ArevaEPRDCPEm Resource

From: BRYAN Martin (EXT) [Martin.Bryan.ext@areva.com]
Sent: Thursday, April 01, 2010 3:12 PM
To: Tesfaye, Getachew
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); WILLIFORD Dennis C (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 346 (4146), FSARCh. 11 OPEN ITEM
Attachments: RAI 346 Response US EPR DC.pdf

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 346 Response US EPR DC.pdf" provides a technically correct and complete response to the single question, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 346 Question 11.05-20.

The following table indicates the respective pages in the response document, "RAI 346 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 346 — 11.05-20	2	7

This concludes the formal AREVA NP response to RAI 346, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Martin (Marty) C. Bryan
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Thursday, December 17, 2009 4:37 PM
To: ZZ-DL-A-USEPR-DL
Cc: Dehmel, Jean-Claude; Roach, Edward; Jennings, Jason; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 346 (4146), FSARCh. 11 OPEN ITEM

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on December 16, 2009, and discussed with your staff on December 17, 2009. No changes were made to the draft RAI questions as a result of that discussion. The question in this RAI is an OPEN ITEM in the safety evaluation report for Chapter 11 for Phases 2 and 3 reviews. As such, the schedule we have established for your application assumes technically correct and complete responses prior to the start of Phase 4 review. For any RAI that cannot be answered prior to the start of Phase 4 review, it is expected that a date for receipt of this information will be provided so that the staff can assess how this information will impact the published schedule.

Thanks,

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 1281

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Subject: Response to U.S. EPR Design Certification Application RAI No. 346 (4146), FSARCh. 11 OPEN ITEM
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From: BRYAN Martin (EXT)

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RAI 346 Response US EPR DC.pdf	169129	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
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Response to

Request for Additional Information No. 346(4146) Revision 1

12/17/2009

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 11.05 - Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems
Application Section: 11.5.2

QUESTIONS for Health Physics Branch (CHPB)

Question 11.05-20:

OPEN ITEM

Follow-up to RAI 276, Question Q11.05-13

FSAR Tier 2, Sections 11.5.1.2 and 5.2.5.3.2 address instrumentation and methods used to quantify reactor coolant system leakage to the secondary side and leakage rates, as required by EPR Technical Specifications (TS) 16.3.4.12.d and TS B16.3.4.12. The TS requirement specifies a maximum leakage rate of 150 gallons per day through any one steam generator (SG) using realistic primary coolant radionuclide concentrations. The technical basis for leakage detection and instrumentation is provided in TS B16.3.4.12, RG 1.45 (Rev. 1), and RIS 2009-02 (Rev. 1)] in selecting appropriate monitoring methods and in establishing radiation monitoring sensitivity. A review of FSAR Tier 2, Sections 11.5.4.3, 5.2.5.3.2, and 10.4.8.6, and Table 11.5-1 indicates that information on the associated radiation monitoring instrumentation does not indicate whether the instrumentation can detect a primary system leakage rate to the secondary side of 150 gallons per day through any one steam generator (SG) and does not describe the methodology that would be used by COL applicants to comply with the requirements of EPR TS 16.3.4.12.d on allowable SG operational leakage rates. Accordingly, the applicant is requested to review and revise FSAR Sections 5.2.5 and 11.5 and address the below noted items in the FSAR, and include in its response descriptions of the model, methodology, assumptions, parametric values used in the calculations and their basis, and references to enable the staff to conduct an independent evaluation.

a. Revise FSAR Table 11.5-1 to identify the appropriate types and numbers of radiation monitors used to satisfy TS 16.3.4.12.d and TS B16.3.4.12, and specify the minimum required radiation monitor sensitivities to satisfy the SG maximum leakage rate technical basis.
b. In FSAR Section 11.5.2 and/or 5.2.5.3.2, describe the methodology to demonstrate that the SG blowdown radiation monitors will be capable of satisfying the technical basis of the primary to secondary leakage rate of 150 gallons per day using realistic RCS radioactive concentrations for COL applicants to comply with the requirements of EPR TS 16.3.4.12.d.
c. In FSAR Sections 5.2.5.3.2 and 5.2.5.5, revise the descriptions and discussions on which types of radiation monitor instrumentation will be used to comply with EPR TS 16.3.4.12.d, and update all internal citations in referencing FSAR Section 11.5 for specific details on the associated radiation instrumentation.

Response to Question 11.05-20(a):

For the U.S. EPR design, the primary instruments used for primary-to-secondary leakage quantification during normal operation are the safety-related main steam line (MSL) radiation monitors. These monitors measure the concentration of radioactive materials in the four MSLs (N-16 and noble gases) and provide early indication of steam generator tube leakage. Each of the four MSLs has four redundant measuring arrangements, with a total of 16 monitors mounted adjacent to the steam lines within the main steam and feedwater valve compartments.

The MSL radiation monitor sensitivity range required to satisfy the SG maximum leakage rate technical basis has been determined to be 1.0E-08 to 1.0E-02 µCi/cc of N-16. For an N-16 concentration of 40 μCi/gm in the primary coolant during full power operation and for a steam-generator tube leakage rate of 150 gallons per day, it was determined that the N-16 concentration at the radiation monitor location in the MSL would be approximately 4.5E-06 μCi/cc. In the presence of N-16, noble gas activity in the MSLs has minimal contribution to the monitor response.

U.S. EPR FSAR Tier 2, Table 11.5-1 is being revised in conjunction with the responses to several questions in RAI 273. The radiation monitors that will be used to satisfy TS 16.3.4.12.d and TS B16.3.4.12, and their sensitivity requirements, will be included in the FSAR markups associated with RAI 273, Supplement 6.

Response to Question 11.05-20(b):

Described below is the methodology to be used to demonstrate that the installed MSL radiation monitors will be capable of satisfying the technical basis for primary-to-secondary leakage detection instrumentation during normal operation using a realistic radioactive concentration in the reactor coolant system (RCS).

The primary-to-secondary leakage rate can be correlated to the MSL radiation monitor reading using the following equation:

$$L' = \delta\ \omega_{N\text{-}16}(P)\ M$$

where

L' = primary to secondary leakage rate (gallons per day, gpd) (TS limit = 150 gpd)

δ = adjustment factor (unitless) to account for possible variation in the power-related variable $\omega_{N\text{-}16}$ between the expected and measured values, as defined below

$\omega_{N\text{-}16}(P)$ = correlation factor between leakage rate and monitor reading (gpd-hr/μR)

= $(7.8658\ F'\ v\ ) / (0.04381\ \psi\ C_{N\text{-}16}\ \exp(-\lambda t))$

F' = steam flow rate (lbm/hr) at power P

v = steam specific volume (ft^3/lbm)

ψ = N-16 dose rate at MSL radiation detector per unit activity concentration in the steam line (27.5" pipe ID, 1.9" wall thickness, 4" detector distance from pipe surface, with buildup)

= 8.044E+05 (μR-cc/hr-μCi)

$C_{N\text{-}16}$ = RCS N-16 concentration at the leakage point to the SG secondary side (μCi/gm), linearly proportional to the power level

λ = N-16 decay constant (= 0.09722 sec^{-1})

t = transit time (sec) from the entry point to the SG secondary side to the MSL radiation monitor location downstream (steam-flow dependent), for in-transit decay

P = power level (percent)

M = radiation monitor reading (μR/hr) due to N-16, under the given conditions

7.8658 = conversion factor ((cc/sec) per (ft^3/hr))

0.04381= conversion factor ((gm/sec) per gpd)

For the U.S. EPR design, variation of the correlation factor $\omega_{N\text{-}16}(P)$ with power is shown in Table 11.05-20-1 and Figure 11.05-20-1. The listed values for this correlation factor can be used for two purposes:

(a) To define the adjustment factor δ using actual measurements for the leakage rate (based on laboratory analysis of SG blowdown activity) and the corresponding actual monitor reading.

(b) For real-time tracking of the leakage rate when using the equation above.

Supplemental leakage tracking information can be extracted from Figure 11.05-20-2.

The adjustment factor δ is empirically defined as:

$$\delta = L_m' / (\omega_{N\text{-}16}(P_m)\ M_m)$$

where

L_m' = primary to secondary leakage rate (gpd) determined through process sampling and laboratory analyses,

P_m = power level (percent) during the measurement,

M_m = radiation monitor reading (μR/hr) during the measurement,

and $\omega_{N\text{-}16}(P_m)$ is extracted from Table 11.05-20-1 or Figure 11.05-20-1, at P_m.

This adjustment factor (δ) can also be used to account for the following:

- Minor variations in the source-to-detector geometry.
- Potential difference in the full-power N-16 concentration at the leakage point into the SG secondary side from the value of 35.2 μCi/gm used in the present application (as incorporated in the definition of $\omega_{N\text{-}16}(P)$).
- Different radiation measurement units (applied to both M and M_m).

Response to Question 11.05-20(c):

A potential identifiable reactor coolant system (RCS) leakage path is through the steam generator tubes to the secondary side. Such leakage can be detected by the following radiation monitors:

- Condenser air removal system discharge noble gas monitors.
- Steam generator blowdown monitors.
- Main steam line (MSL) monitors.

The radiation monitor readings are displayed in the main control room, and the measurements are supplemented by process sampling and laboratory analyses.

The MSL radiation monitors will be of high sensitivity, with each detector placed within specially designed lead shielding that would limit the angle of view to the steam line being monitored. Such an arrangement would minimize the contribution of scatter radiation as well as direct radiation emanating from the adjacent steam lines.

U.S. EPR FSAR Tier 2, Section 5.2.5.5 will be revised to add a new subsection entitled "Main Steam Line Radiation Monitors for Steam Generator Tube Leakage," to describe the radiation monitor instrumentation to be used in complying with TS 16.3.4.12.d, and their capability of satisfying the technical basis of the primary to secondary leakage rate of 150 gallons per day using realistic RCS radioactivity concentrations.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 11.5-1 will be revised as described in the response and the FSAR markups provided in the response to RAI 273, Supplement 6. U.S. EPR FSAR Tier 2, Section 5.2.5.5 will be revised as described in the response and indicated on the enclosed markup.

Table 11.05-20-1—Power Dependent Variable $\omega_{N-16}(P)$

Power Level (Percent)	Steam Flow F' (lbm/hr)	Specific Volume (ft3/lbm)	N-16 Conc. in RCS (µCi/gm)	Transit Time t (sec)	In-Transit Decay (e-λt)	ωN-16 (gpd – hr/µR)
10	4.550E+05	0.32902	3.518E+00	49.01	8.523E-03	1.114E+03
25	1.167E+06	0.32750	8.796E+00	25.25	8.591E-02	1.129E+02
35	1.666E+06	0.33778	1.231E+01	19.98	1.433E-01	7.117E+01
45	2.185E+06	0.33850	1.583E+01	17.22	1.874E-01	5.564E+01
60	2.972E+06	0.34170	2.111E+01	14.83	2.365E-01	4.540E+01
80	4.044E+06	0.36631	2.815E+01	13.09	2.802E-01	4.192E+01
100	5.168E+06	0.39535	3.518E+01	11.99	3.118E-01	4.157E+01

Figure 11.05-20-1—Power Dependent Variable $\omega_{N-16}(P)$

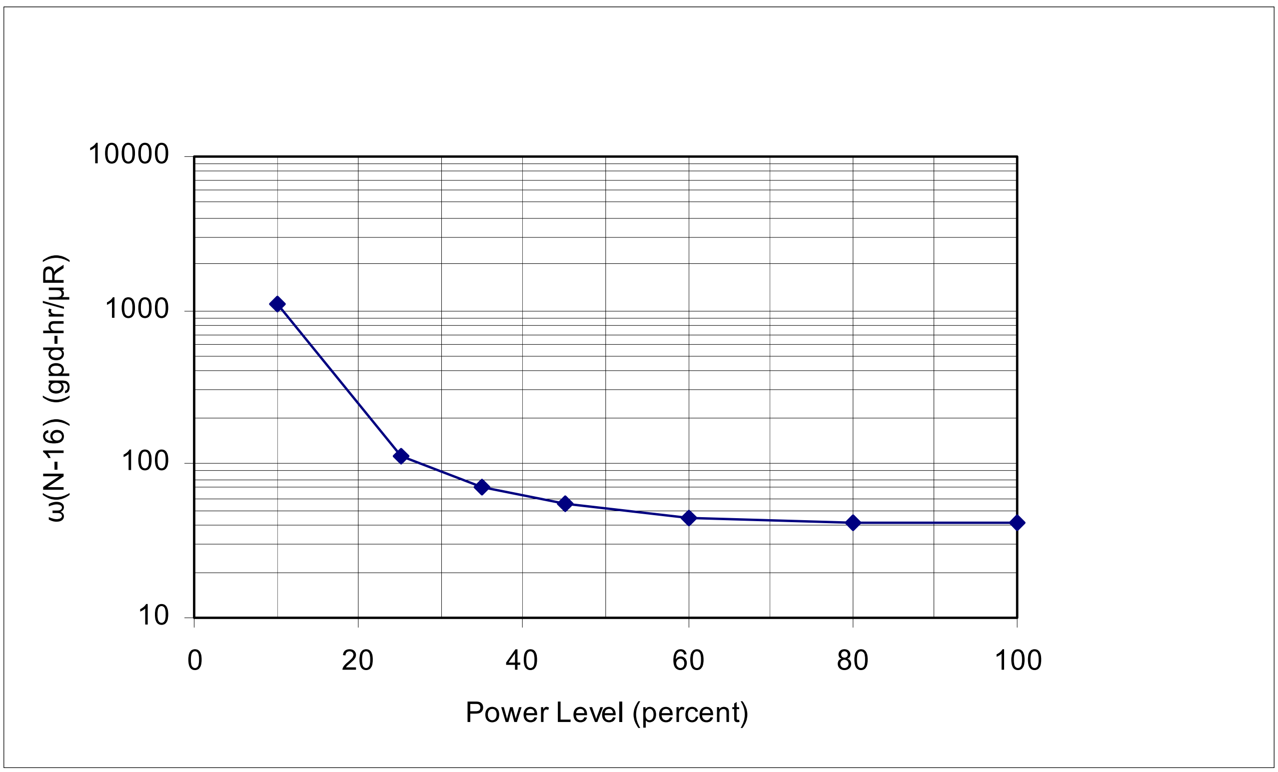
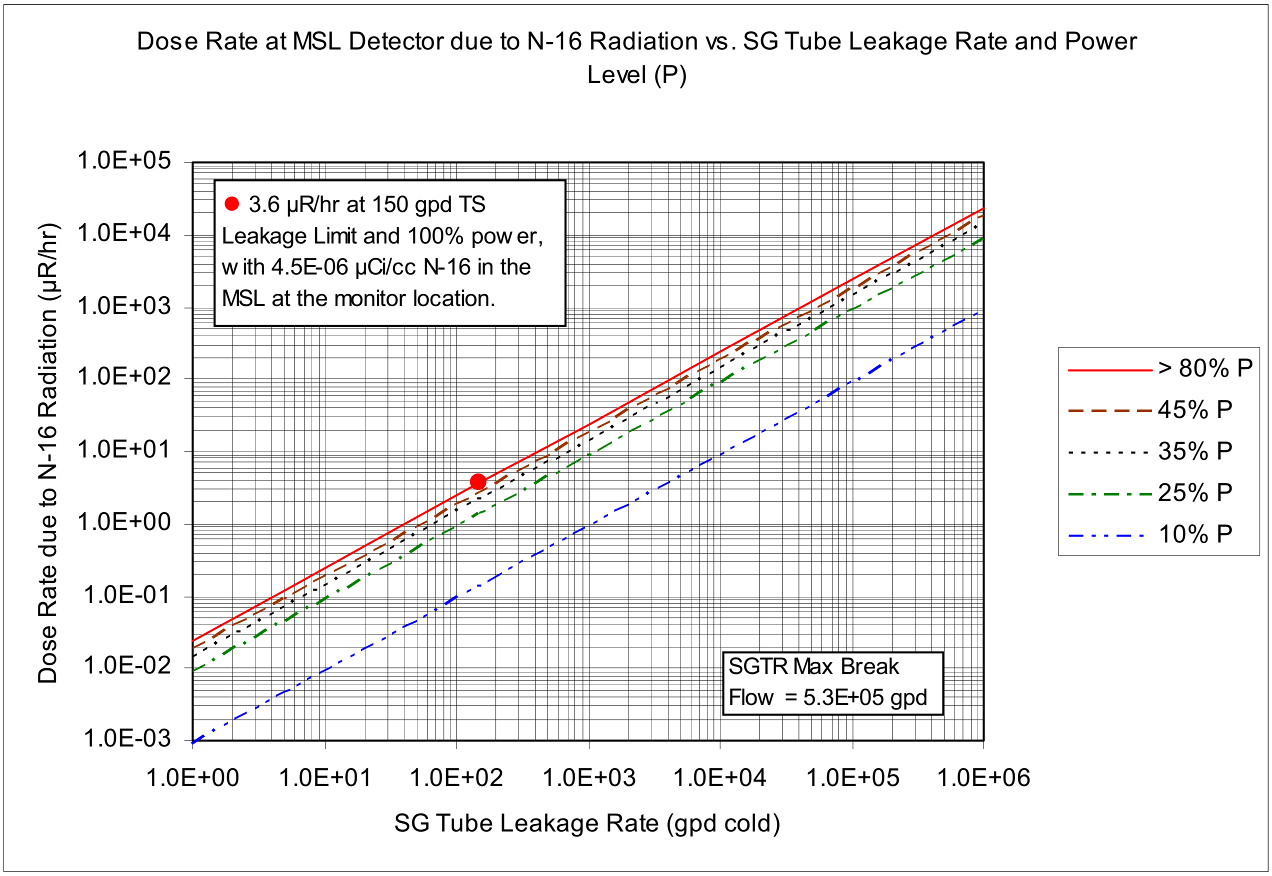


Figure 11.5-20-2—Dose Rate at MSL Detector vs. SG Tube Leakage Rate and Power Level



U.S. EPR Final Safety Analysis Report Markups

The additional monitored leakage connections that discharge to the RCDT include the PSRV valve body drains, the reactor vessel O-ring seal leakoff, RCP static seal (main flange) leakoff, valve stem packing leakage, and safety valve discharge lines from the combined RCP #1 seal return line, the four RCP thermal barrier return lines, the CVCS letdown line, and the CVCS charging line. Additional equipment and component drain connections to the RCDT are used only during shutdown or during startup operations and are isolated from the RCDT by a closed manual valve, or are disconnected and flanged, during power operation and are not expected to affect RCPB leakage monitoring efforts.

5.2.5.5.2 Reactor Building Sump Level

During normal operation the Reactor Building sump collects water from the reactor building floor drains and the Reactor Building annular space floor drain sump. Sump level and automatic pump operation for both sumps are indicated in the MCR to allow prompt identification of any unidentified leakage in the Reactor Building.

5.2.5.5.3 Containment Atmosphere Particulate Radiation Monitoring

Containment atmosphere particulate radioactivity monitoring is one of the systems used in the US EPR design for RCS leakage detection. The particulate monitor is a low range monitor capable of detecting 3E-10 to 1E-6μCi/cc. The monitor sensitivity requirement is to be able to detect a leakage increase of one gpm within one hour (see U.S. EPR FSAR, Tier 2, Chapter 16, TS 16.3.4.12 and corresponding Bases, RG 1.45 and RIS-2009-02), based on a realistic RCS source term. The particulate radiation monitoring system continuously monitors airborne radioactivity in the containment equipment area. Radiation levels are indicated in theMCR. Alarms alert the operators of elevated levels of radioactivity to allow for prompt identification of RCS leakage into the equipment area. The monitor is located in the service area of the containment, which is accessible during normal operation. It draws air from the containment building ventilation system which filters airborne radioactivity within the equipment area. The monitoring system will be designed to function properly in the containment environment.

11.05-20

5.2.5.5.4 Main Steam Line Radiation Monitors for Steam Generator Tube Leakage

The primary instruments for quantification of primary-to-secondary leakage during normal operation are the safety-related main steam line radiation monitors. These monitors measure the concentration of radioactive materials in the four main steam lines (N-16 and noble gases) and provide early indication of steam generator tube leakage. There are four redundant measuring arrangements for each of the four main steam lines, with a total of 16 monitors mounted adjacent to the steam lines within the main-steam and feedwater valve compartments.

11.05-20

The main steam line radiation monitors will be of high sensitivity, with each detector placed within specially designed lead shielding that would limit the angle of view to the steam line being monitored. Such an arrangement minimizes the contribution of scatter radiation as well as direct radiation emanating from the adjacent steam lines. The monitors are capable of satisfying the technical basis of the primary to secondary maximum leakage rate of 150 gallons per day using realistic RCS radioactivity concentrations. The required monitor sensitivity range was determined to be 1.0E-08 to 1.0E-02 μCi/cc of N-16. The steam generator leakage determination is based on correlations which predict the leakage rate as a function of primary-coolant N-16 concentration, power level and monitor reading, taking into consideration the variation of steam flow with power and the N-16 in-transit decay from the leakage point to the radiation monitor location.

In the presence of N-16, noble gas activity in the main steam lines has minimal contribution to the monitor response. The same monitors are used for identification of the affected steam generator in a steam generator tube rupture (SGTR) event, based on the ensuing noble-gas activity within the steam line.

5.2.6 References

1. ASME Boiler and Pressure Vessel Code, Section III," Rules for Construction of Nuclear Facility Components," The American Society of Mechanical Engineers, 2004.

2. ASME Code for Operation and Maintenance of Nuclear Power Plants, The American Society of Mechanical Engineers, 2004.

3. EPRI Report 1014986, "Pressurized Water Reactor Primary Water Chemistry Guidelines," Volume 1, Revision 6, Electric Power Research Institute, December 2007.

4. ASTM A-262, "Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels," American Society for Testing and Materials International, December 2002.

5. EPRI Report MRP-111, "Materials Reliability Program, Resistance to Primary Water Stress Corrosion Cracking of Alloys 690, 52/52M, and 152 in Pressurized Water Reactors," Electric Power Research Institute, March 2004.

6. SRM-SECY-04-0032, "Programmatic Information Needed for Approval of a Combined License Without Inspections, Tests, Analyses and Acceptance Criteria," May 2004.

7. ANP-10263P-A, "Codes and Methods Applicability Report for U.S. EPR," AREVA NP Inc., August 2007.