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TOKYO, JAPAN

January 21, 2009

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-09004

Subject: MHI's Response to US-APWR DCD RAI No. 128-1731 Revision 1

References: 1) "Request for Additional Information No. 128-1731 Revision 1, SRP Section: 12.02 – Radiation Sources, Application Section: 12.2," dated December 16, 2008

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 128-1731 Revision 1".

Enclosed are the responses to Questions 12.02-1, 12.02-2 and 12.02-3 that are contained within Reference 1.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittal. His contact information is below.

Sincerely,

Y. Ogata

Yoshiki Ogata
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.
Enclosures:

1. Response to Request for Additional Information No.128-1731 Revision 1

CC: J. A. Ciocco
C. K. Paulson

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Docket No. 52-021
MHI Ref: UAP-HF-09004

Enclosure 1

UAP-HF-09004
Docket No. 52-021

Response to Request for Additional Information
No. 128-1731 Revision 1

January 2009

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/21/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 128-1731 REVISION 1**
SRP SECTION:	**12.02 – Radiation Sources**
APPLICATION SECTION:	**12.2**
DATE OF RAI ISSUE:	**12/16/2008**

QUESTION NO.: 12.02-1

10 CFR 20.1101(b) requires licensees to ensure that engineering controls are used to keep occupational doses ALARA. The guidance contained in Regulatory Guide 1.206 section C.I.12.2.1 "Contained Sources" notes that the applicant is to provide the models, parameters and bases for all values used to calculate source magnitudes, for normal and accident conditions. The APWR DCD Rev 1 section 12.2 "Radiation Sources" identifies and describes the sources of radiation that form the basis for the shielding design calculations and the sources of airborne radioactivity. Realistic source term information is used to derive information depicted in tables in Section 12.2. Some of the source term information provided may be contradictory or incomplete.

Question 1:

The APWR DCD Table 11.1-9 "Realistic Source Terms" list RCS activity for Co-60 as 2.9E-04 (□Ci/g) and for Co-58 as 2.5E-03 (□Ci/g), while Table 12.2-9 "Isotopic Composition and Specific Activity of Typical Out-of-Core Corrosion Products in the primary coolant" list RCS activity for Co-60 as 8.9E-04 (□Ci/g) and Co-58 as 6.1E-03 (□Ci/g).

In accordance with RG 1.206, justify this apparent discrepancy. If the information provided in Table 12.2-9 is correct, then please provide information in chapter 12 that describes the bases, methods and assumptions, justifying using the values provided in Table 12.2-9. If the information provided in this table is erroneous in some manner, then please change the values in Tables 11.1-9 and 12.2-9, as appropriate, and update the resultant activity and dose rate data that use this information.

ANSWER:

C.I.11.1 "Sources Terms" of RG 1.206 stipulates that, "*The applicant should provide two source terms... The first source term is a conservative or design-basis source term which assumes a design-basis fuel defect level.... The first source term serves as a basis for... (3) shielding requirements and compliance with occupational radiation limits. The second source term is a realistic model which represents the expected average concentrations of radionuclides in the primary and secondary coolant.... The realistic source term is used to calculate the quantity of radioactive materials released annually in liquid and gaseous effluents during normal plant operation...*" In accordance with the above statement, Table 11.1-2 in the US-APWR DCD Section 11.1 shows the design-basis RCS radioactivity concentrations with corrosion products

based on Table 2-10 of NUREG-0017, Rev.1, while Table 11.1-9 lists the realistic RCS radioactivity concentrations. The radioactivity concentrations of corrosion products in the RCS shown in Table 12.2-9 are identical with to those of the design-basis RCS radioactivity concentrations of corrosion products indicated in Table 11.1-2.

C.I.12.2.1 "Contained Sources" of RG 1.206 states that "*The applicant should describe the sources of radiation, during normal plant operations and accident conditions which constitute the bases for radiation protection design. These sources should be described in the manner needed for input to the shield design calculation.*" Thus, DCD Section 12.2 for the US-APWR specifies the design-basis radioactivity concentration or source strength to be used for the shielding design calculation. Therefore, the radioactivity concentration of corrosion products in the RCS shown in Table 12.2-9 are design-basis values, which are equivalent to the mean values of actual data obtained from US plants as listed in Table 2-10 of NUREG-0017 Rev.1. These values in NUREG-0017 Rev.1 were obtained about thirty years ago, prior to the implementation of modern cobalt reduction programs and chemistry practices. Because the US-APWR uses low cobalt materials under water quality control, as described in DCD Chapter 12.1.2.1, the radioactivity concentrations of Co-58 and Co-60 are considered to be well on the conservative side. The values in Table 12.2-9 are thus considered appropriate as design-basis radioactivity concentrations to be used for the shielding design calculation of the US-APWR.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/21/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 128-1731 REVISION 1**
SRP SECTION:	**12.02 – Radiation Sources**
APPLICATION SECTION:	**12.2**
DATE OF RAI ISSUE:	**12/16/2008**

QUESTION NO.: 12.02-2

10 CFR 20.1101(b) requires licensees to ensure that engineering controls are used to keep occupational doses ALARA. The guidance contained in Regulatory Guide 1.206 section C.I.12.2.1 "Contained Sources" notes that the applicant is to provide the models, parameters and bases for all values used to calculate source magnitudes, for normal and accident conditions. The APWR DCD Rev 1 section 12.2 "Radiation Sources" identifies and describes the sources of radiation that form the basis for the shielding design calculations and the sources of airborne radioactivity. Realistic source term information is used to derive information depicted in tables in Section 12.2. Some of the source term information provided may be contradictory or incomplete.

Question 2:

The APWR DCD Section 1.1.4 notes that in some safety evaluations, a core thermal power level of 4540 MWt is used for taking 2 percent allowance for calorimetric error into account. DCD Table 11.1-8 "Parameters Used to Describe Realistic Sources" indicates that the assumed Core thermal power is 4,451 MWt. As noted in DCD Section 12.2.1.1.2 the activity values used for calculating the information provided in chapter 12 are based on the information contained in Chapter 11. Use of 4540 MWt rated core power would result in higher source term values than those presented in chapter 12.

In accordance with RG 1.206, if 4451 MWt is the correct bases for calculating the activity values used in chapter 12, then please provide information in chapter 12 (or 11, as appropriate) to justify the use of 4,451 MWt instead of 4540 MWt as the bases for the Reactor Coolant Activity analysis. If it is determined that a thermal power value different from 4451 MWt is the appropriate bases, then update the source term data provided in DCD chapter 12.

ANSWER:

The information in DCD Chapter 11 is used for the shielding design and occupational exposure calculations as described in DCD Section 12.2. For some safety evaluations described in DCD Section 1.1.4, a core thermal power of 4540 MWt (102%) is assumed to conservatively bound the radioactivity release during accident analyses. However, the calculations in Chapter 11 and 12 are not part of the safety evaluations and therefore use more realistic values for the source terms. As stated in RG 1.112, NUREG-0017 Rev.1 provides acceptable methods for calculating annual average expected releases of radioactive material. NUREG-0017 Rev.1 uses a core thermal

power of 100% as the evaluation condition. Therefore, the core thermal power in DCD Chapter 11 is assumed to be 100%, which is equal to 4451 MWt, as shown in Table 11.1-8 for realistic sources and Table 11.1-1 for design basis sources. The references to RG 1.112 and NUREG-0017 Rev.1 are both included in DCD Chapter 11. Since DCD Chapter 12 deals with normal operations, the evaluation condition is the same as Chapter 11 and the core thermal power of 4451 MWt (100%) is used.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/21/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 128-1731 REVISION 1**
SRP SECTION:	**12.02 – Radiation Sources**
APPLICATION SECTION:	**12.2**
DATE OF RAI ISSUE:	**12/16/2008**

QUESTION NO.: 12.02-3

10 CFR 20.1101(b) requires licensees to ensure that engineering controls are used to keep occupational doses ALARA. The guidance contained in Regulatory Guide 1.206 section C.I.12.2.1 "Contained Sources" notes that the applicant is to provide the models, parameters and bases for all values used to calculate source magnitudes, for normal and accident conditions. The APWR DCD Rev 1 section 12.2 "Radiation Sources" identifies and describes the sources of radiation that form the basis for the shielding design calculations and the sources of airborne radioactivity. Realistic source term information is used to derive information depicted in tables in Section 12.2. Some of the source term information provided may be contradictory or incomplete.

Question 3:

The APWR DCD Section 12.2.1.1.2 "Reactor Coolant System" notes that these sources and their bases are discussed in Chapter 11, Section 11.1 "Source Terms". This section estimates the design basis as well as the realistic source terms in the reactor coolant. Table 11.1-8 "Parameters Used to Describe Realistic Sources" indicates that the nominal Value for Reactor coolant letdown flow rate at a typical plant is 5.0E+02 lb/hr. However, ANSI/ANS-18.1-1999 Table 2 "Parameters Used to Describe the Reference Pressurized Water Reactor with U-Tube Steam Generators" indicates that the nominal Value for Reactor coolant letdown flow rate at a typical plant is 5.0E+03 lb/hr.

In accordance with RG 1.206, please justify this discrepancy. If the information in Table 11.1-8 is incorrect, then please update Table 11.1-8 and the analysis results presented in Sections 11 and 12. If the information in Table 11.1-8 is correct then please provide information in chapter 11 that justifies the use of a value that differs from the ANSI listed nominal value.

ANSWER:

The nominal value for reactor coolant letdown flow rate (yearly average for boron control) at a typical plant is used for adjustment of reactor coolant activity. ANSI/ANS-18.1-1999 specifies to use letdown flow rate (yearly average for boron control) as one of the adjustment factors for removable rate-reactor coolant (Rn).

Table-9 in ANSI/ANS-18.1-1999 lists the values based on the nominal values, wherein the value for R1 as an example for noble gas (class 1) is 9.0E-4 (hr^{-1}).

According to Note in Table-9, R1 is given as:

$$R_1 = \frac{FB + (FD - FB) \cdot Y}{WP} \quad \text{for element class 1} \ldots\ldots\ldots\ldots \text{(Eq.1)}$$

where:

FB : letdown flow rate (yearly average for boron control)
FD : letdown flow rate (purification)
Y : Fraction of the noble gas activity in the letdown stream which is not returned to the reactor coolant system (not including the boron recovery system)
WP : Weight of water in the reactor coolant system

The values for PWRs with U-tube SGs indicated in Table-2 and Table-9 in ANSI/ANS-18.1 are as shown below:

	ANSI/ANS-18.1-1999	ANSI/ANS-18.1-1984
FB(lb/hr)	5.0E+03 (6.3E-02 kg/s)	5.0E+02 (6.3E-02 kg/s)
FD(lb/hr)	3.7E+04	3.7E+04
Y (--)	0.0	0.0
WP (lb)	5.5E+05	5.5E+05
R1(hr^{-1})	9.0E-4	9.0E-4

Substituting 5.0E+03 as FB in Eq.1 does not yeild 9.0E-04 as R1, while substituting 5.0E+02 to Eq.1 leads to 9.0E-04 as R1. It is thus understood that the value of FB as 5.0E+03 lb/hr in Table-2 in ANSI/ANS-18.1-1999 is a typographical error and should read as 5.0E+02 lb/hr. It has also been verified that the PWR-GALE code source employs 9.0E-04(hr^{-1}) as a typical plant R1 value. The discrepancy can also be seen by evaluating the value of FB as 6.2E-02 kg/s for both ANSI/ANS-18.1-1984 and 1999. This value is equivalent to 5.0E+02 lb/hr. Consequently, 5.0E+02 lb/hr is given as the nominal value for reactor coolant letdown flow rate (yearly average for boron control) at a typical plant in Table 11.1-8 in US-APWR DCD.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.