verify the minimum inventory of system Alarms Displays and Controls and the ITAAC verify required safety-related functions of the system. Acceptance criteria are based on meeting the relevant requirements of 10 CFR 52.47(b)(1), which requires that the KHNP DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable criteria met the provisions of Atomic Energy Act, and the NRC regulations. Based on this review, the staff has concluded that the fuel handling area HVAC system of a plant that incorporates the design certification will be built and will operate in accordance with NRC regulations, as the systems conform with RG 1.29, RG 1.52, RG 1.140, and RG 1.13

9.4.2(E) Combined License Information Items

The following is a list of item numbers and descriptions from Table 1.8-2 of the DCD.

Table 9.4.2-1 Combined License Information Items

Item No.	Description	DCD Tier 2 Section
9.4(1)	The COL applicant is to provide the capacities of heating coils in the safety-related air handling units and cooling and heating coils in the non-safety-related air handling units affected by site-specific conditions.	9.4.2

9.4.2(F) Conclusion

Based on the review above, the staff concludes that the SER remains incomplete pending satisfactory resolution of the Open Item identified in the staff's technical evaluation. The staff will update Section 9.4.2 of this SER to reflect the final disposition of the DCD.

We cannot find the open items in the technical evaluation of 9.4.2.
Would you check again?

During normal operation, all iodine filtration trains (AU01A, AU01B, AU01C, and AU01D) are secured and fully bypassed with the upstream and downstream dampers in the auto-closed position. Upon receipt of an ESFAS-SIAS signal, the ~~fuel~~ auxiliary building controlled area emergency exhaust ACUs start automatically and the exhaust air is redirected through the iodine filtration trains.

Therefore, because the ABCAEES is designed to conform to the guidance of RG 1.52, including Regulatory Position C.3 as described in Section 6.5.1 of this report, the staff finds the design of Emergency Exhaust ACUs complies with GDC 60 regarding provisions to suitably control the release of gaseous and liquid radioactive effluents to the environment.

The staff reviewed compliance with RG 1.140 for normal exhaust ACUs (AU03, AU04, AU05, AU06, AU07, and AU08) as discussed below.

RG 1.140, Regulatory Position C.2

Per RG 1.140, Regulatory Position C.2.1, the design of a normal atmosphere cleanup system should be based on the anticipated operating ranges for temperature, pressure, relative humidity, and radiation levels during normal plant operations and anticipated operational occurrences. In DCD Tier 2, Section 9.4.5.1.3, the applicant specifies the design temperature range for the areas served and states that design and construction of ACUs conform to ASME AG-1-2009 and ASME N509-2002. The staff reviewed ASME AG-1 and ASME N509 to determine if the operating ranges for temperature, relative humidity, pressure, and radiation levels were identified for normal plant operations and anticipated operational occurrences.

Both ASME AG-1 and ASME N509 indicate that design requirements shall be specified for temperature, relative humidity, pressure, and radiation levels. While the applicant has only provided information on the operating ranges for temperature associated with normal plant operation for the areas served, the applicant's commitment to use ASME AG-1 and ASME N509 provides assurance that the final design will consider pressures, relative humidity, and radiation levels for normal plant operations and anticipated operational occurrences. Therefore, the staff finds that the design of normal exhaust ACUs conforms to RG 1.140, Regulatory Position C.2.1.

In accordance with RG 1.140, Regulatory Position C.2.2, if the normal atmosphere cleanup system is located in an area with high radiation during normal plant operation, then adequate shielding of components and personnel from the radiation source should be provided.

According to DCD Tier 2, Figures 1.2-11 to 1.2-18, all ACUs and the interspersed ducts, dampers, and related instrumentation are located in rooms inside the auxiliary building. According to DCD Tier 2, Figures 12.3-3 to 12.3-9, these room are assessed as radiation zones from 2 to 7 during normal operation. The staff reviewed DCD Tier 2, Section 12.3, "Radiation Protection Design Features." Designs features are in place to provide adequate shielding between high-radiation areas and the low-radiation areas that are occupied by plant personnel. According to DCD tier 2, Table 12.3-4, "Design Basis Radiation Shield Thicknesses," minimum required shielding thicknesses for rooms in Auxiliary Building are identified.

Further staff analysis of the protection measures is provided in Section 12.3 of this report. The staff finds that the design of Normal Exhaust ACUs conforms to RG 1.140, Regulatory Position C.2.2.

In accordance with RG 1.140, Regulatory Position C.2.3, the operation of any normal atmosphere cleanup system should not degrade the expected operation of any ESF system that

c. External telephone

This system provides a convenient means of communication between major buildings and offsite areas. Switching and distribution equipment for the external telephone system is compatible with the other neighbor unit.

d. PABX power source

The PABX is powered from the plant non-safety-related load group and consists of independent battery chargers and batteries for each PABX node. The batteries have the capability to operate the plant telephone system for approximately 16 hours following loss of normal alternating current (ac) power.

The staff finds the information provided in APR1400 DCD, Tier 2, Rev 0, Section 9.5.2 regarding the Telephone System, supplements meeting the requirements of 10 CFR 50.47(b)(8).

Plant Time Synchronizing System

This system consists of a master clock and subsidiary clocks. The master clock is located in the communication equipment room and subsidiary clocks are located throughout the plant. The master clock provides standard time synchronizing signals to necessary plant equipment.

The staff finds the information provided in APR1400 DCD, Tier 2, Rev 0, Section 9.5.2 regarding the ~~Commercial Telephone~~ System, supplements meeting the requirements of 10 CFR Part 50, Appendix E.

Plant Time Synchronizing

Local Area Network System and Virtual Private Network

The LAN system is a computer network. It consists of routers, backbone switches, workgroup switches, servers, clients, network interface cards, and fiber-optic/twisted pair cables. The plant LAN links up plant terminals with construction and the head office host computers. LAN system is located in the MCR, TSC, Operations Support Center (OSC), etc. The VPN system is a private network across public networks like the Internet. The VPN system provides plant with the capability of communicating to other units and the head office. Plant VPN links the plant computer terminals with the head office host computers. The COL applicant provides the LAN and VPN system (COL 9.5(8)).

The staff finds the information provided in APR1400 DCD, Tier 2, Rev 0, Section 9.5.2 regarding the LAN and VPN System, supplements meeting the requirements of 10 CFR 50.47(b)(8).

Wireless Communication System

This system is designed to provide a stand-alone method of plant-wide communication between designated personnel equipped with, or having access to wireless two-way radios. This is the primary source of communications for emergency personnel. The wireless communication system is comprised of transmitters, receivers, antennas, amplifiers, and radio base station equipment. Antennas and amplifiers are distributed throughout the plant. Repeaters are used to allow seamless radio coverage throughout the plant. For areas that are not properly served by the primary antenna, other antennas and cables interconnecting the repeaters to the base station equipment are provided such that there is improved radio signal penetration. Radio coverage is provided throughout the plant, although radio usage in certain I&C areas is

The staff identifies Confirmatory Item per RAI 8179, Question 09.05.03-3 to verify the backup power sources in the revised DCD Tier 1, Section 2.6.8.1 and DCD Tier 2, Section 9.5.3.2**.**

In Section 9.5.3.3, "Safety Evaluation," of the DCD Tier 2, the applicant stated that during LOOP, SSE, and SBO, the emergency AC lighting is interrupted until the power supply to the Class 1E AC buses is restored. During this period, the emergency DC lighting powered from the station battery or the individual self-contained battery pack provides adequate illumination for safe shutdown operations and for movement of personnel to the access and egress route. Since the self-contained battery pack lighting provides a minimum illumination of 0.1 foot-candle, the staff in RAI 8179, Question 09.05.03-4, requested the applicant to clarify whether both types of emergency DC lighting are used to provide adequate illumination during LOOP, SSE, and SBO; and to confirm that all safe-shutdown operations can be performed with the self-contained battery lighting only. In the November 4, 2015 response, the applicant stated that the emergency DC lighting powered from both the station battery and the individual self-contained battery pack provides illumination during LOOP, SSE, and SBO. The applicant further clarified that in areas where self-contained battery pack lighting fixtures only cannot provide sufficient illumination for safe-shutdown operations, emergency DC lighting fixtures fed from the station batteries are provided to ensure required illumination levels in those areas. The staff finds the applicant's response acceptable since both types of emergency DC lighting will be provided to ensure adequate illumination in areas required for safe shutdown operations during an SBO event. However, since the applicant's clarification is not in the DCD, the staff in follow-up RAI 8466, Question 09.05.03-11, requested the applicant to revise Section 9.5.3 of the DCD Tier 2 to incorporate the above clarification. In their response dated March 10, 2016, the applicant provided a mark-up revision of Section 9.5.3.2 of DCD Tier 2 to include the above clarification. The staff finds the mark-up change acceptable. Therefore, the staff considers RAI 8466, Question 09.05.03-11 resolved. The staff identifies Confirmatory Item per RAI 8466, Question 09.05.03-11 to verify the above clarification in the revised Section 9.5.3.2 of DCD Tier 2.

Based on the above, the staff finds that the applicant has adequately addressed the effect of an SBO on the emergency lighting system as the emergency DC and AC lighting will be available to provide adequate illumination during an SBO event. The staff also finds that the emergency lighting system conforms to ~~NUEG~~-0800, Section 9.5.3.

NUREG

RG 1.75, Regulatory Position C(1) recommends supplemental capability and testing criteria for an acceptable breaker or fuse that is automatically opened by fault current, in addition to the electrical isolation criteria provided in IEEE Std. 384-1992 for Class 1E isolation devices. In DCD Tier 2, Section 9.5.3.3, the applicant stated that isolation devices, as indicated in IEEE Std. 384-1992, are used to electrically isolate lighting circuits from Class 1E circuits, but did not provide the supplemental capability and testing criteria recommended by RG 1.75. In RAI 8179, Question 09.05.03-1, the staff requested the applicant to provide additional information about the isolation devices that will be used to electrically isolate the Class 1E circuits from the non-Class 1E lighting circuits; and to discuss conformance of the APR1400 design to RG 1.75 in regards to lighting systems. The staff also requested the applicant to add RG 1.75 and IEEE Std. 384-1992 to the references' section 9.5.11, "References," in DCD Tier 2. In the November 4, 2015 response, the applicant stated that the isolation devices between the Class 1E motor control centers (MCCs) and non-Class 1E lighting circuits are Class 1E molded case circuit breakers (MCCBs) with associated relay(s) and protective device(s). The MCCBs have the proper capabilities according to RG 1.75 and IEEE Std. 384-1992, and these capabilities will be demonstrated with periodic testing performed in accordance with RG 1.75, Regulatory Position C(1). The applicant further stated that non-Class 1E cables feeding the emergency AC lighting