COMBUSTION ENGINEERING

May 25, 1988
LD-88-034

Docket No. STN 50-470F
(Project No. 675)

Mr. Guy Vissing, Project Manager
Standardization and Non-Power Reactor
Project Directorate
Office of Nuclear Regulation
Attn: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Response to NRC Request for Additional Information on Chapter 10 CESSAR-DC, Secondary Water Chemistry

References: (A) Letter, G. S. Vissing (NRC) to A. E. Scherer (C-E), dated February 25, 1988

(B) Letter, LD-87-068, A. E. Scherer (C-E) to F. J. Miraglia (NRC), dated November 30, 1987

Dear Mr. Vissing:

Reference (A) requested that Combustion Engineering provide additional information on CESSAR-DC Chapter 10. Enclosure (1) to this letter provides our responses and Enclosure (2) provides the corresponding revisions to our submittal of Reference (B).

Should you have any questions, please feel free to contact me or Dr. M. D. Green of my staff at (203) 285-5204.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

AES:bir
Enclosures: As Stated

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cc: Frank Ross (DOE-Germantown)

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Response to NRC Request for Additional Information Concerning Chapter 10, CESSAR-DC, Secondary Water Chemistry

References:

(1) Letter, G. S. Vissing (NRC) to A. E. Scherer (C-E) dated February 25, 1988

(2) "Safety Evaluation Report Related to the Final Design of the Standard Nuclear Steam Supply Reference System CESSAR System 80", NUREG-0852, dated November 1981

Reference (1) requested that Combustion Engineering provide additional information on CESSAR-DC, Chapter 10. This enclosure provides our responses.

Question 281-8

The EPRI ALWR Requirements Document, Chapter 3, Paragraph 4.2.7, requires a plant design which provides system features which facilitate compliance with EPRI NP-5056-SR, PWR Secondary Water Chemistry Guidelines. Section 10.3.5 does not reference the EPRI Secondary Water Chemistry Guidelines. A generic secondary water chemistry program that conforms with SRP Section 5.4.2.1, Branch Technical Position MTEB 5.3 should be provided.

Response 281-8

The System 80+^{TM} design complies with the EPRI ALWR Requirements Document, Chapter 3, Paragraph 4.2.7. The System 80+ design provides system features which facilitate compliance with the secondary water chemistry requirements described in EPRI Report NP-5056-SR, dated June 1984, "PWR Secondary Water Chemistry Guidelines." Specifically, the secondary water system, the makeup water system, and the process sampling system, as described in CESSAR-DC Sections 9.2.3, 9.3.2, 10.3.5, 10.3.6, 10.4.6, 10.4.7, and 10.4.8, have been designed to be consistent with the referenced EPRI guidelines.

To demonstrate the consistency of CESSAR-DC, Chapter 10, with the above-referenced EPRI "PWR Secondary Water Chemistry Guidelines", Combustion Engineering (C-E) has performed a comparison between the CESSAR-DC proposed operating chemistry limits and the EPRI Guidelines. This comparison revealed six (6) differences. C-E has reviewed these six differences and has elected to conform with the EPRI Guidelines in each instance. Tables 10.3.5-1 and 10.3.5-2 will be revised to reflect C-E's concurrence with the EPRI Guidelines.

In addition to the above chemistry limits, Section 10.3.5 of CESSAR-DC stipulates general provisions for a secondary water chemistry program. These provisions were presented in CESSAR-F and were judged by the NRC staff to meet the acceptance criteria for the non-plant specific details of water chemistry programs as specified in Branch Technical Position MTEB 5-3 [see section 10.3.1 of Reference (2)].

Since the water chemistry limits are consistent with the current EPRI guidelines and since other general provisions have not been changed relative to CESSAR-F, C-E believes that the previous NRC conclusion remains valid.

Question 281-9

Section 10.3.5 provides operating chemistry limits for secondary steam generator water, feedwater and condensate. Normal and Abnormal limits are provided for secondary water. However, the three action levels and corrective actions to be considered (as recommended by the EPRI PWR Secondary Water Chemistry Guidelines) are not provided.

Response 281-9

Section 10.3.5 of CESSAR-DC provides normal, abnormal, and immediate shutdown limits for secondary water and discusses the corrective actions to be performed when these limits are exceeded. This information is presented in the last six (6) paragraphs of Section 10.3.5.1, and in Tables 10.3.5-1 and 10.3.5-2. A detailed comparison of the CESSAR-DC normal, abnormal, and immediate shutdown limits with the EPRI "PWR Secondary Water Chemistry Guidelines" (see Table 1) was performed. This comparison showed that C-E's chemistry limits and recommended Corrective Actions are consistent with the EPRI Action Levels and their recommended corrective actions. CESSAR-DC Section 10.3.5.1 will be revised to make it clear that C-E's secondary water chemistry program includes normal, abnormal, and immediate shutdown limits.

Table 1

EPRI PWR Secondary Water Chemistry Guidelines for Corrective Actions

Action Levels Status	Corrective Actions Status
Normal Value Range	None
Action Level 1 (Normal Range Exceeded)	(1) Return parameter to within Normal Value Range within one week following confirmation of excursion. (2) If parameter is not within Normal Value Range within one week following confirmation of excursion, then go to Action Level 2 for parameters having Action Level 2 values.
Action Level 2	(1) Reduce power to appropriate level (typically 30% or less) within four hours of initiation of Action Level 2. (2) Return parameter to within Normal Value Range within 100 hours or go to Action Level 3 for those parameters having Action Level 3 values.
Action Level 3	(1) Shutdown within 4 hours and clean up by feed and bleed or drain and refill as appropriate until normal values are reached.

Question 281-10

Section 10.3.5 does not provide guideline parameters and corresponding normal and action values for:

a. cold shutdown/wet layup steam generator sample,
b. heat-up (>200°F to <5 percent power) steam generator blowdown sample,
c. feedwater - during fill,
d. heat-up feedwater sample, and
e. power operation condensate sample.

as recommended in the EPRI PWR Secondary Water Chemistry Guidelines.

Response 281-10

As stated in the response to Question 281-8, Section 10.3.5 stipulates requirements which set forth general provisions for a secondary water chemistry program. The requirements set forth in Section 10.3.5 (primarily Tables 10.3.5-1 and 10.3.5-2) define, for plant power operation (>5% power), the secondary water chemistry parameters, their limits, and the allowable time span that these chemistry parameters may be out of their operational limits. In order to more fully distinguish condensate and feedwater chemistry requirements, Table 10.3.5-2 will be revised to be feedwater specific, and a new Table 10.3.5-3, Operating Chemistry Limits for Condensate, will be added to CESSAR-DC. Detailed operating guidelines for cold shutdown/wet layup, system fill, and system heat-up are implemented into plant-specific water chemistry programs which, past experience has shown, are developed based on input from both Combustion Engineering and EPRI.

Question 281-11

Section 10.3.6.2 does not include materials selection recommendations in EPRI ALWR Requirements Document (Chapter 1, Section 5.3.B) regarding prohibition of copper alloys and design considerations identified in EPRI NP-2294, "Guide to the Design of Secondary Systems and Their Components to Minimize Oxygen-Induced Corrosion" for the steam and feedwater system.

Response 281-11

The following will be added to Section 10.3.6.2 to address material selection for minimizing erosion-corrosion of components in the steam and power conversion system, in accordance with EPRI's ALWR Requirements Document:

- No copper alloys are used for components that are in contact with feedwater, steam, or condensate.
- Oxygen induced corrosion is minimized by providing the following component materials:
    - Moisture separator reheater tubes are ferritic stainless steel.
    - Low pressure feedwater heater tubes are type 304L stainless steel with 304L-clad carbon steel tube sheets.
    - High pressure feedwater heater tubes are type 316L stainless steel with 316L-clad carbon steel tube sheets.
    - The condenser tube material is type 304L stainless steel for fresh water applications with chloride levels below 200 ppm. For chloride levels up to 500 ppm, type 316L stainless steel tubing is used. A higher grade of stainless steel (such as 904L or AL-6X) is used for chloride levels between 500 and 800 ppm. For brackish or salt water applications with high chlorides (greater than 800 ppm), or water contaminated by sewage discharges, titanium tubing is used.

- The condenser tube sheets are specified as follows:
    - For 304L stainless steel tubes, 304L stainless-clad carbon steel tube sheets are used.
    - For 316L stainless steel tubes, 316L stainless-clad carbon steel tube sheets are used.
    - For titanium tubing, titanium-clad carbon steel tube sheets are used.
- The main steam piping, hot reheat piping, condensate piping, feedwater piping, and heater drain piping upstream of the drain control valve are carbon steel. Extraction steam piping, heater drain piping downstream of the drain control valves, and other piping exposed to wet steam or flashing liquid flow are either chrome-moly or stainless steel. The degree of corrosion/erosion resistance of the piping material is consistent with the temperature, moisture content, and velocity of the steam to which the piping is exposed.

Question 281-12

Section 10.4.6.2, item 4, the purpose of the resin traps should be included (i.e., to remove resin fines). Item 5 should include the requirement that the minimum flow rate of the condensate polisher should be specified by the manufacturer to prevent channeling.

Response 281-12

C-E agrees with these recommendations. Item 4 of Section 10.4.6.2 will be revised to state, "Resin traps are installed down stream of each ion exchanger to remove resin fines." The sentence, "In addition, a minimum flow rate is specified by the manufacturer to prevent channeling," shall be inserted after the first sentence of Section 10.4.6.2, Item 5.

Question 281-13

Section 10.4.6.2 does not meet the EPRI ALWR Requirements Document regarding utilization of a side stream condensate polisher system which contains deep bed mixed bed ion exchangers.

Response 281-13

The first paragraph of Section 10.4.6.2 will be revised as follows to indicate compliance with the EPRI ALWR Requirements Document:

> "The condensate cleanup system utilizes a side stream, full condensate flow polisher, located downstream of the condensate pumps. Deep bed, mixed resin ion exchangers are utilized to obtain the advantage of their larger capacity in the event of the inleakage of impurities, to reduce the probability of resin discharge to the feed system due to failure of resin retention elements, and to simplify system operation."

Enclosure (2)
to LD-88-034
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PROPOSED REVISIONS TO THE COMBUSTION ENGINEERING STANDARD SAFETY ANALYSIS REPORT

Q/R 281-9

b. Continuous blowdown of the steam generator to reduce the concentrating effects of the steam generator.

c. Chemical addition to establish and maintain an environment which minimizes system corrosion.

d. Preoperational cleaning of the feedwater system.

e. Minimizing feedwater oxygen content prior to entry into the steam generator.

Secondary water chemistry is based on the zero solids treatment method. This method employs the use of volatile additives to maintain system pH and to scavenge dissolved oxygen which may be present in the feedwater.

A neutralizing amine is added to establish and maintain alkaline conditions in the feedtrain. Neutralizing amines which can be used for pH control are ammonia, morpholine, and cyclohexylamine. Ammonia should be used in plants employing condensate polishing to avoid resin fouling. Although the amines are volatile and will not concentrate in the steam generator, they will reach an equilibrium level which will establish an alkaline condition in the steam generator.

Hydrazine is added to scavenge dissolved oxygen which may be present in the feedwater. Hydrazine also tends to promote the formation of a protective oxide layer on metal surfaces by keeping these layers in a reduced chemical state.

Both the pH agent and hydrazine can be injected continuously at the discharge headers of the condensate pumps or condensate demineralizer, if installed. These chemicals are added as necessary for chemistry control, and can also be added to the upper steam generator feed line when necessary.

Operating chemistry limits for secondary steam generator water and feedwater and condensate are given in Tables 10.3.5-1, ~~and~~ 10.3.5-2, and 10.3.5-3.

The limits stated are divided into three ~~two~~ groups: normal, ~~and~~ abnormal, and immediate shutdown. The limits provide high quality chemistry control and yet permit operating flexibility. The normal chemistry conditions can be maintained by any plant operating with little or no condenser leakage. The abnormal steam generator limits are suggested to permit operations with minor system fault conditions until the affected component can be isolated and/or repaired. The immediate shutdown limits represent chemistry conditions at which continued operation ~~will~~ could result in severe steam generator corrosion damage. 10

The following procedures are recommended for protection against secondary system and steam generator corrosion: 12

When the normal range is exceeded, immediate investigation of the problem should be initiated, sampling frequency increased to the abnormal level (at least twice per 8 hour shift) and blowdown increased to one (1) percent of the main steaming rate. The problem should be corrected and the parameter(s) returned to the normal range within one week. If this cannot be done, and the parameter has a listed abnormal range, power should be reduced ~~to 25%~~ as if the abnormal range had been exceeded. 10

Q|R 281-9

When the abnormal range is exceeded, power should be reduced to the lowest value ~~(maximum of~~ typically 25% or less~~)~~ consistent with automatic operation of the feed system. Continued plant operation is then possible while corrective action is taken. Power reduction should be initiated within four hours of exceeding the abnormal range. The problem should be corrected and the parameter(s) returned to the normal range within one hundred (100) hours. If this cannot be done, the unit should be shut down. When an immediate shutdown limit is exceeded the unit must be shut down within four hours to prevent rapid steam generator corrosion. 10

Draining or flushing of the steam generators will be necessary to reduce the impurity concentration. 5

10.3.5.2 Corrosion Control Effectiveness

Alkaline conditions in the feed train and the steam generator reduce general corrosion at elevated temperatures and tend to decrease the release of soluble corrosion products from metal surfaces. These conditions promote the formation of a protective metal oxide film and thus reduce the corrosion products released into the steam generator.

Hydrazine also promotes the formation of a metal oxide film by the reduction of ferric oxide to magnetite. Ferric oxide may be loosened from the metal surfaces and be transported by the feedwater. Magnetite, however, provides an adherent protective layer on carbon steel surfaces.

The removal of oxygen from the secondary water is also essential in reducing corrosion. Oxygen dissolved in water causes general corrosion that can result in pitting of ferrous metals, particularly carbon steel. Oxygen is removed from the steam cycle condensate in the main condenser deaerating section and by the full flow feedwater deaerator which is a portion of the low pressure feedwater heaters. Additional oxygen protection is obtained by chemical injection of hydrazine into the condensate stream. Maintaining a residual level of hydrazine in the feedwater ensures that any dissolved oxygen not removed by the main condenser is scavenged before it can enter the steam generator. 12

The presence of free hydroxide (OH^-) can cause rapid corrosion (caustic stress corrosion) if it is allowed to concentrate in a local area. Free hydroxide is avoided by maintaining proper pH control, and by minimizing impurity ingress in the steam generator.

Zero solids treatment is a control technique whereby both soluble and insoluble solids are excluded from the steam generator. This is accomplished by maintaining strict surveillance over the possible sources of feed train contamination (e.g: Main Condenser cooling water leakage, air inleakage and subsequent corrosion product generation in the Low Pressure Drain System, etc.). Solids are also excluded, as discussed above, by injecting only volatile chemicals to establish conditions which reduce corrosion and, therefore, reduce the transport of corrosion products into the steam generator. Reduction of solids in the steam generator can also be accomplished through the use of full flow condensate demineralization.

In addition to minimizing the sources of contaminants entering the steam generator, continuous blowdown is employed to minimize their concentration.

Q/R 281-11

These systems are discussed in Section 10.4.6. With the low solid levels which result from employing the above procedures, the accumulation of corrosion deposits on steam generator heat transfer surfaces and internals is limited. Corrosion product formation can alter the thermal hydraulic performance in local regions to such an extent that deposits create a mechanism which allows impurities to concentrate to high levels, and thus could possibly cause corrosion. Therefore, by limiting the ingress of solids into the steam generator, the effect of this type of corrosion is reduced. 12

Because they are volatile, the chemical additives will not concentrate in the steam generator, and do not represent chemical impurities which can themselves cause corrosion.

10.3.6 STEAM AND FEEDWATER SYSTEM MATERIALS

10.3.6.1 Fracture Toughness

Materials are in compliance with Sections II and III of the ASME Boiler and Pressure Vessel Code with respect to fracture toughness and meet the requirements of ASME Section III, articles NB-2300, NC-2300, and ND-2300.

10.3.6.2 Materials Selection and Fabrication

1) Materials used are included in Appendix I of Section III of the ASME Code. 12

2) No austenitic stainless steel piping material is used in these systems.

3) Cleaning and acceptance criteria are based on the requirements of ANSI N45.2.1-73 and the recommendations of NRC Regulatory Guide 1.37.

4) Low-alloy steels are not used in the systems for piping materials.

5) The degree of compliance with NRC Regulatory Guide 1.71, "Welder Qualification for Areas of Limited Accessibility", is discussed in Section 1.8.

6) Nondestructive examination procedures for tubular products conform to the requirements of the ASME Code, Section III, NC-2000 for Class 2 materials.

INSERT A

INSERT A (Q/R 281-11)

7) No copper alloys are used for components that are in contact with feedwater, steam or condensate.

8) Oxygen induced corrosion is minimized by providing the following component materials:

   a) Moisture separator reheater tubes are ferritic stainless steel.

   b) Low pressure feedwater heater tubes are type 304L stainless steel with 304L-clad carbon steel tube sheets.

   c) High pressure feedwater heater tubes are type 316L stainless steel with 316L-clad carbon steel tube sheets.

   d) The condenser tube material is type 304L stainless steel for fresh water applications with chloride levels below 200 ppm. For chloride levels up to 500 ppm, type 316L stainless steel tubing is used. A higher grade of stainless steel (such as 904L or AL-6X) is used for chloride levels between 500 and 800 ppm. For brackish or salt water applications with high chlorides (greater than 800 ppm), or water contaminated by sewage discharges, titanium tubing is used.

   e) The condenser tube sheets are specified as follows:

      o For 304L stainless steel tubes, 304L stainless-clad carbon steel tube sheets are used.

      o For 316L stainless steel tubes, 316L stainless-clad carbon steel tube sheets are used.

      o For titanium tubing, titanium-clad carbon steel tube sheets are used.

   f) The main steam piping, hot reheat piping, condensate piping, feedwater piping, and heater drain piping upstream of the drain control valve are carbon steel. Extraction steam piping, heater drain piping downstream of the drain control valves, and other piping exposed to wet steam or flashing liquid flow are either chrome-moly or stainless steel. The degree of corrosion/erosion resistance of the piping material is consistent with the temperature, moisture content, and velocity of the steam to which the piping is exposed.

Q/R 281-8

TABLE 10.3.5-1

OPERATING CHEMISTRY LIMITS FOR SECONDARY STEAM GENERATOR WATER

10

Variable	Normal(1) Specifications	Abnormal Limits
pH (mixed system)(2)	8.5 - 9.0	
(copper free)	9.0 - 9.5(5)	
Cation Conductivity(3)	≤ 0.8 μmhos/cm	0.8-2.0 μmhos/cm
Silica	≤ 300 ppb	
Chloride	≤ 20 ppb	20-100 ppb
Sodium(4)	≤ 20 ppb	20-100 ppb
Sulfate	≤ 20 ppb ~~≤ 15 ppb~~	~~15-100 ppb~~

12

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NOTES:

(1) Normal specifications are those which should be maintained by continuous steam generator blowdown during proper operation of secondary systems.

(2) A mixed system is any secondary system containing copper alloy components.

(3) If the immediate shutdown limit of 7.0 μmhos/cm is exceeded, the unit should be shut down within four hours.

(4) If the immediate shutdown limit of 500 ppb is exceeded, the unit should be shut down within four hours.

(5) In plants where condensate polishers are in operation, the pH of a copper-free system can be controlled to a value of ≥ 8.8, with action required at < 8.8. 12

Q/R 281-8

TABLE 10.3.5-2

OPERATING CHEMISTRY LIMITS FOR FEEDWATER ~~AND CONDENSATE~~ Q/R 281-10

Variable	Normal(1) Specifications	
pH		
a. Mixed system	8.8 - 9.2	
b. Copper-free system	9.3 - 9.6(~~6~~ 3)	
Conductivity (Intensified cation) ~~(Feedwater)~~ (4)	≤ 0.2 μmhos/cm	
Hydrazine (Feedwater)	~~10 - 50~~ ≥20 ppb	
Dissolved Oxygen	≤ 5 ppb	
~~(Feed)~~	~~< 3 ppb~~	
~~(Condensate)~~ ~~(2)~~	~~< 10 ppb~~	
Sodium(~~3~~ 4)	≤ 3 ppb	
Iron ~~(Feedwater)~~	≤ 20 ppb	10
~~pH Control Additive~~	~~(5)~~	
Copper ~~(Feedwater)~~ (~~4~~ 2)	≤ 2 ppb	

NOTES:

(1) Normal specifications are those which should be maintained during proper operation of secondary systems.

~~(2) The condensate abnormal limit is 10-30 ppb, but the requirement for immediate shutdown does not apply even if the problem is not corrected within 100 hrs.~~

~~(3) For the condensate, sodium is monitored at each condenser hot well.~~

(~~4~~ 2) Analysis not required for copper-free systems.

~~(5) Limit is dependent upon pH.~~

(~~6~~ 3) In plants where condensate polishers are in operation, the pH of a copper-free system can be controlled to a value of ≥ 9.0, with action required at < 9.0. 12

(4) Conductivity and sodium are diagnostic parameters. These values were set as a means of addressing steam purity concerns. It is realized that lower values will be needed to meet blowdown limitations in Table 10.3.5-1. Feedwater sodium values of << 1 ppb are required to meet steam generator water quality. Likewise, cation conductivity values of << 0.2 are generally required to meet steam generator water quality.

Q/R 281-8

TABLE 10.3.5-~~2~~ 3

OPERATING CHEMISTRY LIMITS FOR ~~FEEDWATER AND~~ CONDENSATE

Q/R 281-10

Variable	Normal(1) Specifications	
~~pH~~		
~~a. Mixed system~~	~~8.8 – 9.2~~	
~~b. Copper-free system~~	~~9.3 – 9.6(6)~~	
~~Conductivity (Intensified cation)(Feedwater)~~	~~< 0.2 µmhos/cm~~	
~~Hydrazine (Feedwater)~~	~~10 – 50 ppb~~	
Dissolved Oxygen		
~~(Feed)~~	~~< 3 ppb~~	
~~(Condensate)~~ (2)	≤ 10 ppb	
~~Sodium(3)~~	~~< 3 ppb~~	
~~Iron (Feedwater)~~	~~< 20 ppb~~	10
~~pH Control Additive~~	~~(5)~~	
~~Copper (Feedwater)(4)~~	~~< 2 ppb~~	

NOTES:

(1) Normal specifications are those which should be maintained during proper operation of secondary systems at >5% power.

(2) The condensate abnormal limit is 10-30 ppb, but the requirement for immediate shutdown does not apply even if the problem is not corrected within 100 hrs.

~~(3) For the condensate, sodium is monitored at each condenser hot well.~~

~~(4) Analysis not required for copper-free systems.~~

~~(5) Limit is dependent upon pH.~~

~~(6) In plants where condensate polishers are in operation, the pH of a copper-free system can be controlled to a value of > 9.0, with action required at < 9.0.~~ 12

This system is not required for the safe shutdown of the reactor and has no safety function. 12

10.4.4.4 Inspection and Testing Requirements

This system is non safety-related.

10.4.4.5 Instrumentation Application

The control system for the Turbine Bypass System is described in Section 7.7.1.1.5 (Steam Bypass Control System).

10.4.5 CIRCULATING WATER SYSTEM

(Later - pending completion of EPRI Chapter 8)

10.4.6 CONDENSATE CLEANUP SYSTEM

10.4.6.1 Design Basis

The Condensate Cleanup System (CCS) is an integral part of the Condensate System. The CCS is designed to remove dissolved and suspended impurities which can cause corrosion damage to secondary system equipment. The CCS also removes radioisotopes which might enter the system in the event of a primary to secondary steam generator tube leak. The condensate polishing demineralizers (CPD) will also be used to remove impurities which could enter the system due to a condenser circulating water tube leak.

10.4.6.2 System Description

Q/R 281-13

The condensate cleanup system utilizes a side stream② full condensate flow polisher, located downstream of the condensate pumps. Deep bed, mixed resin ion exchangers are utilized to obtain the advantage of their larger capacity in the event of the inleakage of impurities, to reduce the probability of resin discharge to the feed system due to failure of resin retention elements, and to simplify system operation. 12

The final design and layout of the condensate cleanup system are described in the site-specific SAR. The following functional requirements are to be met to ensure a reliable system.

1. The polishing system is sized to meet the chemistry requirements for continuous operation specified in Section 10.3.5 while operating with a condenser leak of 0.001 gpm and to maintain water quality during an orderly unit shutdown (not longer than 8 hours) with a leak of 0.1 gpm irregardless of the type of cooling water.
2. The number and sizing of the ion exchangers are such that the functional requirements can be met while permitting the replacement of resin in one ion exchanger at a time.
3. Plant features are provided to facilitate replacement of ion exchange resin. No ion exchange resin regeneration system is provided.
4. Resin traps are installed down stream of each ion exchanger to remove resin fines.

Q/R 281-12

Q/R: 281-12

5. Design flow rates through the demineralizers are 40 gpm/ft^2 or less. In addition, a minimum flow rate is specified by the manufacturer to prevent channeling. Minimum bed height is 3 ft.

6. The demineralizer outlet lines are fitted with individual flow regulating valves.

7. The system design permits full flow recirculation through each ion exchanger for cleanup and verification of resin bed performance after resin replacement and prior to alignment within the system.

8. Ion exchanger isolation valve and recirculation valves are designed to permit slow, controlled opening to minimize hydraulic surges on the resin bed. 12

10.4.6.3 Safety Evaluation

This system is non safety-related.

10.4.6.4 Inspection and Testing Requirements

This system is non safety-related.

10.4.6.5 Instrumentation Applications

This system is non safety-related.

10.4.7 CONDENSATE AND FEEDWATER SYSTEMS

10.4.7.1 Design Basis

The Condensate and Feedwater Systems are designed to return condensate from the condenser hotwells to the steam generators. In addition, the systems include a number of stages of regenerative feed and condensate heating and provisions for maintaining feedwater quality.

The entire Condensate System is non safety-related. The portions of the Feedwater System that are required to mitigate the consequences of an accident and allow safe shutdown of the reactor are safety-related. The safety-related portions of the system are designed in accordance with the following design bases: 12

1) The system is designed such that failure of a feedwater supply line coincident with a single active failure will not prevent safe shutdown of the reactor.

2) The system components are designed to withstand the effects of and perform their safety functions during a safe shutdown earthquake.

3) Components and piping are designed, protected from, or located to protect against the effects of high and moderate energy pipe rupture, whip, and jet impingement which are not eliminated by leak-before-break analysis.