COMBUSTION ENGINEERING

September 20, 1988
LD-88-099

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

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

Subject: Response to NRC Request for Additional Information on Chapters 5 and 9, CESSAR-DC

References: (A) Letter, G. S. Vissing (NRC) to A. E. Scherer (C-E), dated June 28, 1988

(B) Letter, LD-88-026, A. E. Scherer (C-E) to F. J. Miraglia (NRC), dated April 11, 1988.

Dear Mr. Vissing:

Reference (A) requested that Combustion Engineering provide additional information on CESSAR-DC, Chapters 5 and 9. Enclosure (1) to this letter provides our responses, and Enclosure (2) provides the corresponding proposed revisions to our submittal of Reference (B).

If you have any questions, please feel free to contact me or Mr. S. E. Ritterbusch of my staff at (203) 285-5206.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

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Enclosures: As Stated
cc: Mr. Frank Ross (DOE - Germantown)

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RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION CONCERNING CHAPTERS 5 AND 9, CHEMICAL ENGINEERING BRANCH

Question 281-14 (Pages 5.1-14, Item K.2)

Steam generator secondary water chemistry specifications is referenced as being in Section 10.3.4. However, in Amendment 12 to Chapter 20 (sic) this subject is included in Section 10.3.5. Which section is intended to discuss steam generator secondary water chemistry?

Response 281-14

Section 10.3.5 is intended to discuss steam generator secondary water chemistry. Section 5.1.4.K.2 will be revised to reference Section 10.3.5.

Question 281-15 (Page 5.1-16)

Fluid chemistry should be more specific, such as, reactor coolant water chemistry.

Response 281-15

Combustion Engineering agrees. Section 5.1.4.L.4 will be revised to state "the material is compatible with the reactor coolant water chemistry described in Section 9.3.4."

Question 281-16 (Page 5.1-18, Item 7)

MISV is a typo and should be MSIV.

Response 281-16

Combustion Engineering agrees. Section 5.1.4.M.7 will be revised to correct this typographical error.

Question 281-17 (Page 5.1-22, Item P.3)

Amendment B states that the fire protection system should be consistent with the requirements of GDC. The fire protection section should be more specific and should reference GDC 3 and 5.

Response 281-17

Combustion Engineering will revise CESSAR-DC Section 5.1.4.P.3 to state that a fire protection system shall be provided consistent with the requirements of GDC 3 and 5.

Question 281-18 (Page 5.2-13, Section 5.2.3.2.3)

Reachable halogens is a typo and should be leachable halogens.

Response 281-18

Combustion Engineering agrees. Section 5.2.3.2.3 will be revised to correct this typographical error.

Question 281-19 (Page 5.2-19, Section 5.2.3.4.1.2.1)

The units of conductivity is incorrect and should be μmhos/cm or μS/cm.

Response 281-19

Combustion Engineering agrees. Section 5.2.3.4.1.2.1 will be revised to indicate that the units of conductivity are μmhos/cm.

Question 281-20 (Table 5.4.10-1)

Spray flow, minimum, 375 gal/min and spray flow, continuous, 1.5 gal/min seems inconsistent. Shouldn't continuous spray flow be greater than the minimum?

Response 281-20

The numerical values are correct as provided, however, the terminology of CESSAR-DC Table 5.4.10-1 will be clarified as described below.

The pressurizer spray system consists of piping runs from the discharge side of RCPs 1A and 1B to the pressurizer spray nozzle (CESSAR-DC, Figure 5.1.2-1). A control valve in each line regulates the amount of spray by varying the valve position as a function of pressurizer pressure. The system is designed to provide the spray flow necessary to maintain the pressurizer pressure below the reactor trip setpoint following an insurge of water during maneuvering, load follow, and loss of load transients, such that the pressurizer safety valves are not actuated by overpressure transients. The minimum design capacity for this spray flow for the System 80+ TM design is 375 gallon per minute (gpm).

In order to avoid stratification of the pressurizer boron concentration and to maintain the temperature in the surge and spray lines (thereby reducing thermal shock as the spray control valves open), a small continuous spray flow of approximately 1.5 gpm is maintained to the pressurizer through hand-operated globe valves located in bypass lines around the spray control valves. These spray bypass valves are set during hot functional testing and remain open during plant operation. The spray control valves, on the other hand, are normally closed and are opened automatically to maintain pressurizer pressure.

As discussed above, continuous spray flow through the bypass valves is not greater than the minimum design capacity of the spray control valves. Table 5.4.10-1 will be revised to indicate that 375 gpm is the minimum design capacity, and not the minimum flow, for the pressurizer spray system.

Question 281-21 (Page 9.3-36, Section 9.3.4.3.4)

The maximum amount of oxygen from air dissolved in water at 25° is approximately 8 ppm. This only applies at atmospheric pressure. Please clarify the statement.

Response 281-21

The corresponding paragraph of CESSAR-DC states:

> These data reveal that no chloride stress corrosion occurs at oxygen concentrations below approximately 0.8 ppm. This oxygen limit was reduced by a factor of 8 to give the conservative concentration of 0.10 ppm oxygen. The maximum amount of oxygen from air dissolved in water at 25°C is approximately 8 ppm. At this concentration, a chloride concentration of less than approximately 1.50 ppm would preclude the possibility of chloride stress corrosion. This limit was reduced by a factor of 10 to provide a conservative chloride limit of 0.15 ppm.

The above discussion provides a brief explanation of how the reactor coolant oxygen and chloride limits were established by Combustion Engineering. That explanation remains unchanged from CESSAR-F, and the Chemical and Volume Control System described in Section 9.3.4 of CESSAR-F was approved by the NRC, as documented in the Safety Evaluation Report (NUREG-0852). Notwithstanding that approval, however, the following information is provided as supplemental clarification.

First, the reactor coolant oxygen limit was established based upon data indicating the relationship between oxygen concentration and the susceptibility of austenitic stainless steel to stress corrosion cracking. These data revealed that no stress corrosion occurs at oxygen concentrations below approximately 0.8 ppm. For conservatism this value was reduced to 0.1 ppm. This oxygen limit is applicable for all plant operating modes with the reactor vessel head in place.

During plant operations when the reactor vessel head is removed, the reactor coolant is air saturated. At 25°C this corresponds to approximately 8 ppm of oxygen. For conservatism in establishing the reactor coolant chloride limit, it was assumed that this 8 ppm of oxygen would remain in solution during subsequent plant operations with the reactor vessel head installed, even though the plant chemistry limits require the oxygen concentration to be less than 0.1 ppm for such operation. At 8 ppm of oxygen, a chloride concentration of less than approximately 1.5 ppm will preclude the possibility of stress corrosion cracking. This limit was reduced by a factor of 10 to provide a conservative chloride limit of 0.15 ppm.

No change to CESSAR-DC is planned.

Question 281-22 (Table 9.3.4-1, Sheet 1 of 2)

pH analysis temperature indicates 77°. The temperature unit should be included (i.e. 77°F).

Response 281-22

Combustion Engineering agrees. Table 9.3.4-1 will be revised to indicate the specified pH ranges are for reactor coolant at 77°F.

Question 281-23 (Pg. 9.3-19)

The Advanced Light Water Reactor Requirements Document indicated that the design of the letdown purification line from the reactor coolant system should be such that 30 seconds to one minute is allowed for fluid to flow from the letdown connection to the containment penetration to reduce radiation exposures. Confirm that this consideration is factored in the design of the CVCS system.

Response 281-23

The System 80+™ Chemical and Volume Control System (CVCS) design will include a provision that the design of the letdown purification line from the reactor coolant system will be such that at least thirty (30) seconds will be allowed for fluid to flow from the letdown connection to the containment penetration. This provision is consistent with the intent of the EPRI design requirement provided in the Advanced Light Water Reactor (ALWR) Requirements Document Paragraph No. 6.3.2.6 (Rev. 0). As documented in the Draft Safety Evaluation Report (DSER), dated May, 1988 Combustion Engineering understands this does not conflict with any NRC requirements. Neither the ALWR Requirements Document nor the DSER indicate that this provision is a regulatory requirement.

Question 281-24 (Pg. 9.3-19, Section 9.3.4.1.2)

The Advanced Light Water Requirements Document addresses hydrogen utilization precautions in the CVCS system design and arrangement to minimize the potential for and the effects of hydrogen ignition. Indicate design features to prevent explosive hazards associated with use of hydrogen in the volume control tank.

Response 281-24

Several design features have been incorporated into the design of the volume control tank (VCT) to prevent explosive hazards associated with the use of hydrogen. In addition to proper ventilation, all vent lines and relief valves on the VCT gas space are designed to be hard piped directly to the gaseous waste management system (CESSAR-DC Figure 9.3-1). The gaseous waste management system is specifically designed to safely dispose of all hydrogen discharged to it. All drain and relief valves on the VCT are also designed to be hard piped to specific collection tanks which are designed to safely dispose of hydrogen. Finally, all isolation valves within the VCT cubicle are packless type valves designed to prevent the escape of gases.

The above design features are consistent with the intent of the EPRI design requirement provided in the Advanced Light Water Reactor Requirements (ALWR) Document, Paragraph Nos. 6.4.3.1.1 and 6.4.3.1.4 (Rev. 0). As documented in the Draft Safety Evaluation Report (DSER) dated May, 1988, Combustion Engineering understands that these design features do not conflict with any NRC requirements. Neither the ALWR Requirements Document nor the DSER indicate that these provisions are regulatory requirements.

PROPOSED REVISIONS TO THE

COMBUSTION ENGINEERING STANDARD SAFETY ANALYSIS REPORT

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9. If the isolation valves upstream of the ADVs are electrically controlled and operated, the valve operator and control systems shall be designed to the same IEEE standards as applied to the ADVs. | B

J. Inspection and Testing

1. All ASME B&PV Code, Section III, Class 1 and 2 valves shall be designed, fabricated and installed such that they are capable of being periodically tested in accordance with ASME Code, Section XI.

2. Adequate clearances shall be provided for inservice inspection of the Reactor Coolant Pressure Boundary and the ASME B&PV Code Section III, Class 2 portions of the Main Steam, Main Feed, Emergency Feed, and Blowdown systems' piping, in accordance with the provisions of Section XI of the ASME Boiler and Pressure Vessel Code.

3. Biological shielding and all other insulation, if installed around the Reactor Coolant Pressure Boundary, shall be designed to afford access for inservice inspection as defined by Section XI of the ASME Boiler and Pressure Vessel Code.

4. The pressurizer manway shall be accessible for internal examination of the pressurizer.

K. Chemistry/Sampling

1. A sampling system which provide a means of obtaining remote liquid samples from the RCS for chemical and radiochemical laboratory analysis shall be provided. The sampling system shall be designed to allow for the following tests: corrosion product activity levels, dissolved gas, fission product activity, chloride concentration, coolant pH, conductivity levels and boron concentration. The pressurizer steam space sample lines shall contain 7/32" x 1" orifice as close to the pressurizer as possible. The sample system shall be as shown on Figure 5.1.2-1.

2. A system or systems shall be provided to maintain the steam generator secondary water chemistry within Section ~~10.3.4~~ 10.3.5 specifications during plant

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f. copper acid etchants,

g. penetrants.

If the above materials are intended to be used, the use shall first be approved by C-E.

4. The sample lines in contact with the reactor coolant, including welds shall be designed such that the material is compatible with the ~~fluid~~ reactor coolant water chemistry described in Section 9.3.4.

5. Construction materials or protective coatings containing low melting point elements, particularly lead, mercury and sulfur, shall not be used if they could come in contact with the secondary systems. This is required to reduce to a minimum the potential for stress corrosion cracking of Inconel material in the steam generators.

6. The secondary system piping shall be designed to allow cleaning for the removal of foreign material and rust prior to operation and to prevent introduction of this material into the steam generator. Chemical cleaning or hand cleaning may be employed. During chemical cleaning, no fluid shall enter the steam generators. Suitable bypass piping shall be provided if required. D

7. Non-metallic insulation used on the Reactor Coolant Pressure Boundary shall conform to Regulatory Guide 1.36. The chloride and fluoride content of the non-metallic insulation shall be in the acceptable region as shown in Regulatory Guide 1.36. Tests shall be made on representative samples of the non-metallic thermal insulation shall be demineralized or distilled water.

8. No contaminants, except for cutting oils, shall be left on any RCS component surface except for the time required to perform and evaluate the particular fabrication or inspection operation.

9. Field welding of the RCS piping assemblies and components shall be done in accordance with a welding procedure or procedures by welders qualified to ASME Section IX requirements.

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6. The RCS and main steam piping, MSIVs, primary and secondary safety valves and their discharge piping and ADVs shall be arranged and supported such that the limiting loads are not exceeded for normal and relieving conditions.

7. Following a secondary line break, either all steam paths downstream of the ~~MISV's~~ MSIV's shall be shown to be isolated by their respective control systems following a MSIS actuation signal, or the results of a blowdown through a non-isolated path shall be shown to be acceptable. An acceptable maximum steam flow from a non-isolated steam path is 10% of the main steam rate (MSR) (1.9×10^6 lb/hr @ 1000 psia saturated steam). It is not required that the control systems for downstream valves nor the downstream valves themselves be designed to IEEE 279 and IEEE 308 or ASME Code, Section III and Seismic Category I criteria respectively.

8. The MSIVs for each steam generator shall be arranged such that a maximum of 2000 cubic feet (total for two steam lines per steam generator) is contained in the piping between each steam generator and its associated MSIVs. This volume shall include all lines off of the main steam line up to their isolation valves.

9. The main steam lines shall be arranged such that a maximum of 14,000 cubic feet is contained between the MSIVs and the turbine stop valves. This volume shall include all lines off of the main steam line up to their isolation valves.

10. The main steam lines shall be headered together prior to the turbine stop valves but not upstream of the MSIVs, and a crossconnect line shall be provided which will maintain steam generator pressure differences within the following limits for all normal and upset conditions.

    a. 0-15% power operation pressure difference to be 1 psi.

    b. 15-100% power operation pressure difference to be 3 psi.

11. No automatically actuated valves shall be located upstream of the MSIVs except as required for supply to steam driven emergency feedwater pumps. Provisions shall be made to prevent blowdown of

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8. The design pressure, temperature, and flow rating of the main steam piping and valves shall be greater than or at least equal to the design pressure, temperature, and flow rating of the steam generator secondary side.

P. Related Service

1. The pressure and thermal transients described in Subsection 3.9.1 1 shall be utilized in the design of those portions of the RCS not within the CESSAR design scope.

2. The systems or portions of reactor coolant pressure boundary outside of the CESSAR design scope shall be Safety Class I unless the conditions of 10CFR50.55A are met.

3. A fire protection system shall be provided to protect the RCS consistent with the requirements of GDC 3 and 5 and, shall include as a minimum, the following features:

   a. Facilities for fire detection and alarming.

   b. Facilities for methods to minimize the probability of fire and its associated effects.

   c. Facilities for fire extinguishment.

   d. Methods of fire prevention such as use of fire resistant and non-combustible materials whenever practical, and minimizing exposure of combustible materials to fire hazards.

   e. Assurance that fire protection systems do not adversely affect the functional and structural integrity of safety related structures, systems, and components.

   f. Fire protection systems shall be designed to assure that their rupture or inadvertent operation does not significantly impair the capability of safety related structures, systems, and components.

4. Systems shall be provided for the detection of reactor coolant leakage from unidentified sources.

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5.2.3.2 Compatibility with Reactor Coolant

5.2.3.2.1 Reactor Coolant Chemistry

Controlled water chemistry is maintained within the RCS. Control of the reactor coolant chemistry is the function of the CVCS which is described in Section 9.3.4. Water chemistry limits applicable to the RCS are given in Section 9.3.4.

5.2.3.2.2 Materials of Construction Compatibility with Reactor Coolant

The materials of construction used in the RCPB which are in contact with reactor coolant are designated by an "a" in Table 5.2-2. These materials have been selected to minimize corrosion and have previously demonstrated satisfactory performance in other existing operating reactor plants.

Metallic materials in contact with reactor coolant shall be restricted in cobalt content to as low a level as practical for all stainless steel or nickel base alloy components with a large wetted surface area. Cobalt base alloys shall be avoided except in cases where no proven alternative exists. B

5.2.3.2.3 Compatibility with External Insulation and Environmental Atmosphere

The possibility of leakage of reactor coolant onto the reactor vessel head causing corrosion of the pressure boundary has been investigated by C-E.

Tests have shown that reactor coolant system leakage onto surfaces of the reactor coolant pressure boundary will not affect the integrity of the pressure boundary. B

The insulation supplied by C-E is of the stainless steel reflective type, which minimizes insulation contamination in the event of a chemical solution spillage. In local areas around stainless steel and the nickel based alloy nozzles in the reactor vessel head, small sections of non-metallic insulation are used. However, the quantity of ~~reachable~~ halogens will be limited in accordance with Regulatory Guide 1.36.

leachable

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overlay on the end of the nozzle. Following final stress relief of the component, the stainless steel safe end is welded to the Inconel overlay, using Inconel weld filler metal.

5.2.3.4.1.2 Avoidance of Contamination Causing Stress Corrosion Cracking

5.2.3.4.1.2.1 **NSSS Components.** Specific requirements for cleanliness and contamination protection are included in the equipment specifications for components fabricated with austenitic stainless steel. The provisions described below indicate the type of procedures utilized for NSSS components to provide contamination control during fabrication, shipment, and storage as required by Regulatory Guide 1.37.

Contamination of austenitic stainless steels of the 300 type by compounds which can alter the physical or metallurgical structure and/or properties of the material is avoided during all stages of fabrication. Painting of 300 series stainless steels is prohibited. Grinding is accomplished with resin or rubber-bounded aluminum oxide or silicon carbide wheels which were not previously used on materials other than austenitic alloys. Outside storage of partially-fabricated components is avoided and in most cases prohibited. Exceptions are made for certain components provided they are dry, completely covered with a waterproof material, and kept above ground.

Internal surfaces of completed components are cleaned to produce an item which is clean to the extent that grit, scale, corrosion products, grease oil, wax, gum, adhered or embedded dust or extraneous materials are not visible to the unaided eye. Cleaning is effected by either solvents (acetone or isopropyl alcohol) or inhibited water (hydrazine). Water will conform to the following requirements:

Halides	
Chloride (ppm)	0.60
Fluoride (ppm)	0.40
Conductivity (~~lmhos~~ µmhos/cm)	5.0
pH	6.0-8.0
Visual clarity	No turbidity, oil, or sediment

To prevent halide-induced intergranular corrosion which could occur in aqueous environment with significant quantities of

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TABLE 5.4.10-1

PRESSURIZER PARAMETERS

Property	Parameter	
Design pressure, psia	2500	
Design temperature, °F	700	
Normal operating pressure, psia	2250	
Normal operating temperature, °F	652.7	
Internal free volume, ft^3	2400	B
Normal (full power) operating water volume, ft^3	1200	B
Normal (full power) steam volume, ft^3	1200	B
Installed heater capacity, KW	1800	
Heater type	Immersion	
Spray flow, minimum (design capacity), gal/min	375	
Spray flow, continuous, gal/min	1.5	
Nozzles		
Surge, in. (nominal)	12, schedule 160	
Spray, in. (nominal)	4, schedule 160	
Safety valves, in. (nominal)	(LATER)	B
Instrument		
Level, in. (nominal)	3/4, schedule 160	
Temperature, in. (nominal)	1, schedule 160	
Pressure, in. (nominal)	3/4, schedule 160	
Heater, O.D., in.	1-1/4	

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TABLE 9.3.4-1
(Sheet 1 of 2)

OPERATING LIMITS

1.0 REACTOR COOLANT MAKEUP WATER

Analysis	Normal	
Chloride (Cl)	< 0.15 ppm	
pH	6.0 - 8.0	B
Fluoride (F)	< 0.1 ppm	
Suspended Solids	< 0.35 ppm	B

2.0 PRIMARY WATER

Analysis	Pre Core Hot Functionals (1)	Initial Core Load and Criticality	Power Operation	
pH (77°F)	3.8 - 10.4	4.5 - 10.2	4.5 - 10.2	B
Conductivity	(2)	(2)	(2)	
Hydrazine	30-50 ppm(3)	30-50 ppm(3)	1.5 x Oxygen ppm(4) (max. 20 ppm)	
Ammonia	<50 ppm	<50 ppm	0-2ppm	
Dissolved Gas			(5)	
Lithium	1-2 ppm	0.2-2.3 ppm	0.2-2.3 ppm	
Hydrogen		(6)	25-50 cc (STP)/kg (H_2O) (7)	
Oxygen	≤0.1 ppm	≤0.1 ppm(9)	≤0.1 ppm	
Suspended Solids	<0.35 ppm, 2 ppm max.(8)	<0.35 ppm, 2 ppm max.(8)	<0.35 ppm, 2 ppm max.(8)	
Chloride	≤0.15 ppm	≤0.15 ppm	≤0.15 ppm	
Fluoride	≤0.1 ppm	≤0.1 ppm	≤0.1 ppm	
Boron		≤ Refueling Concentration	≤ Refueling Concentration	