C-E Power Systems
Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Tel. 203/688-1911
Telex 99297

POWER SYSTEMS

Docket No.: STN-50-470F

November 12, 1981
LD-81-085

Mr. Darrell G. Eisenhut
Director for Licensing
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Unresolved Safety Issues Applicable to CESSAR-F

Reference: Letter R. L. Tedesco to A. E. Scherer, dated October 29, 1981.

Dear Mr. Tedesco:

This is in response to the referenced letter which requested that C-E provide information on System 80 design features related to the following Unresolved Safety Issues:

1. Water Hammer (A-1)

2. Steam Generator Tube Integrity (A-4)

3. Reactor Vessel Materials Toughness (A-11)

4. Steam Generator and Reactor Coolant Pump Support (A-12)

Our responses are enclosed; we trust that you will find them satisfactory.

If we can be of any additional assistance, please feel free to contact either myself or Mr. G. A. Davis of my staff at (203)688-1911, Extension 2803.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

AES:dac

E003
S.1/1

A-1 Waterhammer:

The System 80 economizer type steam generators have design features to address the waterhammer phenomenon. Rapid draining of the downcomer feedwater distribution ring is prevented by discharging the feedwater from the top of the feedwater ring. Interface information provided to the applicant also specifies that a downward sloping, right angle elbow be installed off the downcomer nozzle. Therefore, the formation of a relatively large steam pocket within the feedwater piping is precluded, which is a necessary pre-condition for the occurance of damaging waterhammer.

As a further precaution, it is an interface that downward sloping elbows be installed off the economizer feedwater nozzles. Hence, even during the highly unlikely event of a loss of secondary inventory to the extent of uncovering the distribution box, these right angle elbows will again limit the steam pocket. During such an event, refill would be accomplished using the feedring, hence no cold water would be injected into the economizer thereby providing additional protection against condensation induced waterhammer.

Several transients could result in the exposure of the feedwater ring to a steam environment. For instance, large load rejections or turbine/reactor trips may cause the level in the steam generator to drop below the ring. However, in both cases the main feedwater train continues to run during these transients in order to restore the steam generator level. Following a large load rejection, water continues to enter the steam generator through the economizer. Following a turbine/reactor trip, water continues to flow through the ring. In either case, the economizer is not uncovered during these transients and significant downcomer feedwater drainage is prevented due to top discharge (even though the steam generator level may be below the ring).

The system is also protected in the event of a loss of feedwater incident by the same equipment. By providing top discharge nozzles on the feedwater ring, the drainage rate is greatly reduced so that if a steam pocket were formed before the emergency feedwater system is automatically activated on low steam generator level, flow instabilities will not occur.

For the highly unlikely event where the feedring remains exposed for an extended period of time due to a relatively slow drop in level, the downward sloping elbow will ensure that at most only a small steam pocket will be formed. A low steam generator level alarm will also alert the operator to pending ring exposure. This ensures that no destructive fluid flow instabilities will occur even under these conditions.

A-4. Steam Generator Tube Integrity: The primary interest related to steam generator tube integrity is the capability of steam generator tubes to maintain their integrity during normal operation and postulated accident conditions. Pressurized water reactor steam generator tube integrity can be degraded by corrosion induced wastage, stress-corrosion cracking, reduction in tube diameter (denting) and vibration induced fatigue cracks.

Specific measures such as steam generator design features and secondary water chemistry control and monitoring programs that will minimize steam generator tube problems are described in CESSAR-F sections 5.4.2 and 10.3.4, respectively. In addition, Section 3.4.6.2 of CESSAR-F Chapter 16, Technical Specifications, provides required actions to be taken in the event that steam generator tube leakage does occur during operation.

The steam generator design and material features that specifically address the above tube integrity concerns are as follows:

1. "Wastage" is corrosion of steam generator tubes resulting in wall thinning. It is associated with concentrated phosphates in local crevice regions. This phenomeon has been virtually eliminated, industry wide, where secondary water treatment has been converted from a sodium phosphate chemistry control to a volatile chemistry control. The recommended chemistry control of CESSAR-F section 10.3.4 is based on the use of volatile additives.

2. Stress-corrosion cracking of steam generator tubes is an environmentally assisted intergranualar type attack of the high nickel content material when subject to tensile stresses. This type of attack can take place in a corrosive environment or in high purity water. Early problems of wastage and stress-corrosion cracking were related to phosphate chemistry. The change over to volatile chemistry has virtually eliminated these problems. C-E's experience has been accumulated with tubing manufactured to a specification that controls yield strength, and grain size. Bending operations are set up and monitored to assure the production of bent tubes where plastic strain and geometry changes are minimized.

3. Tube denting results from a buildup of support plate corrosion products in the annulus between the tubes and support plates. This buildup expands tightly against the tube wall causing a reduction in diameter. The System 80 design has incorporated design features which markedly reduce the tendency for denting. Support plates have been replaced with an eggcrate design. The eggcrate design provides more open flow area. This minimizes stagnation areas which can concentrate corrosive elements. The secondary side hydraulics have been optimized to provide uniform flow to ensure that localized regions of dryout and low velocities, that permit particulate dropout, do not occur. In addition, the tube support structures, both horizontal and vertical, are fabricated from a ferritic stainless steel which makes them highly resistant to corrosion should fouling occur.

4. Vibration induced fatigue cracks are circumferential cracks produced by flow induced vibration. This type of problem has not been encountered on C-E operating plants. The System 80 tubes support design is optimized based on thermal-hydraulic model results which are compared to the results of full scale tube bundle vibration tests in various flow configurations.

A-11 Reactor Vessel Materials Toughness:

The materials of the beltline region of the System 80 reactor vessels are supplied with controls on Copper, Phosphorous, Vanadium and Sulphur content for both plate materials and also weld deposited materials. Studies have shown that the reduction in fracture toughness due to neutron irradiation is a function of these residual elements. The controls placed on residual elements significantly limit the maximum predicted loss of fracture toughness throughout plant life. Controls placed on System 80 Reactor Vessles are much more strict than controls in effect when early Reactor vessels were fabricated. In addition, the materials used in the beltline region are required to have high unirradiated fracture toughness. Thus the end-of-life toughness properties for the critical area of the reactor vessel are anticipated to be well within the 10CFR50 Appendix G guidelines.

In addition, the surveillance program required by 10CFR Part 50, Appendix H will afford an opportunity to reevaluate the fracture toughness periodically during the design life.

A-12 Potential for Low Fracture Toughness and Lamellar Tearing on PWR Steam Generator and Reactor Coolant Pump Supports:

The steam generator and pump supports for CESSAR plants are designed and fabricated in accordance with Subsection NF of the ASME Code, Section III.

Code materials are employed in the fabrication of the supports and the fracture toughness of these materials is addressed in accordance with code requirements.

Thus, the support materials are selected in accordance with all published NRC requirements and industry standards.