11. RADIOACTIVE WASTE MANAGEMENT

The AP1000 radioactive waste (radwaste) management systems control the handling and treatment of liquid, gaseous, and solid radwaste. These systems include the liquid radwaste system (WLS), the gaseous radwaste system (WGS), and the solid radwaste system (WSS). The WLS is designed to control, collect, process, store, and dispose of liquid radioactive wastes. The WLS is discussed in Section 11.2 of this report. The WLS contains holdup tanks, process pumps, other processing equipment including monitor tanks, and appropriate instrumentation and controls. Ion exchange is the principal waste treatment process in the WLS.

The WGS collects, processes, and monitors gaseous releases. The WGS is discussed in Section 11.3 of this report. The WGS collects gaseous wastes that are potentially radioactive or hydrogen-bearing (i.e., those wastes resulting from degassing the reactor coolant and the contents of the reactor coolant drain tank (RCDT)), stores them for decay in charcoal delay beds, and subsequently releases them to the environment via the plant vent.

The WSS controls the processing of solid wastes generated during reactor operation, as well as the packaging and storage of such processed wastes before shipment to a licensed disposal facility. The WSS is discussed in Section 11.4 of this report.

The process and effluent radiological monitoring instrumentation and sampling systems, which are discussed in Section 11.5 of this report, detect and measure the radioactive materials in plant liquid and gaseous processes and effluent streams.

11.1 Source Terms

The staff reviewed Design Control Document (DCD) Tier 2, Section 11.1, “Source Terms,” in accordance with the guidance and acceptance criteria in Section 11.1, “Source Terms,” of the Standard Review Plan (SRP). The following acceptance criteria are provided in Paragraph II of SRP Section 11.1:

- Title 10 of the Code of Federal Regulations (10 CFR) Part 20, as it relates to limits on doses for persons in unrestricted areas

- 10 CFR Part 50, Appendix I, as it relates to the numerical guidelines for design objectives and limiting conditions for operation (LCOs) to meet the “as low as is reasonably achievable” (ALARA) criterion given in Appendix I

- 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 60, as it relates to the radioactive waste management systems’ design to control releases of gaseous and liquid radioactive effluents, as well as to handle radioactive solid wastes, produced during normal operation

Use of the following regulatory guides (RGs) meet the requirements of the regulations identified above:

- RG 1.110, as it relates to the cost-benefit analysis for radioactive management systems and equipment

- RG 1.112, as it relates to the method of calculating release of radioactive materials in effluents from nuclear power plants

- RG 1.140, as it relates to the design, testing, and maintenance of air filtration and adsorption units of normal ventilation exhaust systems

The specific criteria sufficient to meet the relevant requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I, are as follows:

(1) The parameters used to calculate concentrations of radioactive materials in primary and secondary coolant are consistent with those given in NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors" (PWR-GALE code).

(2) All normal and potential sources of radioactive effluents delineated in Subsection I of SRP Section 11.1 are considered.

(3) For each source of liquid and gaseous waste considered in Subsection I of SRP Section 11.1, the volumes and concentrations of radioactive material given for normal operation and anticipated operational occurrences (AOOs) are consistent with those given in NUREG-0017.

(4) Decontamination factors (DFs) for in-plant control measures used to reduce gaseous effluent releases to the environment, such as iodine removal systems and high-efficiency particulate air (HEPA) filters for building ventilation exhaust systems and containment internal cleanup systems, are consistent with those given in RG 1.140. The building mixing efficiency for containment internal cleanup is consistent with that in NUREG-0017.

(5) DFs for in-plant control measures used to reduce liquid effluent releases to the environment, such as filters, demineralizers, and evaporators, are consistent with those in NUREG-0017.

(6) Radwaste augments used in the calculation of effluent releases to the environment are consistent with the findings of a cost-benefit analysis and are performed using the guidance of RG 1.110.

(7) Effluent concentration limits at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to 10 CFR Part 20.

(8) The source terms result in meeting the design objectives for doses in an unrestricted area, as set forth in Appendix I to 10 CFR Part 50.

(9) The applicant provides in the DCD the relevant information required by 10 CFR 50.34a. This technical information should include all the basic data listed in Appendix B to RG 1.112 needed to calculate the releases of radioactive material in liquid and gaseous effluents. The Gaseous and Liquid Effluent (GALE) computer code, along with the source term parameters given in NUREG-0017, is an acceptable method to perform this calculation.

(10) If the calculational technique or any source term parameter differs from that given in NUREG-0017, the applicant should describe these differences in detail, as well as the bases for the method and parameters used.

In reviewing the AP1000 design against the above criteria, the staff found that some of the above criteria dealt with the source term, which is the subject of this section, while some dealt with the subjects to be discussed in Sections 11.2 through 11.5 of this report. In request for additional information (RAI) 460.002, the staff asked the applicant to identify the relevant DCD sections that address the above criteria. The following are the applicant's responses and the staff's evaluation of these responses:

- The applicant stated that DCD Tier 2, Table 11.1-1, "Parameters Used in the Calculation of Design Basis Fission Product Activities," DCD Tier 2, Table 11.1-7, "Parameters Used to Describe Realistic Sources," and DCD Tier 2, Section 11.1.3 address Criterion 1. The staff reviewed the parameters in these tables and confirmed that they are consistent with those given in NUREG-0017. Therefore, the staff finds Criterion 1 to be satisfied.

- The applicant stated that DCD Tier 2,Table 11.2-6, "Input Parameters for the GALE Computer Code," addresses Criteria 2 through 4. The staff reviewed DCD Tier 2, Table 11.2-6, and DCD Tier 2, Sections 11.2 and 11.3, and found that all sources of radioactive effluents delineated in Subsection I of SRP Section 11.1 were considered, and that the sources are consistent with NUREG-0017. In addition, the DFs used for gaseous effluents and HEPA filter efficiency are consistent with RG 1.140. Therefore, the staff finds that Criteria 2 through 4 are satisfied.

- The applicant stated that DCD Tier 2, Table 11.2-5, "Decontamination Factors," and DCD Tier 2, Table 11.2-6 address Criterion 5. The staff reviewed these two tables and confirmed that the DFs for liquid effluents, such as filters, demineralizers, and evaporators, are consistent with NUREG-0017. Therefore, the staff finds that Criterion 5 is satisfied.

- The applicant stated that Criterion 6 is not applicable to the AP1000 radwaste systems because radwaste augments are not assumed as part of the licensing basis. The staff agrees.

- The applicant stated that DCD Tier 2, Table 11.2-8, "Comparison of Annual Average Liquid Release Concentrations with 10 CFR 20 for Expected Release Effluent Concentration Limits," and DCD Tier 2, Table 11.3-4, "Comparison of Calculated Offsite

Airborne Concentration with 10 CFR 20 Limits," address Criterion 7. Based on the evaluation in Sections 11.2.1 and 11.3.1 of this report, the staff finds the release concentrations acceptable.

- The applicant stated that DCD Tier 2, Sections 11.3.3.1 and 11.3.3.4 address Criterion 8 regarding the doses in an unrestricted area, and meet Appendix I to 10 CFR Part 50. The staff's evaluation is included in Sections 11.2.1 and 11.3.1 of this report. This evaluation led to combined license (COL) Action Items 11.2-2 and 11.3-1.

- The applicant stated that Criterion 9 is met because the GALE computer code is used, and that RG 1.112, Appendix B, is satisfied. Since the GALE code is used, with the NUREG-0017 source terms parameters, as indicated above, the staff finds that Criterion 9 is satisfied.

- The applicant stated that Criterion 10 is not applicable because NUREG-0017 is used for AP1000. The staff agrees.

In Sections 11.2 and 11.3 of this report, the staff evaluated the potential radioactive wastes and the capability of the WLS and WGS to keep radioactive effluents in unrestricted areas ALARA, in accordance with the requirements of 10 CFR Part 50, Appendix I. In addition, Sections 11.2 and 11.3 of this report document the staff's evaluation of compliance with 10 CFR 20.1302, which defines the criteria for radionuclide concentration limits in liquid and gaseous effluents released into unrestricted areas. Sections 11.2 through 11.5 of this report discuss compliance with GDC 60, as it relates to the design of the radioactive waste management systems to control releases of radioactive materials and to conform with the guidance in RGs 1.110 and 1.140. As discussed above, RG 1.112 is satisfied by meeting Criterion 9.

DCD Tier 2, Section 11.1 describes the sources of radioactivity that are generated within the core and have the potential of leaking to the reactor coolant system (RCS) during normal plant operation, including AOOs, by way of defects in the fuel cladding. Two source terms are presented for the primary and secondary coolant. The first is the design-basis source term, which assumes a design-basis fuel defect level of 0.25 percent. Reactor coolant activity is determined based on time-dependent fission product core inventories that are calculated by the ORIGEN code. The first source term serves as a basis for radwaste system design and shielding requirements, and is listed in DCD Tier 2, Tables 11.1-2, 11.1-3, 11.1-5, and 11.1-6. The second source term is a realistic model which represents the expected average concentrations of radionuclides in the primary and the secondary coolant. These values are determined using the model in American National Standards Institute (ANSI)-18.1 and the PWR-GALE code (NUREG-0017, Revision 1). The realistic source term provides the bases for estimating typical concentrations of the principal radionuclides, as listed in DCD Tier 2, Table 11.1-8. This source term model reflects the industry experience at a large number of operating PWR plants.

The NRC staff found that the assumption of a 0.25 percent fuel defect level used for the AP1000 design-basis source term deviates from the fuel defect assumption of 1.0 percent described in SRP Sections 11.2 and 11.3 for the WLS and the WGS. The applicant provided fuel leak data for operating plants in a letter dated June 17, 1997, to demonstrate that the 0.25 percent fuel defect level was an appropriate assumption. The staff independently reviewed the fuel data for the applicant's fuel and found the data were applicable to the AP1000 to justify the 0.25 percent fuel failure assumption. Furthermore, Technical Specification (TS) (LCO) 3.4.11, "RCS Specific Activity," specifies dose limits for iodines and noble gases corresponding to a fuel defect level of 0.25 percent, to ensure that plant operation remains within the limits consistent with the design assumptions. In RAI 460.001, the staff requested the applicant to justify the fuel defect level assumption used specifically for the AP1000. Based on the applicant's response to RAI 460.001, the staff confirmed that the justifications were applicable to the AP1000 fuel.

The staff reviewed the recent fuel data for Westinghouse fuel and compared the data with independent information available to the staff. Based on the results of the comparison, the staff agrees with the applicant that for Westinghouse 17 x 17 Vantage 5 Hybrid (V5H) fuel, the 0.25 percent fuel failure assumption is reasonable. Therefore, the staff finds that the deviation from the fuel defect assumption from the SRP is acceptable for the AP1000.

Based on the above evaluation, the staff finds that the source terms described in DCD Tier 2, Section 11.2 for the AP1000 are acceptable. Sections 11.2 through 11.5 of this report address the issues identified above.

11.2 Liquid Waste Management System

11.2.1 System Description and Review Discussion

The staff reviewed DCD Tier 2, Section 11.2, "Liquid Waste Management System," in accordance with the guidance and acceptance criteria described in SRP Section 11.2. Paragraph II of SRP Section 11.2 provides the following acceptance criteria for the WLS:

- 10 CFR 20.1302, as it relates to limits on doses to persons in unrestricted areas
- 10 CFR 50.34a, as it relates to the inclusion of sufficient design information to demonstrate the design objectives for equipment necessary to control releases of radioactive effluents to the environment
- GDC 60, as it relates to the design of liquid waste management systems to control releases of liquid radioactive effluents
- GDC 61, as it relates to the design of liquid waste management systems to ensure adequate safety under normal and postulated accident conditions

The relevant requirements of the regulations identified above are met by using the regulatory positions contained in the following RGs:

- RG 1.110, as it relates to performing a cost-benefit analysis for reducing cumulative dose to the population by using available technology

- RG 1.143, as it relates to the seismic design and quality group classification of components used in the liquid waste management system and the structures housing this system, as well as the provisions used to control leakages

- 10 CFR Part 50, Appendix I, Sections II.A and II.D, as they relate to the numerical guidelines for dose design objectives and LCOs to meet the ALARA criterion

DCD Tier 2, Section 11.2 describes the WLS design to control, collect, process, store, and dispose of liquid radioactive waste generated as the result of normal operation, including AOOs. The WLS, shown in DCD Tier 2, Figures 11.2-1 and 11.2-2, consists of tanks (effluent holdup tanks, waste holdup tanks, chemical waste tanks, and monitor tanks), pumps, ion exchangers, and filters. The design data for these components are listed in DCD Tier 2, Table 11.2-2.

The WLS processes the following four major categories of radioactively contaminated wastes:

(1) borated waste water from the RCS effluents released through the chemical and volume control system (CVS), primary sampling system sink drain, and equipment leakoffs and drains

(2) floor drains from various building sumps and equipment drains

(3) detergent waste from hot sinks and showers, and some cleanup and decontamination processes

(4) chemical waste from the laboratory and other relatively small volume sources

The WLS does not normally process nonradioactive secondary system effluent. The steam generator (SG) blowdown system, as described in DCD Tier 2, Section 10.4.8, and the turbine building drain system normally handle secondary system effluents. Radioactivity can enter the secondary systems from SG tube leakage. If significant radioactivity is detected in secondary-side systems, blowdown is redirected to the WLS for processing and disposal in a monitored fashion.

The effluent subsystem processes borated and hydrogen-bearing liquid from the RCS through the CVS and the RCDT. There are two effluent holdup tanks, each with a capacity of 105,992 liters (28,000 gallons). Normally, these wastes are processed through a prefilter, ion exchangers, and an after-filter. The processed waste is then collected in one of the effluent waste monitor tanks, sampled, and discharged (if acceptable). Each of the effluent waste monitor tanks has a capacity of 56,781 liters (15,000 gallons). The processed waste may also be recirculated for further processing by the subsystem. The applicant’s estimates of the normal generation rate of these wastes can be found in DCD Tier 2, Table 11.2-1.

A set of four ion exchangers connected in series make up the principal process equipment for treating liquid radwaste from the effluent holdup tanks and the waste holdup tanks. The four ion exchangers have a waste prefilter (upstream of the ion exchangers) and a waste after-filter (downstream of the ion exchangers) and consist of the following:

- one specific ion exchanger (containing activated charcoal on a zeolite resin) that acts as a deep-bed filter and removes oil from floor drain wastes
- one cation bed ion exchanger
- two mixed bed ion exchangers.

Design flexibility exists to manually bypass any of these ion exchangers, as well as to interchange the order of the last two mixed beds, to provide complete usage of the resin. The applicant stated that the media for the ion exchangers will be selected by the COL applicant to optimize system performance. A COL applicant referencing the AP1000 certified design should identify the media it plans to use for the cation bed and the mixed bed ion exchangers in the WLS. DCD Tier 2, Section 11.2.5.3 specifies that the COL applicant will identify the types of liquid waste ion exchange and adsorbent media to be used in the WLS, dependent upon developments in ion exchange technology and specific characteristics of the liquid radwaste to be processed. This is COL Action Item 11.2-3, as identified in DCD Tier 2, Table 1.8-2.

Based on DCD Tier 2, Table 11.2-1, the combined normal generation rate of the liquid wastes serviced by both effluent holdup tanks and the waste holdup tank is 7,287 liters/day (1,925 gallons/day). In RAI 460.004, the staff asked the applicant to provide additional information on the process capacity of the WLS. In its response, the applicant stated that the ion exchanger has a processing capability of 40,882 liters/day (10,800 gallons/day) or 284 liters/minute (75 gallons/minute). This information was incorporated into DCD Tier 2, Section 11.2.1.2.1. This provides an adequate margin for processing surges in the generation rates of all wastes serviced by the two subsystems. The subsystem holdup tanks, which have a capacity of 105,992 liters (28,000 gallons) per tank, have an adequate margin for collecting large increases in the generation of wastes.

The WLS piping permits connection of mobile processing equipment. When liquid wastes are processed by mobile equipment, the treated liquid waste is returned to the WLS for eventual discharge to the environs, or to an ultimate disposal point for liquids that are to be removed from the plant site.

The detergent waste subsystem collects wastes that are generally high in dissolved solids, but low in radioactivity, from plant hot sinks and showers and some cleanup and decontamination processes. The detergent wastes are generally not compatible with the ion exchange resins and are collected in the chemical waste tank. The size of the chemical waste tank (33,690 liters or 8,900 gallons) is adequate. Normally, these wastes are sampled. If the detergent waste activity is below acceptable limits, the waste can be discharged without processing. When detergent waste activity is above acceptable limits and processing is necessary, the waste water may be transferred to a waste holdup tank and processed in the same manner as other radioactively contaminated waste water, if onsite equipment is suitable to do so.

If onsite processing capabilities are not suitable for the composition of the detergent waste, processing can be performed using mobile equipment brought into the radwaste building, or the waste water can be shipped offsite for processing. After processing by the mobile equipment, the water may be transferred to a waste holdup tank for further processing or transferred to a monitor tank for sampling and discharge. The applicant estimates, in DCD Tier 2, Table 11.2-1, that the normal generation rate of these wastes will be 908 liters/day (240 gallons/day) and assumes that the waste will be fully discharged to the environs. The capacity of the limiting processing equipment (i.e., ion-exchanger) is 408,824 liters/day (108,000 gallons/day) in this subsystem. This capacity provides an adequate margin for processing a surge in the generation rate of this waste.

Radioactively contaminated chemical wastes are normally generated at a low rate and collected in the chemical waste tank shared with detergent wastes. Chemicals are added to the tank, as needed, for pH or other chemical adjustment. The design includes alternatives for processing or discharge. These wastes may be processed onsite, without being combined with other wastes, using mobile equipment. When combined with detergent wastes, they may be treated like detergent wastes, as described above. If onsite processing capabilities are not suitable, processing can be performed using mobile equipment or the waste water can be shipped offsite for processing.

SG blowdown is normally processed by the SG blowdown treatment system demineralizers, as discussed in DCD Tier 2, Section 10.4.8. In the AP1000 design, SG blowdown does not normally contribute to any liquid radwaste discharge to the environs. Under normal conditions, the processed blowdown is totally recycled in the plant (i.e., discharged to the condenser hot well). However, if the blowdown flow is detected to be excessively radioactive, it will be manually aligned to the inlet of the waste holdup tank for processing before its eventual discharge to the environment.

Process discharge is normally aligned to one of the three monitor tanks. The release of processed liquid waste from any monitor tank to the environs is permitted only when sampling of the subject tank’s contents indicates that such a release is permissible. The effluent discharge line includes a radiation monitor. The discharge flow rate for borated wastes should be preset by the COL applicant to limit the boric acid concentration in the circulating water blowdown stream to an acceptable level, in compliance with local requirements. A COL applicant referencing the AP1000 certified design should identify its planned discharge flow rate for borated wastes. DCD Tier 2, Section 11.2.5.4 states that a COL applicant will determine the rate of discharge and the dilution necessary to maintain an acceptable concentration, in compliance with local requirements. This is COL Action Item 11.2-4, as identified in DCD Tier 2, Table 1.8-2.

When the waste discharge flow is diluted by the circulating water blowdown flow of 22,712 liters/minute (6,000 gallons/minute), the discharge flow rate for any waste stream should be restricted, as necessary, to maintain an acceptable concentration level for radionuclides in liquid effluents discharged into any unrestricted area. The above criterion for liquid waste discharge flow ensures compliance with the 10 CFR Part 20, Appendix B, Table 2, Column 2, limits for concentrations of radionuclides in liquid effluents discharged into any unrestricted area. All WLS discharges are made through a single liquid waste discharge line to the circulating water blowdown stream. The dilution factor provided for the activity released is site dependent and will be provided by the COL applicant (COL Action Item 11.2-4).

All WLS releases are monitored by a radiation monitor prior to dilution and discharge. The monitor is located on the common discharge line downstream of the WLS monitor tanks, in compliance with the 10 CFR Part 20, Appendix B, Table 2, Column 2, limits for radionuclide concentrations in liquid effluents discharged into unrestricted areas. These radiation monitors will provide a signal to terminate liquid radwaste releases to unrestricted areas before the discharge concentration in the line exceeds a predetermined setpoint. As discussed above, the radiation monitors are provided for controlling and monitoring release of radioactive materials from liquid effluents to unrestricted areas, as required by GDC 60. The staff will review the operational setpoints of the subject radiation monitors on a plant-specific basis for each COL application. A COL applicant referencing the AP1000 certified design should identify the planned operational setpoints for its WLS radiation monitors in its plant-specific offsite dose calculation manual (ODCM). DCD Tier 2, Section 11.5.7 provides for a COL applicant to develop an ODCM to address operational setpoints for the radiation monitors, as well as programs for monitoring and controlling the release of radioactive material into the environment, thus eliminating the potential for unmonitored and uncontrolled release. This is COL Action Item 11.5-1, as identified in DCD Tier 2, Table 1.8-2.

The applicant calculated the annual liquid effluent releases (shown in DCD Tier 2, Table 11.2-7) using the PWR-GALE code methodology. DCD Tier 2, Table 11.2-6 provides the standard design parameters for running this computer program to calculate expected primary and secondary coolant radionuclide concentrations and liquid effluents. DCD Tier 2, Table 11.2-2 lists the component data for the WLS. Specifically, the table lists the number of WLS holdup tanks, monitor tanks, pumps, filters, and ion exchangers (and their types), and their design capacities or flow rates, whichever is applicable. DCD Tier 2, Table 11.2-1 lists the collection rates and primary coolant activity fractions of the individual liquid waste streams. DCD Tier 2, Table 11.2-5 lists the DFs for different categories of radionuclides provided by the different types of ion exchangers. DCD Tier 2, Figure 11.2-2 lists the WLS piping and instrumentation drawings (P&IDs). DCD Tier 2, Tables 11.2-7, 11.2-8, and 11.2-9 provide the results of the GALE code. SRP Section 11.2 recommends the GALE code methodology. The staff reviewed the input data and found them to be acceptable.

Because demonstration of specific compliance with 10 CFR Part 50, Appendix I, dose guidelines for liquid effluents is not within the scope of the standard design, the staff will review each compliance demonstration for each COL application. RG 1.110 provides guidance for performing a cost-benefit analysis in order to reduce cumulative dose to the population by using available technology. DCD Tier 2, Section 11.2.5.2 states that the COL applicant will provide a site-specific cost-benefit analysis to address the requirements of 10 CFR Part 50, Appendix I, regarding population doses resulting from the release of liquid effluents. The COL applicant will also demonstrate conformance with RG 1.110, as it relates to performing a site-specific cost-benefit analysis for reducing dose. This is COL Action Item 11.2-2, as identified in DCD Tier 2, Table 1.8-2.

The requirements of 10 CFR 20.1302 permit an applicant to demonstrate compliance with applicable dose limits, in part, by showing that the annual average concentrations of radioactive materials in those liquid effluents to be released into an unrestricted area do not exceed the limits specified in the subject table column. DCD Tier 2, Table 11.2-8 demonstrates that the sum of the ratios of the liquid effluent concentrations of radionuclides in any unrestricted area to the liquid effluent concentration limits for the respective radionuclides given in 10 CFR Part 20, Appendix B, Table 2, Column 2, are well below 1.0 percent.

In RAI 460.001, the staff asked the applicant to justify its assumption of a 0.25 percent fuel defect level. This assumption deviates from the fuel defect assumption of 1.0 percent in SRP Section 11.2 for the liquid waste management system. The applicant provided justification for this deviation in its response to RAI 460.001. For the reasons set forth in Section 11.1 of this report, the staff finds this deviation acceptable.

In addition, the applicant explained that for the maximum release concentration, DCD Tier 2, Table 11.2-9 sets forth results, assuming a maximum defined fuel defect level, that correspond to a 1.0 percent fuel defects for all fission product nuclides, except iodine and noble gas. For iodine and noble gas, the TS limits corresponding to a 0.25 percent fuel defect level were assumed. The results in DCD Tier 2, Table 11.2-9 demonstrate that the sum of the ratios of the liquid effluent concentrations of radionuclides in any unrestricted area to the liquid effluent concentration limits for the respective radionuclides given in 10 CFR Part 20, Appendix B, Table 2, Column 2, is 0.53 percent. This value is below 1.0 percent and provides for a sufficient margin before reaching the maximum defined fuel defect level. Therefore, compliance with 10 CFR 20.1302 is demonstrated by the information included in DCD Tier 2, Table 11.2-9. In addition, Criterion 7, which was discussed in Section 11.1 of this report, is met.

The WLS is a non-safety-related system and serves no safety function except system isolation from the containment, when required. The system valves interfacing with the containment, which serve the above safety function, are safety-related and seismic Category I, as shown in DCD Tier 2, Table 3.2-3. In DCD Tier 2, Table 3.2-3, the applicant indicated that the WLS is located in the seismic Category I auxiliary building. All waste collection and waste monitor tanks, the chemical waste tank, and the condensate storage tank are equipped with level indication and provisions for high-level alarms in the control room. Local indication and controls are available on portable displays which may be connected to the data display and processing system.

The staff reviewed DCD Tier 2, Section 11.2 and Appendix 1A for conformance with RG 1.143, “Design Guidance for Radwaste Management Systems, Structures, and Components Installed in Light Water-Cooled Nuclear Power Plants.” In Appendix 1A, the applicant committed to comply with all the positions in RG 1.143, with one exception relating to Criterion C.6.2.1. In RAI 460.003, the staff pointed out that the AP1000 conforms with Criterion C.6.2.1 based on DCD Tier 2, Section 3.7.2, which states that the radwaste building of the AP1000 is designed to Uniform Building Code—1977. In response to RAI 460.003, the applicant agreed with the staff and revised DCD Tier 2, Appendix 1A, to be consistent with DCD Tier 2, Section 3.7.2. Therefore, AP1000 conforms to RG 1.143.

The tanks of the WLS (effluent holdup tanks, waste holdup tanks, monitor tanks, and chemical waste tank) are located in the auxiliary building which is designed to seismic Category I criteria. The other components, such as ion exchangers, filters, degasifier, pumps, applicable valves, and heat exchangers, are also in the auxiliary building. All WLS tank overflows are routed to a watertight room within the auxiliary building and drained to the auxiliary building sump, which is pumped to a waste holdup tank. Since the auxiliary building is designed to seismic Category I criteria, the staff finds the WLS to be acceptable with respect to meeting the seismic design guidance specified in RG 1.143.

Components (such as heat exchangers, pumps, tanks, degasifier, ion exchangers, filters, and valves) in the WLS are nonseismic and are classified as AP1000 Class D (i.e., Quality Group D in RG 1.26), as shown in DCD Tier 2, Table 3.2-3. The quality assurance (QA) program for design, fabrication, procurement, and installation of radwaste systems is in accordance with the overall QA program described in DCD Tier 2, Chapter 17. DCD Tier 2, Section 17.5 states that the COL applicant will address its design phase QA program, as well as its QA program for procurement, fabrication, installation, construction and testing of structures, systems and components in the facility. The evaluation of the overall QA program is in Chapter 17 of this report. As set forth in Chapter 17 of this report, a COL applicant will address these matters pursuant to COL Action Item 17.5-1, and the staff will review them in the context of the COL application. The staff finds the WLS acceptable with respect to meeting the QA guidance specified in RG 1.143, provided that the overall QA program described in any particular COL application is acceptable.

The liquid waste system is designed to handle most liquid effluents and other anticipated events using installed equipment. However, for events occurring at a very low frequency, or producing effluents not compatible with the installed equipment, temporary equipment may be brought into the radwaste building mobile treatment facility truck bays. Connections are provided to and from various locations in the liquid waste system to facilitate connections with mobile equipment. This allows the mobile equipment to be used in series with installed equipment, as an alternative to the treated liquids returning to the liquid waste system, or as an ultimate disposal point. The staff will review any mobile processing equipment that may be used for processing liquid radwaste on a plant-specific basis for particular COL applications using the guidelines of RG 1.143. The COL applicant should discuss how any mobile processing equipment intended for use in the processing of liquid radwaste meets the guidelines of RG 1.143. DCD Tier 2, Section 11.2.5.1 addresses this COL action item. By meeting the guidance in RG 1.143 and RG 1.110, the WLS, with the exception of this COL action item, meets the requirements of GDC 61, as specified in SRP Section 10.2. This is COL Action Item 11.2-1, as identified in DCD Tier 2, Table 1.8-2.

The NRC Inspection Enforcement Bulletin (IEB) 80-05, “Vacuum Condition Resulting in Damage to Chemical Volume Control System (CVCS) Holdup Tanks (sometimes called ‘Clean Waste Receiver Tanks’),” addresses issues concerning the release of radioactive material or other adverse effects as a result of low-vacuum conditions causing tank buckling. The low-vacuum condition could be created by the cooling of hot water in a low-pressure tank. Except for the RCDT located in the containment building, no other tank in the WLS is exposed to hot water. The RCDT has several design features, including an external design pressure provided in DCD Tier 2, Table 11.2.2, of 204.7 kiloPascals (kPa) (15 pounds per square inch gauge (psig)), which eliminate the possibility of structural collapse of the RCDT resulting from steam condensation. Because of these design features, the RCDT will not collapse even if exposed to a full vacuum. The staff noted that all of the WLS tanks have vents that are adequately sized to prevent tank collapse during drain down. Therefore, the staff finds that the design of the AP1000 WLS adequately addresses the concern identified in IEB 80-05 and is, therefore, acceptable.

11.2.2 Conclusion

For the reasons set forth above, the staff concludes that the design of the WLS is acceptable and meets the requirements of 10 CFR 20.1302; 10 CFR Part 50, Appendix I; 10 CFR 50.34a; GDC 60; and GDC 61. This conclusion is based on the following:

- The AP1000 design has met the dose requirements of 10 CFR 20.1302 by assuring that the annual average concentration of radioactive materials in liquid effluents released into an unrestricted area will not exceed the limits specified in 10 CFR Part 20, Appendix B, Table 2, Column 2.

- The AP1000 design has demonstrate compliance with 10 CFR 50.34a, as it relates to sufficient design information being provided, as set forth in the above discussion.

- A COL applicant referencing the AP1000 certified design will demonstrate compliance with 10 CFR Part 50, Appendix I, requirements for offsite individual doses and population doses resulting from liquid effluents by preparing a site-specific cost-benefit analysis in accordance with RG 1.110 (COL Action Item 11.2-2).

- The AP1000 design has met the requirements of GDC 60 with respect to controlling releases of liquid effluents by radiation monitoring of the WLS releases. All WLS releases are monitored by a radiation monitor, which will generate a signal to terminate liquid radwaste releases before the discharge concentration exceeds a predetermined set point. A COL applicant will identify the operational setpoint for its WLS radiation monitors in its plant-specific ODCM (COL Action Item 11.5-1).

- Compliance with the requirements of GDC 61 is demonstrated by meeting the guidelines of RG 1.143 and RG 1.110 (COL Action Item 17.5-1).

Based on the above review, the staff has determined that the AP1000 WLS design meets the guidelines of SRP Section 11.2 and is therefore acceptable.

11.3 Gaseous Waste Management System

11.3.1 System Description and Review Discussion

The staff reviewed DCD Tier 2, Section 11.3, “Gaseous Waste Management System,” in accordance with the guidance and acceptance criteria described in SRP Section 11.3. Paragraph II of SRP Section 11.3 provides the following acceptance criteria for the WGS:

- 10 CFR 20.1302, as it relates to limits on doses to persons in unrestricted areas

- 10 CFR 50.34a, as it relates to providing sufficient design information to demonstrate the effectiveness of design objectives for equipment necessary to control releases of radioactive effluents to the environment

- GDC 3, as it relates to protecting gaseous waste handling and treatment systems from the effects of an explosive mixture of hydrogen and oxygen

- GDC 60, as it relates to the design of radioactive waste management systems to control releases of gaseous radioactive effluents

- GDC 61, as it relates to the control of radioactivity in the WGS and the ventilation systems associated with fuel storage and handling areas

- 10 CFR Part 50, Appendix I, Sections II.B, II.C, and II.D, as they relate to the numerical guidelines for dose design objectives and LCOs necessary to meet the ALARA criterion

The relevant requirements of the regulations identified above are met by using the regulatory positions contained in the following RGs:

- RG 1.140, as it relates to the design, testing, and maintenance of normal ventilation exhaust systems at nuclear power plants

- RG 1.143, as it relates to the seismic design and quality group classification of components used in the gaseous waste management system and the structures housing this system, as well as the provisions used to control leakage

- SRP Branch Technical Position Effluent Treatment Systems Branch (BTP ETSB) 11-5, as it provides guidelines to analyze postulated radioactive releases as a result of postulated leakage or failure of a waste gas storage tank

The WGS controls, collects, processes, stores, and disposes of gaseous radioactive wastes generated during normal operation, including AOOs. The WGS involves the gaseous radwaste system, which deals with potentially hydrogen-bearing and radioactive gases generated during plant operation. Additionally, it involves the management of building ventilation, containment purge, and condenser air removal system exhausts. The AP1000 WGS is a once-through, ambient-temperature, activated carbon delay system. The system includes a gas cooler, a moisture separator, an activated carbon-filled guard bed, and two activated carbon-filled delay beds. The system also includes an oxygen analyzer subsystem and a gas sampling subsystem. The major inputs to the WGS are RCS gases stripped from the CVS letdown flow by the WLS vacuum degasifier during RCS dilution and boration, as well as during degassing prior to a reactor shutdown. Other inputs to the WGS are the gases from the RCDT vent and the gases stripped from the RCDT liquid by the WLS degasifier.

The flow through the WGS consists of hydrogen and nitrogen (as carrier gases), fission gases, and water vapor. Influents to the WGS pass through the following four stages:

(1) a gas cooler, which cools the influent waste gas to 7.2 °C (45 °F) by a chilled water system

(2) a moisture separator, which removes the moisture formed when the gas steam is cooled

(3) a guard bed, which protects the delay beds from abnormal moisture carryover, or chemical contaminants, by removing them from the waste stream

(4) two 100-percent capacity delay beds

The fission gases in the waste gas stream undergo dynamic adsorption by the activated carbon in the delay beds and, therefore, experience significant delay during their transit through the beds. DCD Tier 2, Section 11.3.5.2 states that the COL applicant will identify the types of adsorbent media to be used in the WGS. This is COL Action Item 11.3-2, as identified in DCD Tier 2, Table 1.8-2. Radioactive decay of the fission gases during the delay periods significantly reduces the radioactivity of the gas flow leaving the system. The effluent from the delay bed passes through a radiation monitor and is discharged to the environs via the system ventilation exhaust duct and the plant vent. In response to RAI 460.005(C), the applicant stated that sufficient holdup time is provided by the WGS because the system can be isolated at any time. The system is not normally in operation. It is operated, as necessary, during changes in RCS boron concentration and when reductions in the RCS noble gas inventory are made. Because the anticipated operation in the system provides 61 days holdup of xenon isotopes and over 2 days holdup of krypton isotopes, the staff does not expect that any alteration in the system operation will be necessary due to adverse meteorological conditions. Therefore, the WGS satisfies GDC 60, as it relates to sufficient holdup capacity for retention of radioactive gaseous effluents.

The design data for the WGS are provided in DCD Tier 2, Table 11.3-2. In addition, a list of gaseous radwaste system instrumentation and control items is provided in this table. The system contains provisions for continuously monitoring the moisture level at the inlet of the guard bed. Monitoring the performance of individual components in the system is done by collecting and analyzing grab samples. Connections between the two delay beds allow for the collection of samples at the inlet and outlet of the guard bed, and at the outlet of the second delay bed. The WGS has a radiation monitor that continuously monitors the discharge from the delay beds. The monitor will automatically send a signal to terminate the discharge when the radiation level in the discharge stream reaches a predetermined setpoint. The COL applicant will determine this setpoint. A COL applicant referencing the AP1000 certified design should identify its planned operational setpoint for the WGS radiation monitor in its plant-specific ODCM. DCD Tier 2, Section 11.5.7 states that the COL applicant will identify operational setpoints for the radiation monitors and will identify programs for monitoring and controlling the release of radioactive material to the environment, thus eliminating the potential for unmonitored and uncontrolled release (see COL Action Item 11.5-1).

In addition to the WGS exhaust, the other exhaust released to the environs via the radiation monitored plant vents include:

- the containment purge exhaust
- the auxiliary building exhaust
- the annex building release
- the radwaste building exhaust

The turbine steam sealing (gland seal) system exhaust and the condenser air removal system exhaust, which includes the gland seal exhaust during plant startup, are routed to a common header that discharges the exhausts to the environs via a radiation-monitored turbine building vent. The gland seal system and condenser air removal system exhausts are not filtered prior to their release to the environs, as they are not normally radioactive. However, upon detection of unacceptable levels of radiation in the exhausts, which may occur as a result of a SG tube leak, appropriate corrective actions will be manually performed. The turbine building exhaust is released to the environs via unmonitored turbine building vents, because it is not expected to have detectable radioactivity. In DCD Tier 2, Section 11.3.3.3, the applicant provided release-point characteristics for the plant vent and the turbine building vent, through which the combined discharge of the condenser air removal system and the gland seal system occurs.

Based on the above, suitable control of releases from the WGS is provided by the radiation monitoring system (RMS), as discussed in DCD Tier 2, Section 11.5, which automatically sends a signal to terminate releases from the WGS when a high-activity setpoint is exceeded in the system discharge line. Furthermore, the WGS provides sufficient holdup capacity. Therefore, the WGS design conforms with GDC 60 with regard to the control of radioactive releases to unrestricted areas.

In response to RAI 460.005(D), the applicant discussed compliance with GDC 61. The fuel storage and handling areas for the AP1000 include the fuel handling area of the auxiliary building, which encloses the spent fuel pool (SFP), and the containment building, which encloses the reactor cavity. Based on the calculated radiological releases resulting from a design-basis fuel-handling accident (FHA) in either area, there is no need to provide safety-related isolation or filtration systems to maintain plant safety (see DCD Tier 2, Section 15.7.4).

The ventilation systems serving these plant areas incorporate specific design features to mitigate the potential releases of abnormal (i.e., non-design-basis accident) airborne radioactivity from these areas. In addition to automatic isolation of the fuel handling area or containment purge valves due to a high-radiation signal, the isolation dampers or valves can be manually controlled from the main control room (MCR). The fuel handling area isolation dampers and containment isolation valves are provided with remote position indication. During abnormal airborne radiological conditions, the containment purge valves can be manually opened, through administrative procedures, to override a high-radiation signal, thereby allowing cleanup of the containment atmosphere. DCD Tier 2, Section 9.4.7.4 states that the exhaust air filtration units of the containment air filtration system (VFS) are designed and tested in accordance with American Society of Mechanical Engineers (ASME) Standards N-509-1989 and N-510-1989. These ASME standards discuss the instrumentation necessary for the periodic inspection and verification of system airflow rates, air temperatures, and filter pressure drops. Based on the above, the staff finds that the WGS complies with GDC 61, as it relates to radioactivity control in the WGS and the ventilation systems associated with fuel storage and handling areas.

In DCD Tier 2, Appendix 1A, the applicant provided a discussion of how the VFS meets the guidelines of RG 1.140, "Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light Water Cooled Nuclear Power Plants." As shown in DCD Tier 2, Table 9.4-1, the VFS has a 4-inch charcoal absorber and HEPA filters upstream and downstream of the absorber. The staff finds that the applicant has credited filter efficiencies of 90 and 99 percent for removal of iodine and other radionuclides in particulate form, respectively, in its calculation of gaseous effluents from containment purge exhaust. These efficiencies are in accordance with the specified efficiencies for 4-inch charcoal absorber and HEPA filters in RG 1.140. Therefore, the staff agrees with the filter efficiencies credited by the applicant in the calculation of containment purge exhaust effluents.

Although the auxiliary building and annex building exhausts are not normally filtered prior to their release, as stated above, the ventilation systems serving these areas incorporate design features that provide automatic filtration of the exhausts, prior to their release, under certain circumstances. Specifically, a high-radiation signal from any of the monitors in the exhaust ducts of the annex building, the fuel handling area of the auxiliary building, and the radiologically controlled portion of the auxiliary building will result in isolation of the normal supply and (unfiltered) exhaust ducts to the affected area and will connect the VFS exhaust filter and fans to the isolated area. (See DCD Tier 2, Sections 9.4.3.2.3.2 and 9.4.7.2.3.) On the basis of the above discussion and the evaluation presented in Section 9.4 of this report, the staff finds that the WGS meets the guidelines of RG 1.140 as they relate to the normal ventilation exhaust systems for air filtration.

The WGS is a non-safety-related system and has no accident mitigation functions. The WGS and the structures housing this system are designed in accordance with the applicable positions of RG 1.143 with respect to the following guidelines for gaseous radwaste systems:

- general guidelines for design, construction, and testing criteria for radwaste systems
- specific seismic design criteria for the WGS
- general seismic design criteria for structures housing radwaste systems
- general guidelines for providing quality assurance for radwaste management systems

DCD Tier 2, Appendix 1A, pertaining to the AP1000 radwaste management systems' conformance with RG 1.143, provides a discussion of how the design of the WGS and its housing structures meet the applicable guidelines of RG 1.143. DCD Tier 2, Appendix 1A, Criteria Section C.2.3, states that the guard bed and the delay beds, including supports, in the gaseous radwaste system are designed for seismic loads in accordance with RG 1.143. Seismic loads for this equipment were established using one-half of the safe-shutdown earthquake floor response spectra. The loads resulting from this seismic response spectra are equivalent to, or greater than, those resulting from an operating-basis earthquake. The WGS is housed in a seismic Category I structure (the auxiliary building). The QA program for design, fabrication, procurement, and installation of radwaste systems is in accordance with the overall QA program described in DCD Tier 2, Chapter 17.

In DCD Tier 2, Table 3.2-3, the applicant classified WGS equipment and components such as the gas cooler, sample pumps, guard and delay beds, moisture separator, and applicable valves as AP1000 Class D (i.e., RG 1.26 Quality Group D). The QA program for design, fabrication, procurement, and installation of radwaste systems is in accordance with the overall QA program described in DCD Tier 2, Chapter 17. DCD Tier 2, Section 17.5 states that the COL applicant will address its design phase QA program, as well as its QA program for procurement, fabrication, installation, construction and testing of structures, systems and components in the facility. The evaluation of the overall QA program is in Chapter 17 of this report. As set forth in Chapter 17 of this report, a COL applicant will address these matters pursuant to COL Action Item 17.5-1, and the staff will review them in the context of the COL application. The staff finds the WGS acceptable with respect to meeting QA guidance specified in RG 1.143, provided that the overall QA program described in any particular COL application is acceptable.

Because the potential exists for a buildup of explosive mixtures of hydrogen and oxygen in the WGS, the system should be designed to either withstand the effects of a hydrogen explosion, or have design features to preclude the formation or buildup of explosive mixtures, in accordance with SRP Section 11.3 guidelines. DCD Tier 2, Section 11.3.1.2.3.1, and the applicant's response to RAI 460.005(B) describe the design features for preventing the formation or buildup of explosive mixtures in the WGS. The WGS operates at a slightly positive pressure to prevent air in-leakage. A continuous purge flow of nitrogen is provided at the outlet of the WGS to prevent back-leakage of air through the discharge check valves. Dual oxygen analyzers are provided for continuous sampling in a side stream taken off the process flow paths. These analyzers sound an alarm, both locally and in the MCR, upon high oxygen levels. The alarm setpoint is at an oxygen concentration level that would allow adequate time for operator action. A hydrogen analyzer is also provided for direct measurement of hydrogen concentration in the sampling side stream. The operator can use the analyzer reading, in conjunction with a flammability chart, to assess the flammability potential during an upset situation in which oxygen enters the system. The entire system is electrically at the same potential, thereby eliminating the buildup of static electricity and sparking. The WGS throttling and isolation valves are packless metal diaphragm types which eliminate leakage into or out of the system through the steam seals. The dual oxygen analyzers are independent such that at an operator selectable oxygen concentration of 4 percent or less, the system automatically provides a signal to isolate oxygen inputs and initiate a nitrogen purge. Based on the above information, the staff finds that the WGS satisfies GDC 3 for protection from the potential effects of an explosive mixture.

The applicant calculated annual gaseous effluent releases using the PWR-GALE code (see DCD Tier 2, Table 11.3-3). DCD Tier 2, Table 11.2-6 provides the standard design parameters for running the computer program, which calculates expected primary and secondary coolant radionuclide concentrations and gaseous effluents. DCD Tier 2, Tables 11.3-1 and 11.3-2 list the design data for the WGS. DCD Tier 2, Figures 11.3-1 and 11.3-2 depict the schematics and the P&ID of the WGS. Demonstration of specific compliance with the requirements of 10 CFR Part 50, Appendix I, for a maximally exposed offsite individual and population doses resulting from gaseous effluents depends on site-specific factors and is, therefore, not within the scope of the AP1000 standard design. The staff will review such matters for each COL application. DCD Tier 2, Section 11.5.7 states that the calculation of offsite individual doses is the responsibility of the COL applicant. In addition, DCD Tier 2, Section 11.3.5.1 states that the COL applicant will provide a site-specific cost-benefit analysis to address the requirements of 10 CFR Part 50, Appendix I, regarding population doses resulting from gaseous effluents. This is COL Action Item 11.3-1, as identified in DCD Tier 2, Table 1.8-2. This COL action item addresses Criterion 8 which was discussed in Section 11.1 of this report. The staff finds this COL action to be acceptable to demonstrate compliance with the requirements of 10 CFR Part 50, Appendix I.

DCD Tier 2, Table 11.3-4 provides the ratios of the airborne concentrations of radionuclides listed in 10 CFR Part 20, Appendix B, Table 2, Column 1, at the site boundary to the concentration limits for these radionuclides. The table shows that the sum of the ratios is 0.33, which is within the criterion of 1.00 set forth in Table 2, Note 4. In response to RAI 460.001, the applicant explained that the assumption used for the maximum release concentrations is based on 1 percent failed fuel with the exception of iodine and noble gases. These are limited by TS to 0.25 percent failed fuel. The staff finds this assumption acceptable because a 1 percent fuel failure rate is consistent with SRP 11.3, and the TS limit governs the fuel failure rate with respect to iodine and noble gases, thus providing a basis for deviating from the SRP guidance for these fission products. On the basis of the results presented in DCD Tier 2, Table 11.3-4, the staff finds that the WGS design complies with 10 CFR 20.1302, and Criterion 7 which was discussed in Section 11.1 of this report.

In its response to RAI 460.005(A), the applicant provided a waste gas system leak or failure analysis, as well as the justification for the assumptions used in that analysis. The analysis was performed to demonstrate that the WGS design meets the applicable guidelines of BTP ETSB 11-5. This BTP stipulates that the total body dose at the exclusion area boundary (EAB), as a result of the release of radioactivity for two hours from a postulated failure of the WGS, calculated in accordance with the BTP assumptions, should not exceed 0.5 rem. The applicant analyzed the accident using a short-term (0–2 hours) χ/Q of 6×10^{-4} seconds per meter-cubed (sec/m^3) at the EAB, a release duration of 1 hour, instead of 2 hours, as suggested by the BTP, and other assumptions consistent with those in the BTP. In the above response, the applicant justified a release duration of 1 hour as consistent with the isolation time of the AP1000 design. The applicant calculated a 0 - 2 hour total body dose within 0.5 rem, which satisfies BTP ETSB 11-5. Based on the above, the staff finds the analysis acceptable.

The staff reviewed all applicable information submitted in DCD Tier 2, Section 11.3 and in the applicant's responses to staff RAIs related to the radwaste management systems for the AP1000. Based on the above information, as discussed in the evaluation, the staff concludes that the WGS meets the requirements of 10 CFR 50.34a, as it relates to the provision of design information sufficient to demonstrate that the design objectives for the equipment necessary to control releases of radioactive effluents to the environment have been met.

11.3.2 Conclusions

Based on the above, the staff concludes that the design of the WGS is acceptable in that it meets the acceptance criteria provided in SRP Section 11.3 and described below:

- The system is capable of maintaining gaseous effluents in unrestricted areas below the limits stated in 10 CFR 20.1302 during periods of fission product leakage at design levels for the fuel.

- The system's design features control the release of radioactive materials to the environs via gaseous effluents in accordance with GDC 60.

- The system's design features comply with GDC 61, as it relates to radioactivity control in the WGS and the ventilation systems associated with fuel storage and handling areas.

- The system's design features comply with GDC 3, as it relates to protecting the WGS from the effects of an explosive mixture of hydrogen and oxygen.

- A COL action Item provides for demonstrating WGS compliance with 10 CFR Part 50, Appendix I, requirements for population doses (COL Action Item 11.3-1).

- The system's design features satisfy RG 1.140 and RG 1.143.

- The capability of the system's design features ensure WGS conformance with BTP ETSB 11-5 guidelines in the analysis of a postulated waste gas system leak or failure.

- The application provides information sufficient to comply with 10 CFR 50.34a, as it relates to demonstrating that the design objectives for the equipment necessary to control releases of radioactive effluents to the environment have been met.

11.4 Solid Waste Management System

11.4.1 System Description and Review Discussion

The staff reviewed DCD Tier 2, Section 11.4, "Solid Waste Management," in accordance with the guidance and acceptance criteria described in SRP Section 11.4. Paragraph II of SRP Section 11.4 provides the following acceptance criteria for the WSS:

- 10 CFR 20.1302, as it relates to radioactive materials released in gaseous and liquid effluents to unrestricted areas. These criteria apply to releases resulting from WSS operation during normal plant operations and anticipated operational occurrences.

- 10 CFR 50.34a, as it relates to providing adequate system design information

- GDC 60, as it relates to the design of the WSS incorporating the means to handle solid wastes produced during normal plant operation, including AOOs

- GDC 63 and 64, as they relate to the design of the radioactive management system to monitor radiation levels and leakage

- 10 CFR Part 61, as it relates to classifying, processing, and disposing of solid wastes

- 10 CFR Part 71, as it relates to packaging of radioactive materials

The relevant requirements listed above are reviewed using the regulatory positions identified in RG 1.143, as they relate to the seismic design and quality group classification of the components used in the WSS and the structures housing this system, as well as the provisions to control leakage.

The WSS consists of equipment and instrumentation to collect, segregate, store, process, sample, and monitor solid wastes. The WSS is designed to collect and accumulate wet solid wastes (e.g., spent ion exchange resins, deep bed filtration media, filter cartridges), dry active wastes (e.g., rugs, paper, clothing, HVAC filters), and mixed wastes for shipment to a licensed waste disposal facility. The system is located in the auxiliary and radwaste buildings. Processing and packaging of wastes are completed by mobile systems in the auxiliary and radwaste buildings. The packaged waste is stored in the auxiliary and radwaste buildings until it is shipped offsite to a licensed disposal facility.

DCD Tier 2, Figure 11.4-1 identifies the flows of wastes through the WSS. DCD Tier 2, Table 11.4-10 lists WSS equipment design parameters. DCD Tier 2, Table 3.2-3 identifies the AP1000 WSS pumps, tanks, filters, and certain valves as Class D. The spent resin system, which is part of the WSS, contains the following major components:

- two spent resin tanks, each with a volume of 8.5 cubic meters (m^3) (300 cubic feet (ft^3))
- a resin mixing pump
- a resin transfer pump
- a resin fines filter
- a resin sampling device

The spent resin tanks provide holdup capacity for spent resin and filter bed media decay before processing. The resin mixing pump fluidizes and mixes the resins in the spent resin tanks, transfers water between spent resin tanks, discharges excess water from the tanks to the WLS for processing and disposal, and flushes the resin transfer lines. The resin transfer pump recirculates spent resins, via either one of the spent resin tanks, for mixing and sampling, for transferring spent resins between tanks, and for blending high- and low-activity resins to meet the specific activity limit for disposal. The resin transfer pump is also used to transfer spent resins to a waste container in the fill stations or in its shipping cask, which is located in the auxiliary building railcar bay. The resin sampling device collects a representative sample of the spent resin either during spent resin recirculation or during spent resin waste container filling operations. The filter transfer cask permits remote changing of filter cartridges, dripless transport to the storage area, transfer of the filter cartridges into and out of the filter storage, and loading of the filter cartridges into disposal containers. The resin dewatering pump, which is a part of the potable dewatering system, removes water from the spent resin disposal container and discharges it to the spent resin tanks. Waste disposal containers are to be selected from available designs that meet the requirements of the U.S. Department of Transportation (DOT) and the NRC.

A filter transfer cask is used to change the high-activity filters of the CVS and spent fuel cooling system. The filter vessel is drained. If recent applicable sample analysis for the filter media is available, the filter cartridge can be loaded directly into a disposal container. However, if analysis is required, the filter cartridge is placed in a high-activity filter storage tube until sample analysis results are available. Upon completion of the analysis, and determination of packaging requirements, a transfer cask is used to retrieve the cartridge from the storage tube and deposit it in the waste container.

DCD Tier 2, Section 11.4 states that the WSS does not handle large, radioactive waste materials, such as core components. In RAI 460.009, the staff requested additional information on how these radioactive materials would be handled. In response, the applicant stated that large and highly radioactive core or primary components will be handled on a specialized basis. In general, these components can be held in the radwaste accumulation area or the SFP for decay, or decontaminated either in place or in the hot machine shop and shipped to offsite facilities. Bays in the radwaste building can also be used as temporary staging and processing areas to decontaminate and package such components.

At the radwaste building, low- and moderate-activity filter cartridges are deposited into disposal or storage drums. The drums are stored within portable shield casks in the shielded accumulation room, which is serviced by the mobile systems facility crane. Depending on dose rates and analysis results, stabilization may or may not be needed. Cartridges not needing stabilization are loaded into standard, 55-gallon shipping drums with absorbent. The drums may be compacted using a mobile system. When stabilization is necessary, the cartridges may be loaded into either high-integrity containers or standard drums. If standard drums are used, mobile equipment is employed to encapsulate the contents of the drums. DCD Tier 2, Section 11.4.2.3.2 provides the details of the spent filter processing operations.

Chemical wastes are accumulated in the chemical waste tank; they are normally processed by mobile equipment to reduce the volume and packaged into drums. The drums are then stored in the packaged waste storage room of the radwaste building. Mixed wastes are collected in suitable containers and brought to the radwaste building. They are normally sent to an offsite facility having mixed waste processing and disposal capabilities.

Normally, the spent resin from the condensate polishing system demineralizers is nonradioactive and is transferred directly to a truck or to the spent resin tank until it can be removed offsite. If the condensate resins are radioactive, they are transferred from the condensate polishing vessels or a spent resin tank to a temporary processing unit. The resins are then dewatered and processed, as necessary, for offsite disposal. The applicant estimates that the condensate polishing spent resins will have negligible radioactivity (see DCD Tier 2, Table 11.4-6). Also, the applicant estimates the maximum generation volume for radioactive condensate polishing resins to be 5.83 m^3 (206 ft^3) per year. In DCD Tier 2, Sections 10.4.6.3 and 11.4.2.1, the applicant stated that nonradioactive spent resins do not need any special packaging, and that radioactive condensate polishing resin will be disposed of in containers, as permitted by DOT regulations. After packaging, the resins may be stored in the radwaste building. DCD Tier 2, Section 10.4.6.3 states that a spill containment barrier is provided to contain spent resin tank or condensate polish vessel contents in the event of a tank failure. The spill containment barrier is a curb surrounding the area containing the spent resin tank and condensate polisher vessel, which has sufficient height to contain the contents of a full tank or vessel.

On the basis of their contact dose rates, dry wastes are segregated by portable shielding into low-activity, moderate-activity, and high-activity wastes. The bags or containers containing these dry wastes are transported to the radwaste building and placed into low-, moderate-, or high-activity storage areas, depending upon their activity levels. High-activity wastes are normally compacted in drums using a mobile compactor system. Moderate-activity wastes are sorted and compacted by mobile equipment. The packaged wastes may be loaded directly into a truck for shipment, or may be stored in the packaged waste storage room until a truck load is accumulated. Low-activity waste generally contains a large amount of nonradioactive material. These wastes will usually be processed through a mobile radiation monitoring and sorting system to remove nonradioactive items for reuse or local disposal. The remaining radioactive wastes are then compacted or packaged for disposal. DCD Tier 2, Section 11.4.2.3.3 and Figure 11.4-1 provide the processing details for dry solid wastes.

DCD Tier 2, Section 11.4.1.3 states that the waste disposal containers are to be selected from available designs that meet (1) the disposal requirements of 10 CFR Part 61, (2) specific criteria of the disposal facility chosen, and (3) the radioactive waste transportation requirements of 10 CFR Part 71 and relevant DOT regulations. The verification of waste characteristics, waste packaging, and waste disposal are within the purview of the COL applicant. Similarly, the staff considers that the COL applicant will control the development of a process control program (PCP), in compliance with 10 CFR Part 61, which identifies the operating procedures (i.e., boundary conditions for a set of process parameters such as settling time, drain time, drying time, etc.) for processing wet solid wastes. Therefore, for each COL application, the staff will review the PCP, including dewatering or solidification (if performed), and determine whether the COL application demonstrates that the WSS complies with the requirements of 10 CFR 61.55, 10 CFR 61.56, 10 CFR Part 71, and relevant DOT regulations. A COL applicant referencing the AP1000 certified design should submit a PCP that identifies the operating procedures for processing wet solid wastes. The mobile system PCP should include a discussion of conformance to RG 1.143, and should address the issues raised in Generic Letters (GLs) 80-009 and 81-039. It should also include a discussion of equipment containing wet solid wastes in the nonseismic radwaste building. In DCD Tier 2, Section 11.4.6, the applicant identified a COL action item to meet the above guidance concerning dewatering or solidification of we wastes. This is COL Action Item 11.4-1, as identified in DCD Tier 2, Table 1.8-2. It is consistent with the guidance in BTP ETSB 11-3.

The liquid and gaseous effluents resulting from the WSS operation are released during normal operation, including AOOs, to unrestricted areas through the WLS, and the monitored plant vent, respectively. The liquids resulting from wet waste processing are routed to the WLS to be processed before release to the environment. Specifically, the excess water from the spent resin tanks is pumped by the resin mixing pump to the WLS through a resin-fines filter. The radwaste and auxiliary buildings contain and drain spillage to the WLS through the radioactive waste drain system. Sloped floors and floor drains are provided to collect and control the release of radioactive materials that could be removed from stored solid waste by water contact.

The primary spent resin tanks are located in the seismic Category I auxiliary building that will retain the maximum liquid and spent resin inventory of the spent resin tanks. The spent resin tank vent and overflow connections have screens to prevent the discharge of spent resins. The WSS has a resin-fines filter to minimize the spread of high-activity resin fines. The liquids and gases that result from WSS operation are monitored by the WLS and WGS radiation monitors before their release to the environs. In Sections 11.2 and 11.3 of this report, the staff evaluated whether the activity of liquid and gaseous effluents is within the release limits of 10 CFR 20.1302 and found the AP1000 design to be acceptable.

In response to RAI 460.006, the applicant identified the system’s design features for complying with GDCs 60, 63, and 64. GDC 60 requires that means be provided to handle radioactive solid wastes produced during normal reactor operation, including AOOs. GDC 63 and 64 address the radioactive system being designed for monitoring radiation levels and leakage within the system. DCD Tier 2, Section 11.4 states that the WSS has the capability to handle the applicable categories of solid radwaste. The higher radioactivity solid wastes, such as primary resins and filters, are handled and packaged in specific areas of the auxiliary building. As part of the auxiliary building, the HVAC for these areas is supplied by the radiologically controlled area ventilation system (VAS). The VAS is continuously monitored for radioactivity, and if activity above a predetermined setpoint is detected, the discharge is automatically diverted to the VFS. The VFS provides filtration and additional monitoring before discharge via the plant vent.

Liquid that drains from the auxiliary building is collected in the auxiliary building sump and routed to the WLS for processing and “monitored discharging.” An area radiation monitor (ARM) is provided in this area. Lower activity solid wastes are processed and packaged in certain areas of the radwaste building. Ventilation for these areas is supplied by the radwaste building HVAC system, which includes a radiation monitor and alarm before discharge to the plant vent. The floor of the radwaste building is curbed and sloped to ensure all drainage is collected in sumps, which are in turn routed to the auxiliary building sump for processing by the WLS. An ARM is provided in this area. Based on the above discussion, the staff finds that the WSS complies with GDC 60, 63, and 64 with respect to monitoring and controlling solid waste storage and monitoring releases of radioactive materials to the environment, respectively.

The WSS is a non-safety-related system and has no accident mitigation functions. The bulk of the system is located in the radwaste building, which is not a seismic Category I structure. According to DCD Tier 2, Appendix 1A, which pertains to the conformance of the radwaste management systems to RG 1.143, the primary spent resin tanks are located in the auxiliary building, which is a seismic Category I structure. This seismic Category I structure will hold the maximum liquid and spent resin inventory of the spent resin tanks. Thus, the WSS complies with Positions C.3.3 and C.5 of RG 1.143 regarding seismic design criteria for structures housing solid radwaste management systems.

The design of components and subsystems of the mobile systems that are used by contractors to process wet solid wastes and chemical wastes are not within the scope of the AP1000 standard design. The portion of the WSS that is within the scope of the AP1000 standard design is designed in accordance with Positions C.3, C.4, and C.7 of RG 1.143 with respect to specific guidelines for solid radwaste systems; general guidelines for design, construction, and testing criteria for radwaste systems; and general guidelines for providing QA for radwaste management systems. DCD Tier 2, Appendix 1A provides a detailed discussion of how the design of the WSS, and its housing structure, meets the applicable guidelines of RG 1.143. Specifically, the subject Appendix states that the WSS components are designed and tested to the guidelines set forth in the codes and standards listed in Table 1 of RG 1.143.

DCD Tier 2, Table 3.2-3 states that components such as pumps, tanks, filters, and applicable valves of the WSS are designed to AP1000 Class D quality standards, which are equivalent to the Quality Group D standards of RG 1.26. The QA program for design, fabrication, procurement, and installation of radwaste systems is in accordance with the overall QA program described in DCD Tier 2, Chapter 17. DCD Tier 2, Section 17.5 states that the COL applicant will address its design phase QA program, as well as its QA program for procurement, fabrication, installation, construction and testing of structures, systems and components in the facility. The evaluation of the overall QA program is in Chapter 17 of this report. As set forth in Chapter 17 of this report, a COL applicant will address these matters pursuant to COL Action Item 17.5-1, and the staff will review them in the context of the COL application. The staff finds the WSS acceptable with respect to meeting QA guidance specified in RG 1.143, provided that the overall QA program described in any particular COL application is acceptable.

The staff will review, on a plant-specific basis, the mobile systems facility proposed by the COL applicant (or its contractors) against the guidelines of RG 1.143. A COL applicant referencing the AP1000 certified design should discuss how any mobile processing equipment intended for use in the processing of solid radwaste meets the guidelines of RG 1.143 (see COL Action Item 11.4-1).

Based on the above, the staff finds that the AP1000 design conforms to the relevant guidance of the regulatory positions identified in RG 1.143, as they relate to the seismic design, quality group classification of components used in the WSS and the structures housing the system, and the mobile process equipment.

BTP ETSB 11-3, Position B111, provides the staff's evaluation guidance regarding the characteristics of solid waste storage capacity necessary to allow time for short-lived radionuclides to decay prior to shipping. These characteristics are summarized as follows:

- Tanks accumulating spent resins from reactor water purification systems should be capable of accommodating at least 60-days waste generation at normal generation rates. Tanks accumulating spent resins from other sources, as well as tanks accumulating filter sludges should be capable of accommodating at least 30-days waste generation at normal generation rates.

- Storage areas for solidified wastes should be capable of accommodating at least 30-days waste generation at normal generation rates. These storage areas should be located indoors.

- Storage areas for dry wastes and packaged containment equipment should be capable of accommodating at least one full offsite waste shipment.

In its response to RAI 460.007, Revision 1, the applicant provided the following information:

- The expected spent resin generation rate is 11.33 m^3 (400 ft^3) per year. The AP1000 has two spent resin storage tanks, each with a capacity of 8.5 m^3 (300 ft^3). This storage capacity is capable of accommodating more than 60-days of waste generation.

- AP1000 does not incorporate waste solidification, but packaging of resin into high-integrity containers (HICs) may be considered analogous. A standard HIC provides more than 120-days of storage capacity. Space is available in Room 12374 of the auxiliary building for the storage of the HICs.

- Storage areas for dry wastes and packaged containment equipment in Rooms 50351 and 50352 of the radwaste building have sufficient capacity for more than two offsite shipments.

Based on the above, the staff finds that the AP1000 design has sufficient onsite storage capacity for the anticipated solid waste, consistent with BTP ETSB 11-3, Position B.III.

In GL 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites," the staff provided guidance to licensees on the addition of onsite storage facilities for low-level radioactive wastes generated onsite. The staff recognizes that the need for additional onsite storage capacity for low-level radioactive wastes, beyond what has been provided in the AP1000 standard design, is a site-specific issue. This need will depend upon the availability of offsite low-level waste storage space for the site's wastes. Therefore, when such a need is identified, the COL applicant should submit the details of any proposed onsite, low-level radioactive waste storage facility to the NRC. The staff will review and evaluate such a proposed additional site-specific facility against the guidelines in GL 81-38, which is similar to the guidance in Appendix 11.4-A to SRP Section 11.4. However, the staff did not find it necessary to create a COL action item regarding the issues raised in GL 81-38 and, instead, asked the applicant, in RAI 460.008, to address them. In response, the applicant revised DCD Tier 2, Section 11.4.6, to identify GL 81-38 as a part of COL Action Item 11.4-1. The staff finds the revision to DCD Tier 2, Section 11.4.6 to be acceptable.

Based on the information in the DCD and RAI responses discussed above, the staff finds that the WSS meets the requirements of 10 CFR 50.34a, as they relate to the adequacy of design information.

11.4.2 Conclusions

Based on the above, the staff concludes that the design of the WSS is acceptable because it meets the acceptance criteria provided in SRP Section 11.4 as described below:

- The system, in conjunction with the WLS and WGS, is capable of maintaining the concentration of any liquid or gaseous effluents in unrestricted areas arising from system operation below the limits of 10 CFR 20.1302.

- Design features have been incorporated into the system to comply with GDC 60, 63, and 64.

- Provisions for onsite storage of processed solid wastes conform to BTP ETSB 11-3, Position B.III.

- Quality group and seismic classification applied to the structures housing the system conform to RG 1.143.

- COL applicants will be responsible for complying with the requirements of 10 CFR Part 61 and 10 CFR Part 71 (part of COL Action Item 11.4-1).

- The applicant provided information sufficient to satisfy the requirements of 10 CFR 50.34a regarding the adequacy of design information.

Based on the above evaluation of the WSS, conducted in accordance with the applicable acceptance criteria of Section 11.4 of the SRP, the staff finds the WSS to be acceptable.

11.5 Process and Effluent Radiological Monitoring and Sampling System

11.5.1 System Description and Review Discussion

The staff reviewed DCD Tier 2, Section 11.5, “Radiation Monitoring,” in accordance with the guidance and acceptance criteria provided in SRP Section 11.5. Paragraph II of SRP Section 11.4 provides the following acceptance criteria for the process and effluent radiological monitoring and sampling system:

- 10 CFR 20.1302, as it relates to surveying radioactive effluents released to unrestricted areas

- 10 CFR Part 50, Appendix A, GDC 60, as it relates to controlling the release of radioactive materials to the environment

- GDC 63 and 64, as they relate to monitoring radiation in fuel storage and radioactive waste systems and associate handling areas (GDC 63) and the containment and the plant environs (GDC 64)

- 10 CFR 50.34(f)(2)(xvii) and 10 CFR 50.34(f)(2)(xxvii), as they relate to monitoring radiation and radioactivity levels for routine operating and accident conditions

Specific acceptance criteria for the relevant requirements identified above are as follows:

- The gaseous and liquid process streams, or effluent release points, should be monitored and sampled according to Tables 1 and 2 of SRP Section 11.5.

- The design of systems should meet the provisions of the applicable positions in RG 1.21, RG 1.97, and RG 4.15.

The process and effluent radiological monitoring and sampling system is used to measure, record, and control releases of radioactive materials in plant process streams and effluent streams. The system consists of permanently-installed sampling and monitoring equipment designed to indicate routine operational radiation releases, equipment or component failure, system malfunction or misoperation, and potential radiological hazards to plant personnel or to the general public. The system generates signals to initiate the operation of certain safety-related equipment to control radioactive releases under specified condition, as described below.

In the AP1000 design, radiation monitors are provided for the following processes and effluents:

- the auxiliary building fuel handling area exhaust

- exhaust from the rest of the auxiliary building areas, excluding two electrical penetration rooms and two reactor trip switchgear rooms

- containment air filtration exhaust

- exhaust from the health physics area (in annex building) and the hot machine shop area (annex building)

- exhaust from the rest of the annex building

- radwaste building exhaust

- gaseous radwaste system exhaust

- plant vent exhaust
- containment atmosphere
- turbine island vent discharge
- MCR supply air
- primary sampling gaseous sample
- primary sampling liquid sample
- main steamline
- SG blowdown
- component cooling water system
- service water blowdown
- liquid radwaste discharge
- waste water discharge

DCD Tier 2, Sections 11.5.2.3.1, 11.5.2.3.2, and 11.5.2.3.3, and Table 11.5-1 provide information on the monitored stream, detector type, normal range for the detector, automatic function associated with the monitor, principal monitored radionuclides, and the locations of all liquid and gaseous process systems and effluent radiation monitors. DCD Tier 2, Table 11.5-1 indicates that the radiation monitors at the MCR supply air duct are safety-related and the monitors for the containment atmosphere are seismic Category I.

The exhausts from the diesel generator rooms (located in the stand-alone diesel generator building), personnel areas, the electrical and mechanical equipment rooms of the annex building, and the electrical penetration and reactor trip switchgear rooms of the auxiliary building are not monitored because these areas do not contain any radioactive materials, and they interface only with clean areas, thus precluding transfer of radioactive materials from adjoining areas.

The annex building general area HVAC system normally maintains the personnel areas of the annex building at a slightly positive pressure with respect to adjoining areas. Therefore, the staff finds that the justification for not monitoring the exhausts of those areas mentioned above is acceptable. Additionally, the staff finds that the above mentioned DCD Tier 2 sections and table include all of the applicable gaseous and liquid processes and effluent streams identified in Tables 1 and 2 of SRP Section 11.5.

DCD Tier 2, Tables 11.5-1 and 11.5-2 identify all safety-related monitors, and DCD Tier 2, Section 7.1.4 provides information on the requirements for safety-related monitors. DCD Tier 2, Tables 11.5-1 and 11.5-2 list other radiation monitors which are discussed in DCD Tier 2, Section 11.5.

Based on the above, the staff finds that the effluent monitors comply with GDC 64 with regard to the monitoring of radioactive liquid and gaseous effluents from the plant.

The ARMs monitor the radiation levels in selected areas throughout the plant. These are provided to supplement the personnel and area radiation survey provisions of the AP1000 health physics program. DCD Tier 2, Table 11.5-2 lists the following areas with ARMs, along with the nominal range and type of radiation measured:

- containment high range
- primary sample room
- containment area personnel hatch
- MCR
- chemistry laboratory area
- fuel handling area
- railcar bay area
- liquid and gaseous radwaste area
- technical support center
- radwaste building mobile systems facility
- hot machine shop
- annex staging and storage area

The detectors in these areas are gamma-sensitive Geiger-Muller tubes. These detectors are capable of detecting the types and energies of radiation emitted from fuel and radioactive waste. A local readout and alarm module is located in each area to visually guide personnel before they enter the monitored areas. The containment ARMs and fuel handling ARMs provide an alarm locally and in the MCR. Based on the above information, the staff finds that the process and effluent monitoring and sampling system for the AP1000 standard design provides the needed monitoring for fuel and radioactive waste storage, and thus, complies with GDC 63.

Besides the plant vent accident range monitor and the condenser air removal exhaust monitor, which monitor radioactive gaseous effluents during accidents, the following special-purpose radiation monitors are provided either for monitoring during an accident or triggering an automatic control action:

- Two main steamline radiation monitors, for monitoring radionuclide concentrations in the two main steamlines and using the concentration data for calculating radioactive releases to the environment if the SG safety relief or power-operated relief valves are used to release steam to the atmosphere.

- Four containment high-range radiation monitors, for monitoring gamma radiation intensities inside the containment following an accident and using the data for estimating radioactive material inventory in the containment volume.

- Radiation-level monitors (two particulate detectors, two iodine detectors, and two noble gas detectors), to monitor the radiation level in the air supply to the MCR and to activate the MCR emergency habitability system if the concentrations of radioactive materials exceed predetermined setpoints for the monitors.

DCD Tier 2, Sections 11.5.2.3.1 and 11.5.6.2 state that the MCR radiation monitors and containment high-range monitors are environmentally and seismically qualified in accordance with the guidelines of RG 1.89, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants,” and RG 1.100, “Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants.” These monitors receive Class 1E power. DCD Tier 2, Table 11.5-1 indicates that the steamline radiation monitors are non-safety-related and receive non-Class 1E power. DCD Tier 2, Section 11.5.2.3.1 and Table 11.5-1 provide the nominal range and type of radiation measured, the detector type, the location, and the automatic control features (if provided) for these special purpose radiation monitors.

The staff finds the range provided in DCD Tier 2, Table 11.5-1 for gamma radiation measurement by the high-range containment radiation monitors inside the containment to be acceptable because it meets the range criterion for such monitors specified in NUREG-0737, Three Mile Island (TMI) Item II.F.1, Attachment 3, “Containment High-Range Radiation Monitoring.” Therefore, the range complies with the applicable portions of 10 CFR 50.34(f)(2)(xvii). Also, the staff finds the ranges specified in DCD Tier 2, Table 11.5-1, for the steamline and MCR radiation monitors to be acceptable because they are consistent with applicable NRC guidance and industry standards. On the basis of the above discussion, the staff finds that these special-purpose monitors comply with GDC 60 and 64 in terms of their ability to control and monitor the release of radioactive materials to the environment.

The RMS initiates such control actions as reducing or terminating radioactive releases to the environment upon detection of high radiation levels by the monitors in accordance with GDC 60. Specifically, the WGS exhaust monitor and the liquid waste discharge monitor initiate control actions to terminate the applicable discharge upon detection of high radiation levels by the respective monitor. The MCR supply air duct radiation monitor isolates the MCR air intake and exhaust ducts and activates the MCR emergency habitability system upon detection of high radiation levels in the air intake by the MCR radiation monitor. The MCR habitability system is discussed in Section 6.4 of this report. The fuel handling area exhaust radiation monitor, the annex building exhaust radiation monitor, and the auxiliary building exhaust radiation monitor (each located upstream of its respective exhaust air isolation dampers) initiate control actions to automatically divert the exhaust from the applicable area to the VFS upon detection of high radiation levels in the exhaust of the applicable area by its associated radiation monitor. This is accomplished by closure of the affected area supply and exhaust air isolation dampers, opening of the applicable exhaust air isolation dampers of the VFS, and starting the containment air filtration exhaust unit. The turbine island vent discharge radiation monitor facilitates performance of corrective manual actions in a timely manner upon detection of high radiation levels in the subject exhaust. The SG blowdown radiation monitor and the waste water discharge monitor facilitate manual diversion of the applicable stream to the WLS for processing by that system upon the detection of high radiation levels in the applicable stream by the associated radiation monitor. The component cooling water system radiation monitor facilitates manual isolation of the system and timely performance of leak repairs upon detection of radiological leakage into the system. On the basis of the above discussion, the staff finds that the AP1000 design permits control of radioactivity releases to the environs, in accordance with GDC 60.

To comply with the numerical objectives in 10 CFR Part 50, Appendix I, for offsite doses resulting from gaseous and liquid effluents during normal plant operation, including AOOs, COL holders will need to limit annual and quarterly offsite doses. Additionally, if an applicant proposes to use treatment systems (e.g., waste gas treatment by delay beds, demineralizers to treat liquid radwaste, and VFS), the requirements for this design objective will be deemed to have been met if the annual dose is not greater than 5 millirems and the applicant submits an evaluation of the effect of the long-term buildup in the environment of radionuclides with half lives longer than 1 year. The COL applicant will implement the items described above, as specified in a plant controlled document. DCD Tier 2, Section 11.5.7 states that the COL applicant is responsible for addressing the 10 CFR Part 50, Appendix I guidelines for offsite individual doses and population doses via liquid and gaseous effluents. This is COL Action Item 11.5-3, as identified in DCD Tier 2, Table 1.8-2.

Additionally, a COL applicant will be required to limit average annual discharge concentrations from the WGS and WLS to comply with 10 CFR Part 20.1302 which defines the criteria for radionuclide concentration limits in liquid and gaseous effluents. A COL applicant will provide the associated setpoints for the applicable radiation monitors in the plant-specific ODCM. Property designated setpoints, in conjunction with the automatic control features of the applicable effluent monitors (e.g., termination of the discharge or diversions through the VFS), will ensure that the AP1000 effluent monitors comply with 10 CFR 20.1302. The staff will review the plant-specific radiological effluent TSs, as well as the setpoints listed in the plant-specific ODCM, for each COL application. (Conformance with 10 CFR Part 50, Appendix I, and 10 CFR 20.1302 have been previously identified as COL Action Items 11.2-2, 11.2-4, and 11.3-1.) The COL applicant will develop an ODCM that contains the methodology and parameters used for calculation of offsite doses resulting from gaseous and liquid effluents. The ODCM will include planned discharge flow rates. The COL applicant will address operational setpoints for the radiation monitors, as well as programs for monitoring and controlling the release of radioactive material to the environment, thus eliminating the potential for unmonitored and uncontrolled release (COL Action Item 11.5-1).

The staff reviewed DCD Tier 2, Section 11.5, against the SRP guidelines in Section 11.5, Tables 1 and 2. These tables list provisions for monitoring and sampling gaseous and liquid effluent streams. DCD Tier 2, Sections 11.5.2.3.1 through 11.5.2.3.3, Tables 11.5-1 and 11.5-2, Tables 9.3.3-1 through 9.3.3-3, and Tables 9.3.4-1 and 9.3.4-2 set forth the provisions of the design for monitoring and sampling these effluent streams. The system provides for continuous and representative sampling of airborne particulate and iodine radioactivities for the plant vent discharge which is a major gaseous effluent stream. The system also provides for grab sampling for noble gases, iodines, particulates, and tritium for the gaseous radwaste system discharge. For liquid streams, the system provides grab sampling and analysis capability for gross radioactivity determination, identification of principal radionuclides and alpha emitters, and measurement of their concentration for the following areas:

- the chemical waste tank
- the primary spent resin tank
- the WLS monitor tanks
- the waste holdup tanks

SRP Section 11.5, Paragraph II.3, states that provisions should be made for administrative and procedural control for (1) necessary auxiliary or ancillary equipment, (2) special features for the instrumented radiological monitoring sampling, and (3) analysis of process and effluent streams. In RAI 460.011, the staff requested the applicant to demonstrate that the AP1000 design meets this guidance. In response to the RAI, the applicant stated that SRP Section 11.5, Paragraph II.3 cites RGs 1.21 and 4.15 for meeting this guidance. The AP1000 conforms to this guidance, as demonstrated in DCD Tier 2, Sections 9.3.3 and 11.5, particularly Tables 9.3.3-1 and 9.3.3-2 (which list plant sample points) and Tables 11.5-1 and 11.5-2 (which list radiation monitoring points). All major and potentially significant paths for release of radioactivity are monitored. RG 4.15 provides QA guidance for radiation monitoring programs. The guidelines provided in ANSI N13.1-1969 and RGs 1.21 and 4.15 (dealing with sampling programs, reporting radioactivity measurements, and QA for radiological monitoring programs) apply to operational programs. As such they are not within the scope of the AP1000 standard design. Consequently, the staff will review conformance of the radiological monitoring and sampling programs with the specific guidelines of the above documents on a plant-specific basis for each COL application.

DCD Tier 2, Section 11.5 states that the RMS is designed in accordance with ANSI N13.1-1969. DCD Tier 2, Section 11.5.7 states that the COL applicant is responsible for ensuring that the process and effluent monitoring and sampling program at its site conforms to the guidelines of ANSI-N13.1-1969, RG 1.21, RG 4.15. This is COL Action Item 11.5-2, as identified in DCD Tier 2, Table 1.8-2.

The ranges of the following AP1000 post-accident radiation monitors are consistent with the ranges specified in RG 1.97 for such monitors:

- the main steamline radiation monitors
- high-range radiation monitors
- plant vent accident range radiation monitor
- turbine island vent discharge radiation monitor
- primary sample room monitor

DCD Tier 2, Table 11.5-1 and Section 11.5.2.3.3 provide a discussion of postaccident monitoring and sampling instrumentation, particularly as it relates to the compliance of such instrumentation for plant gaseous effluents with the requirements of 10 CFR 50.35(f)(2)

(NUREG-0737, TMI Item II.F.1, Attachments 1 and 2). Based on a review of the above DCD Tier 2 sections, the staff finds that only the plant vent discharges gaseous effluents directly to the environment. The plant vent has an accident-range effluent monitor to continuously monitor noble gas concentrations in gaseous effluents during and following an accident. Also, the vent is designed to allow for grab samples and analysis of plant gaseous effluents for iodine and particulates during and following an accident. The staff confirmed, from DCD Tier 2, Section 11.5.2.3.3, that the AP1000 design provides a continuous sampling capability and onsite analysis capability for iodines and particulates in the plant vent gaseous effluent during and following an accident.

The turbine island vent discharge has a noble gas effluent monitor which can continuously monitor noble gas concentrations in gaseous effluents through the vent during normal operation, as well as during and following an accident. The upper limits for concentration measurements for the accident-range effluent monitor for the plant vent, the accident- and low-range effluent monitors for the condenser air removal system exhaust vent, and the high-range monitor for the containment area are bounded by the limits specified for such monitors in NUREG-0737, TMI Item II.F.1, Attachments 1 and 2. Accordingly, the staff finds the specified ranges for these monitors acceptable.

Furthermore, the staff reviewed the following information regarding accident monitoring instrumentation:

- procedures and/or methods for converting radiation measurements into release rates of gaseous discharges through the vents
- sampling techniques used to monitor and sample effluent gases to assure that a representative sample is taken
- the sampling system's capability to maintain isokinetic conditions during and following an accident
- collection techniques to extract a representative sample of radioactive iodine and particulates during and following an accident
- calibration frequency and techniques for radiation monitors
- shielding for the sampling systems and the shielding design of the systems to conform with the guidelines of NUREG-0737, TMI Item II.F.1, Attachment 2
- radiation reading capability (readings are continuous)
- location of instrument readouts

Based on its review, the staff finds that the accident monitoring instrumentation provided in the AP1000 design for monitoring noble gases in gaseous effluents, as well as for sampling and analyzing the plant effluent for post-accident releases of radioiodine and particulates, meets the guidelines of NUREG-0737, TMI Item II.F.1, Attachments 1 and 2, regarding accident monitoring instrumentation. Therefore, the design complies with the applicable portions of 10 CFR 50.34(f)(2)(xxvii), which incorporate the subject TMI requirements.

The staff reviewed the AP1000 design regarding the issues identified in NRC Bulletin 80-10, "Contamination of Nonradioactive System and Resulting Potential for Unmonitored, Uncontrolled Release to the Environment." Specifically, the staff reviewed the following AP1000 design features, as identified in DCD Tier 2, Sections 9.2.9, 9.3.5, 9.4.2, and 9.4.10:

- the ability to detect the contamination of nonradioactive systems
- the ability to prevent the potential for unmonitored and uncontrolled release of radioactive material to the environment

On the basis of this review, as discussed in this section and Section 11.2 of this report, the staff finds that the AP1000 design segregates the radioactive systems from the nonradioactive systems, and all radioactive or potentially radioactive effluent pathways are monitored before the effluents are released to the environment. For example, drain systems that carry radioactive wastes generally do not contain piping connections that could allow the inadvertent transfer of radioactive fluid into nonradioactive piping systems. Where such connections do exist, back-flow prevention is provided in the nonradioactive piping. The annex/auxiliary building nonradioactive HVAC system and the diesel generator building HVAC system are segregated from radioactive HVAC systems. The normally nonradioactive secondary coolant system sampling drains and other waste water are diverted to the WLS for processing and monitoring, if detected to be radioactive (a radiation monitor is provided for monitoring the normally nonradioactive waste water discharge). The staff further notes that the applicant considered the issues identified in NRC Bulletin 80-10 regarding contamination of nonradioactive systems as part of the COL surveillance issue (the applicant's submittal dated July 2004, WCAP-15800, Revision 3). On this basis, the staff finds that DCD Tier 2, Sections 9.2.9, 9.3.5, 9.4.2, and 9.4.10 satisfactorily address the concerns raised in NRC Bulletin 80-10. The design features in the AP1000 design are adequate to detect the contamination of nonradioactive systems and to prevent the potential for unmonitored and uncontrolled release of radioactive material to the environment. In addition, the staff expects that the COL applicant will periodically verify that these design features function as intended. A COL applicant referencing the AP1000 certified design should provide details of its proposed program to eliminate the potential for unmonitored and uncontrolled release of radioactive material to the environment. In DCD Tier 2, Section 11.5.7, the applicant stated that the above-requested program will be included in the site-specific ODCM (COL Action Item 11.5-1).

SRP Section 11.5, Paragraph II.2 states that provisions should be made to purge and drain sample streams back to the system of origin or to an appropriate waste treatment system. In RAI 460.010, the staff requested the applicant to explain the provisions in the AP1000 design to address this criterion. In response to the RAI, the applicant stated that AP1000 sample points are listed in DCD Tier 2, Tables 9.3.3-1 and 9.3.3-2 as either "Continuous" or "Grab" sampling.

Continuous sampling provides online monitoring where the sample is not physically removed from its system of origin. Therefore, these continuous sampling streams meet the guidance of the SRP. Grab sampling is discussed in DCD Tier 2, Sections 9.3.3.2.1 (liquid) and 9.3.3.2.2 (gas). As noted in those sections, purge capability is incorporated with the purge flow routed to the effluent holdup tank in the WLS. The samples themselves are carried to an onsite radioactive chemistry laboratory for analysis. This laboratory has provisions for draining radioactive, reactor coolant-grade samples to the WLS effluent holdup tank . Other radioactive samples are drained from the laboratory to the WLS chemical waste tank. A special provision is made in the primary sampling system for containment atmospheric samples, which are purged and pumped to the containment sump. As a contingency, this return connection could also be used for other samples from inside containment. Based on the above, the staff finds that the AP1000 design meets the guidance of SRP Section 11.5, Paragraph II.2, regarding disposition of sample streams.

11.5.2 Conclusions

The staff verified that sufficient information was provided in DCD Tier 2, Section 11.5, and the RAI responses discussed above. For the reasons set forth above, the staff concludes that the process and effluent radiological monitoring instrumentation and sampling systems are acceptable and meet the relevant requirements of 10 CFR 20.1302, 10 CFR 50.34(f)(2)(xvii) and 50.34(f)(2)(xxvii), as well as GDC 60, 63, and 64. This conclusion is based on the following:

- The staff reviewed the provisions proposed in DCD Tier 2, to sample and monitor all plant effluents in accordance with GDC 64. The process and effluent radiological monitoring and sampling systems include instrumentation for monitoring and sampling radioactivity in contaminated liquid, gaseous, and solid waste process and effluent streams. This is demonstrated by the fact that all the processes and effluent streams identified in Section 11.5, Tables 1 and 2, of the SRP are included in DCD Tier 2, Section 11.5.2.3 and DCD Tier 2, Table 11.5-1.

- The staff reviewed the provisions for conducting sampling and analytical programs, in accordance with the guidelines in RG 1.21 and 4.15, as well as the provisions for sampling and monitoring process and effluent streams during postulated accidents in accordance with the guidelines in RG 1.97. These sampling and analytical programs conform to the guidance.

- The staff reviewed the provisions proposed in DCD Tier 2, to provide automatic termination of effluent releases and to ensure control over discharge, in accordance with GDC 60. Section 11.5.1 of this report discusses controlling releases of radioactive materials from WGS exhaust, WLS discharge, MCR air supply, fuel handling area, annex building exhaust, auxiliary building exhaust, turbine island vent discharge, SG blowdown, waste water discharge, and component cooling water. In Section 11.5.1 of this report, the staff reviewed and found the design features aimed at controlling radiation releases acceptable.

As discussed in Section 11.5.1 of this report, the staff review included the provisions proposed in DCD Tier 2, for sampling and monitoring the fuel handling and waste storage areas in accordance with GDC 63.

Based on the above review, the staff has determined that the AP1000 RMS design meets the guidelines of SRP Section 11.5. Therefore, it is acceptable.