12.0 Radiation Protection

12.3 Radiation Protection Design Features

This evaluation documents the staff's review of the applicant's voluntary submittal to demonstrate that the ABWR design meets the requirements of 10 CFR 20.1406(b). Since the requirements of 10 CFR 20.1406 were not applicable at the time the initial ABWR was certified, 10 CFR 20.1406 is not required to be addressed for renewal. However, with the supplemental information provided, the applicant chose to voluntarily comply with 10 CFR 20.1406(b). In addition, COL applicants referencing the ABWR design are required to conform with the operational aspects of 10 CFR 20.1406(a) and any site specific design information is required to address the requirements 10 CFR 20.1406(a).

The staff notes that the originally certified ABWR design included much of the information that would be necessary to conform to the requirements of 10 CFR 20.1406(b). However, the applicant's supplemental information and proposed DCD revisions consolidated the information and included new design information consistent with 10 CFR 20.1406(b) and Regulatory Guide (RG) 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning."

12.3.1 Regulatory Criteria

Because the applicant's proposed design changes are voluntary, they are "amendments," as this term is defined in Chapter 1 of this supplement. Therefore, the proposed changes are evaluated using the regulations in effect at renewal. The following regulatory requirements provide the basis for the acceptance criteria for the staff's review:

- 10 CFR 20.1406(b) requires that applicants for standard design certifications submitted after August 20, 1997, 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.

12.3.2 Summary of Technical Information

In a submittal dated August 4, 2015, (ADAMS Accession No. ML15216A311), the applicant provided information describing how the ABWR design minimizes to the extent practicable contamination of the facility and the environment, facilitates eventual decommissioning, and minimizes, to the extent practicable, the generation of radioactive waste by following the guidance of RG 4.21, thereby addressing the requirements of 10 CFR 20.1406(b). In a January 19, 2016, teleconference (ADAMS Accession No. ML16027A283), the staff asked the applicant to address several issues regarding ABWR compliance with 10 CFR 20.1406(b), that were not fully addressed in the initial submittal, including adding information to the DCD on the use of embedded piping in the ABWR design and on the use of epoxy coatings. Epoxy coatings minimize the potential spread of contamination and allow for easier cleanup of spills. Embedded piping can increase the potential for undetected leaks, which could be released to the environment or result in unnecessary contamination issues when the plant is eventually decommissioned. In addition, leaks in embedded pipes can be difficult to access and repair.

Therefore, in a March 16, 2016, submittal (ADAMS Accession No. ML16076A066), the applicant included additional supplemental information on how the ABWR is designed in accordance with 10 CFR 20.1406(b) in order to address the staff's comments.

12.3.3 Staff Evaluation

The following evaluation addresses information provided in the August 4, 2015 submittal, as supplemented and clarified by the March 16, 2016, submittal. The evaluation also discusses some of the information already provided in the DCD, which is acceptable information to demonstrate that the ABWR has been designed in accordance with the requirements of 10 CFR 20.1406(b).

As part of its submittals, the applicant proposed adding DCD Tier 2, Table 12.3-8 which identifies the DCD chapter and subsections that discuss implementation of the design objectives. The applicant also proposed creating DCD Tier 2, Subsection 12.3.1.5, "Minimization of Contamination and Radioactive Waste Generation," to provide information on how the ABWR minimizes contamination and radioactive waste generation and facilitates decommissioning, including a general description of the design and operational objectives and specific information, which are consistent with the guidance of RG 4.21. The objectives provided by the applicant are as follows:

- Objective 1 - Minimize leaks and spills and provide containment in areas where such events may occur.

- Objective 2 - Provide adequate leak detection capability to provide prompt detection of leakage from any structure, system, or component that has the potential for leakage.

- Objective 3 - Use leak detection methods (e.g., instrumentation, automated samplers) capable of early detection of leaks in areas where it is difficult (inaccessible) to conduct regular inspections (such as spent fuel pools, tanks that are in contact with the ground, and buried, embedded, or subterranean piping) to avoid release of contamination.

- Objective 4 - Reduce the need to decontaminate equipment and structures by decreasing the probability of any release, reducing any amounts released, and decreasing the spread of the contaminant from the source.

- Objective 5 - Facilitate decommissioning by (1) minimizing embedded and buried piping, and (2) designing the facility to facilitate the removal of any equipment or components that may require removal or replacement during facility operation or decommissioning.

- Objective 6 - Minimize the generation and volume of radioactive waste during operation and decommissioning (by minimizing the volume of components and structures that become contaminated during plant operation).

The application (the DCD and the submittals on compliance with 10 CFR 20.1406), discusses many design features consistent with the requirements of 10 CFR 20.1406(b) and the above mentioned objectives. The following paragraphs discuss significant ABWR design features for satisfying 10 CFR 20.1406(b).

Areas where the potential for spills exists contain appropriately sloped floor drains to limit the extent of contamination. To facilitate the cleanup of leaks and spills, and to help prevent the spread of contamination, decontaminable epoxy-type coatings are applied to both steel surfaces and concrete areas appropriate for contamination control. These areas consist of the walls and floors of the Reactor Building and Turbine Building, radwaste areas, rooms containing equipment with liquid radioactive sources, floor drain areas, washdown bays, and tunnels containing piping transporting potentially radioactive contaminated liquids. In addition, equipment and floor drain sumps are lined in stainless steel to reduce crud buildup and to provide surfaces that can be easily decontaminated.

Operating experience has shown that effluent discharge piping and other underground piping can be a source of low-level environmental contamination. In particular, operating experience has shown that the following structure, system, and components (SSCs) have experienced underground piping-related events that have resulted in unmonitored, uncontrolled releases of radioactivity to the environment: condensate storage tank and associated piping, radwaste/effluent discharge piping, and cooling tower blowdown line. To the extent practical, underground piping is avoided in the ABWR design. However, the condensate storage tank piping and CST retention area drain, radwaste effluent discharge pipeline, and the cooling tower blowdown line are underground and/or contain underground piping segments. The proposed DCD updates indicate that these lines will be kept as short and direct as possible. In addition, the applicant stated that the underground piping associated with these SSCs will be designed to preclude inadvertent or unidentified leakage to the environment. This piping is enclosed within a guard pipe and will be accessible for visual inspections via a trench or tunnel. The applicant stated that threaded or flanged connections for this piping will be kept to a minimum, and other joints will be welded or otherwise permanently bonded (all piping containing radioactive material piping connections are welded to the extent practicable). Furthermore, fittings will be kept to a minimum and no in-line components will be incorporated into these lines. These features will reduce the potential for unmonitored and uncontrolled releases to the environment and are consistent with RG 4.21 and 10 CFR 20.1406(b).

DCD Section 12.3.1.2 specifies that plant equipment containing radioactive material is designed to minimize the buildup of radioactive material by minimizing the number of “dead legs” and low points. In addition, butt-welded connections are used instead of socket welds, flanged, or screwed connections. Butt-welded connections are stronger and less likely to leak than the connection types. To minimize trapping of radioactive crud, the design employs straight-through valve configurations, where practical, instead of valve configurations that exhibit flow discontinuities or internal crevices. Equipment, such as heat exchangers, and piping have provisions for draining, flushing, and decontamination to minimize the generation of radioactive waste and facilitate the removal of radioactivity from crud traps. Piping is designed to have a service life equivalent to the life of the plant. This reduces the likelihood for leaks and also reduces potential worker dose to replace components.

In addition, penetrations through outer walls of a building containing radiation sources are sealed to prevent miscellaneous leaks to the environment, and the process radiation monitoring system will monitor all expected radioactive release points and paths within the plant. This minimizes the potential for unmonitored and untreated leakage from escaping the plant.

The plant heating, ventilation and air conditioning systems are designed to minimize airborne radiation exposures to plant personnel and releases to the environment. These systems

maintain airflow from areas of lower potential for contamination to areas of greater potential for contamination.

To facilitate decommissioning and repairs during plant operation, the Reactor Building, Turbine Building, and Radwaste Building are designed for large equipment removal, consisting of entry doors from the outside and numerous cubicles with equipment hatches inside the buildings. Wherever possible, piping carrying radioactive fluids is separated from piping carrying nonradioactive fluids. This reduces the potential for the spread of contamination. Embedded piping will be minimized to the extent practicable, which facilitates the dismantlement of systems, reduces the likelihood of undetected leakage of radioactive fluid, and thereby facilitates decommissioning. In some cases however, piping is embedded, which provides radiation shielding. As discussed above, buried piping will be kept to a minimum, and all buried piping will have features to reduce the potential for unmonitored and uncontrolled releases to the environment.

The ABWR design limits the use of cobalt-bearing materials on moving components that have historically been identified as major sources of reactor coolant contamination. Stainless steel is used in those portions of the system that require high corrosion resistance to minimize the formation of corrosion activation products. In addition, the COL information item in Subsection 12.3.1.1.2 of the ABWR DCD (summarized in Subsection 12.3.7.4) specifies that the COL applicant will address material selection of systems and components exposed to reactor coolant to maintain radiation exposures as low as is reasonably achievable. Therefore, the cobalt content in components in contact with reactor coolant will be minimized, which will reduce plant radiation levels and the potential spread of contamination throughout the plant.

Many additional design features to minimize contamination, facilitate decommissioning, and minimize, to the extent practicable, the generation of radioactive waste are described throughout the DCD. As discussed above, DCD Tier 2, Section 12.3, Table 12.3-8, provides a comprehensive crosswalk of applicable DCD chapters and sections which describe design features that address the above-listed RG 4.21 design objectives.

The staff has reviewed the design features and objectives provided in the applicant's submittals and much of the information previously provided in the DCD and finds that these features are designed in accordance with 10 CFR 20.1406(b).

In addition to the design objectives listed above, RG 4.21 contains the following operational and post-construction objectives associated with the requirements of 10 CFR 20.1406(a):

- Periodically review operational practices to ensure that operating procedures reflect the installation of new or modified equipment, personnel qualification, and training are kept current, and facility personnel are following the operating procedures.

- Facilitate decommissioning by maintaining records relating to facility design and construction, facility design changes, site conditions before and after construction, onsite waste disposal and contamination, and results of radiological surveys.

- Develop a conceptual site model (based on site characterization and facility design and construction) that aids in the understanding of the interface with environmental systems and the features that will control the movement of contamination in the environment.

- Evaluate the final site configuration after construction to assist in preventing the migration of radionuclides offsite via unmonitored pathways.

- Establish and perform an onsite contamination monitoring program along the potential release pathways from the release sources to the receptor points.

In the original submittal the applicant proposes adding another COL information item in DCD Tier 2, Section 12.3.7, "COL License Information," Subsection 12.3.7.5, "Requirement of 10 CFR 20.1406," which states that the COL applicant will address the operational and post-construction objectives of RG 4.21 to meet the requirement of 10 CFR 20.1406. It is appropriate for the COL applicant to address the operational and post-constructive objectives of 10 CFR 20.1406(a). Therefore, this COL information item is acceptable.

The staff verified that the proposed DCD changes described in the submittals were incorporated into Revision 6 of the DCD.

12.3.4 Conclusion

Based on the above, the staff concludes that ABWR DCD, Revision 6, complies with the design requirements of 10 CFR 20.1406(b). In addition, per the COL information item in DCD Section 12.3.7.5, discussed above, COL applicants referencing the ABWR design will provide the operational and post-construction aspects of 10 CFR 20.1406(a), which is acceptable. As a result, the staff concludes that the ABWR DCD adequately addresses the requirements of 10 CFR 20.1406.