COMBUSTION ENGINEERING

June 6, 1988
LD-88-039

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 Concerning Chapters 1 and 10, Materials Engineering Branch

References: (A) Letter, G. S. Vissing (NRC) to A. E. Scherer (C-E), dated March 11, 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 concerning CESSAR-DC Chapters 1 and 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

E003

AES:ss
Enclosure: As Stated

cc: Frank Ross (DOE-Germantown)

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RESPONSE TO NRC REQUEST FOR ADDITIONALINFORMATION CONCERNING CHAPTERS 1 AND 10, MATERIALS ENGINEERING BRANCH

Question 250.1

Amendment 12 to Chapter 1 contains Table 1.8-1 which lists all applicable Regulatory Guides addressed in the System 80 design. Documents published after Regulatory Guide 1.87 are not referenced in CESSAR.

Table 1.8-1 should be revised to include all published Regulatory Guides. CE should describe the specific applicability of each published Regulatory Guide to the System 80+ design.

Response 250.1

Table 1.8-1 was revised [Letter, LD-88-026, A. E. Scherer (C-E) to F. J. Miraglia (NRC), dated April 11, 1988] to include the Regulatory Guides previously listed in Appendix A of the Combustion Engineering Standard Safety Analysis Report-FSAR (CESSAR-F). Many of the Regulatory Guides published after Regulatory Guide 1.87 are, therefore, now included in Table 1.8-1.

As the System 80+™ design is developed and the corresponding CESSAR-DC chapters are submitted, Table 1.8-1 will be updated further to reflect those Regulatory Guides applicable to the System 80+ design. When the System 80+ design is completed, Table 1.8-1 will include all published Regulatory Guides and the specific applicability to the System 80+ design will be stated.

Question 250.2

Amendment 12 to Chapter 10 deletes all information in SAR Section 10.2 "Turbine Generator." CE has incorporated the statement "Later-pending completion of EPRI Chapter 13."

The topic of "Turbine Disc Integrity" is reviewed based on Standard Review Plan Section 10.2.3. Stress corrosion cracking in some low pressure turbine discs has been reported in turbines supplied by the Westinghouse and General Electric companies.

The staff has reviewed this issue based on topical reports submitted by these two vendors.

The System 80+ design could include low pressure turbines from other vendors or newer designs that are not included in the topical reports submitted by the Westinghouse and General Electric companies. Therefore, SAR Section 10.2 should describe the specific type of material property data, the scope of the fracture mechanics evaluation and the in-service inspection program that will be provided to assure the integrity of the turbine disc.

Response 250.2

The Electric Power Research Institute (EPRI) Advanced LWR Requirements Document, Chapter 13 (Turbine Generator Systems) has not been completed at this time. After Combustion Engineering has reviewed EPRI's Chapter 13, CESSAR-DC Section 10.2 will be revised. It is Combustion Engineering's intent to be consistent with EPRI's Chapter 13 requirements.

CESSAR-DC Section 10.2 will include a subsection on "Turbine Disc Integrity," which will address the issue of stress corrosion cracking in low pressure turbine discs consistent with topical reports submitted by Westhinghouse and General Electric.

Question 250.3

Amendment 12 to the SAR describes the mechanical and thermodynamic design recommendations to avoid erosion damage in the feedwater and condensate system piping. CESSAR-DC should describe the criteria for material selection and in-service inspection that will be used to minimize erosion-corrosion of components in the steam and power conversion system.

Response 250.3

The following information* will be incorporated into CESSAR-DC Section 10.3.6, "Steam and Feedwater System Materials," to address material selection for minimizing erosion-corrosion of components in the steam and power conversion system:

- 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 that are ferritic stainless steel or equivalent.
  - Low pressure feedwater heater tubes that are type 304L stainless steel with 304L-clad carbon steel tube sheets or equivalent.
  - High pressure feedwater heater tubes that are type 316L stainless steel with 316L-clad carbon steel tube sheets or equivalent.
  - Condenser tube material that is type 304L stainless steel or equivalent for fresh water applications with chloride levels below 200 ppm; for higher chloride levels up to 500 ppm, type 316L

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*This information is a revision to the response to a previous question [Letter, LD-88-034, A. E. Scherer (C-E) to G. S. Vissing (NRC), dated May 25, 1988, Question 281-11].

stainless steel tubing or equivalent; for chloride levels between 500 and 800 ppm, higher grade of stainless steel (such as 904L, AL-6X, or equivalent); for brackish or salt water applications containing high concentrations of dissolved solids (greater than 1000 ppm) or chlorides (greater than 800 ppm) or water contaminated by sewage discharges, titanium tubing or equivalent.

- Condenser tube sheets that are specified as follows:

  -- for 304L stainless steel tubes, 304L stainless-clad carbon steel tube sheets or equivalent.

  -- For 316L stainless steel tubes, 316L stainless-clad carbon steel tube sheets or equivalent.

  -- For titanium tubing, titanium-clad carbon steel tube sheets or equivalent.

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

Safety Class 2 piping is inspected per ASME Code Section XI, as indicated in CESSAR-DC Section 10.3.4. Non-safety class piping has no regulatory or code requirements for in-service inspection. CESSAR-DC will be revised, however, to require that the owner/operator of the plant provide an inspection program similar to the program outlined in EPRI NP-3944, "Erosion/Corrosion in Nuclear Plant Steam Piping: Causes and Inspection Guidelines," in order to protect their investment and personnel.

PROPOSED REVISIONS TO THE COMBUSTION ENGINEERING STANDARD SAFETY ANALYSIS REPORT

a. Achieve minimum pressure drop between the steam generators and the turbine steam stop valves.

b. Assure similar conditions between each steam stop valve and between each steam generator.

c. Provide adequate piping flexibility to accommodate thermal expansion. 12

d. Assure adequate draining provisions for startup and for operation with saturated steam.

3) Safety related portions of the Main Steam System are contained in seismic category I structures and are designed and located to protect against environmental hazards such as wind, tornadoes, hurricanes, floods, missiles, and the effects of high and moderate energy pipe rupture as detailed in Chapter 3.

10.3.4 INSPECTION AND TESTING REQUIREMENTS

1) ASME Section III Code, Class 2 piping is inspected and tested in accordance with ASME Code Section III and XI. ANSI B31.1 piping is inspected and tested in accordance with Paragraphs 136 and 137.

2) To permit testing for pH and the existence of foreign substances, sample connections are provided in the steam line piping between the steam generator nozzles and equalization header.

3) During initial startup and during periods of unit shutdown, the tripping mechanisms for the main steam isolation valves are tested for proper operation in accordance with the Technical Specifications. The valves are periodically inservice tested for leakage and freedom of movement during plant operation in accordance with ASME Code Section XI, Subsection IWV. 12

4) The secondary safety valves are tested during initial startup or during shutdown operation by checking the actual lift and closing pressures of the valves in comparison to the required design opening and closing pressures in accordance with ASME Code, Section XI, Subsection IWV.

5) ASME Code Section XI, Subsection IWV requirements for inservice testing and inspection of nuclear safety related valves apply to the atmospheric dump and atmospheric dump isolation valves.

10.3.5 SECONDARY WATER CHEMISTRY

10.3.5.1 Chemistry Control Basis

Steam generator secondary side water chemistry control is accomplished by:

a. Close control of the feedwater to limit the amount of impurities which can be introduced into the steam generator.

Non-safety class piping is inspected in accordance with a program similar to the program outlined in report EPRI NP-3944, "Erosion/Corrosion in Nuclear Plant Steam Piping: Causes and Inspection Guidelines".

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 250.3)*

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 that are ferritic stainless steel or equivalent.

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

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

   d) Condenser tube material that is type 304L stainless steel or equivalent for fresh water applications with chloride levels below 200 ppm; for higher chloride levels up to 500 ppm, type 316L stainless steel tubing or equivalent; for chloride levels between 500 and 800 ppm, higher grade of stainless steel (such as 904L or AL-6X or equivalent); for brackish or salt water applications containing high concentrations of dissolved solids (greater than 1000 ppm) or chlorides (greater than 800 ppm) or water contaminated by sewage discharges, titanium tubing or equivalent.

   e) Condenser tube sheets that are specified as follows:

      o for 304L stainless steel tubes, 304L stainless-clad carbon steel tube sheets or equivalent.

      o For 316L stainless steel tubes, 316L stainless-clad carbon steel tube sheets or equivalent.

      o For titanium tubing, titanium-clad carbon steel tube sheets or equivalent.

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

*This insert is a revision to the response to a previous question [Letter, LD-88-034, A. E. Scherer (C-E) to G. S. Vissing (NRC), dated May 25, 1988, Question 281-11].

10.4 OTHER FEATURES OF STEAM AND POWER CONVERSION SYSTEM

10.4.1 MAIN CONDENSER

10.4.1.1 Design Bases

1) The main condenser is designed to condense the low pressure turbine exhaust steam so it can be efficiently pumped through the steam cycle. The main condenser also serves as a collection point for the following:

    a. Feedwater heater drains and vents.

    b. Condensate and Feedwater System makeup.

    c. Condenser steam air ejector inner-condenser drains.

    d. Miscellaneous equipment drains and vents.

2) The main condenser is also designed to condense up to 55 percent of the full load main steam flow bypassed directly to the condenser by the Turbine Bypass System. The steam is bypassed to the main condenser in case of a sudden load rejection by the turbine generator or a turbine trip, and at plant startup and shutdown as described in Subsection 10.4.4. The main condenser hotwells serve as a storage reservoir for the Condensate and Feedwater Systems with sufficient volume to supply maximum condensate flow for 5 minutes. The main condenser is also designed to provide for removal of noncondensable gases from the condensing steam by the Main Vacuum System described in Section 10.4.2. Heat is removed from the main condenser by the Condenser Circulating Water System. 12

10.4.1.2 System Description

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

1) The condenser is designed in accordance with Heat Exchanger Institute Standards. The condenser is a multi-pressure design, with two or more parallel circulating water flow paths. Tubing is of commercially available lengths. The design does not preclude shop pre-fabrication.

2) The condenser tube material is as specified in Section 10.3.6.2. ~~type 304L stainless steel for fresh water applications with chloride levels below 200 ppm. For higher 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 containing high concentrations of dissolved solids (1000 ppm) or chlorides (greater than 800 ppm) or water contaminated by sewage discharges, titanium tubing is used.~~

3) Tube gauge with stainless steel is not thinner than 22 BWG. Tube gauge with titanium is not thinner than 23 BWG. Condenser design precludes or

minimizes steam impingement forces on the condenser tubes for normal operation and turbine bypass valve quick opening events. Tube support plates are designed to minimize tube vibrations.

4) Provisions for chemical injection into the condenser for biofouling control is included in accordance with site specific requirements and applicable regulations.

5) Means are provided to protect the tubes from pitting during periods of condenser shutdown.

6) Tube sheets are specified as ~~follows:~~ stated in Section 10.3.6.2.

   - ~~For 304L stainless steel tubes, use 304L stainless-clad carbon steel tube sheets.~~

   - ~~For 316L stainless steel tubes, use 316L stainless-clad carbon steel.~~

   - ~~For titanium tubing, use titanium-clad carbon steel tube sheets.~~

7) Double tube sheets or welded tube to tube sheet joints are provided.

8) Leak detection trays are included at all tube to tube sheet interfaces. Provisions for early leak detection are provided at tube sheet trays and in each hotwell section. The hotwell is divided into sections to allow for leak detection and location. 12

9) The condenser is designed to deaerate the condensate during startup and normal operation. The design also deaerates any drains which enter the condenser.

10) The condenser and circulating water system are designed to permit isolation of a portion of the tubes (segmented condenser) to permit repair of leaks and cleaning of water boxes while operating at reduced power.

11) The condenser is capable of being filled with water for a hydrotest. Provisions are made to allow draining and cleaning of the hotwell.

12) A stainless steel expansion joint and a water seal trough between the condenser and the turbine are provided.

13) An automatic condenser cleaning system is provided.

14) Heater shells and piping installed in the condenser neck are located outside of the turbine exhaust steam high velocity regions and within the limits specified by the turbine supplier. Internal piping is as short and straight as possible and all steam extraction piping slopes downward toward the heater shells.