Response to

Request for Additional Information No. 102 (1108), Revision 0

10/24/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 16 - Technical Specifications
Application Section: 16.2

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

Question 16-125:

The reactor core Safety Limits (SL) for the DNBR ratio are listed based upon use of either the ACH-2 or BWU-N correlations (1.246 and 1.21, respectively). In response to RAI 5 of the ACH-2 review (ANP-10269P-A), it was stated that the DNBR Technical Specification would be identified with a design limit of 1.30. Similarly, the DNBR limit when using the BWU-N correlation does not match the value provided in corresponding topical report (BAW-10199P-A).

Provide an explanation for these discrepancies.

Response to Question 16-125:

The departure from nucleate boiling ratio (DNBR) for the ACH-2 DNB correlation in U.S. EPR FSAR, Tier 2, Chapter 16, Technical Specifications Section 2.1.1.1 (Safety Limits) will be revised from "≥ 1.246" to "≥ 1.25."

The response to RAI 5 (which includes the 1.30 value) of the ACH-2 review (ANP-10269P-A) was submitted May 2007, prior to the addition of ANP-10269P, Revision 0, Supplement (dated August 2007). Section 4.0 of the NRC's SER for ANP-10269P-A states that the approved DNBR limit for the ACH-2 correlation is equal to or greater than 1.25. The DNBR technical specification for the ACH-2 DNB correlation is ≥ 1.25.

As listed in Table 3 of the NRC's SER for BAW-10199P-A, the DNBR limit for the BWU-N correlation for pressures above 1500 psia is 1.21. This value is consistent with U.S. EPR FSAR, Tier 2, Chapter 16, Technical Specifications Section 2.1.1.1.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Chapter 16, Technical Specifications Section 2.1.1.1 will be revised as described in the response and indicated on the enclosed markup.

Question 16-126:

Technical Specification Section 4.3.1.1 item (c) indicates a nominal pitch of 11.28" between the center of fuel assemblies placed in the spent fuel storage racks. The storage rack design as submitted in UN-TR-08-001P includes two different regions with different pitches (10.9" for Region 1 and 9.028" for Region 2). Provide clarification for the spent fuel storage rack pitch dimensions.

Response to Question 16-126:

As noted in FSAR Section 9.1.2, the spent fuel storage racks are the responsibility of the COL applicant. The spent fuel racks discussed in FSAR Section 9.1.2 describe a typical rack configuration. The center to center spacing provided Technical Specification Section 4.3 is a representative, bracketed value to be provided by the COL applicant. A Reviewer's note in Technical Specification 3.7.16, Spent Fuel Storage, also notes that the spent fuel storage configuration will be provided by the COL applicant. The storage rack parameters cited in UN-TR-08-001P are site specific and therefore are not appropriate for inclusion in the U.S. EPR GTS.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 16-127:

The peak fuel centerline temperature safety limit is listed as 4901 deg-F, decreasing by 14 deg-F per 10,000 MWD/MTU burnup. The supporting fuel mechanical design topical report (ANP-10285P) calculates the limit based on steady state peak linear heating rate. The reactor core technical specifications safety limits bases (second paragraph of the Background section) also specifies steady state peak linear heating rate instead of an absolute fuel temperature to preclude fuel centerline melting.

a) Justify the 4901 deg-F value and modify the wording of the bases to correspond to the absolute fuel temperature limit, instead of steady state peak linear heating rate.

b) Identify whether the 4901 deg-F value refers to UO2 or Gd rods (and provide the value for the other rods).

c) Provide the support for the 14 deg-F per 10,000 MWD/MTU burnup dependence.

Response to Question 16-127:

a) In Section 12.3 of the COPERNIC topical report (BAW-10231P-A, Revision 1, COPERNIC Fuel Rod Design Computer Code), the definition of the limiting fuel rod melt temperature provided by Equation 12 – 3 and is stated as:

$$T_L = 2705 - 0.76Bu$$

$$where:$$

$$T_L = Limiting\ Fuel\ Rod\ Melt\ Temperature\ (^oC)$$

$$Bu = Pellet\ Burnup\ (GWd/tU)$$

This is the specification stated in Safety Limit 2.1.1.2. The initial 2705 ºC (4901°F) melt limit includes a 1.05 multiplicative adjustment (reduction) to the best estimate fuel melt temperature that is provided in BAW-10231P-A equations 10 – 11 and 12 – 2. The justification for this value to meet the 95/95 confidence level is given in the COPERNIC topical report and the associated SER.

b) The equation for the limiting fuel melt temperature is applicable to both the UO_2 and the UO_2:Gd_2O_3 rods. This is specified in the BAW-10231P-A in Section 10.2.4

c) When converted to temperatures in units of degree-Fahrenheit and burnup in units of 10000MWD/MTU, the “14° F per 10,000MWD/MTU” burnup dependence is equivalent to 0.76° C per GWd/tU as given by the following:

$$T_L = 4901 - 13.68Bu$$

$$where:$$

$$T_L = Limiting\ Fuel\ Rod\ Melt\ Temperature\ (^oF)$$

$$Bu = Pellet\ Burnup\ (10000MWD/MTU)$$

The U.S. EPR FSAR, Tier 2, Chapter 16, Technical Specifications Section 2.1.1 Bases will be revised to address that the overheating of the fuel is prevented by maintaining the peak linear heat rate (LHR) below the level that would cause the fuel centerline temperature to reach the fuel rod melt temperature limit.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Chapter 16, Section B 2.1.1 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

2.0 SAFETY LIMITS (SLs)

2.1 SLs

2.1.1 Reactor Core SLs

In MODES 1 and 2:

2.1.1.1 The departure from nucleate boiling ratio (DNBR) shall be maintained ≥ ~~1.246~~1.25 when using the ACH-2 DNB correlation and ≥ 1.21 when using the BWU-N correlation; and

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2.1.1.2 The peak fuel centerline temperature shall be < 4901°F, decreasing by 14°F per 10,000 MWD/MTU of burnup.

2.1.2 RCS Pressure SL

In MODES 1, 2, 3, 4, and 5, the RCS pressure shall be ≤ 2803 psia.

2.2 SL VIOLATIONS

2.2.1 If SL 2.1.1.1 or 2.1.1.2 is violated, be in MODE 3 within 1 hour.

2.2.2 If SL 2.1.2 is violated:

2.2.2.1 In MODE 1 or 2, restore compliance and be in MODE 3 within 1 hour.

2.2.2.2 In MODE 3, 4, or 5, restore compliance within 5 minutes.

B 2.0 SAFETY LIMITS (SLs)

B 2.1.1 Reactor Core

BASES

BACKGROUND

GDC 10 (Ref. 1) require that specified acceptable fuel design limits are not exceeded during steady state operation, normal operational transients, and anticipated operational occurrences (AOOs). This is accomplished by having a departure from nucleate boiling (DNB) design basis, which corresponds to a 95% probability at a 95% confidence level (the 95/95 DNB criterion) that DNB will not occur and by requiring that fuel centerline temperature stays below the melting temperature.

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The restrictions of these SLs prevent overheating of the fuel and cladding, as well as possible cladding perforation, which would result in the release of fission products to the reactor coolant. Overheating of the fuel is prevented by maintaining the steady state peak linear heat rate (LHR) below the level ~~at which~~that could cause fuel centerline ~~melting occurs~~temperature to reach the fuel rod melt temperature limit. Overheating of the fuel cladding is prevented by restricting fuel operation to within the nucleate boiling regime, where the heat transfer coefficient is large and the cladding surface temperature is slightly above the coolant saturation temperature.

Fuel centerline melting occurs when the local LHR, or power peaking, in a region of the fuel is high enough to cause the fuel centerline temperature to reach the melting point of the fuel. Expansion of the pellet upon centerline melting may cause the pellet to stress the cladding to the point of failure, allowing an uncontrolled release of activity to the reactor coolant.

Operation above the boundary of the nucleate boiling regime could result in excessive cladding temperature because of the onset of DNB and the resultant sharp reduction in heat transfer coefficient. Inside the steam film, high cladding temperatures are reached, and a cladding water (zirconium water) reaction may take place. This chemical reaction results in oxidation of the fuel cladding to a structurally weaker form. This weaker form may lose its integrity, resulting in an uncontrolled release of activity to the reactor coolant.

The proper functioning of the Protection System (PS), ~~and~~ main steam safety valves (MSSVs), and main steam relief trains (MSRTs) prevents violation of the reactor core SLs.