12.0 Radiation Protection

12.1 Ensuring that Occupational Radiation Exposures are ALARA

12.1.1 Policy Considerations

Administrative programs and procedures, in conjunction with facility design, ensure that the occupational radiation exposure to personnel will be kept as low as reasonably achievable (ALARA).

12.1.1.1 Design and Construction Policies

The ALARA philosophy was applied during the initial design of the plant and implemented via internal design reviews. The design was reviewed in detail for ALARA considerations and was reviewed, updated and modified as necessary during the design phase as experience was gained from operating plants. Engineers reviewed the plant design and integrated the layout, shielding, ventilation and monitoring instrument designs with traffic control, security, access control and health physics aspects to ensure that the overall design is conducive to maintaining exposures ALARA.

All pipe routing containing radioactive fluids was reviewed as part of the engineering design effort. This ensured that lines expected to contain significant radiation sources are adequately shielded and properly routed to minimize exposure to personnel.

Operating plant results were continuously integrated during the design phase of the ABWR Standard Plant.

12.1.1.2 Operation Policies

Out of ABWR Standard Plant scope.

12.1.1.3 Compliance with 10CFR20 and Regulatory Guides 8.8, 8.10 and 1.8

Compliance of the ABWR design with Title 10 of the Code of Federal Regulations, Part 20 (10CFR20), is ensured by the compliance of the design and operation of the facility within the guidelines of Regulatory Guides 8.8, 8.10, and 1.8.

12.1.1.3.1 Compliance with Regulatory Guide 8.8

The policy considerations regarding plant operations contained in Regulatory Guide 8.8 are out of ABWR Standard Plant Scope. See Subsection 12.1.4.4 for COL license information.

12.1.1.3.2 Compliance with Regulatory Guide 8.10

Out of ABWR Standard Plant scope. See Subsection 12.1.4.1 for COL license information.

12.1.1.3.3 Compliance with Regulatory Guide 1.8

Out of ABWR Standard Plant scope. See Subsection 12.1.4.2 for COL license information.

12.1.2 Design Considerations

This subsection discusses the methods and features by which the policy considerations of Subsection 12.1.1 are applied. Provisions and designs for maintaining personnel exposures ALARA are presented in detail in Subsections 12.3.1 and 12.3.2.

12.1.2.1 General Design Consideration for ALARA Exposures

General design considerations and methods employed to maintain inplant radiation exposures ALARA, consistent with the recommendations of Regulatory Guide 8.8, have two objectives:

(1) Minimizing the necessity for and amount of personnel time spent in radiation areas, and

(2) Minimizing radiation levels in routinely occupied plant areas in the vicinity of plant equipment expected to require personnel attention.

Both equipment and facility designs are considered in maintaining exposures ALARA during plant operations. Events considered include normal operation maintenance and repairs, refueling operations and fuel storage, inservice inspection and calibrations, radioactive waste handling and disposal, etc.

The features of the plant design which ensure that the plant can be operated and maintained with ALARA exposures will also serve to assist in achieving ALARA exposures during the decommissioning process. Examples of features which will assist in maintaining low occupational exposures during decommissioning include the following:

(1) Provisions for draining, flushing, and decontaminating equipment and piping.

(2) Design of equipment to minimize the buildup of radioactive material and to facilitate flushing of crud traps.

(3) Shielding which provides protection during maintenance or repairs and during decommissioning operations.

(4) Provision of means and adequate space for utilization of movable shielding.

(5) Separation of more highly radioactive equipment from less radioactive equipment and provision of separate shielded compartments for adjacent items of radioactive equipment.

(6) Provision for access hatches for the installation or removal of plant components.

(7) Provision of design features such as the Reactor Water Cleanup (CUW) System and the condensate demineralizer to minimize crud buildup.

12.1.2.2 Equipment Design Considerations for ALARA Exposures

12.1.2.2.1 General Design Criteria

No specific instructions have been given to component designers and engineers regarding ALARA design as provided by specific Acceptance Criterion II.2 of SRP Section 12.1. However, the engineering design procedures require that the component design engineer consider the applicable Regulatory Guides (including Regulatory Guide 8.8) as a part of the design criteria. In this way, the radiation problems of a component or system are considered. A summary survey of the components designs was made to determine the factors considered. The following paragraphs cite some examples of design considerations made to implement ALARA.

12.1.2.2.2 Equipment Design Considerations to Limit Time Spent in Radiation Areas

(1) Equipment is designed to be operated and have its instrumentation and controls in accessible areas both during normal and abnormal operating conditions. Equipment such as the CUW System and the Fuel Pool Cleanup (FPC) System are remotely operated, including the backwashing and precoat operations.

(2) Equipment is designed to facilitate maintenance. Equipment such as the RHR heat exchanger is designed with an excess of tubes in order to permit plugging of some tubes. The heat exchanger has drains to allow draining of the shell-side water. Some of the valves have stem packing of the cartridge type that can be easily replaced. Refueling tools are designed for drainage and with smooth surfaces in order to reduce contamination. Vessel and piping insulation is of an easily removable type.

(3) The material selected for use in the system have been chosen to fulfill the environmental requirements. Valves, for example, use grafoil stem packing to reduce leakage and maintenance.

(4) Past experience has been factored into current designs. The steam relief valves have been redesigned as a result of inservice testing.

12.1.2.2.3 Equipment Design Considerations to Limit Component Radiation Levels

(1) Equipment and piping were designed to reduce the accumulation of radioactive materials in the equipment. The piping, where possible, was constructed of seamless pipe as a means to reduce radiation accumulation on the seam. The filter demineralizers in the CUW System and FPC System are backwashed and flushed prior to maintenance.

(2) Equipment designs include provisions for limiting leaks or controlling the fluid that does leak. This includes piping the released fluid to the sumps and the use of drip pans with drains piped to the floor drains.

(3) The materials selected for use in the primary coolant system consist mainly of austenitic stainless steel, carbon steel and low alloy steel components.

(4) The system design includes a CUW System and a condensate demineralizer system on the reactor feedwater. These systems are designed to limit the radioactive isotopes in the coolant.

(5) External recirculation pumps and recirculation piping were replaced by internally mounted recirculation pumps. Such pumps can be removed easily as an integral or package unit for maintenance outside the lower drywell radiation zone.

12.1.2.3 Facility Layout General Design Considerations for Maintaining Radiation Exposures ALARA

12.1.2.3.1 Minimizing Personnel Time Spent in Radiation Areas

Facility general design considerations to minimize the amount of personnel time spent in radiation areas include the following:

(1) Locating equipment, instruments, and sampling stations, which require routine maintenance, calibration, operation, or inspection, for ease of access and minimum required occupancy time in radiation areas

(2) Laying out plant areas to allow remote or mechanical operation, service, monitoring, or inspection of highly radioactive equipment

(3) Providing, where practicable, for transportation of equipment or components requiring service to a lower radiation area

12.1.2.3.2 Minimizing Radiation Levels in Plant Access Areas and Vicinity of Equipment

Facility general design considerations directed toward minimizing radiation levels in plant access areas and in the vicinity of equipment requiring personnel attention include the following:

(1) Separating radiation sources and occupied areas where practicable (e.g., pipes or ducts containing potentially high radioactive fluids not passing through occupied areas).

(2) Providing adequate shielding between radiation sources and access and service areas. Of special note, the reactor pressure vessel shield wall in the upper drywell extends to within four inches of the upper drywell ceiling, thus permitting continued operation in the upper drywell during refueling and providing shielding in the case of a refueling accident.

(3) Locating equipment, instruments, and sampling sites in the lowest practicable radiation zone.

(4) Providing central control panels to permit remote operation of all essential instrumentation and controls from the lowest radiation zone practicable.

(5) Where practicable for package units, separating highly radioactive equipment from less radioactive equipment, instruments, and controls.

(6) Providing means and adequate space for utilizing moveable shielding for sources within the service area when required.

(7) Providing means to control contamination and to facilitate decontamination of potentially contaminated areas where practicable.

(8) Providing means for decontamination of service areas.

(9) Providing space for pumps and valves outside of highly radioactive areas.

(10) Providing remotely-operated centrifugal discharge and/or backflushable filter systems for highly radioactive radwaste and cleanup systems.

(11) Providing labyrinth entrances to radioactive pump, equipment, and valve rooms.

(12) Providing adequate space in labyrinth entrances for easy access.

(13) Maintaining ventilation air flow patterns from areas of lower radioactivity to areas of higher radioactivity.

(14) Providing both automatic logic control and mechanical stop devices for control of the traversing incore (TIP) probe to prevent withdrawal of the radioactive portions of the TIP onto the cable spoolers.

12.1.3 Operational Considerations

Out of ABWR Standard Plant scope. See Subsection 12.1.4.3 for COL license information.

12.1.4 COL License Information

12.1.4.1 Regulatory Guide 8.10

Compliance with Regulatory Guide 8.10 shall be demonstrated by the COL applicant (Subsection 12.1.1.3.2).

12.1.4.2 Regulatory Guide 1.8

Compliance with Regulatory Guide 1.8 shall be demonstrated by the COL applicant (Subsection 12.1.1.3.3).

12.1.4.3 Occupational Radiation Exposures

COL applicants will provide, to the level of detail provided in Regulatory Guide 1.70, the criteria and/or conditions under which various operating procedures and techniques shall be provided to ensure that occupational radiation exposures ALARA are implemented (Subsection 12.1.3).

12.1.4.4 Regulatory Guide 8.8

Compliance with Regulatory Guide 8.8 shall be demonstrated by the COL applicant (Subsection 12.1.1.3.1).