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MFN 08-145

Docket No. 52-010

March 17, 2008

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to NRC Request for Additional Information Letter 131 Related to the ESBWR Design Certification – Radioactive Waste Management Systems – RAI Numbers 11.2-16S01, 11.2-17 through 11.2-31, 11.3-4 through 11.3-12, 11.4-15S02, 11.4-19 through 11.4-32, and 11.5-48 through 11.5-53**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter dated January 15, 2008. GEH response to RAI Numbers 11.2-16S01, 11.2-17 through 11.2-31, 11.3-4 through 11.3-12, 11.4-15S02, 11.4-19 through 11.4-32, and 11.5-48 through 11.5-53 are addressed in Enclosure 1. DCD Markups related to these responses are provided in Enclosure 2 in sequential order from the DCD.

Please note that the DCD Markups include previous Chapter 11 markups from the November 16, 2007 MFN Letter 07-608 for RAI Numbers 11.2-16, 11.4-15S01, 11.4-18 and 14.3-143S01.

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NRO

If you have any questions or require additional information, please contact me.

Sincerely,

R.E. Brown for/

James C. Kinsey
Vice President, ESBWR Licensing

Reference:

1. MFN 08-039, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 131 Related To ESBWR Design Certification Application*, dated January 15, 2008.

Enclosures:

1. Response to NRC Request for Additional Information Letter No. 131 Related to ESBWR Design Certification Application – Radioactive Waste Management Systems – RAI Numbers 11.2-16S01, 11.2-17 through 11.2-31, 11.3-4 through 11.3-12, 11.4-15S02, 11.4-19 through 11.4-32, and 11.5-48 through 11.5-53
2. DCD Markups

cc:	AE Cubbage	USNRC (with enclosures)
	GB Stramback	GEH/San Jose (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	eDRF	0000-0081-5194 for RAI 11.5-48
		0000-0081-8356 for RAI 11.5-49
		0000-0082-3440 for RAI 11.5-53
		0000-0082-3959 for all other RAIs

Enclosure 1

MFN 08-145

Response to Portion of NRC Request for Additional Information Letter No. 131

Related to ESBWR Design Certification Application

Radioactive Waste Management Systems

RAI Numbers 11.2-16 S01, 11.2-17 through 11.2-31, 11.3-4 through 11.3-12, 11.4-15S02, 11.4-19 through 11.4-32 and 11.5-48 through 11.5-53

NRC RAI 11.2-16 S01:

a. In DCD, Tier 2, Sections 11.2.2.2 and 11.2.2.3, the ion exchange demineralizers are referred to as "Deep-bed ion exchangers" and also as "Mixed bed ion exchangers." Please explain this inconsistency and update DCD, Tier 2, Sections 11.2.2.2 and 11.2.2.3 accordingly. Also, note that the same observation applies to the proposed revision of DCD, Tier 1, Section 2.10.1, which was included in GEH's response to this RAI.

b. The response to RAI 11.2-16 included a proposed update DCD, Tier 1, Table 2.10.1-2. A review of Table 2.10.1-2 indicates that Table 2.10.1-2, "ITAAC For The Liquid Waste Management System" Item 1 is incomplete, as it does not address the introduction of media into subsystem tanks and vessels. Table 2.10.1-2 should state, under the "Inspections, Tests, Analysis" header, that the inspections of the as-built system, includes the introduction of the appropriate types of filtration and adsorbent media in tanks and vessels to meet or exceed the decontamination factors listed in DCD Tier 2, Table 11.2-3. Accordingly, revise DCD, Tier 1, Table 2.10.1-2 to make this commitment clear.

GEH Response:

a. GEH agrees and will revise affected DCD sections to use the terminology “mixed bed demineralizers” for consistency.

b. NRC guidance explains that ITAAC are not required, or are established in varying degrees, for all structures, systems, and components included in a standard design certification. Regarding the request that “Table 2.10.1-2 should state, under the “Inspections, Tests, Analysis” header, that the inspections of the as-built system, includes the introduction of the appropriate types of filtration and adsorbent media in tanks and vessels to meet or exceed the decontamination factors listed in DCD Tier 2, Table 11.2-3,” this appears to be beyond that group of structures, systems, and components that would be covered by an ITAAC.

Specific amounts of filtration media are specified in detailed design and are explained in Tier 2 material. As described in Tier 2, Section 11.5.7, controls to maintain offsite doses below 10CFR 20 limits are assured during operation of the plant by sampling of the tank to be discharged prior to release via the element in the Offsite Dose Calculation Manual (ODCM). In addition, there is a radiation monitor with automatic shutoff valve (currently ITAAC 2.10.1-2 addresses this design feature), which provides additional assurance that offsite doses are maintained below 10CFR 20 limits. With this operational program and design feature, the filtration and adsorbent media are not the significant protective feature necessary to meet Part 20 requirements, although a licensee operating such a system will certainly ensure that the design basis of the system is met through the introduction of the filtration and adsorbent media in the tanks and vessels. Accordingly, the graded approach for ITAAC would not include this verification as a requirement of Tier 1 of the DCD for the reasons discussed below.

In accordance with the guidance provided by Standard Review Plan (SRP) 14.3, and the graded approach identified in the SRP that has been incorporated into the ITAAC determination process for the ESBWR, GEH reviewed previously certified designs for similar ITAAC requirements. Previously certified designs (AP-1000 and ABWR) and current operating plants Final Safety Analysis Reports do not specify similar requirements. Also, DCD Subsection 14.3.7.3, item b. 3) (which identifies the graded approach delineated in the SRP) states that nonsafety systems that have ITAAC include: "...actively/automatically control offsite doses below 10CFR 20 limits." Media absorbent media in process tanks and vessels performs no active or automatic function to control doses below 10CFR 20 limits and, thus, do not fall within this guidance for ITAAC. Processed liquid effluent from sample tanks cannot be discharged to the environment until sample analysis. Current BWR practice is to maintain liquid effluent release to maintain the plant within INPO first quartile values, which are well below ODCM limits, and (typically) the state issued National Pollutant Discharge Elimination System (NPDES) permit limits. The development and adherence to the ODCM and the NPDES permit ensure that 10CFR 20 limits are met.

DCD Impact:

DCD Tier 2, Subsections 11.2.2.2 and 11.2.2.3 will be revised as noted on the attached markup to use the term mixed bed demineralizers.

NRC RAI 11.2-17:

DCD Tier 2, Revision 4, Section 11.4.2.3 for the Pumps section and Tanks section includes the following commitment: "Pump/Tank codes are per the noted requirements of Table 3.2-1 for K20 Solid Waste Management Systems." However, a similar commitment for pump and tank K10 codes for the Liquid Waste Management Systems were not included in DCD, Tier 2, Section 11.2.2.3. Accordingly, revise DCD, Tier 2, Section 11.2.2.3 to include the commitment to meet the tank and vessel code provisions (K10) for the LWMS, as described in DCD, Tier 2, Section 3.2, Table 3.2-1.

GEH Response:

GEH agrees and will include the commitments.

DCD Impact:

DCD Tier 2, Subsection 11.2.2.3 will be revised as noted on the attached markup.

NRC RAI 11.2-18:

DCD, Tier 2, Revision 4, Section 11.2, Table 11.2-2c does not include subsystems and subsystem components shown in Figures 11.2-1a, 11.2-1b, and 11.2-4. Please explain why the Resin Trap for the Equipment Drain Processing System and the Chemical Drain Processing system are not listed on Table 11.2-2c. Update DCD, Tier 2, Table 11.2-2c accordingly.

GEH Response:

GEH agrees that DCD, Tier 2, Revision 4, Section 11.2, Table 11.2-2c does not include the Resin Trap for the Equipment Drain Processing System and the Chemical Drain Processing system listed on Table 11.2-2, and will update DCD, Tier 2, Table 11.2-2c to include the resin traps and chemical drains system components. The resin traps were not included previously, as they are not considered major components. Please note there are no resin traps on the chemical drain process subsystem. The components in the chemical drain process subsystem are identified in Tables 11.2-2a and 11.2-2b.

DCD Impact:

DCD, Tier 2, Section 11.2, Table 11.2-2c will be revised as noted on the attached markup.

NRC RAI 11.2-19:

The Equipment Drain Collection Tanks have potentially thermally hot inputs, but there are no provisions shown for tank cooling or heat exchangers.

Does the Equipment Drain Process Subsystem have temperature limits? Does the time to process maximum input listed on DCD, Tier 2, Table 11.2-4 include additional time to cool the contents of tanks to a temperature suitable for processing? Would elevated temperatures of process streams have detrimental impacts in achieving the decontamination factors listed in DCD, Tier 2, Table 11.2-3? Address the above questions and update DCD,

Tier 2, Section 11.2 tables and text accordingly.

GEH Response:

GEH provides the following responses to the questions posed above in sequential order:

Does the Equipment Drain Process Subsystem have temperature limits?

The most limiting temperature in the Equipment Drain Process Subsystem is the reverse osmosis membrane, which varies with membrane manufacturer or anion resin in the mixed bed demineralizer, and is typically on the order of 140°F.

Does the time to process maximum input listed on DCD, Tier 2, and Table 11.2-4 include additional time to cool the contents of tanks to a temperature suitable for processing?

No

Would elevated temperatures of process streams have detrimental impacts in achieving the decontamination factors listed in DCD, Tier 2, and Table 11.2-3?

Yes, if temperatures of the process fluid were to exceed the temperature limits of the resin, the demineralizer resin may break down causing the release of anions. However, based on existing BWR radwaste system designs and over 30 years of BWR operating experience, heat exchangers are not required for cooling the contents of the equipment drain collection tank. Thermally hot inputs drain to sumps prior to coming to radwaste, and experience has shown that the residence time in the sump provides for heat dissipation and no adverse thermal impacts on radwaste.

DCD Impact:

No DCD changes will be made in response to this RAI.

NRC RAI 11.2-20:

DCD, Tier 2, Figures 11.2-1a, 11.2-1b, 11.2-3, and 11.2-4 show overflows and drain funnels with no end dispositions. Revise the above listed figures to provide the disposition or endpoints of these overflows. If it is to a tank/sump, then include sump/tank size, pump flow rate capability, and where the sump/tank will flow or be pumped to, such as which subsystem components. Address the above issues and update DCD, Tier 2, Section 11.2 tables and text accordingly.

GEH Response:

GEH agrees with the staff's findings that DCD, Tier 2, Figures 11.2-1a, 11.2-1b, 11.2-3, and 11.2-4 show overflows and drain funnels with no end dispositions. DCD, Tier 2, Figures 11.2-1a, 11.2-1b, 11.2-3, and 11.2-4 will be revised adding drain funnels showing destinations to floor and equipment drains. The power generation design basis of floor and equipment drains is described DCD, Tier 2, Section 9.3.3.1 that states: "Drainage systems are designed to accommodate the maximum anticipated normal volumes of liquid without overflowing including such inputs as the anticipated water flow from a fire hose and other fire suppression water discharges to the area floor drains without impacting the safety function of any safety-related component or system. However, as delineated in Subsection 3.4.1.3, no credit is taken for the drainage system in the flooding analysis." Sump/tank size, pump flow rate capability, and where the sump/tank will flow or be pumped to, such as which subsystem components, will not be added to DCD, Tier 2, Section 11.

DCD Impact:

DCD, Tier 2, Figures 11.2-1a, 11.2-1b, 11.2-3, and 11.2-4, will be revised as noted on the attached markup.

NRC RAI 11.2-21:

A review of DCD, Tier 2, Figure 11.2-4 shows that the Chemical Drain Collection Tank is not equipped with a vent. Accordingly, justify the omission of a vent for this tank or update DCD, Tier 2, Figure 11.2-4 to include a vent in its design.

GEH Response:

GEH concurs with the staff finding and will update DCD, Tier 2, Figure 11.2-4 to include a vent in the design.

DCD Impact:

DCD Tier 2, Figure 11.2-4 will be revised as noted on the attached markup.

NRC RAI 11.2-22:

DCD, Tier 2, Section 11.2.2.2 and Table 11.2-4 do not provide the expected reverse osmosis reject rate to the Concentrated Waste Tank from the Equipment and Floor Drain Processing Subsystems. Address this omission and update DCD, Tier 2, Section 11.2 text and tables accordingly.

GEH Response:

GEH concurs with the staff finding that DCD, Tier 2, Subsection 11.2.2.2 and Table 11.2-4 does not provide the expected reverse osmosis reject rate to the Concentrated Waste Tank from the Equipment and Floor Drain Processing Subsystems. DCD, Tier 2, Subsection 11.2.2.2 text will be updated. This waste stream is processed through the Solid Waste Management System (SWMS) system with other incidental liquid waste in the SWMS system; therefore, no updates to the tables are required.

DCD Impact:

DCD, Tier 2, Subsection 11.2.2.2 will be revised to provide reverse osmosis reject rate to the Concentrated Waste Tank from the Equipment and Floor Drain Processing Subsystems.

NRC RAI 11.2-23:

A comparison of DCD, Tier 2, Figure 11.2-1 against Figures 11.2-1a and 11.2-1b indicates an inconsistent number of reverse osmosis (RO) units.

Figure 11.2-1 shows one RO unit each for the Equipment Drain Subsystem and Floor Drain Subsystem, while Figures 11.2-1a and 11.2-1b show two RO units for each. Accordingly, revise DCD, Tier 2 figures to make the functional arrangements of these subsystems internally consistent in DCD, Section 11.2.

GEH Response:

GEH agrees and will revise DCD Figure 11.2-1 to show two reverse osmosis (RO) units.

DCD Impact:

DCD Tier 2, Figure 11.2-1 will be revised as noted on the attached markup.

NRC RAI 11.2-24:

DCD, Tier 2, Revision 4, Section 11.2.2.2 is not specific on the description of process systems used to vent LWMS tanks. The second sentence states that tanks are vented to the atmosphere without noting that before being released to the atmosphere, vents are processed through the radwaste ventilation system. Accordingly, update the text describing system operation so as to be consistent with that of Page 11.2-5 for tanks.

GEH Response:

GEH concurs with the Staff findings and will update DCD, Tier 2, Revision 4, Subsection 11.2.2.3 describing system operation to be consistent with that of Page 11.2-5 for tanks.

DCD Impact:

DCD, Tier 2, Subsection 11.2.2.3 will be revised as noted on the attached markup.

NRC RAI 11.2-25:

DCD, Tier 2, Revision 4, Section 11.2.2.2 states that one additional equipment drain collection tank is shared with the floor drain subsystem, but the discussion fails to note whether this tank is in addition to those listed in DCD, Tier 2, Table 11.2-2a. Accordingly, update the discussion for the floor (high conductivity) drain subsystem on page 11.2-4 and in Table 11.2-2a to clarify the design status of the additional drain tank.

GEH Response:

GEH concurs with the staff finding and will update DCD, Tier 2, Revision 4, Subsection 11.2.2.2.1 and 11.2.2.2.2 to clarify the discussion.

DCD Impact:

DCD, Tier 2, Subsection 11.2.2.2.1 and 11.2.2.2.2 will be revised as noted on the attached markup.

NRC RAI 11.2-26:

DCD, Tier 2, Revision 4, Section 11.2.3, radioactive releases, fails to refer to the proper reference for NUREG-0016 since Reference No. 11.2-7 cites draft Regulatory Guide (RG) DG-1145 for it. Accordingly, update reference 11.2-7 to include the proper citation of NUREG-0016.

GEH Response:

GEH concurs with the staff findings and will update reference 11.2-7 to include the proper citation of NUREG-0016.

DCD Impact

DCD, Tier 2, Reference 11.2-7 will be revised as noted on the attached markup

NRC RAI 11.2-27:

DCD. Tier 2, Revision 4, Section 11.2.3, radioactive releases, fails to refer to Table 11.2-3, in addition to DCD, Section 12, as one of the basis of parameters used in calculating annual effluent releases and doses. Accordingly, update the discussion to note that the source term is based, in part, on decontamination factors listed in Table 12.2-3.

GEH Response:

GEH concurs with the Staff's findings, DCD. Tier 2, Revision 4, Subsection 11.2.3 will be updated to note that the source term is based, in part, on decontamination factors listed in Table 12.2-19b.

DCD Impact:

DCD. Tier 2, Subsection 11.2.3 will be revised as noted on the attached markup.

NRC RAI 11.2-28:

DCD, Tier 2, Revision 4, Section 11.2.5, instrumentation requirements, refers to the wrong subsection in DCD, Tier 2, Section 11.5 for the LWMS radwaste discharge monitor. Accordingly, update DCD, Tier 2, Section 11.2.5 to cite the proper DCD subsection as 11.5.3.2.5 instead of 11.5.3.2.6.

GEH Response:

GEH concurs with the staff finding and will update DCD, Tier 2, Subsection 11.2.5 to properly cite the DCD subsection as 11.5.3.2.5 instead of 11.5.3.2.6.

DCD Impact:

DCD, Tier 2, Subsection 11.2.5 will be revised as noted on the attached markup.

NRC RAI 11.2-29:

DCD, Tier 2, Revision 4, Section 11.2, Table 11.2-2b and Figure 11.2-4 show an inconsistent number of pumps. DCD Table 11.2-2b lists two (2 pumps for the chemical drain system but Figure 11.2-4 shows only one. Accordingly, update the table and figure for consistency in listing the number of pumps.

GEH Response:

GEH concurs with the staff finding and will update DCD, Tier 2, Revision 4, Section 11.2, Figure 11.2-4 to show 2 chemical drain pumps.

DCD Impact:

DCD, Tier 2, Section 11.2, Figure 11.2-4 will be revised as noted on the attached markup.

NRC RAI 11.2-30:

A review of DCD, Tier 2, Revision 4, Section 11.2, Figures 11.2-1 to 11.2-4 reveals that legends are missing in explaining the details of the piping drawing for the LWMS. Accordingly, revise DCD Tables 11.2-1 to 11.2-4 to include the appropriate sets of legends for the purpose of interpreting system functional operations.

GEH Response:

GEH concurs with the staff findings, DCD, Tier 2, Revision 4, Section 11.2, Figures 11.2-1 to 11.2-4 will be updated to include legends.

DCD Impact:

DCD, Tier 2, Section 11.2, Figures 11.2-1 to 11.2-4 will be revised as noted on the attached markup.

NRC RAI 11.2-31:

DCD, Tier 2, Revision 4, Section 11.2.3, radioactive releases, does not refer to DCD, Tier 2, Section 9.3.2 for process sampling. Accordingly, revise DCD, Tier 2, Section 11.2.3 for the purpose of referring to the sampling provisions described in DCD Section 9.3.2.

GEH Response:

GEH concurs with the staff finding and will revise DCD, Tier 2, Subsection 11.2.3 to refer to the sampling provisions described in DCD Subsection 9.3.2.

DCD Impact:

DCD, Tier 2, Subsection 11.2.3 will be revised as noted on the attached markup.

NRC RAI 11.3-4:

A review of DCD, Tier 2, Revision 4, Section 11.3.1, design bases, reveals that it fails to cite the requirements of Part 20, Appendix B, Table 2 effluent concentration limits for airborne effluents. Accordingly, revise DCD, Tier 2, Section 11.3.1 to include the requirements of Part 20, Appendix B, Table 2 effluent concentration limits, in addition to those of Appendix I to Part 50.

GEH Response:

GEH concurs with the staff findings and will revise DCD, Tier 2, Subsection 11.3.1 to include the requirements of Part 20, Appendix B, Table 2 effluent concentration limits, in addition to those of Appendix I to Part 50.

DCD Impact:

DCD, Tier 2, Subsection 11.3.1 will be revised as noted on the attached markup.

NRC RAI 11.3-5:

A review of DCD Tier 2, Revision 4, Section 11.3.2.2, component design, indicates inconsistent descriptions of leak testing methods. This section refers to the use of a soap bubble test for leak testing, while other sections of the DCD refer to helium leak testing, e.g., DCD, Tier 2, Section 11.3.5. Accordingly, revise DCD, Tier 2, Section 11.3 to ensure consistency in describing the proposed leak testing method.

GEH Response:

GEH concurs with the staff find and will revise DCD, Tier 2, Section 11.3 to ensure consistency in describing the proposed leak testing method.

DCD Impact:

DCD, Tier 2, Section 11.3 will be revised as noted on the attached markup.

NRC RAI 11.3-6:

A review of DCD, Tier 2, Revision 4, Section 11.3.2.2, component design, charcoal adsorber vessels, indicates that it does not commit to the tank and vessel codes requirements of DCD, Tier 2, Section 3.2, Table 3.2.1 for the OGS adsorber vessels. Accordingly, revise DCD, Tier 2, Section 1.3.2.2 to include the commitment to meet the tank and vessel code provisions (K30 for the OGS) as described in DCD, Tier 2, Section 3.2, Table 3.2-1. For consistency, see related code compliance entry in DCD, Tier 2, Section 11.4.2.3.

GEH Response:

GEH concurs with the staff finding and will revise DCD, Tier 2, Subsection 11.3.2.6 to include the commitment to meet the tank and vessel code provisions (K30 for the OGS) as described in DCD, Tier 2, Section 3.2, Table 3.2-1 using similar wording as DCD, Tier 2, Subsection 11.4.2.3.

DCD Impact:

DCD, Tier 2, Subsection 11.3.2.6 will be revised as noted on the attached markup.

NRC RAI 11.3-7:

DCD, Tier 2, Revision 4, Section 11.3.2, releases, does not refer to DCD, Tier 2, Section 9.3.2 for process sampling. Accordingly, revise DCD, Tier 2, Section 11.3.2 for the purpose of referring to the sampling provisions described in DCD, Tier 2, Section 9.3.2.

GEH Response:

GEH concurs with the staff finding. DCD, Tier 2, Subsection 11.3.2 will be revised to refer to the sampling provisions described in DCD, Tier 2, Subsection 9.3.2.

DCD Impact:

DCD, Tier 2, Subsection 11.3.2 will be revised as noted on the attached markup.

NRC RAI 11.3-8:

DCD, Tier 2, Revision 4, Section 11.3.6, instrumentation requirements, does not refer to Section 11.5 for the associated process radiation monitoring subsystem. Accordingly, revise DCD, Tier 2, Section 11.3.6 to include references to the pre- and post treatment offgas radiation monitors and the charcoal vault radiation monitor - see DCD, Tier 2, Section 11.5.3.2. For consistency, see related entry in DCD, Tier 2, Section 11.2.5.

GEH Response:

GEH concurs with the staff findings. DCD, Tier 2, Subsection 11.3.6 will be revised to include references to the pre and post treatment offgas radiation monitors, and the charcoal vault radiation monitor using DCD, Tier 2, Subsection 11.5.3.2 as a guide for consistency.

DCD Impact:

DCD, Tier 2, Subsection 11.3.6 will be revised as noted on the attached markup.

NRC RAI 11.3-9:

DCD, Tier 2, Revision 4, Section 11.3.9 lists references that are not cited in the text of Section 11.3. The references are Nos. 11.3-4, 11.3-5, the text or delete them from DCD, Tier 2, Section 11.3.9. Similarly, update reference 11.3-10 cited in DCD, Tier 2, Table 11.3-4 since the referenced document is not RG 1.109.

GEH Response:

GEH concurs with the staff findings, and will delete reference Nos. 11.3-4, 11.3-5 in Subsection 11.3.9 and update Reference 11.3-10 cited in DCD, Tier 2, Table 11.3-4.

DCD Impact:

DCD, Tier 2, Subsection 11.3.9 and Table 11.3-4 will be revised as noted on the attached markup.

NRC RAI 11.3-10:

DCD, Tier 2, Revision 4, Section 11.3, Table 11.3-1 does not include the estimated delay time for argon and krypton. Accordingly, revise DCD, Tier 2, Table 11.3-1 to include the delay time for argon and krypton since these parameters form part of the design bases. For consistency, see related entry in this table for xenon.

GEH Response:

GEH concurs with the staff findings. DCD, Tier 2, Revision 4, Section 11.3, Table 11.3-1 will be revised to include the estimated delay time for argon and krypton using the related entry in this table for xenon.

DCD Impact:

DCD, Tier 2, Section 11.3, Table 11.3-1 will be revised as noted on the attached markup.

NRC RAI 11.3-11:

DCD, Tier 2, Revision 4, Section 11.3, Table 11.3-6 provides inconsistent results for Xe-133 releases. Confirm whether the estimated Xe-133 release is 13.5 Ci or 135 Ci, e.g., possible error in SI to Ci conversion. Accordingly, revise DCD Tier 2, Table 11.3-6 to include the proper estimate of Xe-133 releases.

GEH Response:

GEH concurs with the inconsistency identified by the staff. DCD, Tier 2, Revision 4, Section 11.3, Table 11.3-6 will be revised to show the estimated Xe-133 release is 135 Ci.

DCD Impact:

DCD, Tier 2, Section 11.3, Table 11.3-6 will be revised as noted on the attached markup.

NRC RAI 11.3-12:

DCD, Tier 2, Revision 4, Section 11.3, Table 11.3-7 does not provide a reference for the basis of the atmospheric dispersion parameter (X/Q).

Accordingly, revise DCD Table 11.3-7 to include a reference as the basis for the assigned value of 2.0E-03 s/m3 for the atmospheric dispersion parameter (X/Q).

GEH Response:

GEH concurs with the omission identified by the staff and will revise DCD Table 11.3-7 to include a reference as the basis for the assigned value of 2.0E-03 s/m3 for the atmospheric dispersion parameter (X/Q).

DCD Impact:

DCD, Tier 2, Section 11.3, Table 11.3-7 will be revised as noted on the attached markup.

NRC RAI 11.4-15 S02:

The response to RAI 11.4-15 S01 included a proposed update of DCD, Tier 1, Section 2.10.2 and Table 2.10.2-2 on the Solid Waste Management System (SWMS). A review of the proposed revision to the associated ITAACs of Table 2.10.2-2 indicates that it is not complete as it does not provide reasonable assurance that the SWMS will be built in accordance with the approved design in accordance with 10 CFR Part 52.47(b)(1). The functional arrangement of the SWMS, as described in the Design Description of Subsection 2.10.2, does not provide adequate information.

Provide a process flow diagram showing major equipment and flow path of the SWMS in DCD, Tier 1, Section 2.10.2. Note that the concerns associated with this RAI response also apply to design descriptions, functional arrangements, and ITAACs assigned to the Liquid Waste Management System (LWMS) and Gaseous Waste Management System (GWMS). Accordingly, provide process flow diagrams showing major equipment and flow paths of the LWMS and GWMS in DCD, Tier 1, Sections 2.10.1 and 2.10.3, respectively.

GEH Response:

NRC guidance explains that ITAAC are not required, or are established in varying degrees, for all structures, systems, and components included in a standard design certification. In accordance with the guidance provided by Standard Review Plan (SRP) 14.3, and the graded approach identified in the SRP that has been incorporated into the ITAAC determination process for the ESBWR design, GEH reviewed previously certified designs for similar ITAAC requirements. Previously certified designs (AP-1000 and ABWR) and current operating plants Final Safety Analysis Reports do not specify similar requirements. Also, SRP 14.3, Appendix A, IV.4.A, regarding design descriptions and figures that are to be incorporated into the Tier 1 ITAAC, states: "the design descriptions address the most safety-significant aspects of each of the systems of the design." None of these radioactive waste management systems perform any safety significant function. Using the graded approach identified in the SRP, for non-safety systems, the only aspect requiring a Tier 1 ITAAC is a non-safety system that "...actively/automatically control offsite doses below 10 CFR 20 limits." DCD Subsection 14.3.7.3, item b. 3) identifies this graded approach delineated in the SRP. The current ITAACs for the LWMS (2.10.1) and GWMS (2.10.3) identify the testing of the closure valve that receives a high radiation signal to prevent inadvertent effluent releases to the environment. No similar feature exists for the SWMS.

Therefore, GEH concludes that the current ITAACs for the LWMS, SWMS and the GWMS, and as amended by the changes provided in GEH letter MFN 07-608, dated November 16, 2007, meet the guidance and graded approach provided by the SRP, and 10CFR 52.47(b)(1) for the testing of the closure valves to prevent inadvertent releases to the environment to control doses below 10CFR 20 limits.

DCD Impact:

No DCD changes are proposed.

NRC RAI 11.4-19:

DCD, Tier 2, Figure 11.4-2 includes Sample Point in the legend box, but none are noted in the system drawing. Provide the technical rationale for not including sampling points. Note that waste products processed by this subsystem will need to be characterized in determining compliance with the waste form characteristics of 10 CFR Part 61.55 and 61.56 and waste acceptance criteria of the radwaste disposal site. If sampling points are not included by design in this subsystem, describe alternate means for sampling waste streams and products from this subsystem in DCD, Tier 2, Sections 11.4.2.2 and 11.4.6 (COL information Item 11.4-3-A, Process Control Program).

GEH Response:

GEH concurs with the staff and will revise DCD, Tier 2, Figure 11.4-2 to include Sample Points for waste products processed by this subsystem to enable characterizing waste for compliance to 10 CFR Part 61.55 and 61.56, and waste acceptance criteria of the radwaste disposal site.

DCD Impact:

DCD, Tier 2, Figure 11.4-2 will be revised as noted on the attached markup.

NRC RAI 11.4-20:

Throughout DCD, Tier 2, Chapter 11.4, the phase separators are referred to as "Low Activity Phase Separators", but Figure 11.4-1, Solid Waste Management System Process Diagram, refers to the phase separator as "Low Activity Sludge Phase Separators." Address this inconsistency in terminology and revise DCD, Tier 2, Section 11.4 and associated figures accordingly.

GEH Response:

GEH agrees with the inconsistency identified by the staff. DCD, Tier 2, Chapter 11.4, Figure 11.4-1, Solid Waste Management System Process Diagram, wording will be revised to reflect "Low Activity Phase Separators."

DCD Impact:

DCD, Tier 2, Chapter 11.4, Figure 11.4-1 will be revised as noted on the attached markup.

NRC RAI 11.4-21:

In DCD, Tier 2, Section 11.4.2.1, "Summary Description," and Section 11.4.2.2, "Wet Solid Waste Collection Subsystem," the list of wastes that the SWMS processes/collects is incomplete as it does not address spent charcoal media from the Liquid Waste Processing System. Address the omission of spent charcoal media in the listing of wastes and revise DCD, Tier 2, Sections 11.4.2.1 and 11.4.2.2 accordingly.

GEH Response:

GEH concurs with the staff regarding the omission of spent charcoal media and will revise DCD, Tier 2, Subsection 11.4.2.1, "Summary Description," and Subsection 11.4.2.2, "Wet Solid Waste Collection Subsystem," to add spent charcoal media to the list of wastes that the SWMS processes and collects.

DCD Impact:

DCD, Tier 2, Subsections 11.4.2.1 and 11.4.2.2 will be revised as noted on the attached markup.

NRC RAI 11.4-22:

The "Thermal Drying Unit" as described in DCD, Tier 2, Section 11.4.2.2 "wet solid waste processing subsystem" and shown on Figure 11.4-3, is listed as an option. Clarify if this equipment is within the scope of the DCD, Tier 2 and revise DCD, Tier 2, Section 11.4.2.2 accordingly.

GEH Response:

GEH concurs the need to clarify DCD, Tier 2, Subsection 11.4.2.2 "wet solid waste processing subsystem" and Figure 11.4-3, and will remove the "Thermal Drying Unit".

DCD Impact:

DCD, Tier 2, Section 11.4.2.2 and Figure 11.4-3 will be revised as noted on the attached markup.

NRC RAI 11.4-23:

DCD, Tier 2, and Figure 11.4-2 shows the Concentrated Waste Tank being pumped to the Solid Waste Processing Subsystem, yet Figure 11.4-3 does not show this input. Figure 11.4-1 shows an input to the Low Activity Resin Holdup Tank from Concentrated Waste, yet Figure 11.4-2 does not show this input. Address these discrepancies in system flow paths and revised tank. DCD, Tier 2, Section 11.4.2 and associated figures accordingly.

GEH Response:

GEH concurs with the discrepancy identified by the staff. DCD, Tier 2, Figure 11.4-2 will show the Concentrated Waste Tank being pumped to the Solid Waste Processing Subsystem (Figure 11.4-3 now shows this input). Figure 11.4-2 now shows an input from the concentrated waste tank.

DCD Impact:

DCD, Tier 2, Figure 11.4-2 will be revised as noted on the attached markup.

NRC RAI 11.4-24:

DCD, Tier 2, Table 11.4-1 lists HIC Return Pumps under Process Equipment, but the function of these pumps is not described nor do they appear on Figure 11.4-3. Provide the information about the function of these subcomponents and revise DCD, Tier 2, Section 11.4.2 and associated tables and figures.

GEH Response:

GEH concurs with the staff's findings and will revise DCD, Tier 2, Subsection 11.4.2 to change the name of the HIC Return Pumps to dewatering pumps to agree with the description on Figure 11.4-3. The function of the dewatering pumps will be added to Subsection 11.4.2.

DCD Impact:

DCD, Tier 2, Subsection 11.4.2.2 will be revised as noted on the attached markup.

NRC RAI 11.4-25:

DCD Tier 2, Table 11.4-1 lists the quantity of Dewatering Equipment Fill Heads as three, with Figure 11.4-3 not providing any further information. Address the differences in the number of fill heads between tables and figures, and revise DCD Tier 2, Section 11.4.2 and associated tables and figures accordingly.

GEH Response:

GEH agrees and will correct the differences in DCD Tier 2, Table 11.4-1 to show one fill head.

DCD Impact:

DCD Tier 2, Table 11.4-1 and Figure 11.4-3 will be revised as noted on the attached markup.

NRC RAI 11.4-26:

In DCD, Tier 2, Figure 11.4-2, the horizontal line coming from the bottom of Phase Separator (A) ends abruptly with no connections to other portions of the system. The vertical line coming from the bottom of the Condensate Resin Holdup Tank, after the second air-operated valve, ends abruptly as well. Address these inconsistencies in system flow paths and revise DCD, Tier 2, Figure 11.4-2 accordingly.

GEH Response:

GEH agrees that the drawing inconsistency exists and will correct the drawing inconsistencies in system flow paths and revise DCD, Tier 2, Figure 11.4-2 accordingly.

DCD Impact:

DCD, Tier 2, Figure 11.4-2 will be revised as noted on the attached markup.

NRC RAI 11.4-27:

DCD, Tier 2, Figure 11.4-3 describes the function of the "dewatering pump. This pump appears to be drawn backwards in the figure. As drawn, it appears to be pumping from the High and Low Activity Phase Separators into the Liner and Thermal Drying Units. Also, on the dewatering skid drawing, there is an open gate valve with no disposition or connection to other portions of the subsystem. Confirm the flow direction of the dewatering pump, address the inconsistencies in system flow paths, and revise DCD, Tier 2, Section 11.4.2 and Figure 11.4-3 accordingly.

GEH Response:

GEH agrees with the inconsistencies in flow direction of the dewatering pump, system flow paths, and will revise DCD, Tier 2, Figure 11.4-3 accordingly.

DCD Impact:

DCD, Tier 2, Figure 11.4-3 will be revised as noted on the attached markup.

NRC RAI 11.4-28:

DCD, Tier 2, Figure 11.4-2 identifies the presence of 11 radiation monitors (see symbol RE in figure), but DCD, Tier 2, Sections 11.4.5, 11.5.3, and 12.3 (Table 12.3-4) do not describe such radiation monitors. The radiation monitors are shown to be mounted on tanks/vessels and subsystem piping. The description and operational functions of the radiation monitors are not described in the proposed revision of DCD, Tier 2, Section 11.4. Confirm whether such radiation monitors are part of the design; if so, provide information about their operational functions; and revise DCD, Tier 2, Sections 11.4.5, 11.5.3, and 12.3, and associated tables and figures.

GEH Response:

GEH agrees the radiation monitors shown on DCD, Tier 2, Figure 11.4-2 are not described or identified in DCD, Tier 2, Sections 11.4.5, 11.5.3, and 12.3, and associated tables and figures. DCD, Tier 2, Figure 11.4-2 will be revised to delete these radiation monitors as they are no longer part of the design. These monitors were previously added for operational convenience and are not required to perform a safety or operational function described in Chapter 11.

DCD Impact:

DCD, Tier 2, Figure 11.4-2 will be revised as noted on the attached markup.

NRC RAI 11.4-29:

DCD, Tier 2, Figure 11.4-4 shows the disposition of dry solid wastes, but it does not address NRC requirements and policy for their disposition.

Specifically:

a. For wastes processed manually, the figure should note that such activities are performed by the COL holder.

b. For tools and materials returned to plant, the figure should note that they would be returned for controlled use and uncontrolled use consistent with the COL holder's radiation protection program.

c. For disposal as regular trash, the figure should note that such dispositions would comply with the NRC policy on non-detectable activity for the release of materials and equipment from nuclear power plants.

d. For radioactive waste destined for DAW Sealand shipments, the figure should note that the endpoints of such shipments are authorized low-level radioactive waste disposal sites and licensed waste processors.

As shown, the figure conveys disposition methods of radioactive materials contrary to Part 20.2001 and NRC policy for the release of materials and equipment from nuclear power plants in unrestricted areas. Accordingly, revise DCD, Tier 2, Figure 11.4.4 by changing the legend or introducing appropriate footnotes to each shown disposition endpoints.

GEH Response:

GEH agrees with the staff's identification of inadequacy of the dry active waste (DAW) processing description in DCD, Tier 2, Figure 11.4.4, and will revise the figure to describe disposition methods of radioactive materials that are not contrary to Part 20.2001 and NRC policy for the release of materials and equipment from nuclear power plants in unrestricted areas.

DCD Impact:

DCD, Tier 2, Figure 11.4.4 will be revised as noted on the attached markup.

NRC RAI 11.4-30:

DCD, Tier 2, Revision 4, Section 11.4.1 refers to the wrong reference for 10 CFR 61 when compared to Section 11.4.7. Reference 11.4-13 identifies Part 50, Appendix A, GDC 61 rather than 10 CFR Part 61. Accordingly, revise the citation for reference 11.4-13 in DCD, Tier 2, Section 11.4.7.

GEH Response:

GEH concurs with the staff's identification that DCD, Tier 2, Revision 4, Subsection 11.4.1 refers to the wrong reference that should be 10 CFR 61. GEH will revise the citation for reference 11.4-13 in DCD, Tier 2, Subsection 11.4.7, accordingly.

DCD Impact:

DCD, Tier 2, Subsection 11.4.1 will be revised as noted on the attached markup.

NRC RAI 11.4-31:

DCD, Tier 2, Revision 4, Section 11.4.1 refers to a superseded provision of SRP Section 11.4 on the allowable time for the storage of LLW at reactor sites. The five-year (5) time constraint has been dropped in the current version of Section 11.4 of the SRP (NUREG-0800, March 2007). Accordingly, it is suggested that the discussion be revised and that the reference to the five-year (5) time constraint be deleted from DCD, Tier 2, Section 11.4.1.

GEH Response:

GEH agrees that DCD, Tier 2, Revision 4, Subsection 11.4.1 refers to a superseded provision of SRP Section 11.4 for the allowable time for the storage of low-level waste (LLW) at reactor sites. GEH will revise DCD, Tier 2, Section 11.4.1, by deleting the five-year (5) time constraint for the storage of LLW at reactor sites.

DCD Impact

DCD, Tier 2, Subsection 11.4.1 will be revised as noted on the attached markup.

NRC RAI 11.4-32:

DCD, Tier 2, Revision 4, Section 11.4.7 lists reference 11.4-23 (Part 20), but this reference is not cited in the text of Section 11.4. Accordingly, confirm whether the citation for reference 11.4-23 needs to be included in the text of DCD, Tier 2, Section 11.4 and revise the text accordingly.

GEH Response:

GEH agrees with the staff finding that DCD, Tier 2, Revision 4, Subsection 11.4.7 lists reference 11.4-23 (Part 20) that is not cited in the text of Section 11.4. Reference 11.4-23 will be deleted.

DCD Impact:

DCD, Tier 2, Subsection 11.4.7 will be revised as noted on the attached markup.

NRC RAI 11.5-48:

DCD, Tier 2, Revision 4, Section 11.5.2, system design bases and criteria, refers to a prior version of ANSI/IEEE N42-18. DCD, Tier 2, Revision 4, Section 11.5.8, in (reference 11.5-19) cites the 2004 current version of the standard, while DCD, Tier 2, Section 11.5.2 refers instead to the 1980 version. Accordingly, update DCD, Tier 2, Section 11.5.2 to refer to the correct version of the standard, as ANSI/IEEE N42-18-2004.

GEH Response:

GEH agrees to update the DCD section to refer to the correct version as stated in reference 11.5-19.

DCD Impact:

DCD Tier 2, Subsection 11.5.2 will be revised as noted on the attached markup.

NRC RAI 11.5-49:

A review of DCD, Tier 2, Revision 4, Section 11.5.2, system design bases and criteria, reveals that it fails to identify how the design of the PRMS complies with RG 1.97, Revision 4, SRP Section 7.5, and BTP 7-10 for Type E Variables in assessing airborne effluent concentrations or release rates.

Note that the staff had closed a prior RAI (No. 11.5-8) based on the understanding that DCD, Section 7.5.3 would address the implementation of Revision 4 of RG 1.97 via the guidance of SRP BTP-7-10, as they relate to Type E Variables. However, a review of DCD, Revision 4, Section 7.5.3 indicates that all requirements have been dropped from the DCD, specifically DCD, Tier 2, Table 7.1-1 excludes the PRMS from the guidance of RG 1.97 and BTP 7-10. Even though SRP Section 7.5.1.3.5 states that compliance with these requirements will be addressed during the detailed design phase, Section 7.5.7 of the DCD does not include any corresponding COL action items.

Accordingly, revise DCD, Tier 2, Section 11.5.2 to indicate how the guidance of SRP BTP 7-10 will be addressed for Type E Variables, given that BTP 7-10 states that the ranges and footnotes provided for radiation monitoring equipment in Revision 3 of RG 1.97 (see Table 2 for BWRs) should be applicable and would be acceptable for plants using Revision 4 of RG 1.97. If this provision of SRP BTP 7-10 is not used, then the other provision of BTP 7-10 should be implemented, which states that deviations from either Revision 2 or 3 of RG 1.97 should be supported by analyses demonstrating that the operational range of the radiation expected types of events or accidents.

GEH Response:

The ESBWR design uses common plant stacks for venting purposes during normal and post-accident operations.

The ESBWR design will have one Type E variable that will require monitoring for releases to the plant environs: Common Plant Vent. The Common Plant Vent will require monitoring for noble gases, particulates, and halogens. Monitoring will be provided for each Common Plant Vent (Plant Stack) in the ESBWR design.

The instrument ranges for assessing noble gases, particulates, and halogens in the ESBWR design are provided in DCD Tier 2, Revision 4, Table 11.5-1, Table 11.5-2, and Table 11.5-9.

Based upon a review of the range requirements using the guidance from Regulatory Guide 1.97, Revision 3, Table 2, the instrument ranges for the ESBWR design as noted in Tables 11.5-1, 11.5-2, and 11.5-9 encompass the recommended ranges and footnotes within Regulatory Guide 1.97, Revision 3, for BWRs with no deviations.

DCD Tier 2, Subsection 11.5.3.2.13, Plant Stack RMS, notes: "the Plant Stack radiation monitor is a post-accident monitor and meets the guidelines of Regulatory Guide 1.97...."

The PRMS will be added to DCD Tier 2, Table 7.1-1, showing applicability to RG 1.97. Subsection 11.5.2, System Design Bases and Criteria, 5th bullet, and DCD Tier 2, Table 1.9-20 currently lists RG 1.97 and BTP HICB-10 as applicable.

DCD Tier 2, Subsection 7.5.3.3.4 will be revised to include USNRC Regulatory Guide 1.97 as applicable to the PRMS and DCD Tier 2, Subsection 7.5.3.3.5 will be revised to include BTP HICB-10 (Reference 11.5-26) as applicable to the PRMS.

DCD Impact:

DCD Table 1.9-21 will be changed to reflect the RG 1.97 Revisions 3 and 4 applicability to the ESBWR design.

DCD Tier 2, Table 7.1-1, Regulatory Requirements Applicability Matrix, will be revised to indicate that USNRC Regulatory Guide 1.97 and BTP HICB-10 apply to the PRMS.

The following will be added to DCD Tier 2, Subsection 7.5.3.3.4:

"RG 1.97, Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants:

- Conformance: The PRMS conforms to RG 1.97."

The following will be added to DCD Tier 2, Subsection 7.5.3.3.5, prior to the entry for HICB-11:

"BTP HICB-10, Guidance on Application of Regulatory Guide 1.97:

- The PRMS design conforms to BTP HICB-10 (Reference 11.5-26)."

The following new bullet will be added to DCD Tier 2, Subsection 11.5.2:

BTP HICB-10 (Reference 11.5-26)

Markups for the proposed changes are attached.

NRC RAI 11.5-50:

DCD, Tier 2, Revision 4, Section 11.5.3.1.6 should clarify the origin and radiological status of the water used for the isolation condenser pool. The water supplied by the makeup water system. If this is true, DCD, Tier 2, Section 11.5.3.1.6 should be updated to make this point clear and DCD, Tier 2, Sections 9.2.3 and 5.4.6 should be cited as the basis. If this is not true, please discuss the origin and radiological status of the water used.

GEH Response:

GEH agrees with the staff finding that DCD, Tier 2, Revision 4, Subsection 11.5.3.1.6 should clarify the origin and radiological status of the water used for the isolation condenser pool. GEH agrees that the water for the isolation condenser pool is supplied by the makeup water system. DCD, Tier 2, Subsection 11.5.3.1.6 will be updated for clarification and DCD, Tier 2, Subsections 9.2.3 and 5.4.6 cited as the basis.

DCD Impact:

DCD, Tier 2, Subsection 11.5.3.1.6 will be revised as noted on the attached markup.

NRC RAI 11.5-51:

DCD, Tier 2, Revision 4, Section 11.5.4.5 refers to NUREG-1301 and -1302 as the basis documents for the development of the offsite dose calculation manual, but these documents are not included in the references (see Section 11.5.8). Accordingly, update DCD, Tier 2, Section 11.5.8 to include NUREG-1301 and NUREG-1302 as references.

GEH Response:

GEH agrees with the staff finding that DCD, Tier 2, Revision 4, Subsection 11.5.4.5 refers to NUREG-0133 and -1302 as the basis documents for the development of the offsite dose calculation manual, and should be included in the references. DCD, Tier 2, Subsection 11.5.8 will be revised to include NUREG-0133 and NUREG-1302 as references with citations in the appropriate text portion Section 11.5. Please note that NUREG-1301 is for Pressurized Water Reactors and GEH ESBWR cannot obviously reference this citation.

DCD Impact:

DCD, Tier 2, Subsection 11.5.4.5 will be revised as noted on the attached markup.

NRC RAI 11.5-52:

DCD, Tier 2, Revision 4, Section 11.5.4.7 states that analytical sensitivities of effluent monitors will be determined, but the definition of the PRMS subsystem should also include process monitors in its scope. Accordingly, update DCD, Tier 2, Section 11.5.4.7 to include both effluent and process radiation monitoring subsystems.

GEH Response:

GEH concurs with the staff that DCD, Tier 2, Revision 4, Subsection 11.5.4.7 states that analytical sensitivities of effluent monitors will be determined, but the definition of the PRMS subsystem should also include process monitors in its scope. DCD, Tier 2, Subsection 11.5.4.7 will be updated to include both effluent and process radiation monitoring subsystems.

DCD Impact:

DCD, Tier 2, Subsection 11.5.4.7 will be revised as noted on the attached markup.

NRC RAI 11.5-53:

DCD, Tier 2, Revision 4, Section 11.5.4 and Tables 11.5-7 and 11.5-8 need further clarifications for the footnote addressing detection sensitivity. The footnote (***) states that detection sensitivities will be based on the ANSI/IEEE N42.18 standard, but it should be noted that this standard applies only to instrumentation described as continuous radiation monitors. As can be noted from either table, the presence and concentrations of a number of radionuclides (e.g., Sr-89, Sr-90, etc.) would not be determined by continuous radiation monitoring instrumentation. Accordingly, revise the footnotes (***) in DCD, Tier 2, Tables 11.5-7 and 11.5-8 to include the appropriate references, such as RG 1.21 and 4.15 as the basis of the analytical sensitivities for nuclides that would be analyzed by means other than by the use of continuous radiation monitoring systems.

GEH Response:

GEH agrees to revise the footnotes accordingly. Note that for DCD Tier 2, Table 11.5-8, footnote (**) is the applicable footnote.

DCD Impact:

DCD Tier 2, Table 11.5-7 footnote (***) and DCD Tier 2, Table 11.5-8 footnote (**) will be changed per the attached markup.

Enclosure 2

MFN 08-145

DCD Markups

Table 1.9-21

NRC Regulatory Guides Applicability to ESBWR

RG No.	Regulatory Guide Title	Appl. Rev.	Issued Date	ESBWR Appli-cable?	Comments
1.94	Quality Assurance Requirements for Installation, Inspection, and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants	1	04/1976	—	COL. See Table 1.9-21b. See also proposed Rev 2 published 09/1979 as RS 908-5.
1.95	Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release	1	01/1977	No	Withdrawn 12/26/2001. Guidance incorporated in Rev. 1 of RG 1.78
1.96	Design of Main Steam Isolation Valve Leakage Control Systems for Boiling Water Reactor Nuclear Power Plants	1	06/1976	No	No MSIV LCS. URD optimization – see Table 1.9-21a
1.97	Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident	3	05/1983	Yes	Instrument Ranges Only
1.97	Criteria for Accident Monitoring Instrumentation for ~~Light-Water-Cooled~~ Nuclear Power Plants ~~to Assess Plant and Environs Conditions During and Following an Accident~~	4	06/2006	Yes	
1.98	Assumptions Used for Evaluating the Potential Radiological Consequences of a Radioactive Offgas System Failure in a Boiling Water Reactor	0	03/1976	No	Superceded by BTP ESTB 11-5 in SRP 11.3.

The LWMS normally operates on a batch basis. Provisions for sampling at important process points are included. Protection against accidental discharge is provided by detection and alarm of abnormal conditions and by administrative controls.

The LWMS is divided into several subsystems, so that the liquid wastes from various sources can be segregated and processed separately, based on the most economical and efficient process for each specific type of impurity and chemical content. Cross-connections between subsystems provide additional flexibility in processing the wastes by alternate methods and provide redundancy if one subsystem is inoperative.

The radwaste processing equipment is designed to meet or exceed the decontamination factors in Table 11.2-3.

11.2.2.2 System Operation

The LWMS is operated at atmospheric and greater pressures. Tanks are vented to the atmosphere via the radwaste ventilation system described in Section 9.4. No condensing vapors are housed to create a vacuum. The vent is also large enough to accommodate the airflow associated with pumping down the tank at a maximum flowrate. Therefore, no adverse conditions are expected.

The LWMS consists of the following four process subsystems.

11.2.2.2.1 Equipment (Low Conductivity) Drain Subsystem

The equipment drain collection tanks receive low conductivity inputs from various sources within the plant. These waste inputs have a high chemical purity and are processed on a batch basis. The equipment drain subsystem consists of three collection tanks and collection pumps, a ~~mobile based~~ processing system featuring a filtration system, reverse osmosis, ~~Deep-Bed~~Mixed-bed Ion Exchanger and the associated plumbing, instrumentation and electrical systems as required, and two sample tanks and sample pumps. Additional collection capacity is provided by cross connection to the floor drain collection tanks. ~~One collection tank is normally used as a surge tank that can collect waste from the low conductivity waste and/or High Conductivity Waste (HCW).~~ Cross-connections with the floor drain subsystem allow processing through the ~~mobile~~ process system for floor drain treatment. The equipment drain subsystem is shown on Figure 11.2-1a.

A strainer or filter is provided downstream of the last ion exchanger in series to collect any crud and resin fines that may be present.

The process effluents are collected in one of the two sample tanks for chemical and radioactivity analysis. If acceptable, the tank contents are returned to the condensate storage tank for plant reuse. A recycle line from the sample tanks allows the sampled effluents that do not meet water quality requirements to be pumped back to an Equipment (Low Conductivity) Drain Collection Tank or Floor (High Conductivity) Drain Collection Tank for additional processing. If the plant condensate inventory is high, the sampled process effluent may be discharged.

Filters are backwashed periodically to maintain capacity. Backwash waste is discharged to a phase separator. Spent ~~deep-bed~~mixed-bed ion exchanger resin is either discharged to a low activity spent resin holdup tank as a slurry or sent directly to a High Integrity Container (HIC).

Reverse osmosis units create a brine waste steam with a nominal value of 3 gpm based on industry experience, which is discharged to the concentrated waste tank.

11.2.2.2.2 Floor (High Conductivity) Drain Subsystem

The floor drain collection tanks receive HCW inputs from various floor drain sumps in the Reactor Building (RB), Turbine Building (TB), and radwaste building. The floor drain collection tanks also receive waste input from the chemical drain collection tank.

The floor drain subsystem consists of two floor drain collection tanks and collection pumps, a ~~mobile based~~ processing system featuring a filtration system, reverse osmosis, ~~Deep-Bed~~Mixed-bed Ion Exchanger and the associated plumbing, instrumentation and electrical systems as required, and two sample tanks and sample pumps. The waste collected in the floor drain collection tanks is processed on a batch basis. Cross-connections with the equipment drain subsystem also allow for processing through that subsystem. The floor drain subsystem is shown on Figure 11.2-1b.

Additional collection capacity is ~~also~~ provided by cross connection to the ~~one additional~~ equipment drain collection tanks ~~that is shared with the floor drain subsystem~~.

A strainer or filter is provided downstream of the last ion exchanger in series to collect crud and resin fines that may be present.

The floor drain sample tanks collect the process effluent, so that a sample is taken for chemical and radioactivity analysis before discharging or recycling. The discharge path depends on the water quality, dilution stream availability and plant water inventory. Off-standard quality effluent can be recycled to floor drain collection tanks or equipment drain collection tanks. If the treated effluent meets water quality standards and if the water inventory permits it to be recycled, the processed floor drain effluent can be recycled to the condensate storage tank or discharged off-site.

The liquid waste filter sludge is periodically discharged to a low activity phase separator. Spent ~~deep-bed~~mixed-bed ion exchanger resin is discharged to a low activity spent resin holdup tank as slurry.

The capability exists to accept used condensate polishing resin in a condensate resin receiver tank. The used condensate polishing resin from Condensate Purification System is transferred to the condensate resin receiver tank, as described in Subsection 10.4.6.2.3, prior to use in the pre-treatment ~~deep~~mixed-bed ion exchanger in the floor drain subsystem.

Reverse osmosis units create a brine waste steam with a nominal value of 3 gpm based on industry experience, which is discharged to the concentrated waste tank.

11.2.2.2.3 Chemical Drain Subsystem

To the greatest extent practicable, waste chemicals will be kept out of the LWMS, including the Chemical Drain Subsystem. The chemical waste collected in the chemical drain collection tank consists of laboratory wastes and decontamination solutions. After accumulating in the chemical drain collection tank, the tank contents are transferred to the low activity spent resin tank, detergent drain tank, or to the floor drain collection tanks. Chemical Control programs ensure that unapproved liquids are not added to chemical drain subsystem or LWMS. The chemical drain subsystem is shown in Figure 11.2-4.

11.2.2.2.4 Detergent Drain Subsystem

Waste water containing detergent from the controlled laundry and personnel decontamination facilities throughout the plant is collected in the detergent drain collection tanks. The detergent drain subsystem consists of two detergent drain collection tanks and collection pumps, a ~~mobile-based~~ processing system (consisting of a filtration system, organic pre-treatment equipment, and the associated plumbing, instrumentation and electrical systems as required), and two sample tanks and sample pumps. The detergent waste treatment includes suspended solid removal processing and organic material removal processing, as necessary. The treated waste is collected in sample tanks. A sample is taken and if discharge standards are met, then the waste is discharged off-site. Off-standard quality water can either be recycled for further processing to the detergent collection tank or to the floor drain collection tank. A cross-connection with the chemical drain collection subsystem is also provided. The detergent drain subsystem is shown on Figure 11.2-3.

11.2.2.3 Detailed System Component Description

The LWMS consists of permanently installed tanks, pumps, pipes, valves, and instruments, and ~~mobile~~ process systems for waste processing. ~~Mobile~~ Process systems provide an operational flexibility and maintainability to support plant operation. The major components of the LWMS are as follows below.

11.2.2.3.1 Pumps

The LWMS process pumps are constructed of materials suitable for their intended service.

Pump codes are per the noted requirements of Table 3.2-1 for K10 Liquid Waste Management Systems.

~~Neutralization chemicals in the LWMS are added with centrifugal or positive displacement pumps (or functionally similar pumps). These pumps are constructed of materials suitable for their intended service.~~

11.2.2.3.2 Tanks

Tanks are sized to accommodate the expected volumes of waste generated in the upstream systems that feed waste into the LWMS for processing. The tanks are constructed of stainless steel to provide a low corrosion rate during normal operation. They are provided with mixing eductors and/or air spargers. The capability exists to sample all LWMS collection and sample tanks. ~~All~~ LWMS tanks are vented into the radwaste ventilation system ~~through a filtration unit and eventually discharged into radwaste sumps~~. The LWMS tanks are designed in accordance with the equipment codes listed in Table 11.2-1.

All atmospheric liquid radwaste tanks are provided with an overflow connection at least the size of the largest inlet connection. The overflow is connected below the tank vent and above the high-level alarm setpoint. Each collection tank room is designed to contain the maximum liquid inventory in the event that the tank ruptures. Tank cubicles are lined with steel to preclude accidental releases to the environment. Concrete walls are sealed and coated for added protection. Tanks are vented to the radwaste ventilation system. The radwaste ventilation system is described in Section 9.4.

Tank codes are per the noted requirements of Table 3.2-1 for K10 Liquid Waste Management Systems.

11.2.2.3.3 ~~Mobile~~ Process Systems

The Combined Operating License (COL) Applicant is responsible, initially and subsequently, for the identification of ~~mobile/portable~~ LWMS process systems connections that are considered non-radioactive, but later become radioactive through interfaces with radioactive systems; i.e., a non-radioactive system becomes contaminated due to leakage, valving errors or other operating conditions in radioactive systems using the guidance and information in Inspection and Enforcement (IE) Bulletin 80-10 (May 6, 1980) (Reference 11.2-10) (COL 11.2-1-A).

The COL Applicant will include site-specific information describing how the implementation of operating procedures and design features for installation and operation of the ~~mobile/portable~~ LWMS process systems will address the requirements of Part 20.1406 (Reference 11.2-9) (COL 11.2-2-A). Specifically the operational procedures and design of the ~~mobile/portable~~ LWMS process systems should minimize, to the extent practicable, contamination of the facility and the environment, facilitate decommissioning, and minimize the generation of radioactive wastes. This information is placed into Section 12.6 provided applicable referencing is included in Subsection 11.2.1.

The ~~mobile~~ process systems are ~~of a skid-mounted design and~~ configured for relatively easy installation and process reconfiguration at system connections. ~~In-plant supply and return connections from permanently installed equipment to the mobile system are provided for operational flexibility.~~

The LWMS ~~mobile~~ process systems are located in the ~~Liquid Waste Treatment System bay~~Radwaste Building (RW) to allow truck access and ~~mobile~~ process system installation~~skid loading and unloading~~. Modular shield walls are provided in the RW to allow shield walls to be constructed to minimize exposure to personnel during operation and routine maintenance.

11.2.2.3.4 Equipment Drain RO and ~~Deep~~ Mixed-Bed Demineralizer ~~Mobile~~ Process Subsystem

~~A conceptual~~ The design of the Equipment Drain Reverse Osmosis System (RO) and ~~Deep~~ Mixed-Bed Demineralizer ~~Mobile~~ Process Subsystem is depicted in Figure 11.2-1. The equipment drain ~~mobile~~ process system utilizes ~~unit operations such as~~ filters for removing suspended solid and radioactive particulate material, and charcoal adsorbtion for organic material removal. Backwash operation for ~~depth~~ filtration units is performed when the differential pressure across the filter exceeds a preset limit. ~~Depth~~ F~~f~~iltration backwash waste is discharged to a low activity phase separator. ~~Spent organic removal media, if used, is packaged directly into the container when the differential pressure exceeds a preset limit or waste quality of the effluent from the unit exceeds a preset value.~~

The equipment drain pretreatment filtration and reverse osmosis feeds the ~~mixed-bed~~ ion exchangers. Exhausted resins from a mixed bed ion exchange unit are sluiced to the low activity spent resin holdup tank when an effluent purity parameter (such as conductivity) exceeds a preset limit or upon high differential pressure across the unit. Fine mesh strainers with backwashing connections are provided in the ion exchange vessel discharge and in the downstream piping to prevent resin fines from being carried over to the sampling tanks. RO concentrates are accumulated in the Concentrated Waste Tank to facilitate processing.

The ~~mobile~~ process system ~~is skid mounted and~~ is designed and configured for relatively easy installation and process reconfiguration. In-plant supply and return connections from permanently installed equipment to the ~~mobile~~ process system are provided for operational flexibility.

11.2.2.3.5 Floor Drain RO and ~~Deep~~Mixed Bed Demineralizer ~~Mobile~~ Process Subsystem

~~A conceptual~~ The design of the Floor Drain RO and ~~Deep~~ Mixed-Bed Demineralizer ~~Mobile~~ Process Subsystem is depicted in Figure 11.2-1. The floor drain ~~mobile~~ process subsystem utilizes pre-filtration equipment for removing suspended solids and organic impurities, filtration equipment that include a Reverse Osmosis System (RO) for removing ionic impurities, and ~~deep~~mixed-bed ion exchangers for polishing.

Exhausted ion exchange resins may be sluiced to the spent resin tank or directed to a liner when a chemistry parameter (such as conductivity) exceeds a preset limit or upon high differential pressure. Fine mesh strainers with backwashing connections are provided in the ion exchange vessel discharge and in the downstream piping to prevent resin fines from being carried over to the sampling tanks~~, should ion exchangers be used~~. RO concentrates are accumulated in the Concentrated Waste Tank to facilitate processing.

The ~~mobile~~ process system is ~~of a skid mounted design and~~ configured for relatively easy installation and process reconfiguration. In-plant supply and return connections from ~~permanently installed~~ other radwaste equipment to the ~~mobile~~ process system are provided to ensure operational flexibility.

11.2.2.3.6 Detergent Drain Pre-Filter and Charcoal Filter ~~Mobile~~ Process Subsystem

~~A conceptual~~ The design of the Detergent Drain Pre-Filter and Charcoal Filter ~~Mobile~~ Process Subsystem is depicted in Figure 11.2-1. The detergent drain ~~mobile~~ process subsystem utilizes organic pretreatment to remove organics and a filter to remove suspended solids. When the differential pressure of the filter exceeds a preset value, the filter performance is rejuvenated in accordance with the design of the filter. Spent filter media are packaged as ~~active~~ solid waste.

11.2.3 Safety Evaluation - Radioactive Releases

11.2.3.1 Safety Evaluation

The LWMS has no safety-related function. Failure of the system does not compromise any safety-related system or component nor does it prevent shutdown of the plant. No interface with the Class IE electrical system exists.

11.2.3.2 Radioactive Releases

During liquid processing by the LWMS, radioactive contaminants are removed and the bulk of the liquid is purified and either returned to the condensate storage tank or discharged to the environment. The radioactivity removed from the liquid waste is concentrated on filter media, ion exchange resins and concentrated waste. The decontamination factors (DFs) that are listed in

Table 11.2-3 and Table 12.2-19b are in accordance with Nuclear Regulation-0016 (NUREG) (Reference 11.2-7), but are considered conservative values. The filter sludge, ion exchange resins and concentrated waste are sent to the Solid Waste Management System (SWMS) for further processing. Liquid samples are collected using the process sampling system described in Subsection 9.3.2. If the liquid meets the purity requirements it is returned to the plant for condensate makeup. If the liquid is discharged, the activity concentration is consistent with the discharge criteria of 10 CFR 20 (Reference 11.2-2) and dose commitment in 10 CFR 50, Appendix I (Reference 11.2-6).

All radioactive releases will be discharged to the circulating water system. Prior to discharging to the environment the contents of the tank being released are sampled and analyzed to ensure that the activity concentration is consistent with the discharge criteria of 10 CFR 20 (Reference 11.2-2) and dose commitment in 10 CFR 50, Appendix I (Reference 11.2-6) are met. A radiation monitor provides an automatic closure signal to the discharge line isolation valve.

The parameters and assumptions used to calculate releases of radioactive materials in liquid effluents and their bases are provided in Chapter 12. The LWMS design ensures that calculated individual doses from the release of radioactive liquid effluents during normal operation and anticipated operational occurrence is less than 0.03 mSv (3 mrem) to the whole body and 0.1 mSv (10 mrem) to any organ.

Expected releases of radioactive materials by radionuclides in liquid effluents resulting from normal operation, including anticipated operational occurrences, and from design basis fuel leakage are provided in Chapter 12.

An assessment of potential radiological liquid releases following a postulated failure of a LWMS tank and its components in accordance with BTP 11-6 (Reference 11.2-11) is provided in Subsection 15.3.16.

A tabulation of the releases by radionuclides can be found in Chapter 12. The tabulation is for the total system and for each subsystem and includes indication of the effluent concentrations. The calculated concentrations in the effluents are within the concentration limits of 10 CFR 20 (Reference 11.2-2); the doses resulting from the effluents are within the numerical design objectives of Appendix I to 10 CFR 50 (Reference 11.2-6) and the dose limits of 10 CFR 20 (Reference 11.2-2) as set forth in Chapter 12.

11.2.3.3 Dilution Factors

Refer to Section 12.2 for dilution factors used in evaluating the release of liquid effluents.

11.2.4 Testing and Inspection Requirements

LWMS inspection and testing requirements are identified in Table 11.2-1. The LWMS is given a pre-operational test as discussed in Chapter 14. Thereafter, portions of the systems are tested as needed.

During initial testing of the system, the pumps and ~~mobile~~ process systems are performance tested to demonstrate conformance with design flows and process capabilities. An integrity test is performed on the system upon completion.

Provisions are made for periodic inspection of major components to ensure capability and integrity of the systems. Display devices are provided to indicate vital parameters required in routine testing and inspection.

The quality assurance program for design, fabrication, procurement, and installation of the liquid radioactive waste system is in accordance with the overall quality assurance program described in Chapter 17.

11.2.5 Instrumentation Requirements

The LWMS is operated and monitored from the Radwaste Building Control Room (RWBCR). Major system parameters, i.e., tank levels, process flow rates, filter and ion exchanger differential pressure, ion exchanger effluent conductivity, etc., are indicated and alarmed as required to provide operational information and performance assessment. A continuous radiation detector, as described in Subsection 11.5.3.2.~~6~~5, is provided to monitor the discharge of radioactivity to the environs. Key system alarms are repeated in the main control room.

11.2.6 COL Information

11.2-1-A Implementation of IE Bulletin 80-10

The COL Applicant is responsible, initially and subsequently, for the identification of ~~mobile/portable~~ LWMS process system connections that are considered non-radioactive, but later become radioactive through interfaces with radioactive systems; i.e., a non-radioactive system becomes contaminated due to leakage, valving errors or other operating conditions in radioactive systems using the guidance and information in IE Bulletin 80-10 (May 6, 1980) (Reference 11.2-10) (Subsection 11.2.2.3).

11.2-2-A Implementation of Part 20.1406

The COL Applicant will include site-specific information describing how the implementation of operating procedures and design features for installation and operation of the ~~mobile/portable~~ LWMS process system will address the requirements of Part 20.1406 (Reference 11.2-9) (Subsection 11.2.2.3).

11.2.7 References

11.2-1 Nuclear Regulatory Commission (NRC), Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants", Revision 2, November 2001.

11.2-2 Title 10 Code of Federal Regulations Part 20, "Standards for Protection Against Radiation."

11.2-3 Title 10 Code of Federal Regulations Part 50, "Domestic Licensing of Production and Utilization Facilities" and 50.34a "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents – Nuclear Power Reactors."

11.2-4 Title 10 Code of Federal Regulations Part 50, Appendix A, General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."

11.2-5 Nuclear Regulatory Commission (NRC), Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable", Revision 3, June 1978.

11.2-6 Title 10 Code of Federal Regulations Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents."

11.2-7 ~~Draft Guide DG-1145: Combined License Applications for Nuclear Power Plants (LWR Edition), 1.11 Radioactive Waste Management.~~USNRC, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors," NUREG-0016, Revision 1, January 1979.

11.2-8 Generic Letter 89-01, January 31, 1989, specifically, Enclosure 3, Section 6.13 Process Control Program, PCP.

11.2-9 Title 10 Code of Federal Regulations, Part 20.1406.

11.2-10 IE Bulletin 80-10, May 6, 1980.

11.2-11 NUREG-0800, Standard Review Plan, For the Review of Safety Analysis Reports for Nuclear Power Plants, Branch Technical Position 11-6, "Postulated Radioactive Releases Due to Liquid-Containing Tank Failures", March 2007.

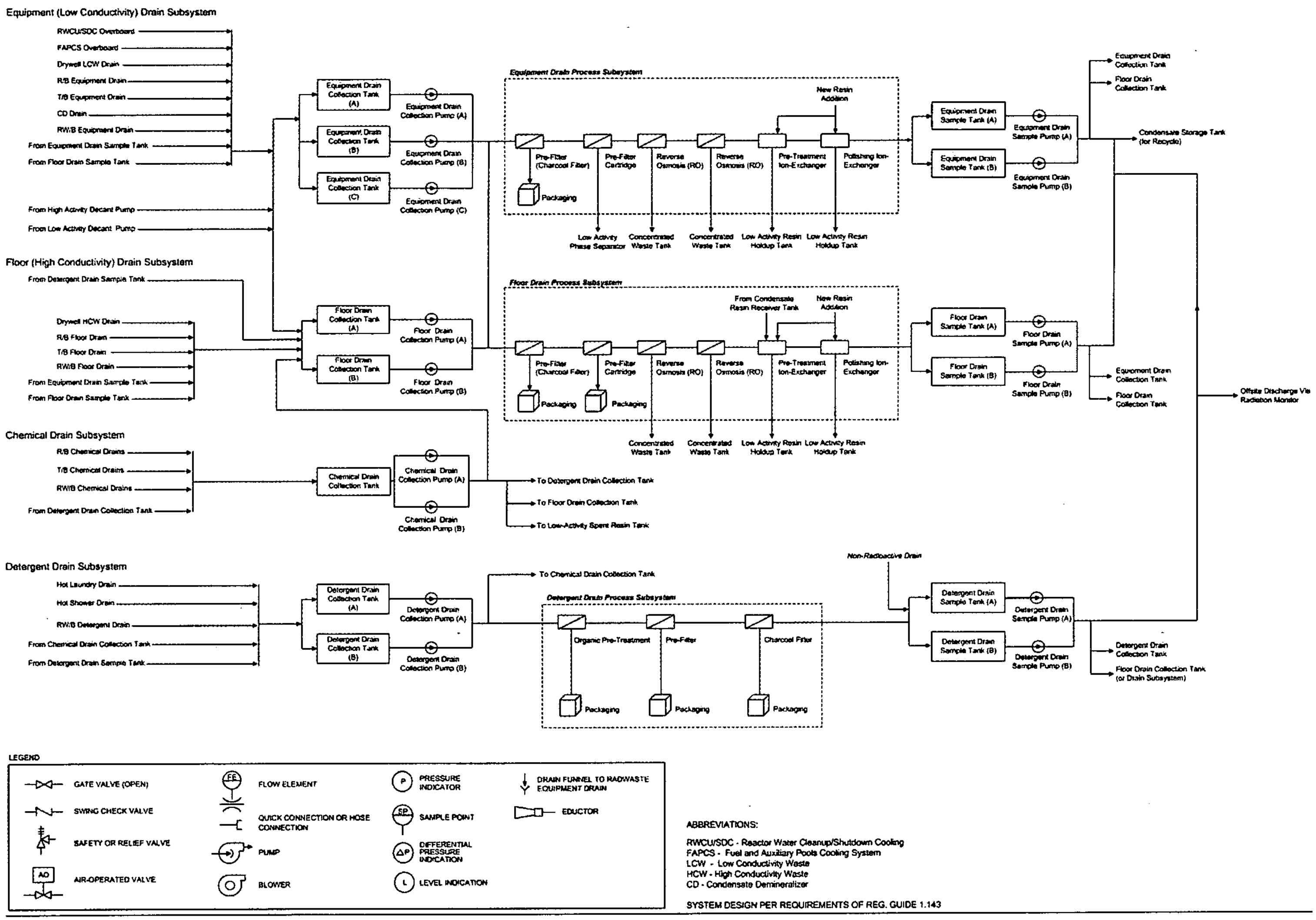
Table 11.2-2c

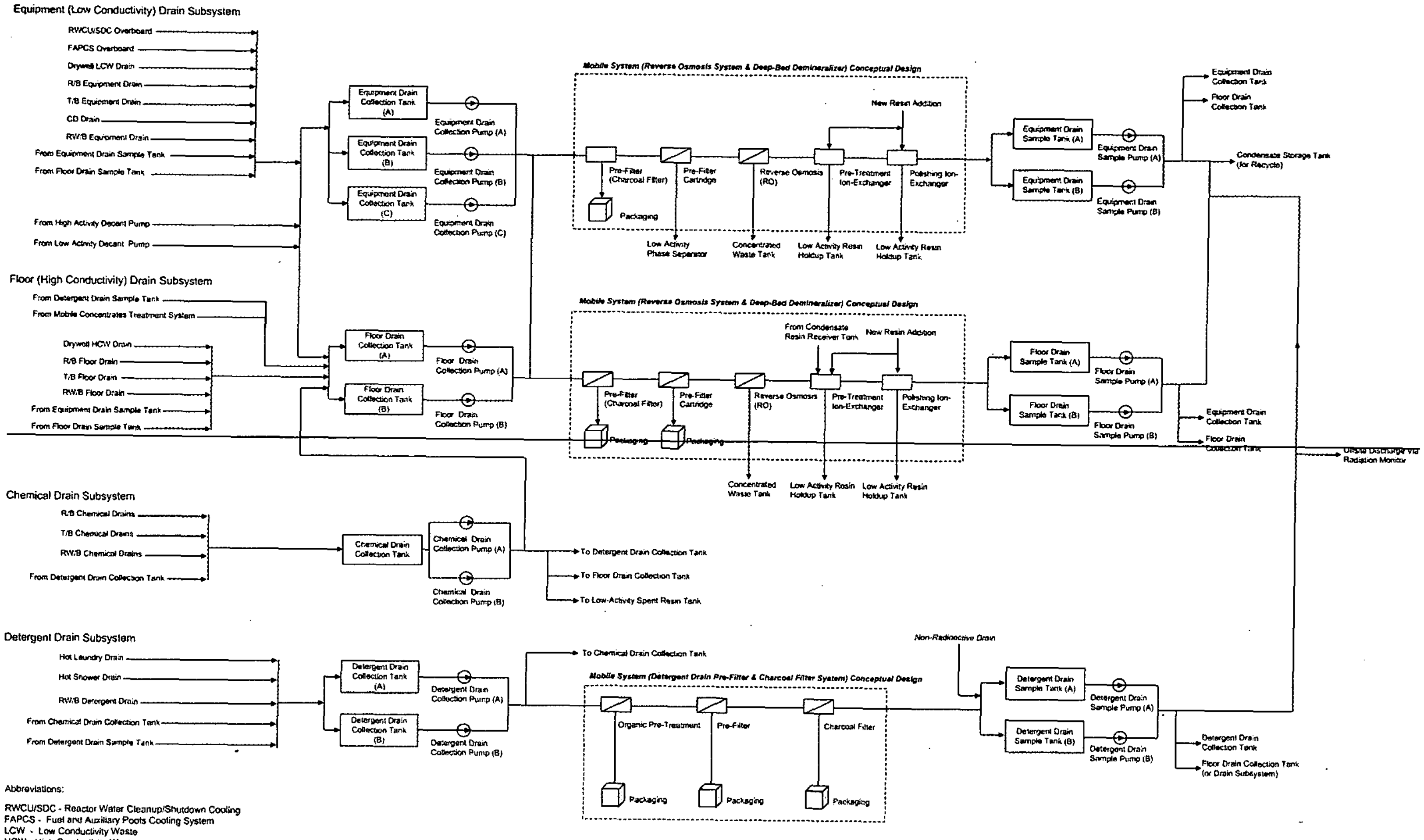
LWMS Component Capacity (Mobile Systems) Conceptual Design

Component*	Type	Quantity**	Nominal Cap.
Mobile Systems for Equipment Drain ProcessingProcess Subsystem		1	20,000L/h (88gpm)
Equipment Drain Charcoal Filter	Charcoal Filter or others		
Equipment Drain Pre-filter	Cartridge Type		
Equipment Drain Filter	Reverse Osmosis (RO)		
Equipment Drain Ion Exchangers	Mixed Bed Type		
Equipment Drain Intermediate Pump Resin Trap	Horizontal, Centrifugal Basket Type		
Mobile Systems for Floor Drain ProcessingProcess Subsystem		1	15,000L/h (66gpm)
Floor Drain Charcoal Filter	Charcoal Filter		
Floor Drain Pre-Filters	Cartridge Type		
Floor Drain Filter	Reverse Osmosis (RO)		
Floor Drain Ion Exchangers	Mixed Bed Type		
Floor Drain Intermediate Pump Resin Trap	Horizontal, Centrifugal Basket Type		
Mobile Systems for Detergent Drain ProcessingProcess Subsystem		1	2,000L/h (8.8gpm)
Detergent Drain Organic Pre-Treatment	Charcoal or others		
Detergent Drain Pre-Filter	Cartridge Type		
Detergent Drain Charcoal Filter	Charcoal Filter		

* Typical components are shown for each mobile process subsystem.

** This column shows mobile system quantitiesy for each subsystem, not each component quantity.


Equipment (Low Conductivity) Drain Subsystem
RWCU/SDC Overboard
FAPCS Overboard
Drywell LCW Drain
R/B Equipment Drain
T/B Equipment Drain
CD Drain
RW/B Equipment Drain
From Equipment Drain Sample Tank
From Floor Drain Sample Tank
From High Activity Decant Pump
From Low Activity Decant Pump
Equipment Drain Collection Tank (A)
Equipment Drain Collection Tank (B)
Equipment Drain Collection Tank (C)
Equipment Drain Collection Pump (A)
Equipment Drain Collection Pump (B)
Equipment Drain Collection Pump (C)
Equipment Drain Process Subsystem
New Resin Addition
Pre-Filter (Charcoal Filter)
Pre-Filter Cartridge
Reverse Osmosis (RO)
Reverse Osmosis (RO)
Pre-Treatment Ion-Exchanger
Polishing Ion-Exchanger
Packaging
Low Activity Phase Separator
Concentrated Waste Tank
Concentrated Waste Tank
Low Activity Resin Holdup Tank
Low Activity Resin Holdup Tank
Equipment Drain Sample Tank (A)
Equipment Drain Sample Tank (B)
Equipment Drain Sample Pump (A)
Equipment Drain Sample Pump (B)
Equipment Drain Collection Tank
Floor Drain Collection Tank
Condensate Storage Tank (for Recycle)
Floor (High Conductivity) Drain Subsystem
From Detergent Drain Sample Tank
Drywell HCW Drain
R/B Floor Drain
T/B Floor Drain
RW/B Floor Drain
From Equipment Drain Sample Tank
From Floor Drain Sample Tank
Floor Drain Collection Tank (A)
Floor Drain Collection Tank (B)
Floor Drain Collection Pump (A)
Floor Drain Collection Pump (B)
Floor Drain Process Subsystem
From Condensate Resin Receiver Tank
New Resin Addition
Pre-Filter (Charcoal Filter)
Pre-Filter Cartridge
Reverse Osmosis (RO)
Reverse Osmosis (RO)
Pre-Treatment Ion-Exchanger
Polishing Ion-Exchanger
Packaging
Packaging
Concentrated Waste Tank
Concentrated Waste Tank
Low Activity Resin Holdup Tank
Low Activity Resin Holdup Tank
Floor Drain Sample Tank (A)
Floor Drain Sample Tank (B)
Floor Drain Sample Pump (A)
Floor Drain Sample Pump (B)
Equipment Drain Collection Tank
Floor Drain Collection Tank
Offsite Discharge Via Radiation Monitor
Chemical Drain Subsystem
R/B Chemical Drains
T/B Chemical Drains
RW/B Chemical Drains
From Detergent Drain Collection Tank
Chemical Drain Collection Tank
Chemical Drain Collection Pump (A)
Chemical Drain Collection Pump (B)
To Detergent Drain Collection Tank
To Floor Drain Collection Tank
To Low-Activity Spent Resin Tank
Detergent Drain Subsystem
Hot Laundry Drain
Hot Shower Drain
RW/B Detergent Drain
From Chemical Drain Collection Tank
From Detergent Drain Sample Tank
Detergent Drain Collection Tank (A)
Detergent Drain Collection Tank (B)
Detergent Drain Collection Pump (A)
Detergent Drain Collection Pump (B)
To Chemical Drain Collection Tank
Detergent Drain Process Subsystem
Organic Pre-Treatment
Pre-Filter
Charcoal Filter
Packaging
Packaging
Packaging
Non-Radioactive Drain
Detergent Drain Sample Tank (A)
Detergent Drain Sample Tank (B)
Detergent Drain Sample Pump (A)
Detergent Drain Sample Pump (B)
Detergent Drain Collection Tank
Floor Drain Collection Tank (or Drain Subsystem)
LEGEND
GATE VALVE (OPEN)
SWING CHECK VALVE
SAFETY OR RELIEF VALVE
AO
AIR-OPERATED VALVE
FE
FLOW ELEMENT
QUICK CONNECTION OR HOSE CONNECTION
PUMP
BLOWER
P
PRESSURE INDICATOR
SP
SAMPLE POINT
ΔP
DIFFERENTIAL PRESSURE INDICATION
L
LEVEL INDICATION
DRAIN FUNNEL TO RADWASTE EQUIPMENT DRAIN
EDUCTOR
ABBREVIATIONS:
RWCU/SDC - Reactor Water Cleanup/Shutdown Cooling
FAPCS - Fuel and Auxiliary Pools Cooling System
LCW - Low Conductivity Waste
HCW - High Conductivity Waste
CD - Condensate Demineralizer
SYSTEM DESIGN PER REQUIREMENTS OF REG. GUIDE 1.143

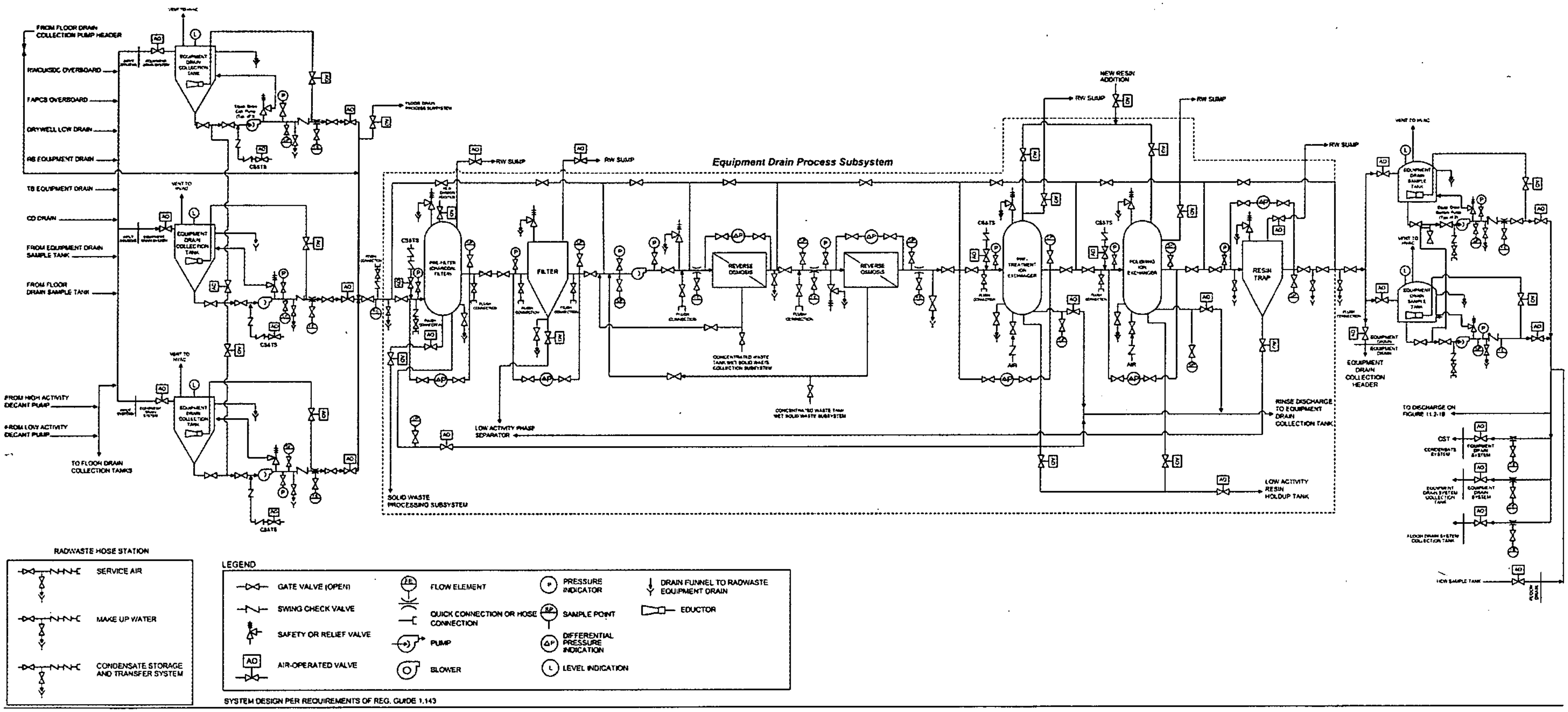


Abbreviations:

RWCU/SDC - Reactor Water Cleanup/Shutdown Cooling
FAPCS - Fuel and Auxiliary Pools Cooling System
LCW - Low Conductivity Waste
HCW - High Conductivity Waste
CD - Condensate Demineralizer

Materials per the requirements of Reg. Guide 1.143

Figure 11.2-1. Liquid Waste Management System Process Diagram


Equipment Drain Process Subsystem
FROM FLOOR DRAIN COLLECTION PUMP HEADER
FAPCS OVERBOARD
DRYWELL LCW DRAIN
RB EQUIPMENT DRAIN
TB EQUIPMENT DRAIN
CD DRAIN
FROM EQUIPMENT DRAIN SAMPLE TANK
FROM FLOOR DRAIN SAMPLE TANK
FROM HIGH ACTIVITY DECANT PUMP
FROM LOW ACTIVITY DECANT PUMP
TO FLOOR DRAIN COLLECTION TANKS
RW SUMP
NEW RESIN ADDITION
FILTER
REVERSE OSMOSIS
RESIN TRAP
LOW ACTIVITY PHASE SEPARATOR
SOLID WASTE PROCESSING SUBSYSTEM
RINSE DISCHARGE TO EQUIPMENT DRAIN COLLECTION TANK
LOW ACTIVITY RESIN HOLDUP TANK
RADWASTE HOSE STATION
SERVICE AIR
MAKE UP WATER
CONDENSATE STORAGE AND TRANSFER SYSTEM
LEGEND
GATE VALVE (OPEN)
SWING CHECK VALVE
SAFETY OR RELIEF VALVE
AIR-OPERATED VALVE
FLOW ELEMENT
QUICK CONNECTION OR HOSE CONNECTION
PUMP
BLOWER
PRESSURE INDICATOR
SAMPLE POINT
DIFFERENTIAL PRESSURE INDICATION
LEVEL INDICATION
DRAIN FUNNEL TO RADWASTE EQUIPMENT DRAIN
EDUCTOR
SYSTEM DESIGN PER REQUIREMENTS OF REG. GUIDE 1.143

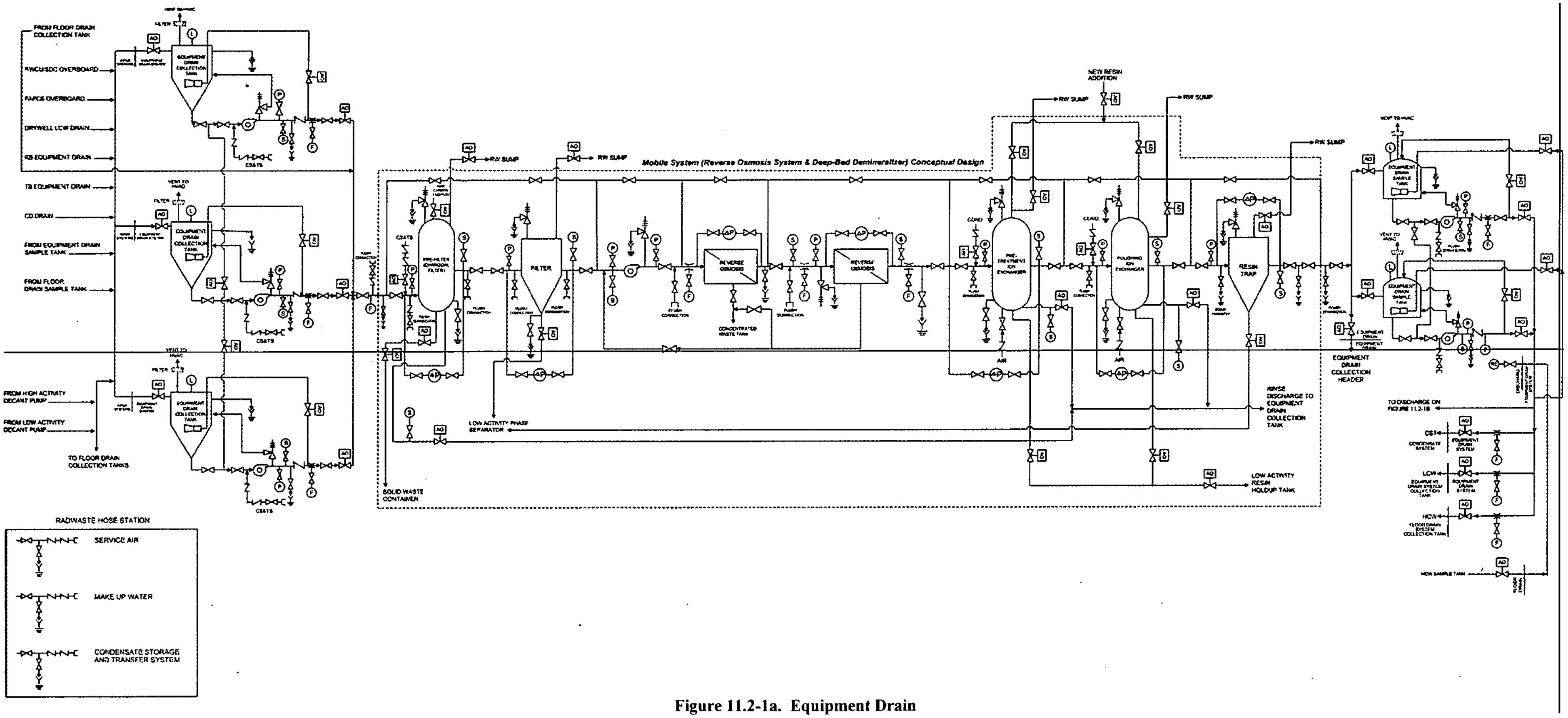
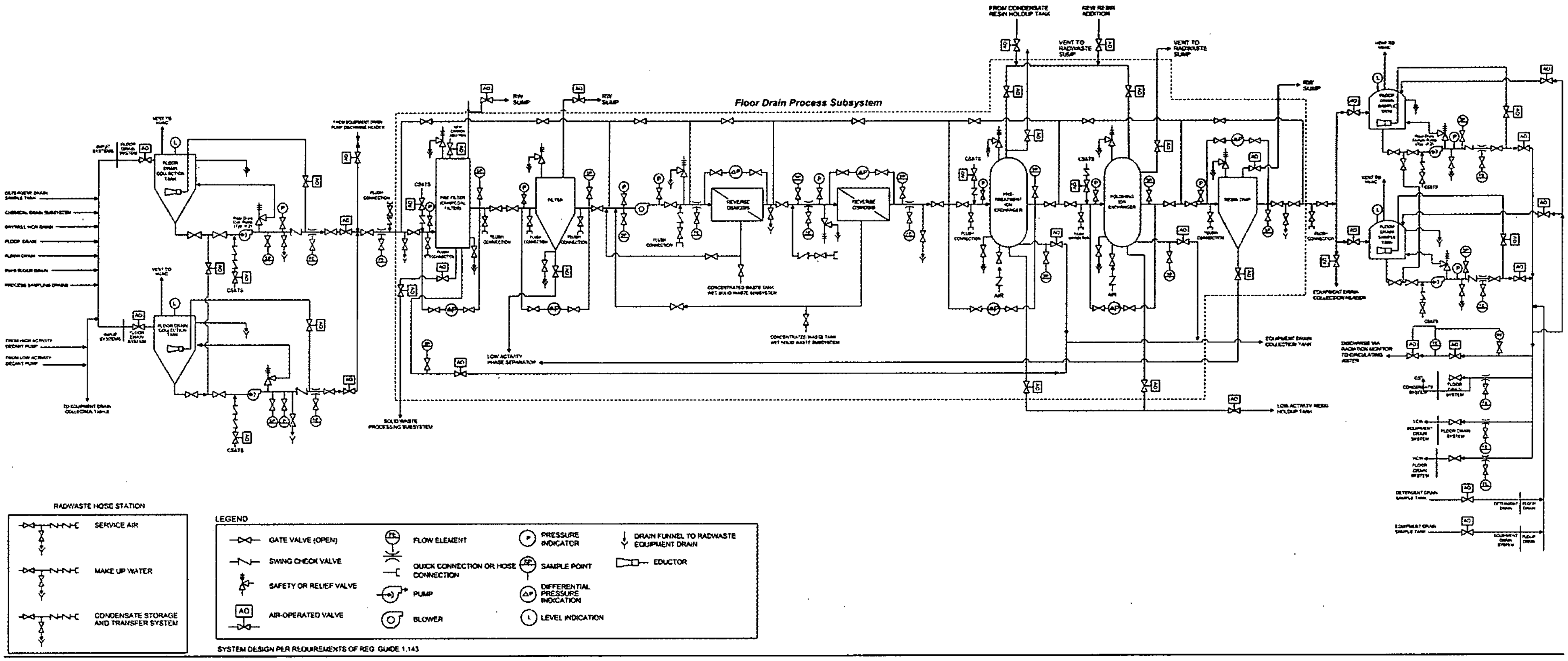


Figure 11.2-1a. Equipment Drain


Floor Drain Process Subsystem
RADWASTE HOSE STATION
SERVICE AIR
MAKE UP WATER
CONDENSATE STORAGE AND TRANSFER SYSTEM
LEGEND
GATE VALVE (OPEN)
SWING CHECK VALVE
SAFETY OR RELIEF VALVE
AIR-OPERATED VALVE
FLOW ELEMENT
QUICK CONNECTION OR HOSE CONNECTION
PUMP
BLOWER
PRESSURE INDICATOR
SAMPLE POINT
DIFFERENTIAL PRESSURE INDICATION
LEVEL INDICATION
DRAIN FUNNEL TO RADWASTE EQUIPMENT DRAIN
EDUCTOR
SYSTEM DESIGN PER REQUIREMENTS OF REG GUIDE 1.143

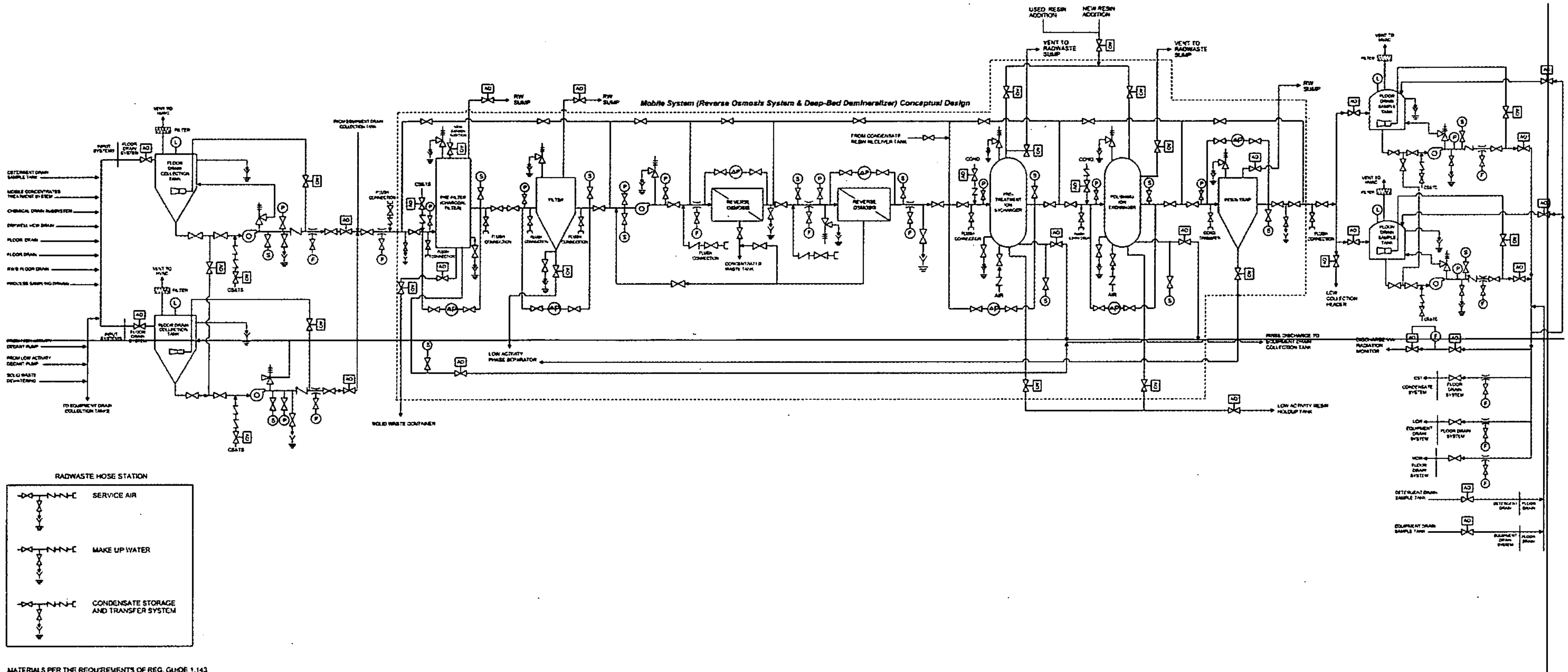
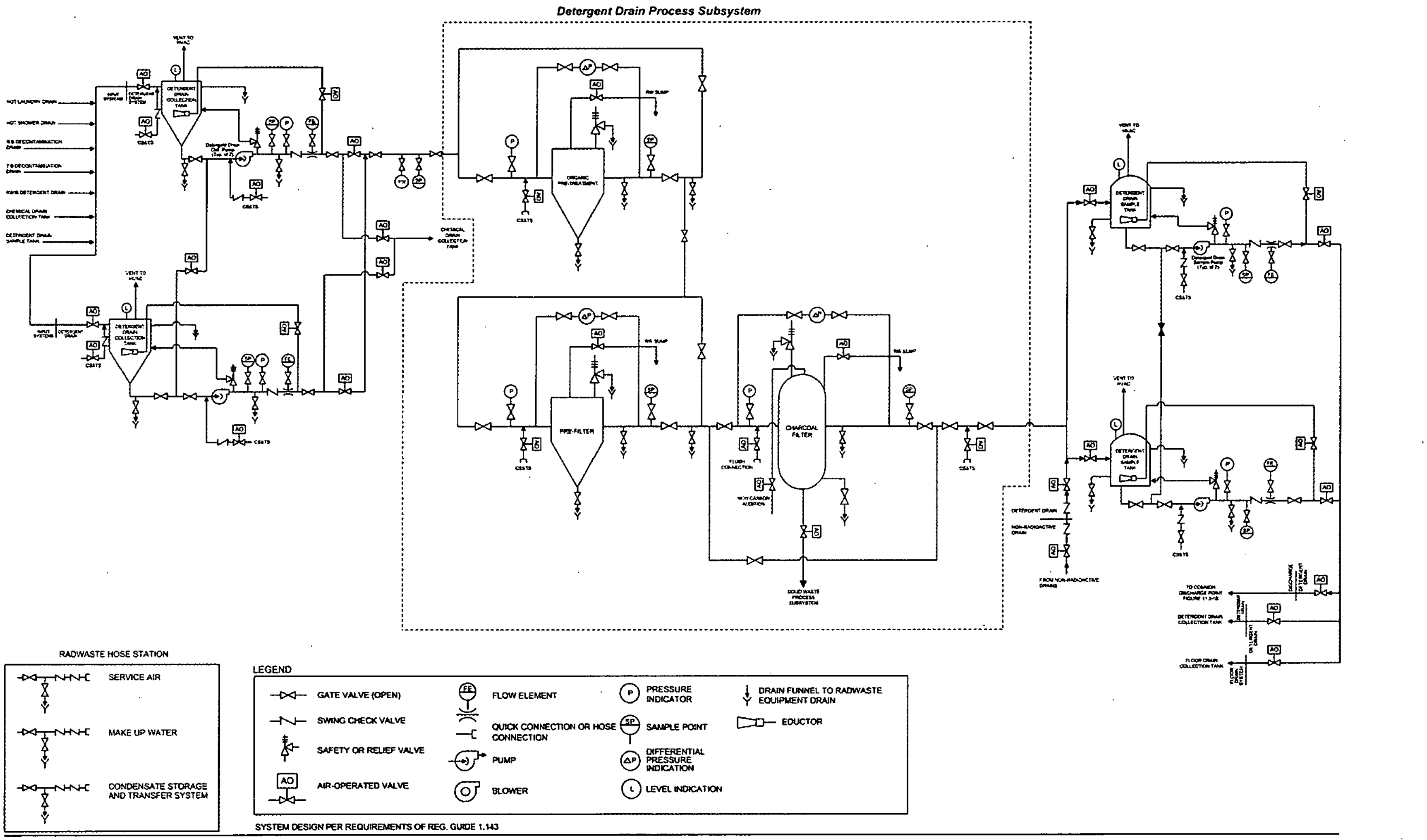
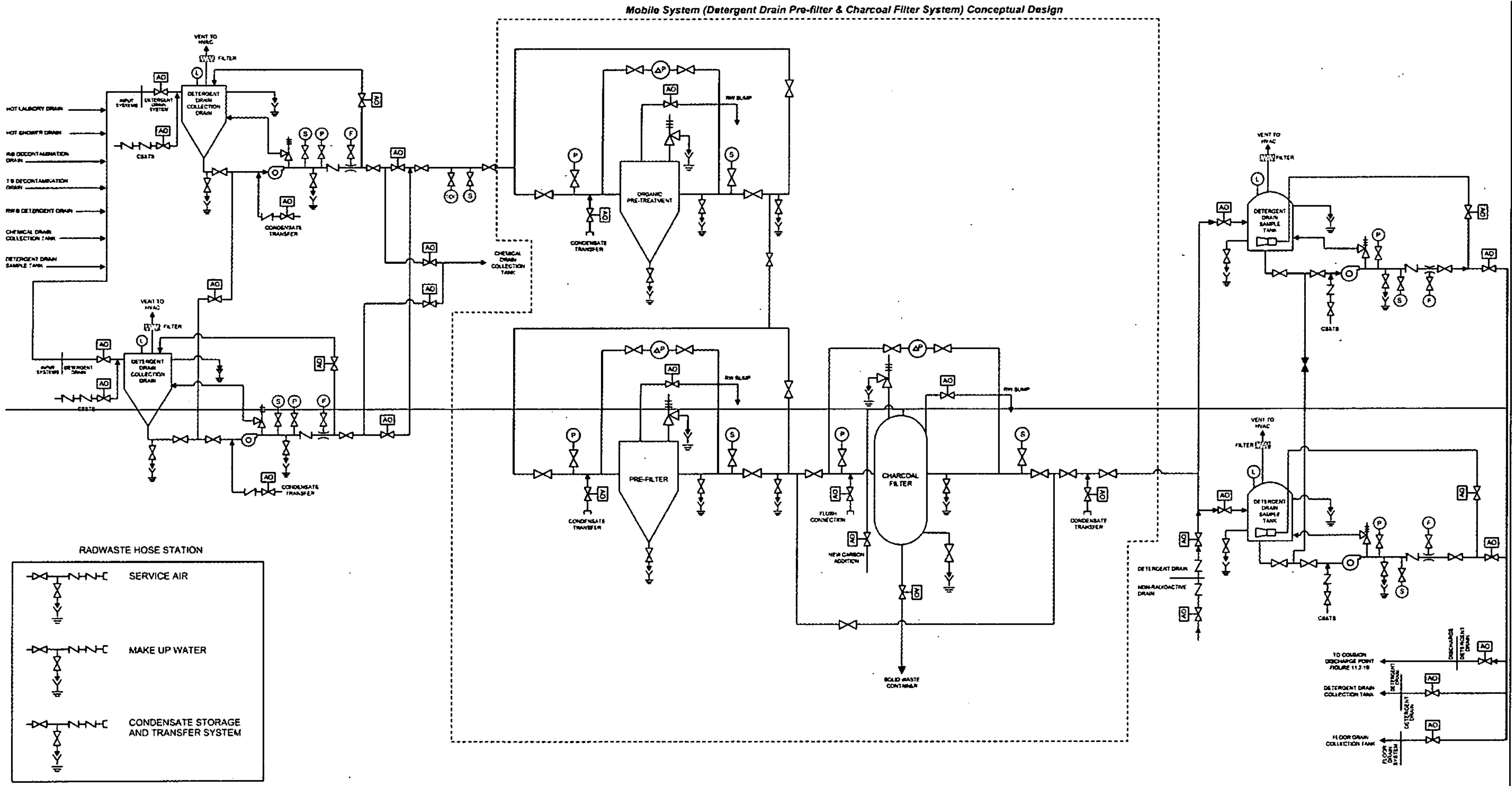


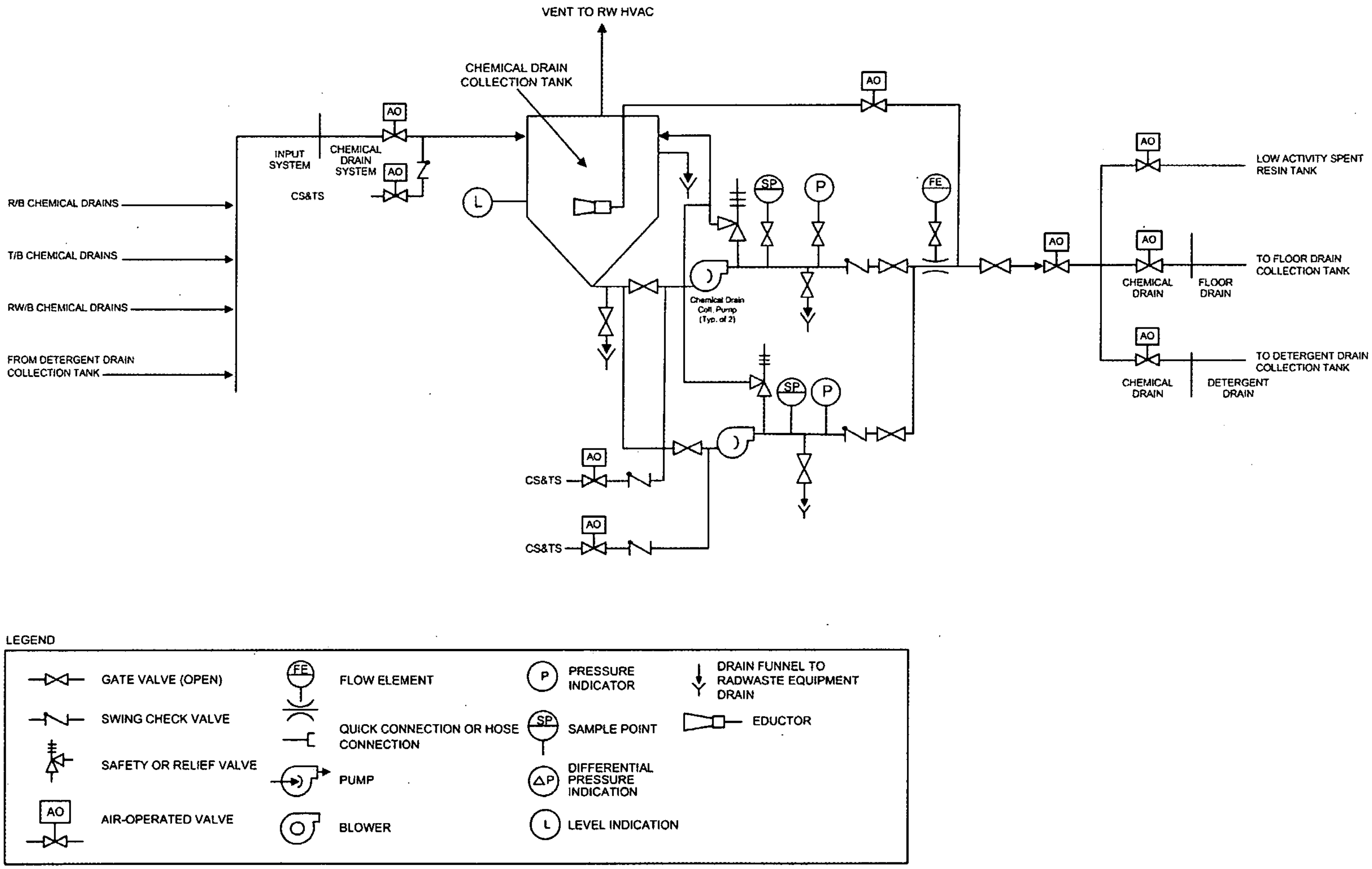
Figure 11.2-1b. Floor Drain


Detergent Drain Process Subsystem
CHARCOAL FILTER
PRE-FILTER
RADWASTE HOSE STATION
SERVICE AIR
MAKE UP WATER
CONDENSATE STORAGE AND TRANSFER SYSTEM
LEGEND
GATE VALVE (OPEN)
SWING CHECK VALVE
SAFETY OR RELIEF VALVE
AIR-OPERATED VALVE
FLOW ELEMENT
QUICK CONNECTION OR HOSE CONNECTION
PUMP
BLOWER
PRESSURE INDICATOR
SAMPLE POINT
DIFFERENTIAL PRESSURE INDICATION
LEVEL INDICATION
DRAIN FUNNEL TO RADWASTE EQUIPMENT DRAIN
EDUCTOR
SYSTEM DESIGN PER REQUIREMENTS OF REG. GUIDE 1.143

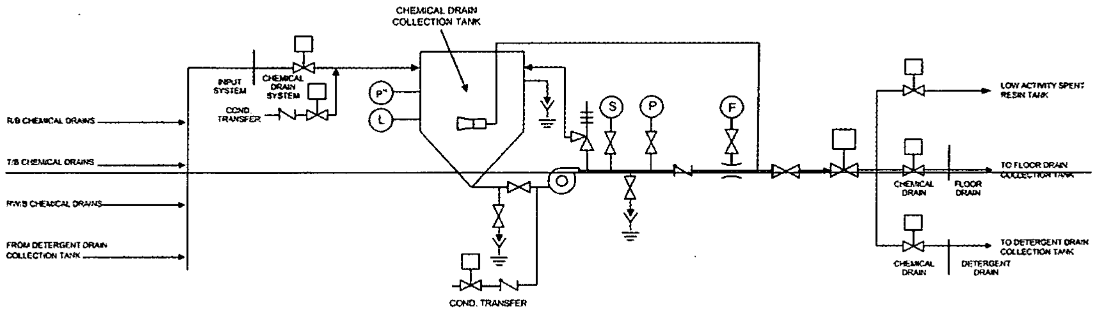


MATERIALS PER THE REQUIREMENTS OF REG. GUIDE 1.143

Figure 11.2-3. Detergent Drain



SYSTEM DESIGN PER REQUIREMENTS OF REG. GUIDE 1.143



MATERIALS PER THE REQUIREMENTS OF REG. GUIDE 1.143

Figure 11.2-4. Chemical Drain

11.3 GASEOUS WASTE MANAGEMENT SYSTEM

11.3.1 Design Bases

The objective of the gaseous waste management system is to process and control the release of gaseous radioactive effluents to the environs so as to maintain the exposure of persons in unrestricted areas to radioactive gaseous effluents as low as reasonably achievable according to 10 CFR 50, Appendix I (Reference 11.3-1), 10 CFR 20, Appendix B Table 2 effluent concentration limits, (Reference 11.3-2) and 10 CFR 50.34a (Reference 11.3-1). This is accomplished while maintaining occupational exposure as low as reasonably achievable without limiting plant operation or availability.

The two main sources of plant gaseous radioactive effluents are the building ventilation systems, which are discussed in Section 9.4, and the power cycle Offgas System (OGS) that is described and reviewed in this section.

The OGS provides for holdup, and thereby, decay of radioactive gases in the offgas from the main condenser air removal system (Subsection 10.4.2) and consists of process equipment along with monitoring instrumentation and control components.

The OGS minimizes and controls the release of radioactive material into the atmosphere by delaying release of the offgas process stream initially containing radioactive isotopes of krypton, xenon, iodine, nitrogen, and oxygen. This delay, using activated charcoal absorber beds, is sufficient to achieve adequate decay before the process offgas stream is discharged from the plant.

The OGS design minimizes the explosion potential in the OGS through recombination of radiolytic hydrogen and oxygen under controlled conditions as required by GDC 3 (Reference 11.3-19). Additional GDC 3 requirements are addressed in Subsection 9.5.1 Appendix 9A and Appendix 9B.

The gaseous effluent treatment systems are designed to limit the dose to off-site persons from routine station releases to significantly less than the limits specified in 10 CFR 20 (Reference 11.3-2) and to operate within the relevant limits specified in the plant-specific Technical Specifications (TS).

As a conservative design basis for the OGS, an average annual noble radiogas source term (based on 30-minute decay) is assumed. The OGS System Design Parameters are shown in Table 11.3-1. The system is mechanically capable of processing three times the source term without affecting delay time of the noble gases. Table 11.3-5 lists the isotopic distribution at t = 0. Table 11.3-1 shows the xenon time delays with an assumed air in-leakage.

Design guidelines described in Branch Technical Position (BTP) - Effluent Treatment Systems Branch (ETSB) 11-5 (Reference 11.3-18) minimize radiation and radiological consequences due to a single failure of an active component were considered in the design of the OGS.

Using the isotopic activities at the discharge of the OGS, the DF for each noble gas isotope can be determined. Section 11.1 presents source terms for normal operational and anticipated occurrence releases to the primary coolant. Tables in this section, if not designated otherwise, are based upon a design basis annual average offgas release rate (measured after 30 minutes decay from the core) of noble gases and as shown in Table 11.3-1. For normal expected conditions, the leak rates and doses are expected to be less than one-fifth of the design basis numbers.

The average annual exposure at the site boundary during normal operation from all gaseous sources does not exceed the dose objectives of 10 CFR 50, Appendix I (Reference 11.3-1), to individuals in unrestricted areas (Refer to Section 12.2). The radiation dose design basis for the treated offgas is to provide sufficient holdup until the required fraction of the radionuclides has decayed with the daughter products retained by the charcoal.

The gaseous waste management system equipment is selected, arranged, and shielded to maintain occupational exposure as low as reasonably achievable in accordance with NRC RG 8.8 (Reference 11.3-14).

The gaseous waste management system is designed to the requirements of the GDC 60 (Reference 11.3-15) and 64 (Reference 11.3-16).

A list of the OGS major equipment items, including materials, rates, process conditions, number of units supplied, and relevant design codes, is provided in Table 11.3-2.

The OGS is also designed to the requirements indicated in DCD Section 3.2.

In accordance with IE Bulletin 80-10, tThe OGS interconnections between plant systems are designed to minimize the contamination of non-radioactive systems and uncontrolled releases of radioactivity in the environment as required by Bulletin 80-10, May 6, 1980 (Reference 11.3-13).

A discussion of OGS compliance with 10 CFR 20.1406 (Reference 11.3-17) is located in Section 12.6.

11.3.2 Offgas System Description

11.3.2.1 Process Functions

Major process functions of the OGS include the following:

- Recombination of radiolytic hydrogen and oxygen into water to reduce the gas volume to be treated and the explosion potential in downstream process components;
- Two-stage condensation of bulk water vapor first using condensate and then chilled water as the coolant reducing the gaseous waste stream temperature to the value shown in Table 11.3-1;
- Dynamic adsorption of krypton and xenon isotopes on charcoal at the approximate temperature shown in Table 11.3-1;
- Monitoring of offgas radioactivity levels and hydrogen gas content;
- Release of processed offgas to the atmosphere; and
- Discharge of liquids to the condenser and/or LWMS.

Samples of the offgas system are collected using the process sample system described in Subsection 9.3.2.

normal for power operation. However, it may be used if the resulting activity release is acceptable.

11.3.2.5.11 Valves

All valves with operators located on the gas process stream are operable from the main control room. Where radiation levels permit, valves handling process fluids are installed in service areas where maintenance can be performed if needed during operation.

11.3.2.5.12 Nitrogen and Air Purge

A nitrogen purge and air supply line is connected to the offgas process just upstream of the first in-line charcoal adsorber vessel (guard bed). This arrangement is to allow the vessel to be nitrogen purged after a possible fire is detected or dried with heated air if the charcoal is wetted, while the offgas flow is bypassed around it and through the remaining charcoal vessels. Another nitrogen purge line is also provided just upstream of the remaining charcoal adsorber vessels that allows them to be purged, if required, without interrupting the processing of offgas through the guard bed. Both nitrogen purge lines are equipped with double check valves and tell-tale leak-off connections to permit periodic checks to confirm their integrity and to minimize contamination of the nitrogen system. The isolation valves in the nitrogen and air purge lines and the connection for the gas supply are accessible from outside the charcoal vault.

11.3.2.6 Component Design

For portions of the system that may contain an explosive mixture, the design provides for ignition sources to be minimized and the system to be able to sustain an explosion without loss of integrity. This analysis is covered in proprietary report NEDE-11146 (Reference 11.3-11).

Calculation methods for translation of detonation pressures into wall thickness are summarized in the ANSI-55.4 (Reference 11.3-6). Equipment are designed and constructed in accordance with the requirements of Table 11.3-2.

Tank codes are per the noted requirements of Table 3.2-1 for K30 Solid Waste Management Systems.

11.3.2.6.1 Materials

Per RG 1.143 (Reference 11.3-3), Regulatory Position 2.2, materials for pressure-retaining components of process systems[1] are selected from those covered by the material specifications listed in Section II, Part A of the ASME Boiler and Pressure Vessel Code, except that malleable, wrought or cast-iron materials, and plastic pipe are not allowed in this application. The components satisfy the mandatory requirements of the material specifications with regard to manufacture, examination, repair, testing, identification, and certification.

11.3.2.6.2 Pressure Relief

Adequate pressure relief is provided at all locations where it is possible to isolate a portion of the system containing a potential heat source that could cause excessive pressure. Adequate pressure

1 "Process System" refers to that portion of the OGS that normally processes SJAE Offgas.

11.3.5 Testing and Inspection Requirements

Because the gaseous radioactive waste system has no safety-related function, no inservice inspection of the components is required.

Preoperational and startup testing, which includes hydrostatic testing of system components and piping; soap bubble testing of instrument and purge lines, helium leak testing; and verification of air ejector pressure and flow, preheater operation (recombiner inlet temperature), catalyst temperature, and offgas condenser operation; is accomplished as described within Section 14.2. These inspection and testing provisions are in compliance with the requirements of RG 1.143 (Reference 11.3-3).

During normal operation, the hydrogen analyzers, process components, and monitoring instrument channels are periodically tested and calibrated to ensure that the explosive gas mixture is below the flammability limit and projected doses from gaseous effluent releases are kept as low as reasonably achievable and below regulatory limits.

The quality assurance program for design, fabrication, procurement, and installation of the gaseous radioactive waste system is in accordance with the overall quality assurance program described in Chapter 17.

11.3.6 Instrumentation Requirements

Control and monitoring of the OGS process equipment is performed locally or remotely from the main control room. Generally, system control is from the main control room. Instrument components are installed wherever possible in accessible areas to facilitate operation and maintenance. Only instrument sensing elements are permitted behind shield walls.

The temperature of the gaseous waste stream is measured in the preheater and at various locations in the recombiner to assure that recombination is occurring. The gaseous waste stream temperature is also measured after both the offgas condenser and the cooler condenser to assure the stream is cooled sufficiently to remove undesired moisture. These temperatures are alarmed in the main control room.

The flow rate of the offgases is continuously monitored. The offgas flow rate, in conjunction with activity concentrations as measured by the monitor downstream of the recombiners and the monitor downstream of the charcoal adsorbers, permits monitoring fission gases from the reactor, calculation of offgas discharge to the vent, and calculation of the charcoal adsorber system performance.

OGS hydrogen concentration and effluent radiation level are continuously monitored and at a preset high level, alarm locally and in the Main Control Room.

Offgas pre-treatment radiation monitors are described in Subsection 11.5.3.2.1. Offgas post-treatment radioactive monitors are described in Subsection 11.5.3.2.2.

11.3.7 Radioactive OffGas System Leak or Failure

11.3.7.1 Basis and Assumptions

The radiological consequences for an OGS accident as specified in Standard Review Plan 11.3 (Reference 11.3-18), BTP 11-5 are presented. The BTP assumptions were used except as

11.3.7.2 Results

The DBA evaluation assumptions are given in Table 11.3-4, the isotopic flows and releases in Table 11.3-5 and Table 11.3-6, and the meteorology and dose results in Table 11.3-7.

The dose results are given in Table 11.3-7, and are within the limiting 25 mSv (2.5 Rem) whole body dose for an offgas system designed to withstand explosions and earthquakes, per BTP 11-5 (Reference 11.3-18) and RG 1.143 (Reference 11.3-3).

11.3.8 COL Information

None.

11.3.9 References

11.3-1 Title 10 Code of Federal Regulations Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions to Meet the 'As Low As Is Reasonably Achievable' for Radioactive Material in Light-Water Cooled Nuclear Power Reactors."

11.3-2 Title 10 Code of Federal Regulations Part 20, "Standards for Protection Against Radiation."

11.3-3 Nuclear Regulatory Commission (NRC), Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants."

11.3-4 (Deleted) ~~American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII - Division 1.~~

11.3-5 (Deleted) ~~American Institute of Steel Construction (AISC), Manual of Steel Construction.~~

11.3-6 American National Standards Institute, "Gaseous Radioactive Waste Processing Systems for Light Water Reactor Plants," ANSI/ANS-55.4.

11.3-7 W.E. Browning, et al., "Removal of Fission Product Gases from Reactor Offgas Streams by Absorption," June 11, 1959, Oak Ridge National Laboratory (ORNL) CF59-6-47.

11.3-8 D.P. Seigwarth, "Measurement of Dynamic Absorption Coefficients for Noble Gases on Activated Carbon," Proceedings of the12th AEC Air Cleaning Conference.

11.3-9 Dwight Underhill, et al., "Design of Fission Gas Holdup Systems, Proceedings of the Eleventh AEC Air Cleaning Conference," 1970, p. 217.

11.3-10 General Electric Co., "Radiological Accident Evaluation - The CONAC03 Code," NEDO-21143-1, December 1981.

11.3-11 General Electric Co., "Pressure Integrity Design Basis for New Off-Gas Systems," NEDE-11146, July 1971 (Proprietary).

11.3-12 (Deleted) ~~Draft Guide DG-1145: Combined License Applications for Nuclear Power Plants (LWR Edition), 1.11 Radioactive Waste Management.~~

11.3-13 Bulletin 80-10, May 6, 1980.

Table 11.3-1

Offgas System Design Parameters*

Design Parameter	Design Value
Design basis noble radiogas release rate	3700 MBq/s (100,000 μCi/s)
Assumed air in-leakage	51 m^3/h standard (30 scfm)
Xenon delay	60-day
Krypton delay	78.6 hours**
Argon delay	27.2 hours**
Iodine removal efficiency	99.99** and ***
Maximum gaseous waste stream temperature	67°C (153°F)
Charcoal temperature (approximate)	35°C (95°F)
Maximum cooler condenser temperature	18°C (65°F)
Chilled water temperature	7°C (45°F)
Gaseous waste stream temperature	35°C (95°F)
Nominal recombiner preheater temperature	177°C (351°F)
Maximum recombiner preheater temperature	210°C (410°F)
Out-of-service hydrogen/oxygen catalytic recombiner minimum temperature	121°C (250°F)
Minimum activated charcoal ignition temperature	156°C (313°F)
Minimum air bleed supply rate	0.17 m^3/min (6 scfm)
Air bleed to standby recombiner train at startup and normal operation	0.17 m^3/min (6 scfm)
Radiolytic gas flow range	0 to 8.6 m^3/min (302 scfm)
Charcoal adsorber vault temperature range	29°C (84°F) to 40°C (104°F)
Charcoal particle size	8 – 16 mesh United States Standard (USS) with less than 0.5% under 20 mesh
Charcoal moisture content	< 5% by weight
Maximum offgas activity input concentration	5.9E+6 Bq/cm^3
Charcoal Guard Bed Mass	33,000 lbs (15 metric tons)
Charcoal Bed Mass	490,000 lbs (222 metric tons)

* For additional information on radioactive releases, refer to Sections 11.1 or 12.2.
** Offgas processing equipment will meet or exceed these values.
*** No Iodine is assumed to be released.

Table 11.3-4

Offgas System Failure Accident Parameters

I. Data and Assumptions Used to Estimate Source Terms	
a. Power Level	4,500 MWt
b. Offgas Release Rate	1.67E+4 MBq/s[1] (4.5E+5 μCi/s)
c. Duration of Release	1h
II. Dispersion and Dose Data	
a. Meteorology	Table 11.3-7
b. Dose Methodology	Reference 11.3-~~10~~ 18
c. Dose Conversion Assumptions	Reference 11.3-1~~0~~8~~, RG 1.109~~
d. Activity Releases	Table 11.3-6
e. Dose Evaluations	Table 11.3-7

1 Isotopic rates refer to a 30-minute decay time.

Table 11.3-6

Releases to the Environment

Isotope	Release Rate		Releases	
	MBq/s	Ci/s	MBq	Ci
Kr-83m	4.88E+2	1.32E-2	1.76E+6	4.75E+1
Kr-85m	9.22E+2	2.49E-2	3.32E+6	8.97E+1
Kr-85	4.00E+0	1.08E-4	1.44E+4	3.89E-1
Kr-87	2.50E+3	6.75E-2	8.99E+6	2.43E+2
Kr-88	2.91E+3	7.88E-2	1.05E+7	2.84E+2
Kr-89	2.90E+1	7.83E-4	1.04E+5	2.82E+0
Total Kr	6.85E+3	1.85E-1	2.47E+7	6.67E+2
Xe-131m	3.28E+0	8.86E-5	1.18E+4	3.19E-1
Xe-133m	4.86E+1	1.31E-3	1.75E+5	4.73E+0
Xe-133	1.39E+3	3.76E-2	5.01E+6	1.35E+~~1~~2
Xe-135m	1.13E+3	3.05E-2	4.06E+6	1.10E+2
Xe-135	3.65E+3	9.85E-2	1.31E+7	3.55E+2
Xe-137	1.15E+2	3.12E-3	4.15E+5	1.12E+1
Xe-138	3.46E+3	9.36E-2	1.25E+7	3.37E+2
Total Xe	9.80E+3	2.65E-1	3.53E+7	9.53E+2
Kr+Xe	1.67E+4	4.50E-1	5.99E+7	1.62E+3

Table 11.3-7

Offgas System Failure Meteorology and Dose Results

EAB X/Q	Whole Body Dose	BTP 11-5 Dose Limit
2.0 E-3 s/m^3*	6.2 mSv (0.62 Rem)	25 mSv (2.5 Rem)

* DCD Table 2.0-1

11.4 SOLID WASTE MANAGEMENT SYSTEM

The Solid Waste Management System (SWMS) is designed to control, collect, handle, process, package, and temporarily store wet and dry solid radioactive waste prior to shipment. This waste is generated as a result of normal operation and anticipated operational occurrences.

The SWMS is located in the radwaste building. It consists of the following ~~five~~ four subsystems:

- ~~Wet solid waste~~SWMS collection subsystem,
- ~~Mobile wet solid waste processing~~SWMS process subsystem,

~~□Mobile Concentrate Treatment System,~~

- Dry solid waste accumulation and conditioning subsystem, and
- Container storage subsystem.

The SWMS Process Diagram depicting all ~~five~~ four subsystems is provided in Figure 11.4-1. The radwaste building general arrangement drawings are provided in Figures 1.2-21 through 1.2-25. The SWMS component capacities are provided in Table 11.4-1. The estimated annual shipped waste volumes generated from the SWMS subsystems are provided in Table 11.4-2. The SWMS can process wastes at rates higher than shown in Table 11.4-2. The ~~SWMS Spent Resin Sludge Transfer System~~SWMS collection is shown on Figure 11.4-2. The SWMS ~~Solid Radwaste Dewatering~~Process System is shown on Figure 11.4-3.

Process and effluent radiological monitoring systems are described in Section 11.5.

11.4.1 Design Bases

SWMS Bases

The SWMS has no safety-related function.

The SWMS is designed to provide collection, processing, packaging, and storage of bead resin, filter backwash, and dry solid waste resulting from normal operations.

- The SWMS is designed to meet the guidance of RG 1.143 (Reference 11.4-3).
- The SWMS is designed to keep the exposure to plant personnel "as low as reasonably achievable" (ALARA) during normal operation and plant maintenance, in accordance with RG 8.8 (Reference 11.4-4).
- The SWMS is designed to package solid waste in Department of Transportation (DOT)-approved containers for off-site shipment and burial.
- The SWMS is designed to prevent the release of significant quantities of radioactive materials to the environment so as to keep the overall exposure to the public within 10 CFR 20 limits and in accordance with the limits specified in 10 CFR 50 (Reference 11.4-21). Additionally, the SWMS is designed to comply with the requirements of 10 CFR 20.2007 (Reference 11.4-26).
- The SWMS is designed to package the wet and dry types of radioactive solid waste for off-site shipment and disposal, in accordance with the requirements of applicable NRC and DOT regulations, including 10 CFR 61 (Reference 11.4-~~13~~16), 10 CFR 71

(Reference 11.4-22) and 49 CFR 171 (Reference 11.4-24) through 180 (Reference 11.4-25), as applicable. This results in radiation exposures to individuals and the general population within the limits of 10 CFR 20 and 10 CFR 50.

- The seismic and quality group classification and corresponding codes and standards that apply to the design of the SWMS components and piping, and the structures housing the SWMS are discussed in Section 3.2.
- On-site storage space for a six-month volume of packaged waste is provided in the radwaste building. Depending on the availability and accessibility of adequate waste repositories in the future, NUREG-0800, Standard Review Plan 11.4 and BTP - ETSB 11-3 (Reference 11.4-1) Solid Waste Management System, ~~DRAFT~~ Rev. 3 – ~~April 1996~~March 2007, Appendix 11.4-A, Design Guidance for Temporary Storage of Low Level Radioactive Waste provide guidance for construction and management of a temporary storage facility ~~including up to five years waste storage~~. This temporary storage facility and an associated overall site waste management plan is intended to allow the station to operate while methods for further waste minimization and volume reduction are considered, such as the design and construction of additional volume reduction facilities, as necessary, and then the processing of the wastes that may have been stored during the construction of those facilities. ~~Additionally, the five-year duration is to allow time for the regional state compacts to create additional low level waste disposal sites.~~ The inclusion of a temporary storage facility and an overall site management plan per NUREG-0800 Standard Review Plan 11.4 and BTP – ETSB 11-3 (Reference 11.4-1), Draft Rev 3-April 1996, Appendix 11.4-A, may be required (COL 11.4-4-A).
- All atmospheric collection and storage tanks are provided with an overflow connection at least the size of the largest inlet connection. The overflow is connected below the tank vent and above the high-level alarm setpoint. Each tank room is designed to contain the maximum liquid inventory in the event that the tank ruptures.

Isotopic activity in SWMS is presented in Tables 12.2-14a, b, c, and d. Any resultant gaseous and liquid wastes are routed to other plant sections. Gaseous radionuclides from the SWMS are processed by the monitored radwaste building ventilation system. The monitored ventilation system is described in Section 9.4 and Subsection 12.3.3.2.4. Liquid waste is processed by the monitored LWMS system as described in Section 11.2. Process and effluent radiological monitoring systems are described in Section 11.5.

Section 12.3 describes systems to detect conditions that may result in excessive radiation levels per Title 10 Code of Federal Regulations Part 50, Appendix A, GDC 63 (Reference 11.4-14). Section 11.5 describes systems to monitor the effluent discharge paths for radioactive material per Title 10 Code of Federal Regulations Part 50, Appendix A, GDC 64 (Reference 11.4-15).

A description of the SWMS design features addressing 10 CFR 20.1406 (Reference 11.4-7) requirements for permanently installed systems is in Section 12.6. The COL Applicant is responsible for including site-specific information describing how the implementation of operating procedures and design features for installation and operation of the ~~mobile/portable~~ SWMS process subsystem will address the requirements of 10 CFR 20.1406 (Reference 11.4-7). Specifically the operational procedures and design of the ~~mobile/portable~~ SWMS process subsystem should minimize, to the extent practicable, contamination of the facility and the environment, facilitate decommissioning, and minimize the generation of radioactive wastes (COL 11.4-5-A). This information is placed in Section 12.6.

The Area Radiation Monitors for the Radwaste Building Wet Solid Radioactive Waste Treatment Area, the Radwaste Building Dry Solid Waste Treatment Area and the Radwaste Building Packaged Waste Staging Area are depicted on Figure 12.3-41 listed on Table 12.3-4 and discussed in Subsection 12.3.4. The radwaste building seismic capability is described in Section 3.8.

The ~~portable/mobile~~ SWMS process subsystem equipment is located within the radwaste building as previously referenced and described. The location of the SWMS equipment within the radwaste building with monitored process effluents ensures compliance with 10 CFR 20.1302 (Reference 11.4-6), 10 CFR 20 Appendix B (Reference 11.4-8) effluent concentrations, 10 CFR 50.34a (Reference 11.4-10), 10 CFR 50, Appendix A, GDC 60 (Reference 11.4-12) and GDC 61 (Reference 11.4-13), as they relate to radioactive materials released in gaseous and liquid effluents to unrestricted areas.

11.4.2 System Description

11.4.2.1 Summary Description

The SWMS controls, collects, handles, processes, packages, and temporarily stores solid waste generated by the plant prior to shipping the waste offsite. The SWMS processes the filter backwash sludges, RO concentrates, charcoal media, and bead resins generated by the Liquid Waste Management System (LWMS), Reactor Water Cleanup/Shutdown Cooling System (RWCU/SDC), Fuel and Auxiliary Pools Cooling System (FAPCS) and the Condensate Purification System. Contaminated solids such as High Efficiency Particulate Air (HEPA) and cartridge filters, rags, plastic, paper, clothing, tools, and equipment are also disposed of in the SWMS.

The SWMS is capable of receiving, processing, and dewatering the solid radioactive waste inputs for permanent off-site disposal. Liquids from SWMS operations are sent to the appropriate LWMS section for processing as depicted in Figure 11.4-1 and described in Section 11.2.

11.4.2.2 System Operation

The SWMS complies with RG 1.143 (Reference 11.4-3), Revision 2, November 2001, as noted in Subsection 11.4.1. Radwaste Building construction requirements meet the guidance of RG 1.143 (Reference 11.4-3) regarding safety-related classification is located in Subsection 3.8.4 and Subsection 3.8.4.1.5. RG 1.143 (Reference 11.4-3), Section 4.1, requires the design of radioactive waste management systems, structures and components to follow the direction in RG 8.8 (Reference 11.4-4). Compliance with RG 8.8 (Reference 11.4-4), Revision 3, June 1978 is located in Subsection 12.1.1.3 and Subsection 12.3.1. The SWMS consists of four process subsystems as listed below.

11.4.2.2.1 Wet Solid Waste Collection Subsystem

The wet solid waste collection subsystem collects the spent bead resin slurry, spent charcoal media, filter and tank sludge slurry, and concentrated waste into the one of the five tanks in accordance with the waste characteristics. The wet solid waste collection subsystem is shown ~~on~~ in Figures 11.4-~~1 and 11.4-~~2.

Spent bead resin sluiced from the RWCU, FAPCS, Condensate Purification System and LWMS is transferred to three spent resin tanks for storage. Spent resin tanks are categorized as follows:

- High Activity Resin Holdup Tank for receiving RWCU and FAPCS spent bead resin.
- Low Activity Resin Holdup Tank for receiving LWMS spent bead resin.
- Condensate Resin Holdup Tank for receiving Condensate Purification System spent bead resin.

The capability exists to keep the higher activity resins, the lower activity resins and condensate resins in separate tanks. Excess water from holdup tanks is pumped to the equipment drain collection tank or floor drain collection tank.

When sufficient bead resins have been collected in the high or low activity resin holdup tanks, they are mixed via the high or low activity resin transfer pump and sent to the ~~mobile~~ wet solid waste processing subsystem. When sufficient bead resins have been collected in the condensate resin holdup tank, they are mixed via the ~~condensate~~ resin transfer pump and sent to the LWMS pre-treatment ion-exchanger for reuse or the ~~mobile~~ wet solid waste processing subsystem.

Two Low Activity Phase Separators receive suspended solid slurries from the Condensate Purification System, ~~mobile~~ process filtration system of the LWMS and HICs. The suspended solids are allowed to settle and the residual water is transferred by the low activity decant pump to the equipment drain collection tanks or floor drain collection tanks for further processing. When sufficient sludges have been collected in the tank, the sludges are mixed by the low activity resin transfer pump and sent to the ~~mobile~~ wet solid waste processing subsystem by the low activity resin transfer pump.

During transfer operations of spent bead resins, and sludges, suspended solids are kept suspended by periodic and recirculation flushing to prevent them from agglomerating and possibly clogging lines.

~~One~~ The Concentrated Waste Tank receives concentrated waste from the ~~mobile~~ reverse osmosis system of the LWMS. When sufficient concentrated waste has been collected in the tank, the concentrated waste is sent to the ~~Mobile~~ Wet Solid Waste Processing ~~Concentrate Treatment~~ Subsystem by a mixing/transfer pump. A second mixing/transfer pump is provided for operational flexibility.

11.4.2.2.2 ~~Mobile~~ Wet Solid Waste Processing Subsystem

~~A conceptual design of the Mobile~~ The Wet Solid Waste Processing Subsystem is depicted in Figure 11.4-3~~1~~. The ~~mobile~~ wet solid waste processing subsystem consists of a dewatering station for high activity spent resin, and a dewatering station for low activity spent resin and sludge and a dewatering station for concentrated waste. An empty HIC is lifted off of a transport trailer and placed in each empty dewatering station. The tractor/trailer may then be released. The HIC closure lid is removed and placed in a laydown area. Spent cartridge filters may be placed in the HIC at this point, if not shipped in separate containers.

Next, the fill head is positioned over the HIC with a crane. The fill head includes a closed circuit television camera for remote viewing of the fill operation. The HIC is then filled with wet solid waste. Samples can be obtained during the fill operation is provided.

Excess water is removed from the HIC and sent by a dewatering pump to the high activity resin holdup tank or a low activity phase separator~~ that is in the receiving mode~~. Sufficient water is removed to ensure that there is very little or no free standing water left in the HIC. ~~Drying of the HIC contents may also be performed with heated air or moisture removal via an option Thermal Drying System.~~

The fill head is then removed and placed in a laydown area. The closure head is then placed on the HIC. The HIC is provided with a passive vent to prevent pressure build up. Radiation shielding is provided around the HIC stations.

The estimated annual shipped waste volumes from processing wet solid wastes are presented in Table 11.4-2.

~~***Mobile Concentrate Treatment System***~~

~~A conceptual design of the Mobile Concentrate Treatment Subsystem is depicted on Figure 11.4-1. The Mobile Concentrate Treatment Subsystem consists of a dewatering station for concentrated waste.~~

~~An empty HIC is placed in the empty dewatering station. The HIC closure lid is removed and placed in a laydown area. The fill head is then positioned over the HIC with a crane. The fill head includes a closed circuit television camera for remote viewing of the fill operation. The HIC is then filled with concentrates. The capability to obtain samples during the fill operation is provided. Sufficient water is removed to ensure there is very little or no free standing water left in the HIC. Removed water is sent by pump to the Floor Drain Collection Tank or the Low Activity Phase Separator that is in the receiving mode. Drying of the HIC contents may also be performed with heated air or moisture removal via an optional Thermal Drying System.~~

~~The fill head is then removed and placed in a laydown area. The closure head is placed on the HIC. The HIC is provided with a passive vent to prevent pressure build up. Radiation shielding is provided around the HIC stations.~~

~~The estimated annual shipped waste volumes from concentrate wastes are presented in Table 11.4-2.~~

11.4.2.2.3 Dry Solid Waste Accumulation and Conditioning Subsystem

Dry solid wastes consist of air filters, miscellaneous paper, rags, etc., from contaminated areas; contaminated clothing, tools, and equipment parts that cannot be effectively decontaminated; and solid laboratory wastes. The off gas system activated carbon is rejuvenated by the off gas system and does not normally generate dry solid waste. Condition-specific action is taken regarding the removal, replacement, and processing of off gas activated carbon in the unlikely event that significant quantity of off gas system activated carbon requires replacement during the life of the plant. The activity of much of the dry solid wastes is low enough to permit handling by contact. These wastes are collected in containers located in appropriate areas throughout the plant, as dictated by the volume of wastes generated during operation and maintenance. The filled containers are sealed and moved to controlled-access enclosed areas for temporary storage.

Most dry waste is expected to be sufficiently low in activity to permit temporary storage in unshielded, cordoned-off areas. Dry Active Waste (DAW) is sorted and packaged in a suitably sized container that meets DOT requirements for shipment to either ~~an~~ a licensed off-site processor or for ultimate disposal. The DAW is separated into three categories: non-contaminated wastes (clean), contaminated metal wastes, and the other wastes, i.e., clothing, plastics, HEPA filters, components, etc. Non-contaminated (clean) materials identified during the sorting process are removed for plant re-use or general debris disposal.

In some cases, large pieces of miscellaneous waste are packaged into metal boxes in accordance with DOT shipping requirements. DAW and other solid waste is stored until enough is accumulated to permit economical transportation to an off-site burial ground for final disposal or an approved radwaste processor.

The capability exists to bring shipping containers into the truck bay. Bagged DAW can be directly loaded into the shipping container for burial or processing in off-site facilities. A weight scale is provided to ensure optimum shipping/disposal weight of the shipping container.

Cartridge filters that are not placed in HICs are placed in suitability-sized containers meeting DOT requirements.

The estimated shipped waste volumes from processing DAWs are presented in Table 11.4-2.

11.4.2.2.4 Container Storage Subsystem

On-site storage space for a six-months volume of packaged waste is provided. Packaged waste includes HICs, shielded filter containers, 55-gallon (200-liter) drums, and other shipping containers as necessary. The container storage schemes and sequencing is shown in Figure 11.4-1.

11.4.2.2.5 Mixed Waste Processing

To the greatest extent practicable, all discarded chemicals (including those classified as EPA hazardous) will be kept out of the RWMS. Mixed waste volumes generated at ESBWR facilities are anticipated to be less than or equal to the volumes provided in Table 11.4-2. Mixed waste is collected primarily in 55-gallon (208 liters)collection drums and sent offsite to an appropriately permitted vendor processor. However, should circumstances dictate the storage or disposal of larger quantities of mixed waste, other approved containers, such as HICs, or use of multiple approved containers can be used. Storage and disposal of mixed waste is in accordance with the facility's NRC license, DOT transportation regulations, EPA mixed waste regulations, state and local regulations and associated permits.

11.4.2.3 Detailed System Component Description

The major components of the SWMS are as follows.

11.4.2.3.1 Pumps

Typically two types of pumps are utilized in the SWMS:

1. The SWMS process pumps are centrifugal pumps constructed of materials suitable for the intended service.
2. Air-operated diaphragm type pumps are utilized in dewatering stations.

Pump codes are per the noted requirements of Table 3.2-1 for K20 Solid Waste Management Systems.

11.4.2.3.2 Tanks

The SWMS tanks are sized for normal plant waste volumes with sufficient excess capacity to accommodate equipment downtime and expected maximum volumes that may occur. The tanks are constructed of stainless steel to provide a low corrosion rate during normal operation. They are provided with mixing eductors and/or air spargers. The capability exists to sample all SWMS tanks. All SWMS tanks are vented ~~through a filtration unit and the exhausted air is eventually discharged into the plant vent~~to radwaste ventilation. The SWMS tanks are designed in accordance with ASME Section III, Class 3, American Petroleum Institute (API) 620, API 650, or AWWA D-100.

Tank codes are per the noted requirements of Table 3.2-1 for K20 Solid Waste Management Systems.

11.4.2.3.3 Piping

Piping used for hydraulic transport of slurries such as ion exchange resins, filter backwash (sludge), and waste tank sludge are specifically designed to assure trouble-free operation. Pipe flow velocities are sufficient to maintain a flow regime appropriate to the slurry being transported (ion exchange resins, filter backwash, RO concentrate, or tank sludge). An adequate water/solids ratio is maintained throughout the transfer. Slurry piping is provided with manual and automatic flushing with a sufficient water volume to flush the pipe clean after each use.

Piping codes are in accordance with RG 1.143 for Solid Waste Management Systems. Additionally, piping shielding design features are provided in accordance with RG 8.8, Position 2.

11.4.2.3.4 Ventilation

Makeup and exhaust ventilation is described in Section 9.4.

11.4.2.3.5 ~~Mobile~~ Wet Solid Waste Processing Subs~~S~~ystems

The ~~radwaste section includes modular mobile system skids that are~~Wet Solid Waste Processing Subsystem is designed to be readily replaced. This section includes requirements to be included in the replacement of the ~~mobile~~ process systems throughout the life of the ESBWR.

Solid radwaste processing is performed using ~~mobile~~ process systems. A description of these ~~mobile~~ process systems is provided in Subsection 11.4.2.1. A ~~conceptual~~ design is provided in Figure 11.4-~~1~~3. The process ~~Mobile~~ systems ~~are~~ is anticipated to be modernized as more effective technologies are discovered and proven throughout the life of plant operation. ~~To effect this modernization, the various systems, structures, and components associated with the mobile systems are grouped on skids or assemblies.~~ The ~~mobile~~ process systems works in conjunction with ~~permanent~~ other portions of SWMS radwaste equipment and are sized according to physical attributes and processing capability. The COL Applicant ensures ~~mobile~~ process systems, structures and component operations and testing complies with the requirements of RG 1.143 (Reference 11.4-3) and RG 8.8 (Reference 11.4-4) (COL 11.4-1-A). The COL Applicant shall evaluate ~~mobile~~ process systems compliance with the guidance and information in IE Bulletin 80-10 (Reference 11.4-19), May 6, 1980 for the express purpose of identifying and rectifying connections that are considered as non-radioactive, but could become radioactive through interfaces with radioactive systems, (i.e., a non-radioactive system that could become contaminated due to leakage, valving errors or other operating conditions in radioactive systems) (COL 11.4-2-A). The COL Applicant will fully describe a Process Control Program (PCP) (Reference 11.4-20) per 10 CFR 20, Appendix G (Reference 11.4-9) and 40 CFR 190 (Reference 11.4-18), including waste classification as A, B, C per 10 CFR 61.55 (Reference 11.4-16), and 10 CFR 61.56 (Reference 11.4-17) (COL 11.4-3-A).

11.4.3 Safety Evaluation

The SWMS has no safety-related function. There is no liquid plant discharge from the SWMS. Failure of the subsystem does not compromise any safety-related system or component nor does it prevent shutdown of the plant. No interface with the safety-related electrical system exists.

11.4.4 Testing and Inspection Requirements

The SWMS is given a pre-operational test as discussed in Chapter 14. Thereafter, portions of the subsystems are tested as needed.

During initial testing of the system, the pumps and the other equipment are performance tested to demonstrate conformance with design flows and process capabilities. An integrity test is performed on the system upon completion.

Provisions are made for periodic inspection of major components to ensure capability and integrity of the subsystems.

The quality assurance program for design, fabrication, procurement, and installation of the solid radioactive waste system is in accordance with the overall quality assurance program described in Chapter 17.

11.4.5 Instrumentation Requirements

The SWMS is operated and monitored from the radwaste control room or local operating stations within the facility. Major system parameters, i.e., tank levels, process flow rates, etc., are indicated (recorded and alarmed as required) to provide operational information and performance assessment. Key system alarms are repeated in the main control room. Instruments, including back flushing provisions, are located in low radiation areas when possible, as described in Subsection 12.3.1.1.2. These back flushing provisions are designed in accordance with IE Bulletin 80-10 (Reference 11.4-19).

11.4.6 COL Information

11.4-1-A ~~Mobile~~ Process System Regulatory Guide Compliance

The COL Applicant ensures that ~~mobile~~ process systems, structures and component operations and testing comply with the requirements of RG 1.143 (Reference 11.4-3) and RG 8.8 (Reference 11.4-4) (Subsection 11.4.2.3).

11.4-2-A Compliance with IE Bulletin 80-10

The COL Applicant shall evaluate ~~mobile~~ process systems compliance with the guidance and information in IE Bulletin 80-10, (Reference 11.4-19), May 6, 1980 for the express purpose of identifying and rectifying connections that are considered non-radioactive, but could become radioactive through interfaces with radioactive systems, i.e., a non-radioactive system that could become contaminated due to leakage, valving errors or other operating conditions in radioactive systems (Subsection 11.4.2.3).

11.4-3-A Process Control Program

The COL Applicant will fully describe a Process Control Program (Reference 11.4-20) per 10 CFR 20, Appendix G (Reference 11.4-9) and 40 CFR 190 (Reference 11.4-18), including waste classification as A, B, C per 10 CFR 61.55 (Reference 11.4-16), and 10 CFR 61.56 (Reference 11.4-17). The milestone for implementation of the PCP is provided in the COL information included in Section 13.4 (Subsection 11.4.2.3).

The COL Applicant will provide a milestone (See Section 13.4) for full program implementation.

11.4-4-A Temporary Storage Facility

The inclusion of a temporary storage facility and an overall site management plan per NUREG-0800 Standard Review Plan 11.4 (Reference 11.4-1), Draft Rev 3-April 1996, Appendix 11.4-A may be required (Subsection 11.4.1).

11.4-5-A Compliance with Part 20.1406

The COL Applicant is responsible for including site-specific information describing how the implementation of operating procedures and design features for installation and operation of the ~~mobile/portable~~ SWMS process systems will address the requirements of 10 CFR 20.1406 (Reference 11.4-7). Specifically the operational procedures and design of the ~~mobile/portable~~ SWMS process systems should minimize, to the extent practicable, contamination of the facility and the environment, facilitate decommissioning, and minimize the generation of radioactive wastes. This information is placed in Section 12.6 (Subsection 11.4.1).

11.4.7 References

11.4-1 NUREG-0800, Standard Review Plan, 11.4 Solid Waste Management System, ~~DRAFT~~ Rev. 3 – ~~April 1996~~March 2007 and BTP - ETSB 11-3 "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants."

11.4-2 (Deleted)~~Draft Guide DG-1145: Combined License Applications for Nuclear Power Plants (LWR Edition), 1.11 Radioactive Waste Management.~~

11.4-3 Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants", Revision 2, November 2001.

11.4-4 Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable" Revision 3, June 1978.

11.4-5 Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable", Revision 1-R, September 1975.

11.4-6 Title 10 Code of Federal Regulations, Part 20.1302.

11.4-7 Title 10 Code of Federal Regulations, Part 20.1406.

11.4-8 Title 10 Code of Federal Regulations, Part 20 Appendix B.

11.4-9 Title 10 Code of Federal Regulations, Part 20 Appendix G.

11.4-10 Title 10 Code of Federal Regulations, Part 50.34a.

11.4-11 Title 10 Code of Federal Regulations, Part 50.36a.

11.4-12 Title 10 Code of Federal Regulations, Part 50 Appendix A GDC 60.

11.4-13 Title 10 Code of Federal Regulations, Part 50 Appendix A GDC 61.

11.4-14 Title 10 Code of Federal Regulations, Part 50 Appendix A GDC 63.

11.4-15 Title 10 Code of Federal Regulations, Part 50 Appendix A GDC 64.

11.4-16 Title 10 Code of Federal Regulations, Part 61.55.

11.4-17 Title 10 Code of Federal Regulations, Part 61.56.

11.4-18 Title 40 Code of Federal Regulations, Part 190.

11.4-19 IE Bulletin 80-10, May 6, 1980.

11.4-20 Generic Letter 89-01, January 31, 1989, specifically, Enclosure 3, Section 6.13 Process Control Program, PCP.

11.4-21 Title 10 Code of Federal Regulations, Part 50.

11.4-22 Title 10 Code of Federal Regulations, Part 71, Packaging and Transportation of Radioactive Material.

11.4-23 (Deleted) ~~Title 10 Code of Federal Regulations, Part 20.~~

11.4-24 Title 49 Code of Federal Regulations, Part 171.

11.4-25 Title 49 Code of Federal Regulations, Part 180.

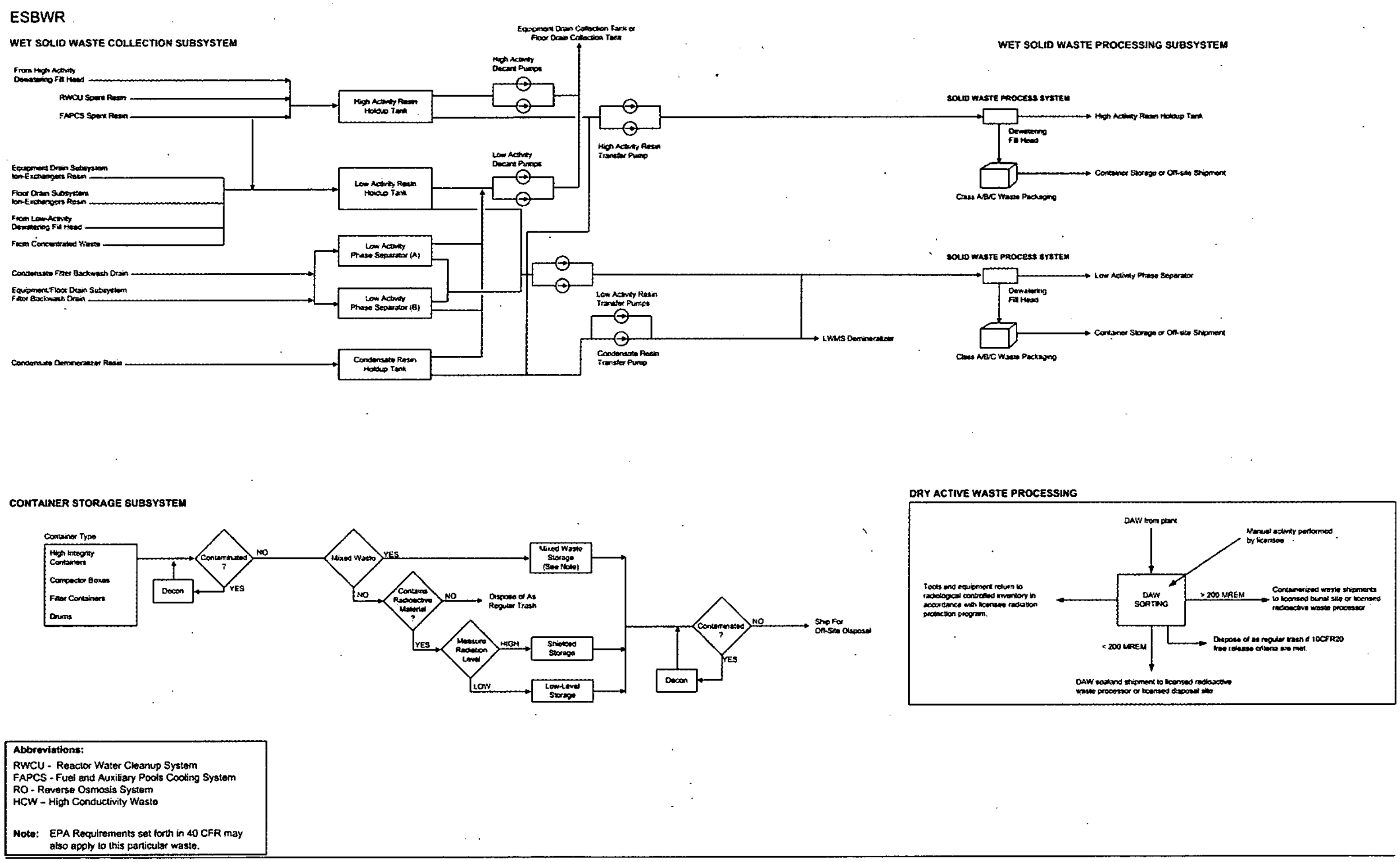
11.4-26 Title 10 Code of Federal Regulations, Part 20.2007.

Table 11.4-1

SWMS Component Capacities

Equipment Description	Type	Quantity	Nominal Capacity* Liter (Gal)
Tanks			
High Activity Resin Holdup Tank	Vertical, Cylindrical	1	70,000 (18,494)
Low Activity Resin Holdup Tank	Vertical, Cylindrical	1	70,000 (18,494)
Condensate Resin Holdup Tank	Vertical, Cylindrical	1	70,000 (18,494)
Low Activity Phase Separator	Vertical, Cylindrical	2	55,000 (14,531)
Concentrated Waste Tank	Vertical, Cylindrical	1	60,000 (15,852)
Pumps			
High Activity Decant Pump	Horizontal, Centrifugal	2	333L/min (88gpm)
Low Activity Decant Pump	Horizontal, Centrifugal	2	333L/min (88gpm)
High Activity Resin Transfer Pump	Horizontal, Centrifugal	2	379L/min (100gpm)
Low Activity Resin Transfer Pump	Horizontal, Centrifugal	2	379L/min (100gpm)
Concentrated Waste Pump	Horizontal, Centrifugal	2	1,333L/min (352gpm)
Condensate Resin Transfer Pump	Horizontal, Centrifugal	2	379L/min (100gpm)
~~Mobile~~ Process Equipment			
Dewatering Equipment Fill Head	N/A	~~3~~1	-
~~HIC Return~~ Dewatering Pump	Diaphragm	2	75L/min (20gpm)

* For tanks, nominal capacity refers to the total tank capacity. Nominal capacity for pumps is in liters/min (gallons/min).


ESBWR
WET SOLID WASTE COLLECTION SUBSYSTEM
Equipment Drain Collection Tank or Floor Drain Collection Tank
From High Activity Dewatering Fill Head
RWCU Spent Resin
FAPCS Spent Resin
High Activity Resin Holdup Tank
High Activity Decant Pumps
High Activity Resin Transfer Pump
Equipment Drain Subsystem Ion-Exchangers Resin
Floor Drain Subsystem Ion-Exchangers Resin
From Low-Activity Dewatering Fill Head
From Concentrated Waste
Low Activity Resin Holdup Tank
Low Activity Decant Pumps
Condensate Filter Backwash Drain
Equipment/Floor Drain Subsystem Filter Backwash Drain
Low Activity Phase Separator (A)
Low Activity Phase Separator (B)
Low Activity Resin Transfer Pumps
Condensate Demineralizer Resin
Condensate Resin Holdup Tank
Condensate Resin Transfer Pump
LWMS Demineralizer
WET SOLID WASTE PROCESSING SUBSYSTEM
SOLID WASTE PROCESS SYSTEM
High Activity Resin Holdup Tank
Dewatering Fill Head
Container Storage or Off-site Shipment
Class A/B/C Waste Packaging
SOLID WASTE PROCESS SYSTEM
Low Activity Phase Separator
Dewatering Fill Head
Container Storage or Off-site Shipment
Class A/B/C Waste Packaging
CONTAINER STORAGE SUBSYSTEM
Container Type
High Integrity Containers
Compactor Boxes
Filter Containers
Drums
Contaminated ?
NO
YES
Decon
Mixed Waste
YES
NO
Mixed Waste Storage (See Note)
Contains Radioactive Material ?
NO
Dispose of As Regular Trash
YES
Measure Radiation Level
HIGH
Shielded Storage
LOW
Low-Level Storage
Contaminated ?
NO
Ship For Off-Site Disposal
YES
Decon
DRY ACTIVE WASTE PROCESSING
DAW from plant
Manual activity performed by licensee
Tools and equipment return to radiological controlled inventory in accordance with licensee radiation protection program.
DAW SORTING
> 200 MREM
Containerized waste shipments to licensed burial site or licensed radioactive waste processor
< 200 MREM
Dispose of as regular trash if 10CFR20 free release criteria are met.
DAW sealand shipment to licensed radioactive waste processor or licensed disposal site
Abbreviations:
RWCU - Reactor Water Cleanup System
FAPCS - Fuel and Auxiliary Pools Cooling System
RO - Reverse Osmosis System
HCW – High Conductivity Waste
Note: EPA Requirements set forth in 40 CFR may also apply to this particular waste.

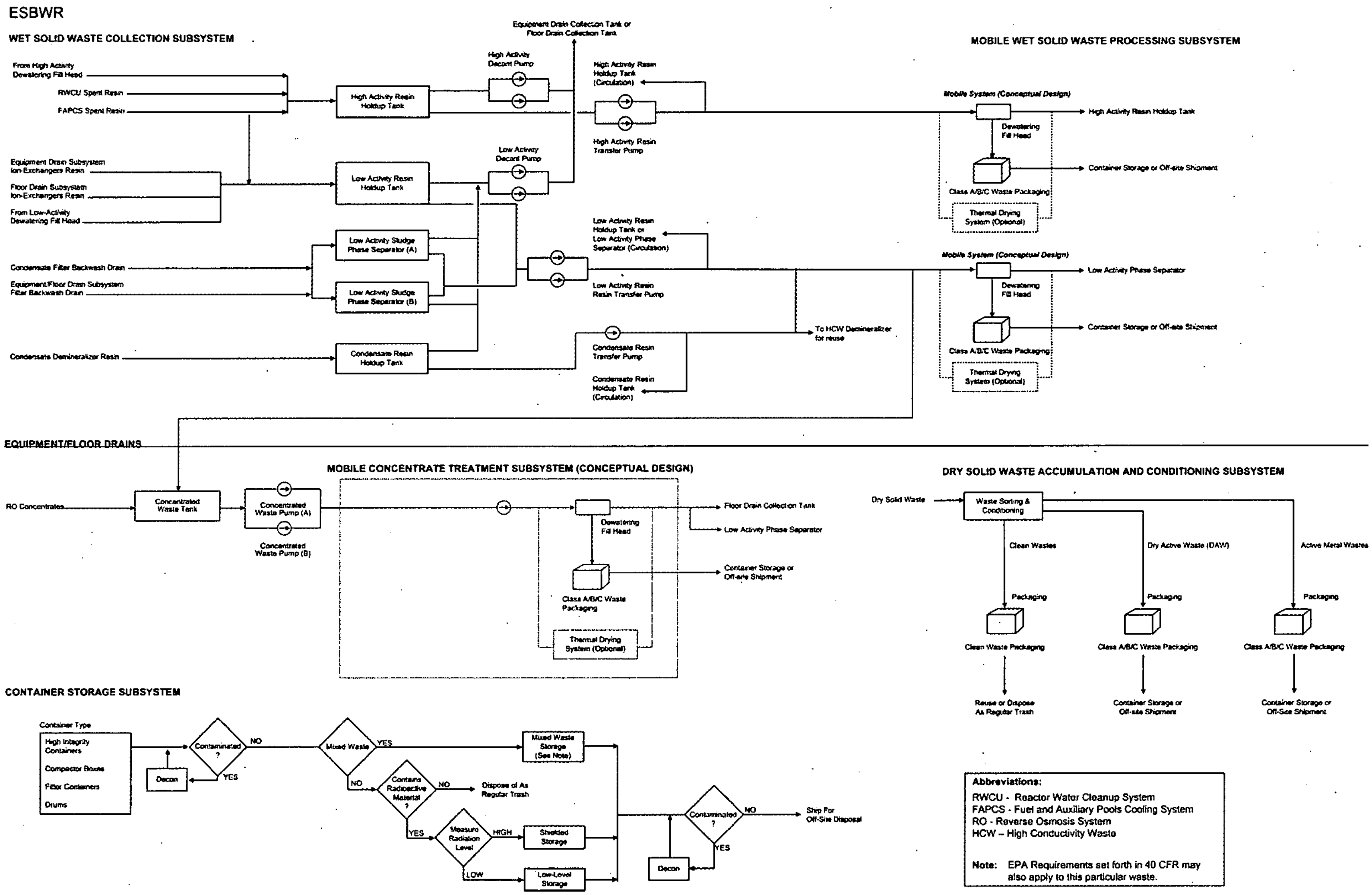
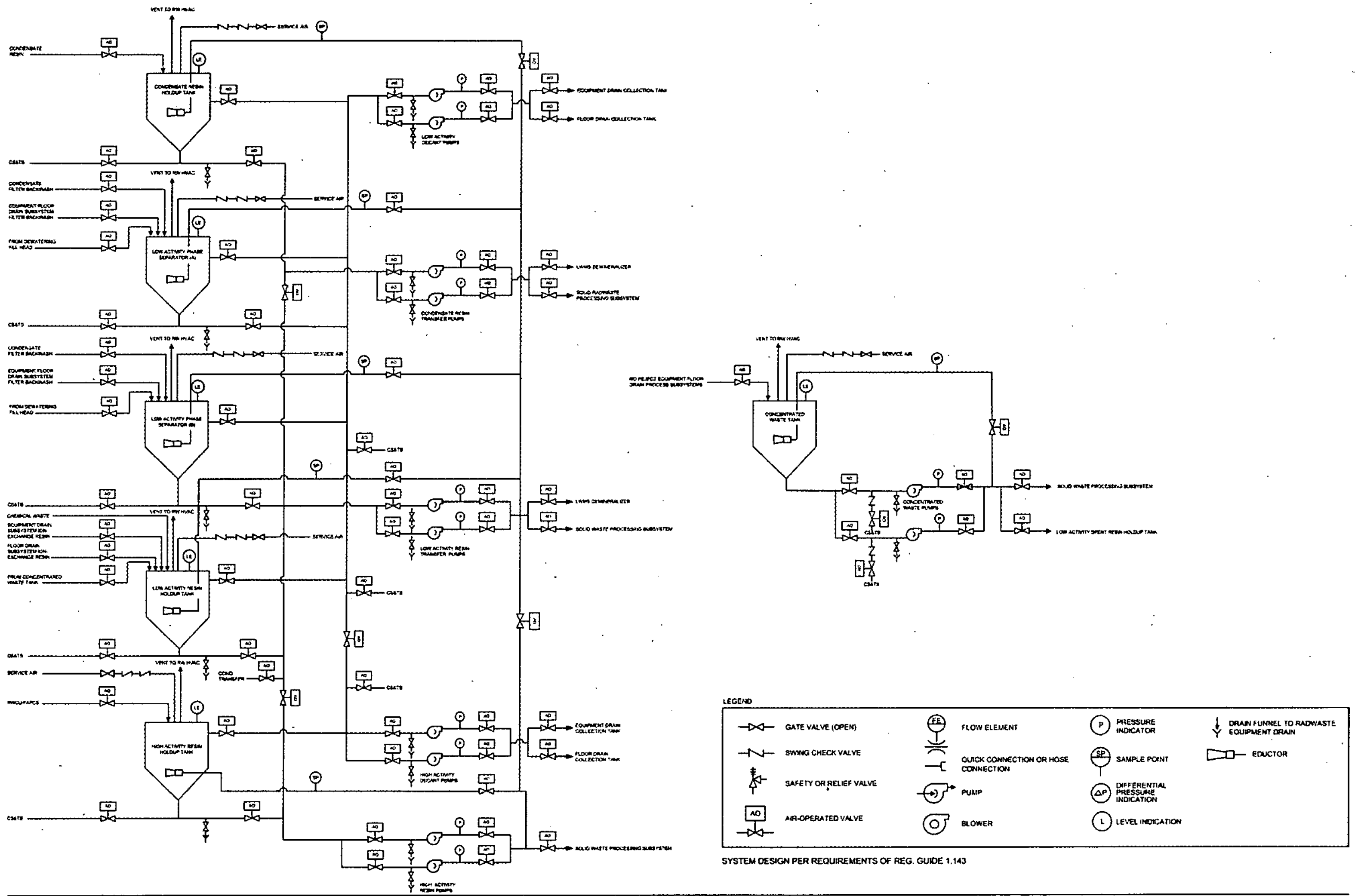


Figure 11.4-1. Solid Waste Management System Process Diagram


LEGEND
GATE VALVE (OPEN)
SWING CHECK VALVE
SAFETY OR RELIEF VALVE
AO
AIR-OPERATED VALVE
FE
FLOW ELEMENT
QUICK CONNECTION OR HOSE CONNECTION
PUMP
BLOWER
P
PRESSURE INDICATOR
SP
SAMPLE POINT
ΔP
DIFFERENTIAL PRESSURE INDICATION
L
LEVEL INDICATION
DRAIN FUNNEL TO RADWASTE EQUIPMENT DRAIN
EDUCTOR
SYSTEM DESIGN PER REQUIREMENTS OF REG. GUIDE 1.143

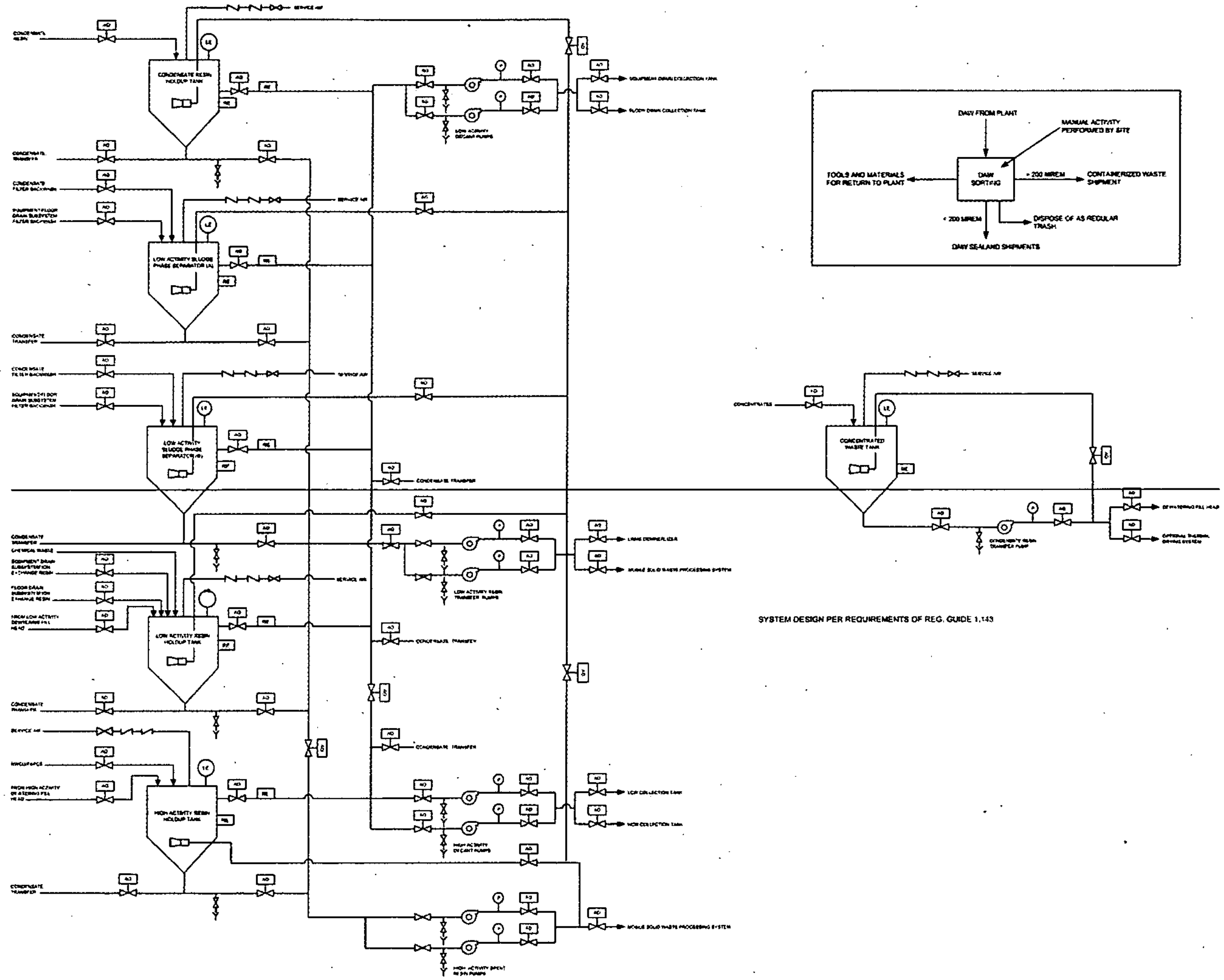
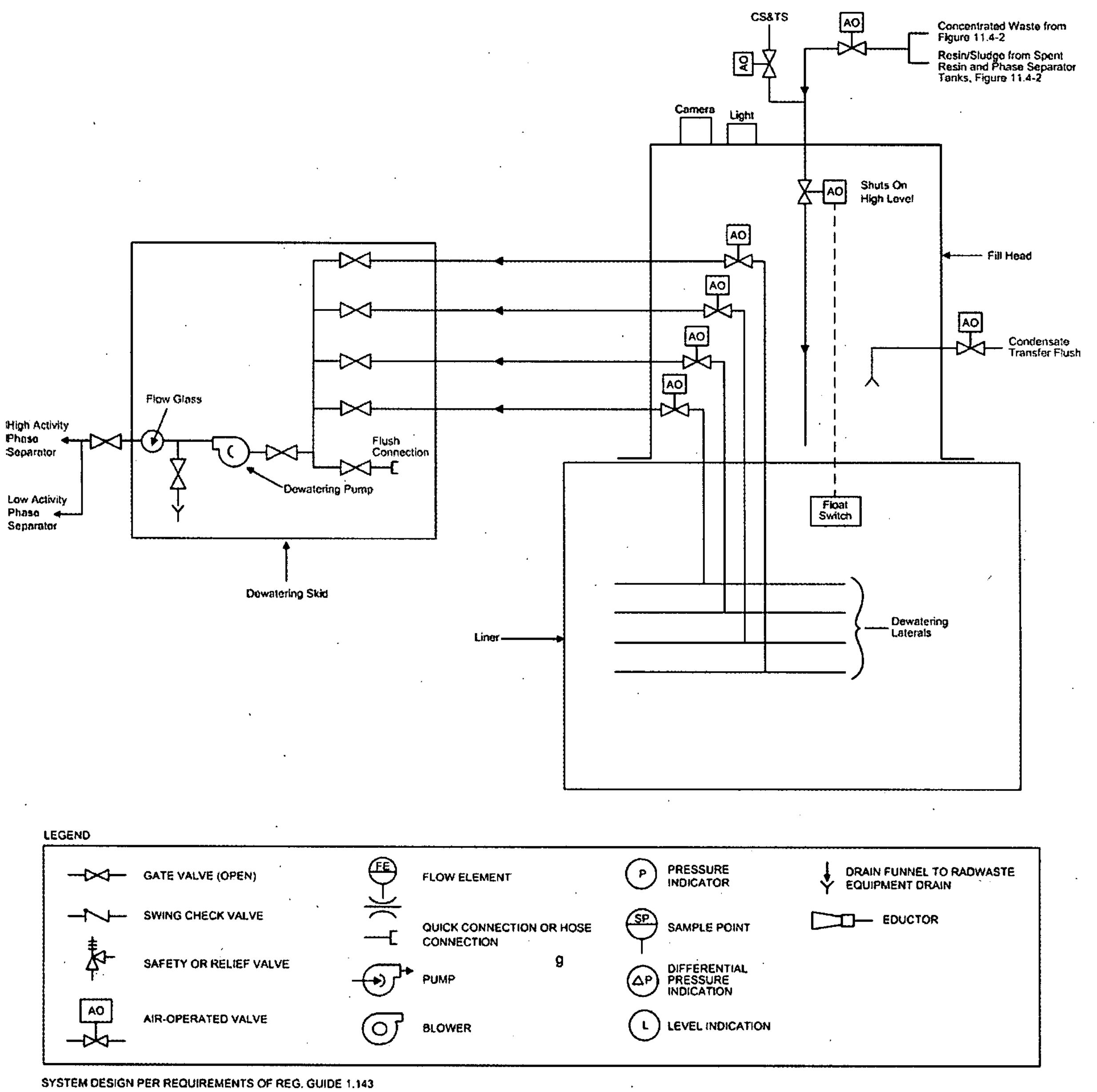


Figure 11.4-2. ~~SWMS Spent Resin Sludge Transfer System~~Wet Solid Waste Collection Subsystem


CS&TS
AO
Concentrated Waste from Figure 11.4-2
Resin/Sludge from Spent Resin and Phase Separator Tanks, Figure 11.4-2
Camera
Light
Shuts On High Level
Fill Head
Condensate Transfer Flush
Flow Glass
High Activity Phase Separator
Low Activity Phase Separator
Flush Connection
Dewatering Pump
Dewatering Skid
Float Switch
Dewatering Laterals
Liner
LEGEND
GATE VALVE (OPEN)
SWING CHECK VALVE
SAFETY OR RELIEF VALVE
AIR-OPERATED VALVE
FLOW ELEMENT
QUICK CONNECTION OR HOSE CONNECTION
PUMP
BLOWER
PRESSURE INDICATOR
SAMPLE POINT
DIFFERENTIAL PRESSURE INDICATION
LEVEL INDICATION
DRAIN FUNNEL TO RADWASTE EQUIPMENT DRAIN
EDUCTOR
SYSTEM DESIGN PER REQUIREMENTS OF REG. GUIDE 1.143

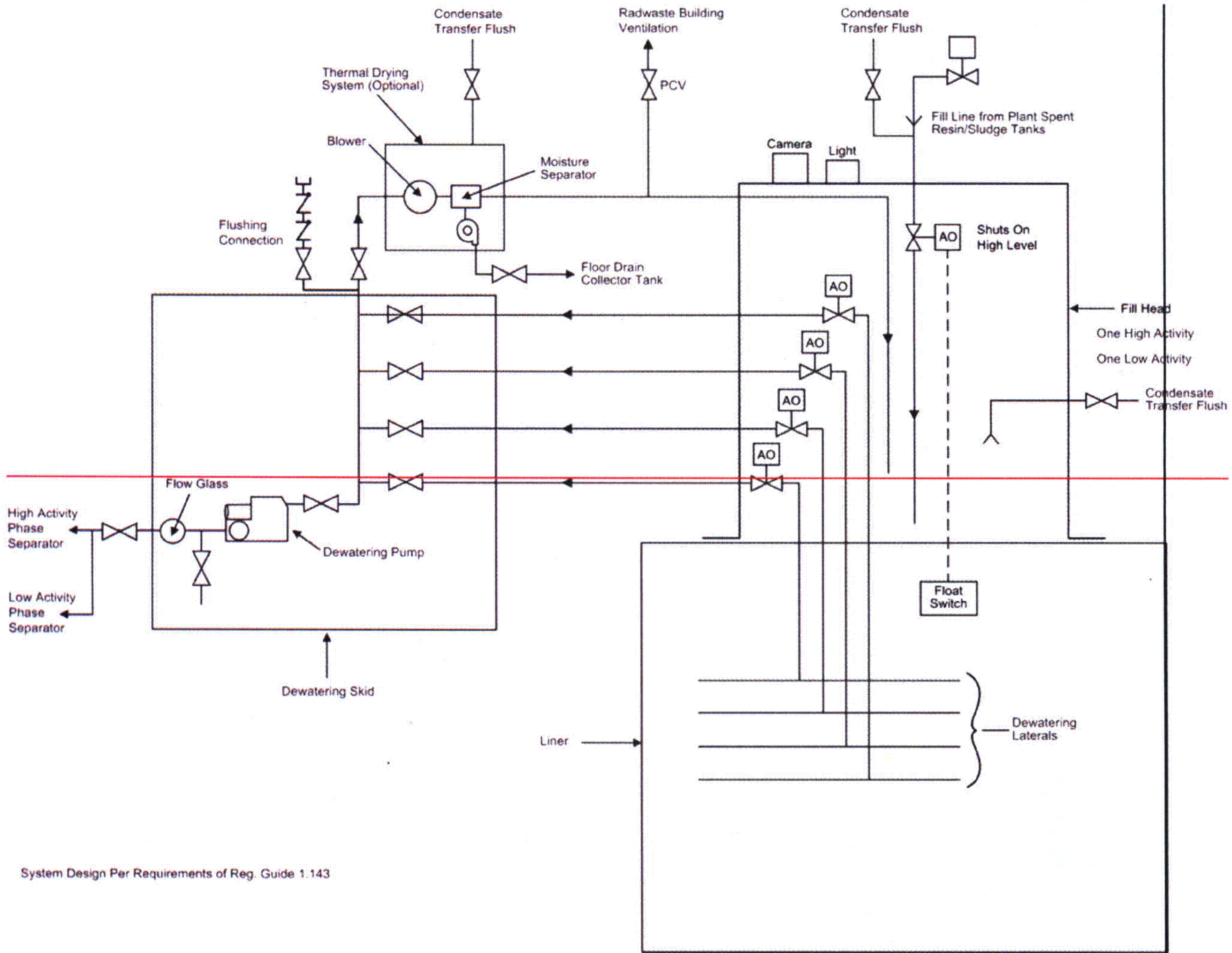


Figure 11.4-3. ~~SWMS Solid Radwaste Dewatering System (Conceptual Design)~~Wet Solid Waste Processing Subsystem

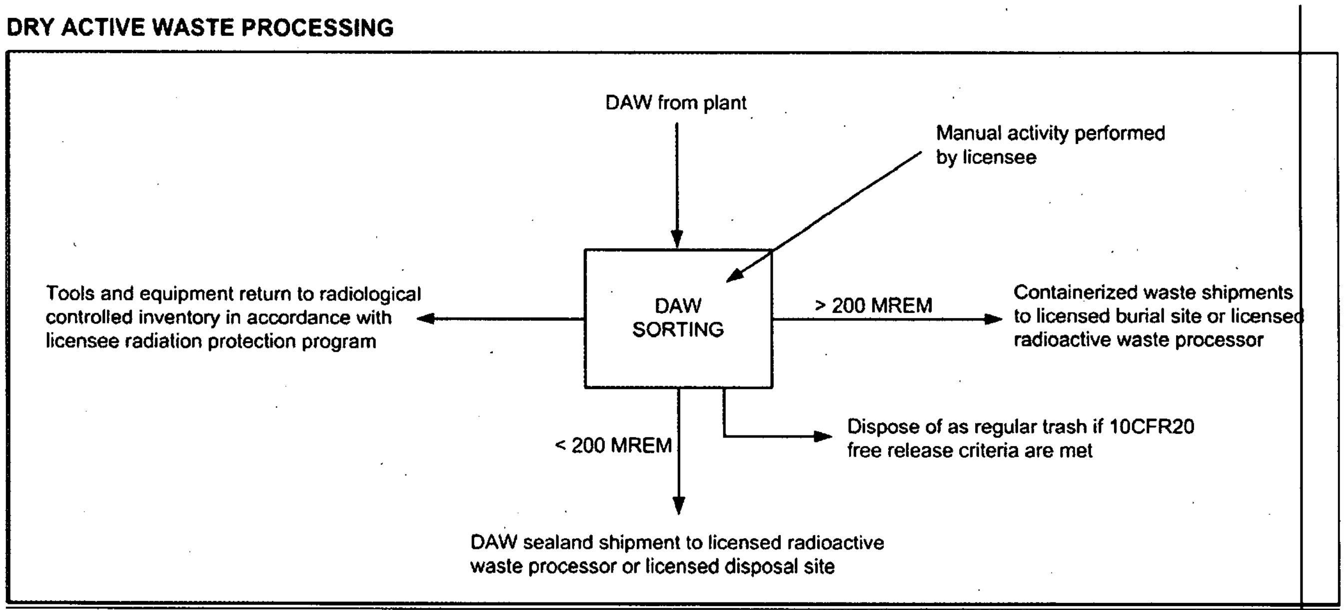


Figure 11.4-4. Dry Active Waste Processing

sampling at certain radiation monitor locations to allow determination of specific radionuclide content.

The following PRMS subsystems are provided to meet the above design objectives:

- Monitoring Gaseous Effluent Streams;
  - Plant Stack RMS,
  - TB Normal Ventilation Air HVAC RMS,
  - TB Compartment Area Air HVAC RMS,
  - Radwaste Building Ventilation Exhaust RMS,
  - Main Turbine Gland Seal Steam Condenser Exhaust RMS,
  - FB Combined Ventilation Exhaust RMS, and
  - TB Combined Ventilation Exhaust RMS.
- Monitoring Liquid Effluent Streams;
  - Liquid Radwaste Discharge RMS.
- Monitoring Gaseous Process Streams;
  - MSL RMS,
  - Offgas Pre-treatment RMS,
  - Offgas Post-treatment RMS,
  - Charcoal vault ventilation RMS, and
  - Drywell Fission Product RMS.
- Monitoring Liquid Process Streams; and
  - Reactor Component Cooling Water Intersystem Leakage RMS.
- Monitoring Gaseous Intake Streams.
  - Technical Support Center (TSC) HVAC Air Intake RMS.

11.5.2 System Design Bases and Criteria

The instrumentation used in the subsystems of the PRMS is designed to be in conformance with the relevant requirements and guidelines of:

- 10 CFR 20.1302 (Reference 11.5-1), 10 CFR 20.1301 (e) (Reference 11.5-22), 10 CFR 20 Appendix B (Reference 11.5-16), 10 CFR 20.1406 (Reference 11.5-23), 10 CFR 50.34a (Reference 11.5-2), 10 CFR 50.36a (Reference 11.5-4).
- 10 CFR 50, Appendix A, GDC 19 (Reference 11.5-17), 60 (Reference 11.5-5), 63 (Reference 11.5-6), and 64 (Reference 11.5-7).
- 10 CFR 50 Appendix I (Reference 11.5-8).

- 10 CFR 50.34 (f) (2) (viii), 10 CFR 50.34 (f) (2) (xvii), 10 CFR 50.34 (f) (2) (xxvii), and 10 CFR 50.34 (f) (2) (xxviii)(Reference 11.5-3).
- Regulatory Guides (RG) 1.21 (Reference 11.5-9), 1.45 (Reference 11.5-10), 1.97 (Reference 11.5-11), 4.15 (Reference 11.5-12).
- Standard Review Plan 11.5. (Reference 11.5-18) of NUREG-0800.
- NUREG-0737 (Reference 11.5-15), Item II.F.1, Attachments 1 and 2.
- ANSI/HPS N13.1-1999 (Reference 11.5-13).
- ANSI/Institute of Electrical and Electronic Engineers (IEEE) N42.18-~~1980~~2004 (Reference 11.5-19).
- BTP HICB-10 (Reference 11.5-26).

Radiation monitoring is provided during normal reactor operations, anticipated operational occurrences, and post-accident conditions.

The safety-related process radiation monitoring subsystems are classified Safety Class 2, Seismic Category I. These subsystems conform to the quality assurance requirements of 10 CFR 50 Appendix B (Reference 11.5-20).

11.5.2.1 Radiation Monitors Required for Safety

The design criteria for the safety-related functions as defined in Subsection 11.5.1.1 include the following functional requirements:

- Withstand the effect of natural phenomena (e.g., earthquakes) without loss of capability to perform their functions.
- Perform the intended safety-related functions in the environment resulting from normal and abnormal conditions (e.g., loss of HVAC and isolation events).
- Meet the reliability, testability, independence, and failure mode requirements of engineered safety-related features.
- Provide continuous output of radiation levels to the main control room.
- Permit checking of the operational availability of each channel during reactor operation with provisions for calibration function and instrument checks.
- Ensure an extremely high probability of accomplishing safety-related functions in the event of anticipated operational occurrences.
- Initiate protective action when operational limits are exceeded.
- Annunciate the high radiation levels in the main control room to alert operating personnel of abnormal conditions.
- Insofar as practical, provide self-monitoring of the radiation monitors to the extent that power failure or equipment failure causes annunciation in the main control room and initiation of the required protective action.
- Register full-scale output if radiation detection exceeds full scale.

The radiation monitors for each of the Control Building Air Intake HVAC subsystems consist of four redundant channels to monitor the air intake to the building. Each radiation channel consists of a gamma sensitive detector and a radiation monitor that is located in the MCR.

Any two-out-of-four channel trips result in the closure of the Control Building Air Intake and exhaust dampers and starting the Emergency air filtration system fans.

Trip circuits initiate their respective alarms in the MCR.

A single channel may be taken out of service for testing without affecting the protective functionality of the remaining channels. Two-out-of-three channel trips cause protective actions in the test mode.

Each channel has a monitor failure alarm in the MCR.

The monitors meet the requirements for safety-related components to provide appropriate reliability. The system warns of the presence of significant air contamination in inlet air and provides isolation of the Control Building intake air ducts.

The range of channel measurement and display is shown in Table 11.5-1 and Table 11.5-2. The range is selected to cover normal operation and be sensitive enough to initiate isolation of the MCR prior to exceeding the 10 CFR 50 Appendix A GDC 19 (Reference 11.5-17) guidelines of 0.05 Sieverts whole body or its equivalent to any part of the body.

11.5.3.1.5 Drywell Sumps LCW/HCW Discharge RMS

This subsystem monitors the gross radiation level in the liquid waste transferred in the drain line from the drywell LCW and HCW sumps to the Radwaste System. One monitoring channel is provided in each sump drain line. Each channel uses a gamma sensitive radiation detector that is located near the drain line from the sump just downstream from the outboard isolation valve. The output from each detector is fed to radiation monitors in the MCR for display and annunciation.

Automatic isolation of the two sump discharge pipes occurs if high radiation levels are detected during liquid waste transfers.

The range of channel measurement and display is shown in Table 11.5-1 and Table 11.5-2. The range is selected to provide sufficient coverage for expected radioactivity concentrations due to accident source terms in these sumps and address the TMI concern about unmonitored transfer of wastes from the containment to the radwaste facility.

LCW/HCW radiation monitors are provided as safety-related since their signals are used to close the safety-related containment isolation valve associated with the liquid radwaste system.

11.5.3.1.6 Isolation Condenser Vent Exhaust RMS

This subsystem monitors the gross radiation from the exhaust of the air from the atmospheric pool area above each isolation condenser. In normal plant operation, the steam from the reactor is directed to the main condenser. The isolation condensers remain in a standby mode, with the path to outside the building without any air flow. This path only has flow through it when the isolation condensers are in operation. The isolation condenser pool (reference Subsection 5.4.6) contains non-radioactive demineralized water supplied from the makeup water system (reference Subsection 9.2.3). Boil-off steam formed in the compartments containing Isolation Condenser samples that are analyzed in the health physics laboratory. Table 11.5-9 provides information concerning the selection of dynamic ranges for monitoring.

11.5.4.4 Setpoints

The trip setpoints for effluent and discharge safety-related radiation monitors are specified in the Offsite Dose Calculation Manual (ODCM) (COL 11.5-2-A). Trip setpoints for nonsafety-related radiation monitors are specified in the plant operating procedures.

11.5.4.5 Offsite Dose Calculation Manual

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 and planned discharge flow rates using the guidance of NUREG-1302 (Reference 11.5-24) and NUREG-0133 (Reference 11.5-25). The COL Applicant will address operational setpoints for the radiation monitors and address programs for monitoring and controlling the release of radioactive material to the environment, which eliminates the potential for unmonitored and uncontrolled release. The ODCM will include planned discharge flow rates (COL 11.5-2-A).

The LWMS provisions for sampling liquid and gaseous waste streams identified in Tables 11.5-5 and 11.5-6 respectively, will be included in the ODCM.

11.5.4.6 Process and Effluent Monitoring Program

In addition, the COL Applicant is responsible for the site-specific programs, aspects of the process and effluent monitoring and sampling as specified in Tables 11.5-5 and 11.5-6 per ANSI/HPS N13.1 (Reference 11.5-13) and Regulatory Guides 1.21 (Reference 11.5-9) and 4.15 (Reference 11.5-12) (COL 11.5-3-A).

11.5.4.7 Subsystem Lower Limit of Detection

The analysis sensitivities derivation of each subsystem's lower limit of detection is to be determined by the COL Applicant based on site-specific conditions and operating characteristics of each installed effluent and process radiation monitoring subsystem (COL 11.5-1-A).

11.5.4.8 Site Specific Offsite Dose Calculation

The COL Applicant is responsible for addressing 10 CFR 50, Appendix I (Reference 11.5-8) guidelines for maximally exposed offsite individual doses and population doses via liquid and gaseous effluents (COL 11.5-4-A).

11.5.4.9 Instrument Sensitivities

The COL Applicant is responsible for the sensitivities, frequencies and basis for each gaseous and liquid sample (COL 11.5-5-A).

11.5.6.3 Maintenance

Control and routine maintenance and cleaning operations of the sampling systems is conducted from either the front or the top of the skid or panel. Lifting eyes or other devices are provided for hoisting the units, to facilitate replacement if it is ever required.

Instrument modules are design to facilitate calibration checks and troubleshooting. Accessibility for power supply adjustments is provided.

Sampling racks and electronic modules are serviced and maintained on an annual basis or in accordance with the operational instructions to ensure reliable operation. Such maintenance includes servicing and replacement of defective components and adjustments, as required, after performing a test or calibration check. If any work is performed that would affect the calibration of the instrument, a re-calibration is performed following the maintenance operation.

11.5.6.4 IE Bulletin 80-10 Evaluation

The Process Radiation Monitoring System comprises subsystems that monitor liquid and gaseous effluents and which utilize components that are designed and installed in various ways. A majority of these subsystems are constructed in a way that it is not possible for them to become contaminated due to leakage, spills, errors in valve lineup or other operating conditions as a result of interfacing with radioactive systems. These types of radiation monitoring subsystems are typically purely electrical in nature and do not physically interconnect with the radioactive systems that they are monitoring. In addition, these PRM subsystems do not interconnect with other non-radioactive systems, thereby eliminating the potential for transfer of radioactive material from a radioactive system to a non-radioactive system.

However, in the design of several PRM subsystems, some interconnections to radioactive systems are necessary. In these cases, the additional subsystem interconnections to non-radioactive systems are limited to purge air, purge water and makeup water for filling loop seals. In these subsystems, the designs of these interconnections are such that the contamination of the non-radioactive system or process due to leakage, spillage, valving errors or other operating conditions is precluded. For example, for equipment requiring the use of purge air, the air is taken from the room atmosphere where the sampling subsystem is located, passed through a prefilter, and then, upon demand, made available for purging of the radiation monitoring subsystem. Because of the design of the filtering mechanism, contamination of the outside air is precluded. In the case of liquid monitors that require flush water, the design of these interconnections is such that the flush water supply is only temporarily connected during maintenance and then completely removed upon termination of the flush. Where loop seals are utilized, which is limited to drains from ventilation ducting provided to collect any condensate in the ventilation line, the loop seals are isolated from the makeup water source by use of isolation valves and backflow preventers.

11.5.6.5 Implementation of 10 CFR 20.1406

The PRM subsystem designs, and procedures used for operation, minimize contamination of the facility and environment, facilitate decommissioning, and minimize the generation of radioactive waste, in accordance with 10 CFR 20.1406, through:

- Minimizing contamination by:

- Locating radiation detectors outside the process that they monitor, whenever feasible, to avoid the potential of coming in contact with a radioactive process;
- Providing atmospheric purging of the internal portion of air sampling skids as necessary;
- Providing the ability for liquid flushing of the internal portions of liquid sampling skids as necessary;
- Designing the interior portions of liquid and gaseous sampling chambers to minimize the plateout of radioactive material; and
- Designing sample extraction points such that they minimize the potential for spillage and contamination of adjacent areas.

• Facilitating decommissioning by:

- Providing equipment, where feasible, that reduces the need for decontamination during the removal and disposal of the equipment.

• Minimizing the generation of radioactive waste by:

- Directing continuous samples from radioactive processes back to the sampled process;
- Utilizing electronic bug sources, where compatible with the subsystem design, in order to minimize the use of radioactive sources; and
- Minimizing the amount of a sample that needs to be extracted, consistent with laboratory and sensitivity requirements.

11.5.7 COL Information

11.5-1-A Subsystem Lower Limit of Detection

The analysis sensitivities derivation of each subsystem's lower limit of detection is to be determined by the COL Applicant based on site-specific conditions and operating characteristics of each installed effluent radiation monitoring subsystem (Subsection 11.5.4.7).

11.5-2-A Offsite Dose Calculation Manual

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 and planned discharge flow rates using the information identified as COL items in Tables 11.5-5 and 11.5-6.

The trip setpoints are developed using the guidance of NUREG-1302 (Reference 11.5-24) and NUREG-0133 (Reference 11.5-25). The COL Applicant will address operational setpoints for the radiation monitors and address programs for monitoring and controlling the release of radioactive material to the environment, which eliminates the potential for unmonitored and uncontrolled release. The ODCM will include planned discharge flow rates (Subsection 11.5.4.5). The ODCM will also include the system information effluent and discharge safety-related radiation monitors are specified in the Offsite Dose Calculation Manual (ODCM) (Subsection 11.5.4.4).

The COL Applicant will evaluate site-specific conditions and requirements in assessing radiation exposure, including N_{16} source and skyshine doses to members of the public in the ODCM in accordance with 10 CFR 20.1301 (e) and 10 CFR 20.1302 (Subsection 12.2.1.3).

The COL Applicant will provide a milestone (See Section 13.4) for full program implementation.

11.5-3-A Process and Effluent Monitoring Program

The COL Applicant is responsible for the site-specific program aspects of the process and effluent monitoring and sampling as specified in Tables 11.5-5 and 11.5-6 per ANSI N13.1 (Reference 11.5-13) and Regulatory Guides 1.21 (Reference 11.5-9) and 4.15 (Reference 11.5-12) (Subsection 11.5.4.6).

The COL Applicant will provide a milestone (See Section 13.4) for full program implementation.

11.5-4-A Site Specific Offsite Dose Calculation

The COL Applicant is responsible for addressing 10 CFR 50, Appendix I (Reference 11.5-8) guidelines for maximally exposed offsite individual doses and population doses via liquid and gaseous effluents (Subsection 11.5.4.8).

11.5-5-A Instrument Sensitivities

The COL Applicant is responsible for the sensitivities, sampling and analytical frequencies and basis for each gaseous and liquid sample (Subsection 11.5.4.9).

11.5.8 References

11.5-1 Title 10 Code of Federal Regulations Part 20.1302, "Compliance with Dose Limits for Individual Members of the Public."

11.5-2 Title 10 Code of Federal Regulations Part 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents-Nuclear Power Plants."

11.5-3 Title 10 Code of Federal Regulations Parts 50.34 (f) (2) (viii), 50.34(f) (2) (xvii), 50.34 (f) (2)(xxvii), and 50.34(f) (2) (xxviii).

11.5-4 Title 10 Code of Federal Regulations Part 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors."

11.5-5 Title 10 Code of Federal Regulations Part 50, Appendix A, General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."

11.5-6 Title 10 Code of Federal Regulations Part 50, Appendix A, General Design Criterion 63, "Monitoring Fuel and Waste Storage."

11.5-7 Title 10 Code of Federal Regulations Part 50, Appendix A, General Design Criterion 64, "Monitoring Radioactivity Releases."

11.5-8 Title 10 Code of Federal Regulations Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents."

11.5-9 Regulatory Guide 1.21, "Measuring and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants."

11.5-10 Regulatory Guide 1.45, "Reactor Coolant Pressure Boundary Leakage Detection Systems."

11.5-11 Regulatory Guides 1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident."

11.5-12 Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operation) - Effluent Streams and the Environment."

11.5-13 ANSI/HPS N13.1-1999, "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities."

11.5-14 None.

11.5-15 NUREG-0737, "Clarification of TMI Action Plan Requirements" (1980).

11.5-16 Title 10 Code of Federal Regulations Part 20 Appendix B, "Annual Limits on Intake (ALI's) and Derived Air Concentrations (DAC's) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage."

11.5-17 Title 10 Code of Federal Regulations Part 50 Appendix A, General Design Criterion 19, "Control Room."

11.5-18 NUREG-0800, Standard Review Plan, 11.5 Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems, DRAFT Rev.4 – April 1996.

11.5-19 ANSI/IEEE N42.18 – 2004, "American National Standard Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity for Effluents – Description." (Redesignation of N13.10-1974 and Reaffirmation of N42.18-1980.)

11.5-20 Title 10 Code of Federal Regulations Part 50 Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

11.5-21 Title 10 Code of Federal Regulations Part 20.

11.5-22 Title 10 Code of Federal Regulations, Part 20.1301 (e) "Dose Limits for Individual Members of the Public."

11.5-23 Title 10 Code of Federal Regulations, Part 20.1406 "Minimization of Contamination."

11.5-24 NUREG-1302, "Offsite Dose Calculation Manual Guidance, Standard Radiological Effluent Controls for BWRs."

11.5-25 NUREG-0133, "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," 1978.

11.5-26 BTP HICB-10, "Branch Technical Position (BTP), Guidance on Application of Regulatory Guide 1.97", Revision 4, June 1997.

Table 11.5-1

Process and Effluent Radiation Monitoring Systems

Monitored Process	No. of Channels	Sample Line or Detector Location	Displayed Channel Range* and **
A. Safety-Related Monitors			
Reactor Building HVAC Exhaust	4	Exhaust duct upstream of exhaust ventilation isolation valve	1E-4 to 1E0 mSv/h (1E-2 to 1E2mRem/h)
Refuel Handling Area HVAC Exhaust	4	Exhaust duct upstream of exhaust ventilation isolation valve	1E-4 to 1E0 mSv/h (1E-2 to 1E2 mRem/h)
Control Building Air Intake HVAC	8	Intake duct upstream of intake ventilation isolation valve	1E-4 to 1E0 mSv/h (1E-2 to 1E2 mRem/h)
LCW Drywell Sump Discharge	1	Drain line from LCW sump	1E-2 to 1E4 mSv/h (1E0 to 1E6 mRem/h)
HCW Drywell Sump Discharge	1	Drain line from HCW sump	1E-2 to 1E4 mSv/h (1E0 to 1E6 mRem/h)
FB General Area HVAC	4	Exhaust duct upstream of exhaust ventilation isolation valve	1E-4 to 1E0 mSv/h (1E-2 to 1E2 mRem/h)
Isolation Condenser Vent Exhaust	16	Exhaust of air space surrounding isolation condensers	1E-4 to 1E0 mSv/h (1E-2 to 1E2 mRem/h)
Containment Purge Exhaust	4	Exhaust duct upstream of exhaust ventilation isolation valve	1E-4 to 1E0 mSv/h (1E-2 to 1E2 mRem/h)
FB Fuel Pool HVAC	4	On HVAC duct leaving Fuel Pool Area	1E-4 to 1E0 mSv/h (1E-2 to 1E2 mRem/h)
B. Monitors Required for Plant Operation			
MSL	4	Immediately downstream of plant MSL isolation valve	1E-2 to 1E4 mSv/h (1E0 to 1E6 mRem/h)

Table 11.5-1

Process and Effluent Radiation Monitoring Systems

Monitored Process	No. of Channels	Sample Line or Detector Location	Displayed Channel Range* and **
Plant Stack	3	On Stack exhaust	1E-3 to 1E10 MBq/m^3 (gaseous) (2.7E-2 to 2.7E11 µCi/m^3) 1E-6 to 1E7 MBq/m^3 (2.7E-5 to 2.7E8 µCi/m^3) (particulate & halogen)
TB Normal Ventilation Air HVAC	2	Exhaust duct from TB Normal ventilation	1E-4 to 1E0 mSv/h (1E-2 to 1E2 mRem/h)
TB Compartment Area Air HVAC	2	Exhaust duct from Compartment area	1E-4 to 1E0 mSv/h (1E-2 to 1E2 mRem/h)
TB Combined Ventilation Exhaust	3	On TB combined exhaust line	1E-3 to 1E3 MBq/m^3 (2.7E-2 to 2.7E4 µCi/m^3) (gaseous) 1E-7 to 1E-1 MBq/m^3 (2.7E-6 to 2.7E0 µCi/m^3) (particulate and iodine)
Radwaste Building Ventilation Exhaust	3	On Radwaste Building exhaust line	1E-3 to 1E3 MBq/m^3 (2.7E-2 to 2.7E4 µCi/m^3) (gaseous) 1E-7 to 1E-1 MBq/m^3 (2.7E-6 to 2.7E0 µCi/m^3) (particulate) 1E-7 to 1E-1 MBq/m^3 (2.7E-6 to 2.7E0 µCi/m^3) (iodine)
Main Turbine Gland Seal Steam Condenser Exhaust	1	Sample line from exhaust from Gland Seal condenser	1E-3 to 1E3 MBq/m^3 (2.7E-2 to 2.7E4 µCi/m^3)
Liquid Radwaste Discharge	1	Sample line from combined liquid Radwaste effluent path	1E-3 to 1E3 MBq/m^3 (2.7E-2 to 2.7E4 µCi/m^3)
Offgas Pre-treatment	1	Sample line after Offgas cooler/condenser	1E-2 to 1E4 mSv/h (1E0 to 1E6 mRem/h)

Table 11.5-1

Process and Effluent Radiation Monitoring Systems

Monitored Process	No. of Channels	Sample Line or Detector Location	Displayed Channel Range* and **
Offgas Post-treatment Skid A	3	Sample line after Charcoal treatment beds	1E0 to 1E7 MBq/m³ (2.7E1 to 2.7E8 µCi/m³) (gaseous) 1E-7 to 1E1 MBq/m³ (2.7E-6 to 2.7E2 µCi/m³) (particulate) 1E-7 to 1E1 MBq/m³ (2.7E-6 to 2.7E2 µCi/m³) (iodine)
Offgas Post-treatment Skid B	1	Sample Line after Charcoal treatment beds	1E0 to 1E7 MBq/m³ (2.7E1 to 2.7E8 µCi/m³) (gaseous)
Charcoal Vault Ventilation	1	On charcoal vault HVAC exhaust line	1E-2 to 1E4 mSv/h (1E0 to 1E6 mRem/h)
Reactor Component Cooling Water Intersystem Leakage	2	Each RCCW heat exchanger line exit	1E-1 to 1E5 MBq/m³ (2.7E0 to 2.7E6 µCi/m³)
TSC HVAC Air Intake	1	Intake HVAC duct	1E4 to 1E0 mSv/h (1E6 to 1E2 mRem/h)
Drywell Fission Product (Particulate)	1	Sample line from drywell atmosphere	1E-7 to 1E-1 MBq/m³ (2.7E-6 to 2.7E0 µCi/m³)
Drywell Fission Product (Gaseous)	1	Sample line from drywell atmosphere	1E-1 to 1E4 MBq/m³ (2.7E0 to 2.7E5 µCi/m³)
FB Combined Ventilation Exhaust	3	Sample Line from HVAC exhaust leaving FB	1E-3 to 1E3 MBq/m³ (2.7E-2 to 2.7E4 µCi/m³) (gaseous) 1E-7 to 1E-1 MBq/m³ (2.7E-6 to 2.7E0 µCi/m³) (particulate) 1E-7 to 1E-1 MBq/m³ (2.7E-6 to 2.7E0 µCi/m³) (iodine)

* MBq/m³ = mega-becquerel per cubic meter; mSv/h = milli-Sieverts per hour

** ~~Performs no safety-related closure function~~The "MBq/m³" displayed channel range measurement unit is utilized to present to the operator the relationship between an acceptable regulatory offsite dose concentration and the actual concentration, measured at the point of interest, in comparable scientific units. Display units for all other channels not indicating "MBq/m³" use other scientific units, such as "mSv/hr", that are comparable with their intended use. The units are not directly used to present to the operator any information concerning offsite dose concentrations. Thus, units such as "mSv/hr" are used to indicate a dose rate associated with the radioactivity contained in the process at the point of measurement, and the subsequent actions taken by the operator are not predicted on directly viewing a relationship with an offsite concentration.

Table 11.5-5

Provisions for Sampling Liquid Streams

No.	Process Systems as listed in NUREG-0800, SRP 11.5 Table 2 (Draft Rev. 4)	ESBWR System (s) that Perform the Equivalent SRP 11.5 Function (Note 1)	In Process	In Effluent	
			Grab Notes 2 & 7	Grab Notes 2 & 7	Continuous Notes 2 & 7
1.	Liquid Radwaste (Batch) Effluent System Note 3	Equipment (Low Conductivity Drain Subsystem, Floor (High Conductivity) Drain Subsystem	S&A	S&A, H3	-
2.	Service Water System	Plant Service Water System	-	S&A, H3	(S&A) Notes 6 & 8
3.	Component Cooling Water System	Reactor Component Cooling Water System	S&A	S&A, H3	(S&A) Notes 6 & 8
4.	Spent Fuel Pool Treatment System	Spent Fuel Pool Treatment System	S&A	S&A, H3	(S&A) Notes 6 & 8
5.	Equipment & Floor Drain Collection and Treatment Systems	LCW Drain Subsystem, HCW Drain Subsystem, Detergent Drain Subsystem, Chemical Waste Drain Subsystem, Reactor Component Cooling Water System (RCCWS) Drain Subsystem	-	S&A, H3	(S&A) Notes 6 & 8
6.	Phase Separator Decant & Holding Basin Systems	Equipment (Low Conductivity) Drain Subsystem, Floor (High) Drain Subsystem	-	S&A, H3	(S&A) Notes 6 & 8
7.	Chemical & Regeneration Solution Waste Systems	Chemical Waste Drain Subsystem	-	S&A, H3	(S&A) Notes 6 & 8

Table 11.5-5

Provisions for Sampling Liquid Streams

No.	Process Systems as listed in NUREG-0800, SRP 11.5 Table 2 (Draft Rev. 4)	ESBWR System (s) that Perform the Equivalent SRP 11.5 Function (Note 1)	In Process	In Effluent	
			Grab Notes 2 & 7	Grab Notes 2 & 7	Continuous Notes 2 & 7
8.	Laboratory & Sample System Waste Systems	Chemical Waste Drain Subsystem	-	S&A, H3	(S&A) Notes 6 & 8
9.	Laundry & Decontamination Waste Systems	Detergent Drain Subsystem	-	S&A, H3	(S&A) Notes 6 & 8
10.	Resin Slurry, Solidification & Baling Drain Systems	Equipment (Low Conductivity) Drain Subsystem, Floor (High) Drain Subsystem	-	S&A, H3	(S&A) Notes 6 & 8
11.	Storm & Underdrain Water System	COL Applicant Note 4	-	(S&A, H3) Notes 3 & 6	(S&A) Notes 3 & 6
12.	Tanks and Sumps Inside Reactor Building	Equipment (Low Conductivity) Drain Subsystem, Floor (High) Drain Subsystem, Chemical Waste Drain Subsystem, Detergent Drain Subsystem	-	S&A, H3	(S&A) Notes 6 & 8
13.	Ultrasonic Resin Cleanup Waste Systems	Note 5	-	Note 5	Note 5
14.	Non-Contaminated Waste Water System	COL Applicant Notes 3 & 4	-	(S&A, H3) Notes 3, 4 & 6	(S&A) Note 4

Table 11.5-5

Provisions for Sampling Liquid Streams

No.	Process Systems as listed in NUREG-0800, SRP 11.5 Table 2 (Draft Rev. 4)	ESBWR System (s) that Perform the Equivalent SRP 11.5 Function (Note 1)	In Process	In Effluent	
			Grab Notes 2 & 7	Grab Notes 2 & 7	Continuous Notes 2 & 7
15.	~~Mobile~~ Liquid Radioactive Waste Processing Systems (Includes Reverse Osmosis Systems)	COL Applicant Notes 3 & 4	S & A	(S&A, H3)	(S&A) Notes 6 & 8

Notes for Table 11.5–5:

1. Table 11.5-5 addresses sampling provisions for BWRs as identified in Table 2 of SRP 11.5. For process systems identified for BWRs in Table 2, but not shown in Table 11.5-5, those systems are not applicable to ESBWR. In some cases, there are multiple subsystems that are used to perform the overall equivalent SRP function and are listed as such in the column.
2. S&A=Sampling & Analysis of radionuclides, to include gross radioactivity, identification and concentration of principal radionuclides and concentration of alpha emitters; R=Gross radioactivity (beta radiation, or total beta plus gamma); H3=Tritium
3. Liquid Radwaste is processed on a batch-wise basis. The Liquid Waste Management System sample tanks can be sampled for analysis of the batch. See Subsection 11.2.2.2 for more information on Liquid Radwaste Management.
4. The COL Applicant will provide design of wastewater effluent systems that monitor the storm, the cooling system tower blow down and sanitation wastes is included in the plant specific Offsite Dose Calculation Manual (COL 11.5-2-A).
5. The ESBWR does not include ultrasonic resin cleanup waste system at this time. Should one be installed, the Liquid Waste Management System would provide sampling and monitoring provisions.
6. The use of parenthesis indicates that these provisions are required only for the systems not monitored, sampled, or analyzed (as indicated) prior to release by downstream provisions.
7. The sensitivity of detection, also defined here as the Lower Limit of Detection (LLD), for each indicated measured variable, is based on the applicable radionuclide (or collection of radionuclides as applicable) as given in ANSI/IEEE N42.18 (Reference 11.5-19).
8. Processed through radwaste Liquid Waste Management System (LWMS) prior to discharge. Therefore, this process system is monitored, sampled, or analyzed prior to release by downstream provisions. See Note 6 above. Depending on Utility's discretion, additional sampling lines may be installed. Continuous Effluent sampling is not required per Standard Review Plan 11.5 Draft Rev. 4, April 1996, Table 2 for this system function.

Table 11.5-7

Radiological Analysis Summary of Liquid Effluent Samples

Sample Description	Sample Frequency	Analysis	Sensitivity (MBq/m^3)****	Purpose
1. Liquid Radwaste Effluent Discharge *	Weekly **	Ba/La-140 and I-131	***	Effluent discharge record
Composite of all discharges *****	Monthly	Gamma Spectrum	***	
		Tritium	***	
		Gross alpha	***	
		Dissolved gas	***	
	Quarterly	Sr-89 and Sr-90	***	

* ESBWR Radwaste is processed on a batch basis. If a tank is to be discharged, analysis will be performed on each batch.

** The ESBWR Liquid Waste Management System (LWMS) is designed to recycle 100% of the liquid radwaste (zero liquid release). The LWMS system has provisions for off-site discharge. If liquid radwaste is discharged, the sampling and analysis will be performed per the requirements of RG 1.21.

*** The sensitivity of detection (also defined here as the Lower Limit of Detection (LLD)) for each indicated radionuclide (or collection of radionuclides as applicable) is defined in ANSI/IEEE N42.18 (Reference 11.5-19) or Regulatory Guide 1.21, "Measuring and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants" (Reference 11.5-9) and Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operation) - Effluent Streams and the Environment" (Reference 11.5-12).

**** The principal gamma emitters for which the LLD specification applies includes the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, and Ce-141. This list does not mean that only these nuclides are to be considered. Other gamma energy peaks that are identifiable, together with those of above radionuclides, shall be analyzed and reported per RG 1.21.

***** A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

Table 11.5-8

Radiological Analysis Summary of Gaseous Effluent Samples

Sample Description	Sample Frequency*	Analysis	Sensitivity (MBq/m^3)***	Purpose
1. TB Combined Ventilation Exhaust	Weekly	Gross β	**	Effluent record
		I-131	**	
		Ba/La-140	**	
	Monthly	Gamma spectrum	**	Effluent record
		I-133 and I-135	**	
		Tritium	**	
		Gross alpha	**	
	Quarterly	Sr-89 and Sr-90	**	Effluent record
2. Plant Stack	As above	As above	**	Effluent record
3. Radwaste Building Ventilation Exhaust	As above	As above	**	Effluent record
4. FB Combined Ventilation Exhaust	As above	As above	**	Effluent record

* All frequencies of sampling will be in accordance with RG 1.21.

** The sensitivity of detection (also defined here as the Lower Limit of Detection (LLD)) for each indicated radionuclide (or collection of radionuclides as applicable) is defined in ANSI/IEEE N42.18 (Reference 11.5-19) or Regulatory Guide 1.21, "Measuring and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants" (Reference 11.5-9) and Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operation) - Effluent Streams and the Environment (Reference11.5-12)."

*** The principal gamma emitters for which the LLD specification applies includes the following radionuclides: Kr-85, Kr-88, Xe-133, Xe=133m, Xe-135, and Xe-138 in noble gas releases, and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141, and Ce-144 in Iodine and Particulate releases. This list does not mean that only these nuclides are to be considered. Other gamma energy peaks that are identifiable, together with those of the above radionuclides, shall be analyzed and reported per RG 1.21.

7.5.3.3.2 General Design Criteria

GDC 1, 2, 4, 13, 19,- 24, and 64:

- Conformance: The PRMS design complies with these GDC.

7.5.3.3.3 Staff Requirements Memorandum

SECY-93-087, Item II.T, Control Room Annunciator (Alarm) Reliability:

- Conformance: The PRMS AMS design meets the requirements of SECY-93-087, Item II.T for redundancy, independence, and separation in that the "alarm system" is considered redundant as follows:
  - Alarm points are sent via dual networks to redundant message processors using dual power supplies. The processors are dedicated to alarm processing.
  - The alarms are displayed, on multiple independent VDUs (dual power supplies on each).
  - The alarms are driven by redundant data links to the AMS (dual power). There are redundant alarm processors.
  - There is one horn and one voice speaker. Test buttons are available to test the horn(s) and all the lights.
  - There are no alarms requiring manually controlled actions for systems to accomplish their safety-related functions.

7.5.3.3.4 Regulatory Guides

RG 1.47–, Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems:

- Conformance: The PRMS design conforms to RG 1.47.

RG 1.53–, Application of the Single Failure Criterion to Nuclear Power Protection Systems:

- Conformance: The PRMS design conforms to RG 1.53.

RG 1.75–, Physical Independence of Electrical Systems:

- Conformance: The PRMS design conforms to RG 1.75 as described in Subsections 8.3.1.3 and 8.3.1.4.

RG 1.97, Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants:

- Conformance: The PRMS conforms to RG 1.97.

RG 1.105–, Setpoints for Safety-Related Instrumentation:

- Conformance: The PRMS design conforms to RG 1.105.

RG 1.118–, Periodic Testing of Electric Power and Protection Systems:

- Conformance: The PRMS design conforms to RG 1.118.

RG 1.153–, Criteria for Power, Instrumentation, and Control Portions of Safety Systems:

- Conformance: The PRMS design conforms to with all ofRG 1.153 and the RGs listed above, with the assumption that the interpretations and clarifications identified in Subsection 7.1.6.4 apply.

RGs 1.152, 1.168, 1.169, 1.170, 1.171, 1.172 and 1.173 are addressed in conjunction with the SSLC/ESF system, Subsection 7.1.6.4.

RG 1.180—, Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems:

- Conformance: The PRMS design conforms with to RG 1.180 as discussed in Subsection 7.1.6.4.

RG 1.204—, Guidelines for Lightning Protection of Nuclear Power Plants:

- Conformance: The PRMS design conforms withto RG 1.204 as discussed in Subsection 7.1.6.4.

7.5.3.3.5 Branch Technical Positions

BTP HICB-10, Guidance on Application of Regulatory Guide 1.97:

- The PRMS design conforms to BTP HICB-10.

BTP HICB-11 - Guidance on Application and Qualification of Isolation Devices:

- Conformance: The PRMS design conforms to BTP HICB-11.

BTP HICB-12 - Guidance on Establishing and Maintaining Instrument Setpoints:

- Conformance: The PRMS design conforms to BTP HICB-12.

BTP HICB-13 - Guidance on Cross-Calibration of Protection System Resistance Temperature Detectors:

- Conformance: BTP HICB-13 does not apply to the PRMS because this system does not use RTD-type sensors.

BTP HICB-14 - Guidance on Software Reviews for Digital Computer-Based Instrumentation and Control Systems:

- Conformance: The PRMS design conforms to BTP HICB-14.

BTP HICB-16 - Guidance on the Level of Detail Required for Design Certification Applications Under 10 CFR Part 52:

Table 7.1-1

Regulatory Requirements Applicability Matrix

Applicable Criteria Guidelines: SRP NUREG-0800, Section 7.1	Reference Standard	System																										
		RPS (Q)	NMS (Q)	SPTM Function (Q)	ADS (Q)	GDCS (Q)	LD&IS (Q)	CRHS (Q)	SSLC /ESF (Q)	SLC (Q)	RSS (Q & N)	RWCU /SDC (N)	ICS (Q)	PAM (Q & N)	CMS (Q &N)	PRMS (Q &N)	ARMS (N)	Interlock Systems (Q & N)	NBS (Q)	RC&IS (N)	FWCS (N)	PAS (N)	SB&PC (N)	NMS (N)	CIS(N)	DPS(N) ATWS/SLC (Q)	Q-DCIS (Q)	N-DCIS (N)
1.75	IEEE Std. 384	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X							X	X	
1.89	IEEE Std. 323	X	X	X	X	X	X	X	X	X			X						X								X	
1.97	IEEE Std. 497		X	X										X		X											X	X
1.105	ANSI/ISA S67.04.01	X	X	X	X	X	X	X	X	X			X		X	X		X	X							X	X	
1.118	IEEE Std. 338	X	X	X	X	X	X	X	X	X	X		X		X	X		X								X	X	
1.151	ANSI/ISA-S67.02									X								X	X		X					X	X	
1.152*	IEEE Std. 7-4.3.2	X	X	X	X	X	X	X	X				X		X	X		X	X	–						X	X	X
1.153	IEEE Std. 603	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X							X	X	
1.168*	IEEE Std. 1012 IEEE Std. 1028	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.169*	IEEE Std. 828	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.170*	IEEE Std. 829	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.171*	IEEE Std. 1008	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.172*	IEEE Std. 830	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.173*	IEEE Std. 1074	X	X	X	X	X	X	X	X				X		X	X		X	X							X	X	(1)
1.180	IEEE Std. 1050	X	X	X	X	X	X	X	X	X	X††	X††	X	X††	X††	X††	X††	X††	X	X††	X††	X††	X††	X††	X††	X††	X	X††
1.204	IEEE Std. 1050	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1.209	IEEE Std. 323	X	X	X	X	X	X	X	X	X			X						X								X	
Branch Technical Positions (BTP)																												
BTP HICB-1	IEEE Std. 603					X												X									X	
BTP HICB-3	IEEE Std. 603	N/A																										
BTP HICB-6	IEEE Std. 603	N/A																										

Table 7.1-1
Regulatory Requirements Applicability Matrix

Applicable Criteria Guidelines: SRP NUREG-0800, Section 7.1	Reference Standard	RPS (Q)	NMS (Q)	SPTM Function (Q)	ADS (Q)	GDCS (Q)	LD&IS (Q)	CRHS (Q)	SSLC /ESF (Q)	SLC (Q)	RSS (Q & N)	RWCU /SDC (N)	ICS (Q)	PAM (Q & N)	CMS (Q &N)	PRMS (Q &N)	ARMS (N)	Interlock Systems (Q & N)†	NBS (Q)	RC&IS (N)	FWCS (N)	PAS (N)	SB&PC (N)	NMS (N)	CIS(N)	DPS(N) ATWS/SLC (Q)	Q-DCIS (Q)	N-DCIS (N)
		System																										
BTP HICB-8	Refer to RG 1.22	X	X	X	X	X	X	X	X	X			X													X	X	
BTP HICB-9	Refer to RG 1.153	X																									X	
BTP HICB-10	Refer to RG 1.97		X	X										X		X												X
BTP HICB-11	Refer to RG1.75 RG 1.153	X	X	X	X	X	X	X	X	X	X		X		X	X		X	X							X	X	X
BTP HICB-12	Refer to RG 1.105	X	X	X	X	X	X	X	X	X			X		X	X		X	X							X	X	X
BTP HICB-13	Refer to RG 1.153	N/A																										
BTP HICB-14*	Refer to RG 1.152	X	X	X	X	X	X	X	X		X		X		X	X		X	X							X	X	X
BTP HICB-16		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
BTP HICB-17*	Refer to RG 1.22, 1.47, 1.53, 1.118, 1.152 & 1.153	X	X	X	X	X	X	X	X		X		X		X	X		X	X							X	X	X
BTP HICB-18*	Refer to RG 1.152	X	X	X	X	X	X	X	X		X		X		X	X		X	X							X	X	X
BTP HICB-19*	NUREG/CR-6303	X	X	X	X	X	X	X	X										X		X					X	X	X
BTP HICB-21*	NUREG/CR-6083	X	X	X	X	X	X	X	X		X		X		X	X		X	X							X	X	X

Notes:
Q=Q-DCIS, N=N-DCIS
X = The code or regulation is applicable to the specified system.
N/A = The code or regulation is not applicable to the ESBWR design.
(1) = Parts or all of this code or regulation are voluntarily invoked for the specified system..
*These criteria are addressed with the digital computer-related functions of the Q-DCIS
†Interlocks are embedded within system logic
††N-DCIS hardware uses industrial methods for EMI/EMF compliance
‡Initiates the 10 CFR 50.62 ARI, SLC and FW runback and trip functions as described in Section 7.8.