ABB
ASEA BROWN BOVERI

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LD-91-019

Docket No. 52-002 (Project No. 675)

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: Response to NRC Requests for Additional Information

Reference: NRC Letter, Reactor Systems Branch RAIs, T. V. Wambach (NRC) to E. H. Kennedy (C-E), dated January 31, 1991

Dear Sirs:

The reference requested additional information for the NRC staff review of the Combustion Engineering Standard Safety Analysis Report - Design Certification (CESSAR-DC). Enclosure I to this letter provides our responses. Enclosure II contains a proposed revision to CESSAR-DC. A response to RAI 440.35 will be provided separately.

Should you have any questions on the enclosed material, please contact me or Mr. Ritterbusch of my staff at (203) 285-5206.

Very truly yours,

COMBUSTION ENGINEERING, INC.

E. H. Kennedy
Manager
Nuclear Systems Licensing

EHK:BF

Enclosures: As Stated

cc: P. Lang (DOE - Germantown)
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Enclosure to
LD-91-019

RESPONSE TO NRC REQUESTS FOR ADDITIONAL INFORMATION,
REACTOR SYSTEMS BRANCH

Question 440.32

Discuss why an initial top peaked ASI of -0.3 is conservative for the rod withdrawal events since this would appear to result in a more rapid negative reactivity insertion on scram.

Response 440.32

The -0.3 ASI identified in CESSAR-DC as being used in the CEA withdrawal analyses was used as the limiting axial power shape for only DNBR calculations. A bottom peaked axial power shape was used to model scram reactivity insertion. For the low-power and full-power CEA withdrawal cases, a +0.3 ASI power shape was used for scram reactivity insertion.

Question 440.33

Why is the maximum assumed reactivity rate at the maximum CEA withdrawal rate only 1.5 X 10^{-4} delta rho/sec compared to 2.5 X 10^{-4} delta rho/sec for System 80?

Response 440.33

The difference in the maximum reactivity rate between the System 80+ and System 80 designs is that the System 80 design utilizes a 5 bank CEA regulating system whereas System 80+ utilizes a 3 bank CEA regulating system. In addition, the reactivity worth of each bank is different between the two designs. The combination of these differences accounts for the two different reactivity rates. The System 80+ design results in reduced peaking factors in the core during critical, HZP operating conditions. Please see CESSAR-DC Sections 4.3.2.4 and 4.3.2.5 for additional information.

Question 440.34

Table 15.4.3-2 gives 0.1 sec. as the time for a dropped CEA to be fully inserted. Since the event is analyzed from full power, the core should essentially be unrodded and a CEA drop over the entire core would take several seconds. Please justify the 0.1 sec. time interval used.

Response 440.34

It is true that a CEA drop would take several seconds; i.e., the technical specifications state that the individual CEA drop time, from a fully withdrawn position, shall be less than or equal to 4 seconds from electrical power interruption to 90% insertion. However, the objective of the single CEA drop analysis is to calculate the minimum DNBR that occurs during this event.

The methodology used for the single CEA drop event uses static power peaking factors such that the drop time of the CEA does not impact the results of the DNBR calculation. An assumed 0.1 sec. drop time merely produces a faster initial transient response than would actually be expected. The DNBR calculation is only sensitive to "where" the CEA is dropped in the core as opposed to "how fast" the CEA is dropped in the core. Since one of the initial conditions used to calculate DNBR concerns radial peaking factors, the maximum radial peaking factor is determined by the location of the dropped CEA and this value in turn is used in the DNBR calculation.

It should be noted that the reactor does not trip for this event and that the minimum DNBR is reached at 105 seconds into the transient, well after the time of CEA drop.

Question 440.36

Discuss the adequacy of a high neutron flux alarm to indicate a boron dilution event in sufficient time during Modes 3, 4 or 5.

Response 440.36

The high neutron flux alarm is activated when the SRM (Source Range Monitoring) ratio exceeds its setpoint. The SRM ratio is defined as follows:

$$\text{SRM ratio} = \frac{\text{Source Range Signal (t)}}{\text{Source range signal at start of dilution}}$$

For Mode 3, 4 and 5 operation, time is calculated from event initiation to loss of shutdown margin. From this time 30 minutes is subtracted to determine the latest allowable time for alarm actuation. In all above modes, it was calculated that at 30 minutes prior to loss of shutdown the SRM ratio will have exceeded its setpoint. Therefore, an operator response time of at least 30 minutes is demonstrated.

It should be noted that the high neutron flux alarm is used when at least one reactor coolant pump is operating during these modes. For cases where the reactor coolant pumps could be idle (Modes 4 and 5), the reactor makeup water flow alarm would provide indication of any boron dilution event, ensuring the 30 minute operator response time before shutdown margin is lost.

Question 440.37

Standard Review Plan 15.4.6 requires redundancy of alarms that alert the operator to an unplanned boron dilution event. Describe the redundant alarms available in each operating mode.

Response 440.37

The Standard Review Plan recommends that 15 minutes exist in Modes 1 through 5 and 30 minutes in Mode 6 between the time that the operator is made aware of an ongoing boron dilution and the time of loss of shutdown margin. However, a 30 minute interval was used as a goal for Modes 1 through 5 as well as the acceptance criterion for Mode 6 for the CESSAR-DC analyses.

The following pre-trip alarms are available for operational Modes 1 and 2: a high power or, under certain conditions, a high pressurizer pressure pre-trip alarm in Mode 1 or a high logarithmic power pre-trip alarm in Mode 2. Furthermore, a high RCS temperature alarm may also occur prior to trip. In operational Modes 3 through 6, either a boron dilution alarm or a reactor makeup water flow alarm will alert the operator to an unplanned boron dilution event. In Modes 3, 4 and 5 with the Reactor Coolant System (RCS) full and at least one Reactor Coolant Pump (RCP) operating, a high neutron flux (boron dilution) alarm will provide indication of a boron dilution event. In Modes 4 and 5 with the RCS full and all RCPs idle or for Mode 5 with the RCS partially drained for system maintenance, deboration is prohibited. Therefore, the reactor makeup water flow alarm will provide indication of any boron dilution event. In Mode 6, the boron concentration is at least 2200 ppm before entering this mode and deboration is prohibited. Therefore, the reactor makeup water flow alarm will provide indication of a boron dilution event.

Depending upon the mode of operation, there are a number of alarms available to alert an operator of a boron dilution event. In addition to the above mentioned alarms, there are also sampling and boronometer indications which would provide information in the case of a boron dilution event.

To address EPRI guidance to reduce the number of alarms presented to operators, Combustion Engineering is currently performing a confirmatory analysis to show that 30 minutes is available for operator action time if a boron dilution alarm is used in place of the reactor makeup water flow alarm in modes other than Mode 6. The results of this analysis will in included in a future amendment to CESSAR-DC.

Question 440.38

The first paragraph describing the results of the CEA ejection analysis should state that the radial averaged fuel enthalpy is less than 280 cal/gm "at the hottest axial location of the hot fuel pin".

Response 440.38

Combustion Engineering agrees, and the phrase "at the hottest axial location of the hot fuel pin" will be added as suggested. The full description of the radial averaged fuel enthalpy for the CEA ejection analysis will then read, "The results show that the radial averaged fuel enthalpy is less than 280 cal/g at the hottest axial location of the hot fuel pin." This correction to the "Results" section of CESSAR-DC Section 15.4.8.3 will be incorporated in a future revision of CESSAR-DC.

Enclosure II to
LD-91-019

PROPOSED REVISION TO THE COMBUSTION ENGINEERING STANDARD
SAFETY ANALYSIS REPORT - DESIGN CERTIFICATION

C. Results

A spectrum of initial states were considered. The case initiated from hot full power (HFP) initial conditions is expected to result in the greatest potential for offsite dose consequences (i.e., the case resulting in the largest number of postulated fuel failures). The results show that the radial averaged fuel enthalpy is less than 280 cal/g*. The following paragraphs describe this event in detail. Refer to Table 15.4.8-2 for the initial conditions and assumptions used for this analysis.

Table 15.4.8-1 contains the sequence of events that occur during a CEA Ejection initiated from hot full power initial conditions.

Figures 15.4.8-1 through 15.4.8-5 show the reactor power, heat flux, and clad and fuel temperatures during the significant portion of transient.

Ejection of a CEA causes the core power to increase rapidly due to the almost instantaneous addition of positive reactivity. However, the rapid increase in core power is terminated by a combination of Doppler feedback and delayed neutron effects. This increase in power results in a high power trip and the reactor power begins to decrease as the CEAs enter the core. Reactivity effects are shown in Figure 15.4.8-6. H

In the hot channel, the increase in heat flux is such that DNB is calculated to occur, resulting in:

1. A rapid decrease in the surface heat transfer coefficient.

2. A rapid decrease in heat flux.

3. A rapid increase in clad temperature.

The rapid increase in clad temperature is sufficient to override the decreased surface heat transfer coefficient, resulting in a second peak in the hot channel heat flux. At this time the CEAs are nearly fully inserted, resulting in a rapid reduction in the core power level. The heat flux continues to decrease for the remainder of the transient.

Initial pressurizer pressure is 1900 psia. The RCS and steam generator pressure for this case is shown in Figures 15.4.8-7 through 15.4.8-12.

* at the hottest axial location of the hot fuel pin