RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**14-7858**
SRP Section:	**12.03-12.04 - Radiation Protection Design Features**
Application Section:	**12.3-12.4**
Date of RAI Issued:	**05/22/2015**

Question No. 12.03-1

REQUIREMENTS

10 CFR 20.1406(b) requires that, “Applicants for standard design certifications, standard design approvals, and manufacturing licenses under part 52 of this chapter, whose applications are submitted after August 20, 1997, shall describe in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste."

Regulatory Guide (RG) 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning,” provides guidance on meeting the requirements of 10 CFR 20.1406. RG 4.21 indicates that, monitoring of some buried, embedded in concrete, or in contact with soil pipes was not sufficiently sensitive at decommissioned plants to identify small leaks and leakage rates and that such situations and conditions should be avoided during facility design. It indicates that leak detection systems should be included within the facility design that are capable, to the extent practical, of detecting minor leaks that otherwise, over time, could potentially cause significant environmental contamination.

ISSUE

The applicant indicates that the specific systems which contain underground piping will be based upon site-specific plant layout conditions. Therefore, COL 12.4(3) indicates that, “The COL applicant is to implement concrete tunnels for piping of the systems that may include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping.” However, the COL item provides no information on if there will be leakage equipment within the tunnels. In addition, while FSAR Section 12.4.2.4.4 indicates that underground piping tunnels are coated with epoxy and are equipped with liquid detection

level switches, there is no discussion regarding if the design will be such that minor leaks can be detected within the system.

INFORMATION REQUESTED

Please update COL 12.4(3) to have the COL applicant describe the leakage detection capabilities within any underground concrete piping tunnels. The leakage detection capabilities should be designed to detect minor leaks, to the extent practicable.

Response

COL 12.4(3) will be updated to have the COL applicant describe the leakage detection capabilities within any underground concrete piping tunnels.

Impact on DCD

DCD Subections 12.4.2.4.4, 12.4.3 and Table 1.8-2 will be revised as indicated in Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical and Environmental Reports.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

12.4.2.4.4 Minimization of Embedded and/or Buried Piping

Embedded or buried piping is minimized using the following approach:

a. Piping is routed inside pipe chases to the extent possible to minimize embedded piping. Drain pipes on the floors above the basemat level are allowed to penetrate the floor and are routed inside pipe chases below the floor level as required.

b. To the extent practicable, double-walled piping is used when embedded piping segments cannot be avoided. The outside piping of the double wall pipe is designed to drain to a local sump or onto the floor for drainage to a nearby sump for collection.

c. For the basemat level, drain pipes are routed in concrete trenches that are sloped toward the local sump. The trenches are coated with epoxy to facilitate drainage and cleaning.

d. For piping that carries contaminated or potentially contaminated fluid and is located outside the plant structures, the piping is routed in underground concrete tunnels to the maximum extent practicable. Systems that contain yard piping routed through underground concrete tunnels may include CCWS, ESWS, CVCS, condensate systems, etc., which are determined based upon site-specific plant layout conditions. The COL applicant is to implement concrete tunnels for those systems that include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping ~~(COL 12.4(3))~~. The tunnels are coated with epoxy and are equipped with sumps with liquid detection level switches. If liquid is accumulated to the detectable level, an alarm is initiated in the MCR for operator actions.

(COL 12.4(3))

12.4.3 Combined License Information

COL 12.4(1) The COL applicant is to estimate construction worker doses based on the site-specific number of operating units, distances, meteorological conditions, and construction schedule.

COL 12.4(2) The COL applicant is to provide operational procedures and programs, including the development of a site radiological environmental monitoring program, to implement the minimization of contamination approach.

COL 12.4(3) The COL applicant is to implement concrete tunnels for piping of the systems that may include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping.

12.4.4 References

1. Regulatory Guide 8.8, "Information Relevant to Ensuring the Occupational Radiation Exposures at Nuclear Power Stations will be ALARA," Rev. 3, U.S. Nuclear Regulatory Commission, June 1978.

2. Regulatory Guide 8.19, "Occupational Radiation Dose Assessment in Light Water Reactor Power Plants Design Stage Man-Rem Estimates," Rev. 1, U.S. Nuclear Regulatory Commission, June 1979.

3. NUREG-0713, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities," U.S. Nuclear Regulatory Commission.

4. ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," The American Society of Mechanical Engineers, 2007.

5. NUREG-0737, "Clarification of TMI Action Plan Requirements," U.S. Nuclear Regulatory Commission, November 1980.

6. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," U.S. Nuclear Regulatory Commission, July 2000.

7. Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," U.S. Nuclear Regulatory Commission, June 2008.

The tunnels are coated with epoxy and are equipped with sumps with liquid detection level switches. If liquid is accumulated to the detectable level, an alarm is initiated in the MCR for operator actions.

Table 1.8-2 (21 of 29)

Item No.	Description
COL 12.4(1)	The COL applicant is to estimate construction worker doses based on site-specific number of operating units, distances, meteorological conditions, and construction schedule.
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COL 12.4(3)	The COL applicant is to implement concrete tunnels for piping of the systems that may include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping.
COL 12.5(1)	The COL applicant is to provide the operational radiation protection program, including the items described in Section 12.5.
COL 13.1(1)	The COL applicant is to provide a description of the corporate or home office organization, its functions and responsibilities, and the number and the qualifications of personnel. The COL applicant is to be directed to activities such as the facility design, design review, design approval, construction management, testing, and operation of the plant.
COL 13.1(2)	The COL applicant is to develop a description of experience in the design, construction, and operation of nuclear power plants and experience in activities of similar scope and complexity.
COL 13.1(3)	The COL applicant is to describe its management, engineering, and technical support organizations. The description includes organizational charts for the current headquarters and engineering structure and any planned modifications and additions to those organizations to reflect the added functional responsibilities with the nuclear power plant.
COL 13.1(4)	The COL applicant is to develop a description of the organizational arrangement. The description is to include organizational charts reflecting the current headquarters and engineering structure and any planned modifications and additions to reflect the added functional responsibilities associated with the addition of the nuclear plant to the applicant's power generation capacity. The description shows how these responsibilities are delegated and assigned or expected to be assigned to each of the working or performance-level organizational units identified to implement these responsibilities. The description includes organizational charts reflecting the current corporate structure and the working- or performance-level organizational units that provide technical support for the operation.
COL 13.1(5)	The COL applicant is to develop the description of the general qualifications in terms of educational background and experience for positions or classes of positions described in the organizational arrangement.
COL 13.1(6)	The COL applicant is to develop a description of the structure, functions, and responsibilities of the onsite organization established to operate and maintain the plant.
COL 13.1(7)	The COL applicant is to provide an organizational chart showing the title of each position, minimum number of persons to be assigned to duplicate positions, number of operating shift crews, and positions that require reactor operator and senior reactor operator licenses.

The tunnels are coated with epoxy and are equipped with sumps with liquid detection level switches. If liquid is accumulated to the detectable level, an alarm is initiated in the MCR for operator actions.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**14-7858**
SRP Section:	**12.03-12.04 - Radiation Protection Design Features**
Application Section:	**12.3-12.4**
Date of RAI Issued:	**05/22/2015**

Question No. 12.03-2

REQUIREMENTS

10 CFR 19.12 (a) requires that all individuals who in the course of employment are likely to receive in a year an occupational dose in excess of 100 mrem (1 mSv) be trained as radiation workers.

10 CFR 20.1301 requires that the total effective dose equivalent to individual members of the public (those individuals not trained in accordance with 10 CFR 19.2 (a)) does not exceed 100 mrem per year.

ISSUE

COL item 12.4(1) states that, “The COL applicant is to estimate construction worker doses based on the site-specific number of operating units, distances, meteorological conditions, and construction schedule.”

This COL item is necessary in order to provide reasonable assurance that construction workers will meet applicable regulatory requirements, such as 10 CFR 20.1301, if the construction workers are not trained radiation workers in accordance with 10 CFR 19.12. While factors such as those mentioned above need to be considered in calculating the dose to construction workers, other factors may also need to be considered in estimating the construction worker dose, such as if there is existing contamination on the construction site from an existing unit, or the location of an existing independent spent fuel storage installation (ISFSI) near the construction area. Therefore, only considering those factors listed in COL 12.4(1) could result in an incomplete analysis of radiation exposure to construction workers.

INFORMATION NEEDED

Since the appropriate considerations are site specific and since there is no way to definitively list all applicable factors for a given site, please update COL item 12.4(1) to indicate that the construction worker dose estimates should consider all applicable site specific factors and not just those listed above. For example, the applicant may choose to update COL Item 12.4(1) to state, “The COL applicant is to estimate construction worker doses based on site-specific information, such as, the number of operating units, distances from radiation sources, meteorological conditions, and construction schedule.”

Response

COL item 12.4(1) will be updated to indicate that the construction worker dose estimates should consider all applicable site specific factors.

Impact on DCD

DCD Subections 12.4.1.4, 12.4.3, and Table 1.8-2 will be revised as indicated in Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical and Environmental Reports.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

tanks are expected to contain radioactivity that yields a dose rate of 0.0025 mSv/hr or less at the tank shielded surface. Therefore, the estimated annual direct dose at the site boundary is expected to be small.

The estimated doses at the site boundary due to released activity are given in Subsections 11.2.3.1 and 11.3.3.1. The resultant annual doses for the general public are within the limits of the applicable regulations.

information such as the number of operating units, distances from radiation sources,

12.4.1.4 Estimated Dose to Construction Workers

The construction worker doses are the sum of the exposures due to direct radiation and airborne radiation from the adjacent operating unit(s). The dose criterion to the construction workers is 1 mSv/yr. The construction worker doses are site-specific and based on the number of operating units, distances, meteorological conditions, and construction schedule. The COL applicant is to estimate construction worker doses based on site-specific ~~number of operating units, distances~~, meteorological conditions, and construction schedule (COL 12.4(1)).

12.4.2 Minimization of Contamination and Radioactive Waste Generation

The APR1400 design includes features and operational programs to conform with 10 CFR 20.1406 and NRC RG 4.21 (Reference 7) to minimize contamination of the facility and environment, facilitate decommissioning, and minimize the generation of radioactive waste throughout the life cycle of the facility.

The design includes control measures that address the requirements in Regulatory Positions C.1 through C.4 and Appendix A of NRC RG 4.21. The control measures are designed to work in conjunction with the operational procedures for the collection, processing, sampling, storing, monitoring, and disposal of radioactive waste during normal operation, including AOOs. The COL applicant is to provide operational procedures and programs, including the development of a site radiological environmental monitoring program, to implement the minimization of contamination approach (COL 12.4 (2)). The design also takes into account the life-cycle planning of the facility and through COL 12.4(2), identifies the operational programs and procedures to address maintenance of structures, systems, and components (SSCs), site radiological environmental monitoring, and documentation of

12.4.2.4.4 Minimization of Embedded and/or Buried Piping

Embedded or buried piping is minimized using the following approach:

a. Piping is routed inside pipe chases to the extent possible to minimize embedded piping. Drain pipes on the floors above the basemat level are allowed to penetrate the floor and are routed inside pipe chases below the floor level as required.

b. To the extent practicable, double-walled piping is used when embedded piping segments cannot be avoided. The outside piping of the double wall pipe is designed to drain to a local sump or onto the floor for drainage to a nearby sump for collection.

c. For the basemat level, drain pipes are routed in concrete trenches that are sloped toward the local sump. The trenches are coated with epoxy to facilitate drainage and cleaning.

d. For piping that carries contaminated or potentially contaminated fluid and is located outside the plant structures, the piping is routed in underground concrete tunnels to the maximum extent practicable. Systems that contain yard piping routed through underground concrete tunnels may include CCWS, ESWS, CVCS, condensate systems, etc., which are determined based upon site-specific plant layout conditions. The COL applicant is to implement concrete tunnels for those systems that include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping (COL 12.4(3)). The tunnels are coated with epoxy and are equipped with sumps with liquid detection level switches. If liquid is accumulated to the detectable level, an alarm is initiated in the MCR for operator actions.

12.4.3 Combined License Information

COL 12.4(1) The COL applicant is to estimate construction worker doses based on the site-specific ~~number of operating units, distances,~~ meteorological conditions, and construction schedule.

information such as the number of operating units, distances from radiation sources,

Table 1.8-2 (21 of 29)

information, such as, the number of operating units, distances from radiation sources,

Item No.	Description
COL 12.4(1)	The COL applicant is to estimate construction worker doses based on site-specific ~~number of operating units, distances,~~ meteorological conditions, and construction schedule.
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COL 13.1(1)	The COL applicant is to provide a description of the corporate or home office organization, its functions and responsibilities, and the number and the qualifications of personnel. The COL applicant is to be directed to activities such as the facility design, design review, design approval, construction management, testing, and operation of the plant.
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COL 13.1(7)	The COL applicant is to provide an organizational chart showing the title of each position, minimum number of persons to be assigned to duplicate positions, number of operating shift crews, and positions that require reactor operator and senior reactor operator licenses.

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APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**14-7858**
SRP Section:	**12.03-12.04 - Radiation Protection Design Features**
Application Section:	**12.3-12.4**
Date of RAI Issued:	**05/22/2015**

Question No. 12.03-3

REQUIREMENTS

10 CFR 20.1406(b) requires that, “Applicants for standard design certifications, standard design approvals, and manufacturing licenses under part 52 of this chapter, whose applications are submitted after August 20, 1997, shall describe in the application how facility design will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste."
SRP Section 12.5 indicates that plant programs and procedures should be consistent with RG 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning” and the applicable portions of RG 4.22, “Decommissioning Planning During Operations.”
In addition, SRP Section 12.5 also states that, Regulatory Positions of C.4 and C.5 of RG 4.22, provide guidance (not discussed in RG 4.21) for complying with 10 CFR 20.1406(c) and 10 CFR 20.1501 to minimize the introduction of radioactive materials in plant facilities and environment, and document the results of radiological surveys, conducted during plant operation, to characterize radiological contamination and plan decommissioning at the time of license termination that is applicable to all licensees.

ISSUE

1. COL item 12.4(2) states that the COL applicant will implement a minimization of contamination approach. However, there is no mention if the programs and procedures will be consistent with RG 4.21 and 4.22. Staff notes that while much of RG 4.22 applies only to reactors currently in operation, portions of the RG apply to all licensees.

2. FSAR Table 1.9-1 indicates that RG 4.22 is not applicable to the APR 1400. However, portions of RG 4.22 provide guidance that would apply to all licensees.

INFORMATION NEEDED

1. COL item 12.4(2) should indicate if their programs and procedures will be consistent with RGs 4.21 and 4.22.

2. Please review FSAR Table 1.9-1 and modify the information related to the applicability of RG 4.22, as appropriate. If RG 4.22 is not applicable to the APR1400 design, please justify this deviation from the SRP.

Response

1. The COL item 12.4(2) will be updated to indicate that the applicant's programs and procedures will be consistent with RGs 4.21 and 4.22.

2. DCD Table 1.9-1 will be updated to correct the applicability of RG 4.22.

Impact on DCD

1. DCD Subections 12.4.2, 12.4.2.2, 12.4.3, 12.4.4 and Table 1.8-2 will be revised as indicated in Attachment 1.

2. DCD Table 1.9-1 will be revised as indicated in Attachment 2.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical and Environmental Reports.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

tanks are expected to contain radioactivity that yields a dose rate of 0.0025 mSv/hr or less at the tank shielded surface. Therefore, the estimated annual direct dose at the site boundary is expected to be small.

The estimated doses at the site boundary due to released activity are given in Subsections 11.2.3.1 and 11.3.3.1. The resultant annual doses for the general public are within the limits of the applicable regulations.

12.4.1.4 Estimated Dose to Construction Workers

The construction worker doses are the sum of the exposures due to direct radiation and airborne radiation from the adjacent operating unit(s). The dose criterion to the construction workers is 1 mSv/yr. The construction worker doses are site-specific and based on the number of operating units, distances, meteorological conditions, and construction schedule. The COL applicant is to estimate construction worker doses based on site-specific number of operating units, distances, meteorological conditions, and construction schedule (COL 12.4(1)).

12.4.2 Minimization of Contamination and Radioactive Waste Generation

The APR1400 design includes features and operational programs to conform with 10 CFR 20.1406 and NRC RG 4.21 (Reference 7) to minimize contamination of the facility and environment, facilitate decommissioning, and minimize the generation of radioactive waste throughout the life cycle of the facility.

The design includes control measures that address the requirements in Regulatory Positions C.1 through C.4 and Appendix A of NRC RG 4.21. The control measures are designed to work in conjunction with the operational procedures for the collection, processing, sampling, storing, monitoring, and disposal of radioactive waste during normal operation, including AOOs. The COL applicant is to provide operational procedures and programs, including the development of a site radiological environmental monitoring program, to implement the minimization of contamination approach (COL 12.4 (2)). The design also takes into account the life-cycle planning of the facility and through COL 12.4(2), identifies the operational programs and procedures to address maintenance of structures, systems, and components (SSCs), site radiological environmental monitoring, and documentation of

in accordance with NRC RG 4.21 and RG 4.22, as applicable, and the documentation by 10 CFR 20.1501

e. SSCs that minimize the generation of radioactive waste during decommissioning activities

12.4.2.2 Operational/Programmatic Considerations and 10 CFR 20.1501

The operational programs and procedures in 10 CFR 20.1406 ~~must~~ must be met. The COL applicant is to address Objectives 5 and 6, described below, to meet the operational and programmatic requirements of NRC RG 4.21 Positions C.1 through C.4 (COL 12.4(2)).

and RG 4.22 (Reference 8), as applicable

The requirements are related to procedures and programs that support the operation and maintenance of the design features described in Objectives 1 through 4 and documentation of any incidents that may occur during the operating life of the facility. The documentation of these incidents, including spillage, leakage, overflows, and associated cleanup requirements, is an integral part of decommissioning planning.

Objective 5 – Operations and Documentation

Objective 5 is met by developing operational procedures for the following:

a. Supplemental control of the SSCs to prevent/minimize the spread of contamination

b. Periodic review of operational procedures to provide reasonable assurance that the procedures reflect lessons learned and up-to-date content, including personnel qualification and training

c. Accurate records and documentation of design, construction, modifications, and operational incidences to facilitate decommissioning

d. Development of radwaste processing and management programs in accordance with NRC RG 4.21 and RG 4.22, as applicable, to

e. Development of maintenance and surveillance programs ~~that~~ provide reasonable assurance that SSCs will perform as designed to prevent the spread of contamination

f. Documentation of the results of subsurface radiological surveys in accordance with 10 CFR 20.1501

COL 12.4(2) The COL applicant is to provide operational procedures and programs, including the development of a site radiological environmental monitoring program, to implement the minimization of contamination approach.

COL 12.4(3) The COL applicant is to implement concrete tunnels for piping of the systems that may include underground piping carrying contaminated or potentially contaminated fluid to minimize buried piping.

12.4 in accordance with NRC RG 4.21 and RG 4.22, as applicable, and the documentation required by 10 CFR 20.1501

1. Regulatory Guide 8.8, "Information Relevant to Ensuring the Occupational Radiation Exposures at Nuclear Power Stations will be ALARA," Rev. 3, U.S. Nuclear Regulatory Commission, June 1978.

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6. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," U.S. Nuclear Regulatory Commission, July 2000.

7. Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," U.S. Nuclear Regulatory Commission, June 2008.

8. Regulatory Guide 4.22, "Decommissioning Planning During Operations," U.S. Nuclear Regulatory Commission, December 2012.

Table 1.8-2 (21 of 29)

Item No.	Description
COL 12.4(1)	The COL applicant is to estimate construction worker doses based on site-specific number of operating units, distances, meteorological conditions, and construction schedule.
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COL 13.1(7)	The COL applicant is to provide an organizational chart showing the title of each position, minimum number of persons to be assigned to duplicate positions, number of operating shift crews, and positions that require reactor operator and senior reactor operator licenses.

in accordance with NRC RG 4.21 and RG 4.22, as applicable, and the documentation required by 10 CFR 20.1501

Table 1.9-1 (30 of 38)

NRC Regulatory Guide	Revision / Issue Date	Conformance or Summary Description of Deviation	DCD Tier 2 Section
4.21 Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning	06/2008	The APR1400 conforms with this NRC RG	5.4.3.5, 5.4.7.4.4, 5.4.12.2.3, 6.2.5.2.3, 6.3.6, 6.5.2.2.1, Table 6.5-2, 6.8.2.1.3, 9.1.2.2.2, 9.1.3.2.3, 9.2.1.2.4, 9.2.2.2.5, 9.3.2.2.4, 9.3.3.2.6, 9.3.4.2.10, 9.4.6.1.1, 9.4.8, 10.3.2.4, 10.4.2.2.3, 10.4.6.2.4, 10.4.7.2.4, 10.4.8.2.4, 10.4.9.2.5, 11.2.1.1, 11.2.1.2, 11.2.2.4.1, 11.3.1.2, 11.3.2.2.2, 11.4, 11.4.2.5.1, 11.5.2.4, 12.1.3.1, 12.1.3.4, 12.3.1.1, 12.3.1.4, 12.3.1.10, 12.3.1.10, 12.3.1.10.1, 12.3.1.10.2, 12.3.1.10.3, Table 12.3-6, Table 12.3-7
4.22 Decommissioning Planning During Operations	12/2012	Not applicable ← (COL)	N/A
5.3 Statistical Terminology and Notation for Special Nuclear Materials Control and Accountability	02/1973	Not applicable	N/A
5.4 Standard Analytical Methods for the Measurement of Uranium Tetrafluoride (UF4) and Uranium Hexafluoride (UF6)	02/1973	Not applicable	N/A

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Application Section:	**12.3-12.4**
Date of RAI Issued:	**05/22/2015**

Question No. 12.03-4

REQUIREMENTS

10 CFR 52.47(a)(5) requires that the FSAR contain the kinds and quantities of radioactive materials expected to be produced in the operation and the means for controlling and limiting radioactive effluents and radiation exposures within the limits set forth in 10 CFR 20.

10 CFR 50, Appendix A, Criterion 61, requires that systems which may contain radioactivity be designed to assure adequate safety under normal and postulated accident conditions, with suitable shielding for radiation protection, and with appropriate containment, confinement, and filtering systems.

SRP Section 12.3-12.4 states that the plant should be subdivided into radiation zones with maximum design dose rate zones and the criteria used in selecting maximum dose rates identified. It also indicates that the assumptions and technics used for radiation shielding should be provided and that anticipated operational occurrences should be considered in the determination of plant shielding and zoning.

ISSUE

While FSAR Section 12.3 indicates that the normal operation shielding and zoning for the plant is based on the source terms provided in 12.2, the application is unclear on how shielding and zoning was determined for radiation sources which are not explicitly provided in 12.2, such as pipes, pumps, ventilation ducts, etc, which are not modeled in FSAR Section 12.2.

INFORMATION NEEDED

1) For sources which are not provided in FSAR Section 12.2, provide a general description of how the dose contributions from those sources were addressed in the plant shielding design and how radiation zone designations were developed for those sources. As part of the response, a) indicate if significant sources (such as piping that will contain resin during resin transfer) were modeled the same way as the sources that are provided in 12.2, based on the 0.25% failed fuel source term and using the same radionuclide transport and shielding and dose assessment codes identified in the FSAR or if an alternative method was used; b) If any shielding thicknesses or zone designations throughout the plant were determined using a different methodology than what is described in the FSAR, please include a description of the alternative methodology and how it was used in the response; c) Provide a general description of the methodology used for determining shielding and zoning for pipe chase and valve rooms; d) Please ensure that the information provided includes a general, but complete, description of the methodology used for determining radiation shielding and zoning throughout the plant and that significant assumptions are identified.

2) Please update FSAR section 12.3 to provide general information indicating how dose contributions from sources which are not explicitly provided in FSAR Section 12.2 are considered in the plant shielding design and the determination of plant radiation zones.

3) While FSAR Section 12.3.2.3 indicates that shielding design thicknesses provided in the FSAR are based on the use of ordinary concrete as the shield material, the application does not discuss the shielding properties of doors or any other shielding material where concrete will not be used. For example, it is unclear if doors will provide equivalent radiation attenuation as the shield wall on which they are located and what other materials throughout the plant may be relied on for radiation shielding.

    a. Please indicate if there are any doors/hatches being relied on to maintain doses within the radiation zone designations provided in the Chapter 12 radiation zone figures. If so, update the FSAR to describe the material composition and shielding properties of these doors/hatches and indicate if they are sufficient to maintain dose rates within the zones specified.

    b. Please update the FSAR to describe all types of materials that will be relied on for radiation shielding throughout the plant, other than concrete or water (as used to shield spent fuel assemblies), which are already discussed in the FSAR. The description should discuss the composition of the material used, the service life of the material (if it will degrade due to the effects of radiation, heat, etc, found at the location where the material will be used), and where it will be used. (the purpose of this question is to identify permanent or long term shielding materials and locations, which will be relied upon and/or included as part of the physical plant design and not temporary shielding, such as lead blankets, which may be used under the operational radiation protection program to address short term or unanticipated shielding needs during operation).

Response

1)

a. Source terms for additional components are provided as a response to RAI RPAC 13-7856, Question 12.02-2, Item No. 1.b). This information will be included in DCD Section 12.2. Other significant radiation sources that are considered in the shielding and zoning but are not presented in DCD Section 12.2 include the source terms from piping in radioactive systems such as CVCS, SCS and Radwaste treatment systems. In the zoning and shielding design of APR1400, the sources in these pipes are determined based on the source terms in the components located upsteam of the corresponding pipe, assuming that the pipes are conveying the radioactive fluid. Such radioactive fluids may include primary coolant for letdown, shutdown cooling and primary sampling, radioactive liquid and gases for LWMS and GWMS and spent resins, which are transferred from each ion exchangers to Spent Resin Long Term Storage Tank. For the determination of shielding requirements and the zoning for these pipes, the same methods as those provided in Section 12.2 are applied, i.e., the same failed fuel fraction and the same computer codes.

b. As indicated above, the same methodology was used for shielding and zoning for the radioactive pipes.

c. Since the detailed layout of piping is not developed in the design certification phase, it is normally difficult to determine the shielding and zoning requirements in the pipe chases and valve rooms. However, since the APR1400 has several plants that are being constructed, the shielding design and zoning for the APR1400 design certification was based on the detailed piping layout of the reference plants. To determine the shielding thickness and radiation zones in the pipe chases and valve rooms, the number and characteristics of the pipes in the corresponding areas are identified by the pipe layout drawings and the P&IDs of the reference plant.

   The dose rates for different kinds of pipes are determined using the corresponding source terms in each pipe. The length of each pipe is assumed to be 20 feet because the dose rate at 1 foot away from the pipe is maximized when the pipe is 20 feet long. If there are multiple pipes in a pipe chase or a valve room, the resultant dose rate in the cubicle and the required minimum shield thicknesses are determined by summing the dose contributions of each pipe.

d. Please refer to the response to the above Item 1) c.

2) DCD Subsection 12.3.2.3 will be updated to provide how dose contributions of the piping are considered in the plant shielding design and the determination of plant radiation zones. Refer to Attachment 1 for the DCD markups.

3)

a. The doors or hatches being relied on to maintain doses within the radiation zone designations provided in the Chapter 12 radiation zone figures are as follows:

   - Personnel Air Lock between Containment Annulus Area (100-C01) and Personnel Air Lock Entrance (100-A14A)

- Personnel Air Lock between Operating Area (156-C01) and Containment Entrance Area (156-A04B)
- Equipment Hatch between Operating Area (156-C01) and Equipment Hatch Access Room (156-A10A)
- Door between Equipment Hatch Access Room (156-A10A) and the building exterior
- Doors between Truck Bay (100-P08) and the building exterior

Since these doors are to be designed by the vendor during the construction phase, the COL applicant is to provide the information on material composition, shielding properties, and the thicknesses equivalent to the minimum required concrete shield thicknesses. In order to have the COL applicant provide this information, a COL item will be added in Subsections 12.3.2.3 12.3.6.

b. There are no other types of materials that are relied on for radiation shielding throughout the plant than the doors and hatches addressed above. Since the information on service life, periodic in-service inspection and maintenance for these doors/hatches to provide reasonable assurance of functionality throughout the life of the plant is to be provided by the COL applicant, this will be added as a COL item. Refer to Attachment 2 for the DCD markups.

Impact on DCD

DCD Subsections 12.3.2.3 will be revised as indicated in Attachment 1.

DCD Subsections 12.3.2.3, 12.3.4, 12.3.4.1.6, 12.3.6 and Table 1.8-2 will be revised as indicated in Attachment 2.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical and Environmental Reports.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

pipe chase. The resin transfer lines are also provided with a flushing capability to minimize the potential for hot spots in the piping.

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The ICI chase is potentially a high-radiation area (greater than 1 Gy/hr) during ICI withdrawal. Stringent access control is provided to this area during movement of the ICI. A lockable access door is provided with a warning light. During withdrawal of the ICI, the warning light illuminates, providing indication that the ICI is being moved. An area radiation monitor is located in the ICI chase to provide indication of radiation levels and to alarm the personnel when the ICI is being withdrawn. Emergency egress from the area is also provided from the ICI chase.

Components that handle a significant amount of radioactive materials, such as LWMS floor drain tanks and equipment waste tanks, are located in shielded cubicles separated from the pump and valve galleries that are provided with labyrinths for access to the galleries. This design approach minimizes radiation streaming and scattering but permits inspection and maintenance access and removal of smaller items such as pumps, valves, and instruments for repair in lower-radiation areas. This design approach meets the requirements of NRC RG 8.8 2.b(4). The plant shielding is designed not only to maintain personnel occupational exposure ALARA, but also to maintain exposure to the general public ALARA.

The APR1400 shielding design has target dose rates that are below the limits for radiation zone designations provided in Table 12.3-2 to provide a sufficient margin in maintaining radiation exposure to plant personnel and the public ALARA.

12.3.3 Ventilation

The spread of airborne contamination within the plant is minimized by the design of the plant HVAC systems to provide airflow from areas of lower potential for airborne contamination to areas of greater potential for airborne contamination. For building compartments with the potential for contamination, the exhaust from the areas is designed with pressure and flow balances to minimize the amount of uncontrolled exfiltration from these areas. These design features provide reasonable assurance that the average concentration of radioactive material in the air in the areas that are normally occupied is less than the small fraction of DAC prescribed in 10 CFR Part 20 Appendix B. Therefore,

A

Shielding thicknesses and radiation zones in the pipe chases and valve rooms are determined based on the number and characteristics of the pipes in the corresponding areas. The dose rates for different kinds of pipes are determined using the corresponding source terms in each pipe. The length of each pipe is assumed to be 20 feet because the dose rate at 1 foot away from the pipe is maximized when the pipe is 20 feet long. If there are multiple pipes in a pipe chase or a valve room, the resultant dose rate in the cubicle and the required minimum shield thicknesses are determined by summing the dose contributions of each pipe.

pipe chase. The resin transfer lines are also provided with a flushing capability to minimize the potential for hot spots in the piping.

The ICI chase is potentially a high-radiation area (greater than 1 Gy/hr) during ICI withdrawal. Stringent access control is provided to this area during movement of the ICI. A lockable access door is provided with a warning light. During withdrawal of the ICI, the warning light illuminates, providing indication that the ICI is being moved. An area radiation monitor is located in the ICI chase to provide indication of radiation levels and to alarm the personnel when the ICI is being withdrawn. Emergency egress from the area is also provided from the ICI chase.

Components that handle a significant amount of radioactive materials, such as LWMS floor drain tanks and equipment waste tanks, are located in shielded cubicles separated from the pump and valve galleries that are provided with labyrinths for access to the galleries. This design approach minimizes radiation streaming and scattering but permits inspection and maintenance access and removal of smaller items such as pumps, valves, and instruments for repair in lower-radiation areas. This design approach meets the requirements of NRC RG 8.8 2.b(4). The plant shielding is designed not only to maintain personnel occupational exposure ALARA, but also to maintain exposure to the general public ALARA.

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The APR1400 shielding design has target dose rates that are below the limits for radiation zone designations provided in Table 12.3-2 to provide a sufficient margin in maintaining radiation exposure to plant personnel and the public ALARA.

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A

The doors or hatches being relied on to maintain doses within the radiation zone designations provided in the Chapter 12 radiation zone figures are as follows:

- Personnel Air Lock between Containment Annulus Area (100-C01) and Personnel Air Lock Entrance (100-A14A)
- Personnel Air Lock between Operating Area (156-C01) and Containment Entrance Area (156-A04B)
- Equipment Hatch between Operating Area (156-C01) and Equipment Hatch Access Room (156-A10A)
- Door between Equipment Hatch Access Room (156-A10A) and the building exterior
- Doors between Truck Bay (100-P08) and the building exterior

The COL applicant is to provide the material composition and shielding properties of these doors/hatches, and these thicknesses equivalent to the minimum required concrete shield thicknesses. Also, the COL applicant is to provide the service life of these doors/hatches and perform periodic in-service inspection and maintenance for these doors/hatches to provide reasonable assurance of functionality throughout the life of the plant. (COL 12.3(1))

personnel exposure due to inhalation of and contact with airborne contamination is maintained ALARA.

Airborne radiation monitoring is provided for areas that are normally occupied and have a significant potential for airborne contamination. The monitors can detect the time-integrated change of the airborne radioactivity within 10 DAC-hours for the most limiting particulate and iodine species in each area.

Airborne radiation monitors are described further in Section 11.5. The locations of the process effluent radiation monitors are shown in Figure 11.5-2. The airborne radiation monitors are located upstream of the filters within the HVAC ventilation systems.

HVAC systems are described in Section 9.4.

12.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

The area radiation monitoring system (ARMS) supplements the personnel and area radiation survey provisions of the plant health physics program described in Section 12.5 and provides reasonable assurance of conformance with the personnel radiation protection requirements of 10 CFR 20, 10 CFR Part 50, 10 CFR Part 70 (Reference 19); the guidelines of NRC RGs 1.21 (Reference 20), 1.97, 8.2 (Reference 21), 8.25 (Reference 5), and 8.8 (Reference 1); and American National Standards Institute (ANSI) N13.1-1999 (Reference 22) and Institute of Electrical and Electronics Engineers (IEEE) Std. 497-2002 (Reference 23). The ARMS is in conformance with ANSI/ANS HPSSC-6.8.1 (Reference 24).

The process and effluent radiation monitoring system and sampling systems are described in Section 11.5.

Portable instruments are used and the associated training and procedures are provided to accurately determine the airborne iodine concentration in areas within the facility where plant personnel could be present during an accident in accordance with the requirements of 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737. The COL applicant is to provide portable instruments and the associated training and procedures in accordance with 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737 (COL 12.3(1)).

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uncertainty calculations associated with the setpoints used for ESF actuation functions. The setpoint methodology follows the methodology in ANSI/ISA-67.04-1994 (Reference 27). The COL applicant is to determine the WARN and ALARM setpoints of the ARMS based on the site-specific conditions and operational requirements (COL 12.3(2)).

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12.3.4.1.7 Calibration Methods and Frequency

The methodology to determine the calibration methods and frequency of the ARMS is provided by the ODCM based on plant procedures.

12.3.4.1.8 Power Supplies

Instrument loops of safety-related monitors are powered from the appropriate train of Class 1E 120 AC distribution panel in the instrument power system (IP), which is powered by the onsite Class 1E emergency diesel generator. When the emergency diesel generator restores power to the skid, skid equipment such as sample pumps returns to the original operating status without having to be manually restarted. The TSC area radiation monitor, which is non-safety-related, is powered from permanent non-safety buses that are backed up by an alternate ac generator. Instrumentation and control power are described further in Subsection 8.3.2.

12.3.4.2 Airborne Radioactivity Monitoring Instrumentation

Airborne radioactivity monitors are installed in selected areas and HVAC systems to provide plant operating personnel with continuous information on the airborne radioactivity levels throughout the plant. These monitors, consisting of gaseous process and effluent radiation monitors (PERMS), are described in Section 11.5 and listed in Table 11.5-1. The airborne radioactivity monitors are as follows:

a. High-energy line break area HVAC exhaust monitor

b. Auxiliary building controlled area common HVAC exhaust monitor

c. Containment purge exhaust monitor

d. Containment air monitor

e. Fuel handling area HVAC exhaust monitor

f. Condenser vacuum vent exhaust monitor

g. Main control room air intake monitor

h. Compound building HVAC exhaust monitor

i. Miscellaneous process monitors

12.3.4.2.1 Design Objectives

The objectives of the airborne radioactivity monitors are presented in Subsection 11.5.1.1.

12.3.4.2.2 Location of Airborne Radioactivity Monitors

The criteria for the location of the airborne radioactivity monitors are presented in Subsection 11.5.1.1 and the monitor locations are shown in Figure 11.5-2.

12.3.4.2.3 System Description

Airborne radioactivity monitors and applicable design criteria are described in Subsection 11.5.1.2.

12.3.5 Dose Assessment

The dose assessment is described in Section 12.4.

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12.3.6 Combined License Information

COL 12.3(1) The COL applicant is to provide portable instruments and the associated training and procedures in accordance with 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737.

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B

COL 12.3(1) The COL applicant is to provide the material composition and shielding properties of the following doors/hatches, and these thicknesses equivalent to the minimum required concrete shield thicknesses.

- Personnel Air Lock between Containment Annulus Area (100-C01) and Personnel Air Lock Entrance (100-A14A)
- Personnel Air Lock between Operating Area (156-C01) and Containment Entrance Area (156-A04B)
- Equipment Hatch between Operating Area (156-C01) and Equipment Hatch Access Room (156-A10A)
- Door between Equipment Hatch Access Room (156-A10A) and the building exterior
- Doors between Truck Bay (100-P08) and the building exterior

In addition, the COL applicant is to provide the service life of these doors/hatches and perform periodic in-service inspection and maintenance for these doors/hatches to provide reasonable assurance of functionality throughout the life of the plant.

COL 12.3(~~2~~3) The COL applicant is to determine the WARN and ALARM setpoints of the ARMS based on the site-specific conditions and operational requirements.

12.3.7 References

1. Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be ALARA," Rev. 3, U.S. Nuclear Regulatory Commission, June 1978.

2. Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," Rev. 1-R, U.S. Nuclear Regulatory Commission, May 1977.

3. 10 CFR Part 20, "Standards for Protection against Radiation," U.S. Nuclear Regulatory Commission.

4. Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning," U.S. Nuclear Regulatory Commission, June 2008.

5. Regulatory Guide 8.25, "Air Sampling in the Workplace," Rev. 1, U.S. Nuclear Regulatory Commission, June 1992.

6. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission.

7. NUREG-0737, "Clarification of TMI Action Plan Requirements" U.S. Nuclear Regulatory Commission.

8. Regulatory Guide 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2006.

9. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluation Design Basis Accidents at Nuclear Power Reactors," U.S. Nuclear Regulatory Commission, July 2000.

10. Regulatory Guide 1.69, "Concrete Radiation Shields and Generic Shield Testing for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Rev. 1, May 2009.

Table 1.8-2 (20 of 29)

Item No.	Description
COL 11.5(4)	The COL applicant is to prepare an ODCM that contains a description of the methodology and parameters for calculation of the offsite doses for the gaseous and liquid effluents. The COL applicant is to follow NEI 07-09A as an alternative to providing an offsite dose calculation manual.
COL 11.5(5)	The COL applicant is to provide analytical procedures and sensitivity for selected radioanalytical methods and types of sampling media for site-specific matter.
COL 11.5(6)	The COL applicant is to develop the calibration procedures in accordance with NRC RG 1.33 and 4.15.
COL 11.5(7)	The COL applicant is to develop detailed location and tubing installation and provide the sampling method including the sampling time to acquire representative sampling.
COL 11.5(8)	The COL applicant is to provide operational procedures and maintenance programs related to leak detection and contamination control.
COL 11.5(9)	The COL applicant is to develop a radiological and environmental monitoring program, taking into consideration local land use and census data in identifying all potential radiation exposure pathways. The COL applicant is to follow NEI 07-09A as an alternative to providing a radiological and environmental monitoring program.
COL 12.1(1)	The COL applicant is to provide the organizational structure to effectively implement the radiation protection policy, training, and reviews consistent with operational and maintenance requirements, while satisfying the applicable regulations and Regulatory Guides including NRC RGs 1.33, 1.8, 8.8, and 8.10.
COL 12.1(2)	The COL applicant is to describe the operational radiation protection program to provide reasonable assurance that occupational radiation exposures are ALARA.
COL 12.1(3)	The COL applicant is to describe how the plant follows the guidance provided in NRC RGs 8.2, 8.7, 8.9, 8.13, 8.15, 8.20, 8.25, 8.26, 8.27, 8.28, 8.29, 8.34, 8.35, 8.36, and 8.38.
COL 12.2(1)	The COL applicant is to provide any additional contained radiation sources, such as instrument calibration radiation sources, that are not identified in Subsection 12.2.1.
COL 12.3(1)	The COL applicant is to provide portable instruments and the associated training and procedures in accordance with 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737.
COL 12.3(2)	The COL applicant is to determine the WARN and ALARM setpoints of the ARMS based on the site-specific conditions and operational requirements

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C

COL 12.3(1)	The COL applicant is to provide the material composition and shielding properties of the following doors/hatches, and these thicknesses equivalent to the minimum required concrete shield thicknesses. - Personnel Air Lock between Containment Annulus Area (100-C01) and Personnel Air Lock Entrance (100-A14A) - Personnel Air Lock between Operating Area (156-C01) and Containment Entrance Area (156-A04B) - Equipment Hatch between Operating Area (156-C01) and Equipment Hatch Access Room (156-A10A) - Door between Equipment Hatch Access Room (156-A10A) and the building exterior - Doors between Truck Bay (100-P08) and the building exterior In addition, the COL applicant is to provide the service life of these doors/hatches and perform periodic in-service inspection and maintenance for these doors/hatches to provide reasonable assurance of functionality throughout the life of the plant.