REQUEST FOR ADDITIONAL INFORMATION 297-2287 REVISION 1

4/1/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 15 - Introduction - Transient and Accident Analyses
Application Section: 15.0.0

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

15-1

Question 15.0.0-1

SRP 15.0, Rev.3, March 2007 states that for new applications, the categorizations and acceptance criteria of this SRP section shall apply, i.e., only two classes of events shall be considered in Chapter 15 analyses, AOO and PA. In DCD Section 15.0.0.1, it appears as if a category of event is defined that is neither an AOO nor a PA. The applicant states, "AOOs with an assumed coincident single failure or operator error…are no longer considered AOOs." This is confusing because single failures are accounted for in the analysis of AOOs. It also states "such events are either evaluated as if they were AOOs or less restrictive acceptance criteria are applied." This is also confusing. It is not clear what acceptance criteria are applied, those for an AOO or those for a PA. Please clarify this paragraph in this section in light of the review guidance provided in SRP 15.0, rev.3, March 2007.

15-2

Question 15.0.0-2

In DCD Section 15.0.0.7, the applicant states, "The reactor trip is assumed to cause a disturbance in the utility grid, which causes the loss of offsite power (LOOP)." In other places in the DCD, the applicant states that, "A turbine trip could cause a disturbance to the grid, which could, in turn, cause a loss of offsite power, which could, in turn, cause a reactor coolant pump coast down." Please clarify this apparent contradiction in the sequence of events as described. Is LOOP caused by the turbine trip, the reactor trip, or by either one independent of the other? Or is the turbine trip the causal event for both the LOOP and the reactor trip? Please clarify the sequence of events that lead to LOOP.

15-3

Question 15.0.0-3

In DCD Section 15.0.0.7, the applicant presents arguments concerning the timing of a LOOP with respect to the timing of reactor trip and RCP coast down. By assuming a time delay in the onset of a LOOP, the onset of DNBR is decoupled from the availability of offsite power because the rods are inserted to the dashpot by the time the LOOP is initiated; therefore, the RCPs continue to run until the rods have been inserted in the core. This argument repeats itself throughout many Chapter 15 scenarios, allowing for the neglect of any LOOP consequences. Please provide more substantial arguments in defense of this assumed time delay, supported by sensitivity calculations that directly address this issue. (see also Question 15.1.2-1).

15-4

Question 15.0.0-4

Does the applicant intend to conduct a grid stability analysis to demonstrate that the grid will remain stable, as assumed in the Chapter 15 analyses, for a minimum of three seconds following a turbine trip, thus delaying the initiation of LOOP and RCP coast down for at least three seconds following a turbine trip event? Or is this issue deferred to COL activities?

15-5

Question 15.0.0-5

The applicant presents arguments that suggest that the three-second delay to the initiation of LOOP following turbine trip is considered a constant parameter in all applicable analyses. How was the three-second delay determined, what is the calculated uncertainty in this value, how was the uncertainty calculated, and has this uncertainty been applied in the analyses?

15-6

Question 15.0.0-6

Provide the results of an assessment for the design basis events analyzed in Chapter 15 of the FSAR that the analyzed event scenario in each of the transients and accidents will bound the results of the specific event occurring from various power level and all modes of plant operation.

15-7

Question 15.0.0-7

Confirm that the assumptions used in the transient and accident analyses are consistent with the range of values specified in technical specifications. For example, the initial pressurizer water level of 95% (if this is the highest level specified in TS) should be assumed in the transients that may lead to the pressurizer going solid for limiting consequences.

15-8

Question 15.0.0-8

Provide the assessment for the parameters, initial conditions, and single failures used in various transients and accidents to support the values and sequence of events assumed in each event that would lead to the most conservative results with respect to each of the acceptance criteria.

15-9

Question 15.0.0-9

Confirm that each of the transients and accidents analyzed has been assessed against multiple acceptance criteria, including specified acceptable fuel design limits (SAFDL), the maximum primary pressure, maximum secondary side pressure, and the minimum departure from nucleate boiling ratio (MDNBR).

15-10

Question 15.0.0-10

Please extend the tables shown in Chapter 15.0 to show for each transient and accident the limiting power, temperatures, flows, levels, scram reactivity, reactivity coefficients, heat transfer coefficients, and degree of SG tube plugging.

15-11

Question 15.0.0-11

FSAR Table 15.0-6 lists the assumed most-limiting single failure in each of the analyzed design basis transients and accidents. How were the assumed failures listed in Table 15.0-6 determined? It appears that most of the assumed single failures listed in this table are the failure of one of the redundant trip functions, emergency core cooling systems, or emergency feedwater systems. These assumptions are not likely to affect the results of the safety analyses since the available redundant system will perform the required safety function. The applicant should provide a sensitivity study for various single failures to determine the most limiting assumed single failure that would lead to the most limiting consequences of each event. For example, a stuck open Main Steam Relief Valve (MSRV) may cause most limiting radiological consequences in a steam generator tube rupture accident instead of the current assumption of the failure of one emergency feedwater system.

15-12

Question 15.0.0-12

In the acceptance review of the US-APWR, the staff requested MHI to provide Emergency Response Guidelines (ERG) for operator actions credited in the FSAR Chapter 15 safety analyses so that the NRC could verify that the future plant Emergency Operating Procedures (EOPs) will correspond to operator actions assumed in the safety analyses. In response to the staff request, MHI in its letter to NRC dated February 8, 2008, provided a table listing the operator actions assumed in various safety analyses. MHI also stated that additional information for operator actions assumed in the Chapter 15 safety analyses that is contained in the ERG, such as the operator action criteria in terms of parameter and values as well as the source of the information (instrument or channel). However, the staff has not yet received that additional information up to date. Please provide the following:

a) The applicant should provide planned schedule of APWR ERG development in light of its availability for developing plant specific emergency operating procedures (EOPs) by COL applicants. Identify any potential conflict with APWR new plant deployment schedule.

b) The applicant should expand FSAR Section 15.0 to address the need for supporting analyses (best estimate and licensing analyses) and the need for verification and validation (V&V) of the developed ERGs to demonstrate that the ERGs will achieve their design intentions and be consistent with the operator actions assumed in the transient and accident documented in Chapter 15 of FSAR.

c) The applicant should expand FSAR Section 15.0 to address the need for supporting analyses (best estimate and licensing analyses) and the need for verification and validation (V&V) of the developed ERGs to demonstrate that the ERGs will achieve their design intentions and be consistent with the operator actions assumed in the transient and accident documented in Chapter 15 of FSAR.

15-13

Question 15.0.0-13

FSAR Section 15.0.0.1 indicates that due to similarities between the APWR and the current generation of operating reactors in the U.S, MHI has determined that no new event type are required to bound the possible initial event. In staff review of Section 4.6.2.4 of MUAP-07016, It seems that a Reactor Coolant Pump (RCP) over-speed at cold condition could result in potential plastic spring deformation and lift off a fuel assembly. Please discuss the need of analyses as an AOO for the RCP over-speed event to address the consequences of fuel performance due to increased cooldown and/or lift of fuel assembly. Also, a RCP over-speed may cause increased primary pressure. Specifically, discuss: a) what temperature and pressure define the hot and cold conditions during a RCP over-speed AOO referred in MUAP-07016, and b) What prohibits a RCP over-speed AOO at cold conditions or makes it less limiting from a fuel assembly lift-off perspective than at hot conditions?

15-14

Question 15.0.0-14

FSAR Tables 8.3.1-4 show four divisions of electrical safety equipment (each division being 50%). It is indicated that the two motor driven emergency feedwater pumps (MDEFWP) are powered by Division B and C Class 1E power supplies respectively. Assuming one division of electrical power supply out for maintenance allowed by Technical Specification and a single failure on the other division, both MDEFWP could be inoperable during a design basis event. Please provide discussion on the operability and adequacy of the two turbine driven emergency feedwater pumps (TDEFWP) with respect to the condition of steam supplies and feed water flow arrangement of the system.

15-15

Question 15.0.0-15

Confirm that for each of the events analyzed both with and without offsite power cases are performed. For DNBR case, a three second time delay of RCP trip may be assumed (provided this time delay is approved by the staff in reviewing FSAR Chapter 8). For peak primary and secondary pressure concern, a LOOP at the time of turbine trip is considered per the criterion set forth in Section 15.0.0.7.

15-16

Question 15.0.0-16

In each of the transient and accident analyses, provide numeric values of MDNBR and peak primary and secondary pressure to compare with the allowable limits and demonstrate that all acceptance criteria are met.

15-17

Question 15.0.0-17

In Section 15.0.0.2.5 it is stated that a conservative bottom-skewed axial power distribution is used to help define the control rod insertion worth. Discuss how this distribution is defined to assure that it is bounding?

15-18

Question 15.0.0-18

RE: MUAP-07026-P (R0)

The reload methodology is meant to be applicable to "fuel design changes in dimensions and/or materials, and of thermal design changes." Are there limits to design changes at which the reload methodology would no longer apply? For example, can it be used if MOX fuel is introduced, or if an axial loading is introduced, or if a core with two different types of fuel design is used, or if the enrichment is above a certain value, or if the burnable absorbers are changed? What criteria are used to make the determination?

15-19

Question 15.0.0-19

RE: MUAP-07026-P (R0)

Is it stated somewhere that the versions of the codes to be used will have been approved by the NRC? If not, where will this statement appear?

15-20

Question 15.0.0-20

RE: MUAP-07026-P (R0)

In Section 3.2.9.3 it is stated that the Doppler and moderator effects are taken into account through a change in absorption cross section. In other documents it has been stated that feedback is taken into account through the use of other cross sections as well. Provide discussion to clarify this discrepancy.

15-21

Question 15.0.0-21

RE: MUAP-07026-P (R0)

In Section 4.2.2.1 it is stated that a conservative factor is applied to the total rod worth. However, in Section 15.0.0.2.5 of Chapter 15, there is no mention of this factor. Provide discussion to clarify. What is the value of this conservative factor and its basis?

15-22

Question 15.0.0-22

RE: MUAP-07026-P (R0)

Explain the rationale for the specific equation for the hot channel factor cited in Section 5.3.1.1?

15-23

Question 15.0.0-23

RE: MUAP-07026-P (R0)

In the discussion of axial power distributions (Section 5.3.1.2) and fuel temperature (Section 5.3.2), it is pointed out that if a parameter is bounded by the reference case, then normal operation and AOO analyses previously done are acceptable. Is this meant to also apply to PAs?