Draft

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U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 12.02 - Radiation Sources
SRP Section: 12.03-12.04 - Radiation Protection Design Features
Application Section: FSAR, Tier 2, Section 11.1, Source Terms; Section 12.1, ALARA; & Section 12.3, Radiation Protection Design Features
Application Section: Section 12.3, Radiation Protection Design Features

QUESTIONS for Health Physics Branch (CHPB)

12.02-1

RG 1.206, Section C.I.12.2.1, Contained Sources, states, in part, that the applicant should describe the sources of radiation, during normal plant operations and accident conditions, that are the bases for the radiation protection design, such that the facility is demonstrated to be in compliance with 10 CFR Part 20 and GDC 61 in Appendix A of 10 CFR Part 50.

1. The EPR FSAR, Tier 2, Section 12.1.1.2, ALARA Design and Construction Policies, states that

   “The US EPR design process…is in accordance with the guidance provided in RG 8.8 Section C.2 to achieve occupational doses and doses to members of the public that are ALARA”

   Section C.2 of RG 8.8 states that, "to provide a basis for design...fission product source terms should be estimated using a 0.25% fuel cladding defect for PWRs."

   In FSAR Tier 2 Section 11.1.2.2, "Design Basis for Shielding," you indicated that you would use this as the basis for the shielding evaluation source term, "except for radiodine, bromines, and noble gases." Instead, you indicated that "radioiodine and bromine are at the TS concentration limits."

   The EPR FSAR does not indicate why the technical specification limits were used, nor does it indicate what basis was used to calculate noble gas concentrations. Please explain your rationale and how this is appropriate in light of the guidance provided in section C.2 of RG 8.8. Discuss whether or not the method used is conservative relative to the 0.25% failed fuel fraction assumption described in RG 8.8.

2. RG 1.206, Section C.I.12.2.1, Contained Sources, states that the applicant should describe the contribution of neutron and gamma streaming to

radiation levels in potentially occupied areas of containment. The EPR FSAR, Tier 2, Section 12.3.1.1, Reactor Building, states that personnel will access the service compartments of containment while at power in order to stage equipment for outages. However, the shielding codes referenced in the FSAR solve gamma-ray transport equations only and do not calculate dose rates due to neutron fluxes, therefore there is no neutron dose rate provided in the FSAR for these at-power containment entries.

In accordance with RG 1.206, describe the contribution of neutron streaming to the radiation levels seen by personnel while accessing the service compartments at power. Describe the method and/or code that was used to estimate the neutron contribution to radiation levels within the service compartment. Relevant operating experience from similar operating reactors may be used.

12.02-2

Airborne radioactivity sources considered for the design of ventilation systems, radiation monitoring, personal protective measures and for dose assessment should be described by location and magnitude such that there is reasonable assurance that the requirements of 10 CFR 20.1203, 10 CFR 20.1204, and 10 CFR Part 20 Appendix B will be met.

The EPR FSAR, Tier 2, Section 12.2.2, Airborne Radioactive Material Sources, provides a description of the airborne sources located in the plant. However,

a) It is not clear from the parameters listed in Table 12.2-19, Parameters and Assumptions for Calculating Airborne Radioactive Concentrations, how the airborne concentrations were calculated for the EPR. Please provide sample airborne radioactivity concentration calculations for the fuel and reactor buildings such that NRC staff can independently verify the methodology used and the concentrations reported in the FSAR. Include all equations, assumptions and any default values that may have been used.
b) Airborne radioactivity concentrations for Safeguard Buildings 1, 2, 3 and 4 were not provided. Justify the exclusion of these buildings as possible airborne areas or provide estimates of the radioactivity concentrations that could be found in these buildings.

12.02-3

Radiation sources that are the basis for the radiation protection program and for shield design calculations should be described such that there is reasonable assurance that the requirements of 10 CFR 20.1201, 20.1206 and 10 CFR 50.34(f)(2)(vii) are met. In addition, RG 1.206, Part C.I.12.2.1, Contained Sources, states, in part,

"The applicant should describe the sources of radiation, during normal plant operations and accident conditions, that are the basis for the radiation protection design."

However, the EPR FSAR in Tier 2, Section 12.2.1, Contained Sources, does not provide information on the following sources which constitute a significant radiation protection and shielding design concern. In accordance with RG 1.206, please provide the following:

i) Spent fuel gamma ray source strengths for maximum burn-up as a function of time after shutdown
ii) Safety Injection System Source strengths at various times following a LOCA.
iii) Normal Residual Heat Removal System source strength as a function of time after shut down.

12.03-12.04-3

1. 10 CFR 20.1501(b) requires licensees to ensure that the instruments and equipment used for quantitative radiation measurements are calibrated periodically for the radiation measured. RG 1.206, Part C.I.12.3.4, Area Radiation and Airborne Radioactivity Monitoring Instrumentation, states that the applicant should provide information regarding the calibration methods and frequency for the monitoring instrumentation.

   The EPR FSAR Tier 1, section 12.3.4, Area and Airborne Radioactivity Monitoring Instrumentation, states that radiation instrumentation complies with 20.1501 and that additional information on calibration of fixed area and airborne radioactivity monitors is provided in the Radiation Protection Program described in Section 12.5. Section 12.5 of the EPR FSAR consists of one COL action item, for which all COL applicant's are referencing NEI 07-03, Generic FSAR Template Guidance for Radiation Protection Program Description. However, NEI 07-03 does not provide any information on the calibration of fixed area and airborne monitors – only calibration of portable monitors.

   In accordance with RG 1.206, provide information on the calibration methods and frequency that will be used for the EPR fixed area and airborne monitors. Discuss to what extent the calibration guidance described in ANSI/ANS 6.8.1, Location and Design Criteria for Area Radiation Monitoring Systems for Light Water Nuclear Reactors will be incorporated. If not, describe the specific alternative approaches used.

2. EPR FSAR, Tier 2, Figure 12.3-24, Safeguard Buildings 2 and 3 -31 Ft Elevation Radiation Zones, shows 4 pumps labeled as "Medium Head Safety Injection System Pumps," although there are two Low Head Safety Injection System Heat Exchangers located in elevation -16 Ft of the same buildings, as shown on Figure 12.3-25, Safeguard Buildings 2 and 3 -16 Ft Elevation Radiation Zones. Correct this typo, or provide clarification.

3. In Tier 2, EPR FSAR, Section 12.3.2.2, Shielding Calculation Methods, the following statement is made: "selection of buildup factors [is]based on the last significant shield material the radiation passes through." Provide more detail as to how the "last significant shield material" was selected, such that NRC staff can reproduce the shielding calculation methodology described in this section of the FSAR.

12.03-12.04-4

Facility design should minimize the potential for creating very high radiation areas during normal operations, including abnormal operational occurrences. High and very high radiation areas should be isolated from normally occupied rooms and corridors such that personnel access to these areas can be controlled in accordance with 10 CFR 20.1601, 10 CFR 20.1602 and the guidance in Regulatory Guide 8.38.

Section 4.4.6.2 of the EPR FSAR, Tier 2 describes the aeroball system as “an electromechanical, computer-controlled, online flux mapping measurement system based on movable activation probes (aeroballs).” These “aeroballs” can be moved into and out of the core through the top of the reactor vessel using a pneumatic transport system. In currently operating reactors movable in-core detectors have become stuck during transit outside of the reactor vessel, thereby creating high or very high radiation areas that have resulted in unplanned personnel exposures. For the aeroball system, it is not clear from the description provided whether the activation probes could become stuck in transit outside of the core and result in unplanned worker exposures, particularly during outages.

i) Discuss what design features and access controls will be in place to ensure that if one or more aeroballs become stuck outside of the core (in transit to the measurement room, for example) workers occupying containment during outages would not receive radiation doses in excess of 10 CFR Part 20 occupational dose limits. Discuss how doses to workers performing maintenance on the aeroball system, including the activation probes themselves, will be maintained below 10 CFR Part 20 limits. Discuss how control of the radioactive aeroballs will be maintained if the balls had to be replaced, particularly since the aeroballs are so small in diameter (0.067 inches) and there are so many of them (2500 aeroballs per stack, 40 stacks in a core). If the aeroball system is in use at currently operating plants, describe any operating experience that may justify the use of such a system.

ii) Provide information or a drawing describing where and how the activation probes are stored following transit from the core (and assuming they are not located in the measurement room). Provide information or a drawing describing the shielding at the storage location to ensure that dose rates to personnel in the area are maintained ALARA.

iii) Provide the isotopic composition and source strengths for the aeroballs following the maximum expected use time at 100% power (including stuck detectors). Also provide source strengths projected over a 3 week period (such as a refueling outage).

iv) EPR FSAR, Tier 2, Figure 4.4-11, Aeroball Probe, indicates that a carrier gas will be used to transport the activation probes. This gas will be located in the core at times and will therefore become activated. Provide information on what gas will be used in the system, how much activity (and what isotopes) will be contained in the gas following the maximum expected in-core time at 100% power, as well as how the used radioactive gas will be disposed of. Discuss what design features will be in place to maintain occupational doses due to the carrier gas ALARA.

12.03-12.04-5

The area radiation monitoring system must meet the provisions of 10 CFR 20.1501, 10 CFR 50.34(f)(2)(xxvii) and GDC 63.

RG 1.206, Part C.I.12.3.4, Area Radiation and Airborne Radioactivity Monitoring Instrumentation, states that the applicant should describe the criteria for selection and placement of the fixed radiation monitors in accordance with ANSI/ANS-HPSSC-6.8.1-1981, “Location and Design Criteria for Area Radiation monitoring Systems for Light-Water Nuclear

Reactors." ANSI/ANS-6.8.1, Section 4.2, Detector Locations, has the following criteria for locating instrumentation:

"… 4.2.2 Special consideration should be given to those normally accessible and occasionally accessible areas which can experience significantly greater exposure rates resulting from operational transients or maintenance activities."

Examples of areas provided in ANSI/ANS 6.8.1 that may meet the criteria described above include:

- the radwaste building, including solid radwaste storage areas, the drumming station control panel area and the radwaste control panel areas
- the primary sample station area,
- hot machine shops,
- decontamination areas,
- the reactor water cleanup heat exchanger area,
- the residual heat removal pump and heat exchanger areas,

EPR FSAR Section 12.3.4.1.1, Normal Operations, states that EPR instrumentation selection and placement follow the criteria of ANSI/ANS-6.8.1. EPR FSAR Tier 2, Table 12.3-3, Radiation Monitor Detector Parameters, describes the locations of fixed area radiation monitors for the EPR design. However, Table 12.3-3 of the EPR FSAR does not list any area monitors for the radwaste building, contrary to the guidance provided in ANSI/ANS 6.8.1, and contrary to the commitment provided in EPR FSAR Section 11.4.1.2.4, Controlled Releases, which states:

"…area radiation monitors throughout the Radioactive Waste Processing Building detect excessive radiation levels and alert the operators to this condition, in accordance with GDC 63. Area radiation monitoring is addressed in detail in Section 12.3.4."

1. Provide the locations of area radiation monitors in Table 12.3-3 for the radioactive waste processing building in accordance with the guidance provided in ANSI/ANS 6.8.1, the commitment provided in Section 11.4 of the EPR FSAR, and the requirements of GDC 63.

2. For several EPR areas which are encompassed by the bulleted list above (including the primary sampling room, the radiochemistry laboratory, the hot workshop located in the nuclear auxiliary building, the CVCS heat exchanger area, and the residual heat removal pump and heat exchanger areas located in the safeguard buildings), no area monitors are provided in Table 12.3-3. Modify Table 12.3-3 to include area monitors at these locations or discuss how workers will be alerted of increasing radiation levels in these and other areas where radiation levels could increase significantly due to transients or maintenance, and where personnel may be present.

12.03-12.04-6

10 CFR 20.1601 requires that lockable doors be provided to all high radiation areas. The EPR FSAR, Tier 2, Section 12.3.1.8.2, Fuel Building, states that

“Occupied areas adjacent to the fuel transfer tube are shielded so that dose rates are less than 100 rads per hour during fuel movement operations, in accordance with section 12 of the NUREG-0800.”

Figures 12.3-9, “Containment Building Section Looking Plant-East as the Reactor Cavity, Core Internals Storage, Transfer pit, and Spreading Area,” and Figure 12.3-4, “Transfer pit at the +17 Ft Elevation in the Reactor Building,” provide a view of the spent fuel transfer pit as well as areas adjacent to the pit within the reactor building that could be occupied. Provide information on the minimum concrete thickness between the pit and these potentially occupied areas within the reactor building, as well as the estimated dose rates in these areas during spent fuel transfer. Discuss design features that will be in place to control access to high radiation areas adjacent to the fuel transfer pit during fuel transfer (for example, the “access to transfer pit” rooms shown in Figures 12.3-34, "Fuel Building +12 Ft Elevation Radiation Zones," and 12.3-4).

12.03-12.04-7

EPR Tier 2, Section 12.3.4.1.3, In-containment High-Range Monitoring, states that the in-containment monitoring instrumentation used during postulated accidents meet the requirements of IEEE Std 497-2002 for a Type C, category 3 instrument and a Type E, category 1 instrument. However, IEEE Std 497-2002 does not discuss “categories.” This standard only groups instrumentation into Types A, B, C, D, or E. Please correct this statement in the FSAR.