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Subject: **Response to Portion of NRC Request for Additional Information Letter Nos. 01, 54 and 71 Related to ESBWR Design Certification Application – Radioactive Waste Management Systems - RAI Numbers 11.2-4S01, 11.2-11S01, 11.2.3-1S01, 11.3-3S01, 11.5-23S01 and 11.5-24S01**

Enclosure 1 contains GE-Hitachi Nuclear Energy Americas (GE-H) responses to the subject NRC supplemental RAIs transmitted via References 1 through 3.

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

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NRO

References:

1. MFN 05-152 – Letter from US Nuclear Regulatory Commission (NRC) to David H. Hinds, *Request for Additional Information Letter No. 01 Related to ESBWR Design Certification Application,* dated November 23, 2005
2. MFN 06-302 – Letter from US Nuclear Regulatory Commission (NRC) to David H. Hinds, *Request for Additional Information Letter No. 54 Related to ESBWR Design Certification Application,* dated August 23, 2006
3. MFN 06-383 – Letter from US Nuclear Regulatory Commission (NRC) to David H. Hinds, *Request for Additional Information Letter No.71 Related to ESBWR Design Certification Application,* dated October 11, 2006
4. MFN 05-153 – Letter from David Hinds to US Nuclear Regulatory Commission (NRC), *Response to NRC Request for Additional Information Letter No. 1Related to ESBWR Design Certification Application – Chapters 11 and 12 – Radiation Protection*, dated December 9, 2005.
5. MFN 06-344 - Letter from David Hinds to US Nuclear Regulatory Commission (NRC), *Response to Portion of NRC Request for Additional Information Letter No. 54 Related to ESBWR Design Certification Application – Radioactive Waste Management – RAI Numbers 11.2-11, 11.2-12, 11.2-14, 11.3-1 and 11.3-3*, dated September 29, 2006
6. MFN 06-311 - Letter from David Hinds to US Nuclear Regulatory Commission (NRC), *Response to Portion of NRC Request for Additional Information Letter No. 54 Related to ESBWR Design Certification Application – Radioactive Waste Management/Radiation Protection – RAI Numbers 11.2-4 through 11.2-8 and 11.4-15*, dated September 11, 2006
7. MFN 07-030 - Letter from James C. Kinsey to US Nuclear Regulatory Commission (NRC), *Response to Portion of NRC Request for Additional Information Letter No. 71 – Radioactive Waste Management Systems – RAI Numbers 11.5-23 and 11.5-24*, dated April 10, 2007

Enclosures:

1. Response to NRC Request for Additional Information Letter Nos. 01, 54 and 71 Related to ESBWR Design Certification Application, dated October 11, 2006 – Radioactive Waste Management Systems, RAI Numbers 11.2-4 S01, 11.2-11 S01, 11.2.3-1 S01, 11.3-3 S01, 11.5-23 S01 and 11.5-24 S01
2. Markup of Supporting DCD Revision 3 Pages

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE-H /San Jose (with enclosures)
RE Brown GE-H /Wilmington (with enclosures)
eDRF 0070-2471 for RAI 11.2- 4 S01
0071-4223 for RAI 11.2-11 S01
0070-2556 for RAI 11.2.3-1 S01
0070-2417 for RAI 11.3-3 S01
0070-1655 for RAI 11.5-23 S01
0071-3409 for RAI 11.5-24 S01

Enclosure 1

MFN 07-371

Response to Portion of NRC Request for Additional Information Letter Nos. 01, 54 and 100 Related to ESBWR Design Certification Application

Radioactive Waste Management Systems

RAI Numbers 11.2-4 S01, 11.2-11S01, 11.2.3-1S01, 11.3-3S01, 11.5-23S01 and 11.5-24S01

For historical purposes, the original text of RAI 7.5-3 (Reference MFN 06-137) and the GE response is included preceding the supplemental response. Any original attachments or DCD mark-ups are not included to prevent confusion.

NRC RAI 11.2-4

DCD Tier 2, Table 11.2-1 specifies equipment codes for use in the liquid waste system. It states that the information is from Regulatory Guide (RG) 1.143, Table 1. The row for atmospheric tanks in Table 11.2-1 reflects RG 1.143, Rev. 1, which adds "ASME Code Section III, Class 3" as an acceptable Design and Fabrication code, and "AWWA D-100" as an acceptable Inspection and Testing code. Revision 2 of RG 1.143 specifies API-650 for these codes. (The currently released version of RG 1.143 contains a misprint for the Inspection & Testing code. Both columns should site API-650. A correction is being processed by the NRC.) Please revise this Table 11.2-1 to reflect Revision 2 of the RG 1.143.

GE Response

DCD Tier 2 Chapter 11 Table 11.2-1 will be revised as shown in the attached markup to comply with Regulatory Guide 1.143, Revision 2 Table 1 as it pertains to atmospheric tanks, including API-650 for the Inspection & Testing code.

NRC RAI 11.2-4 S01:

In RAI 11.2-4, the staff requested that the applicant revise Table 11.2-1 of the DCD Tier 2, to reflect the guidance of RG1.143, Revision 2, for atmospheric tanks. In its response, the applicant agreed to revise the table in accordance with RG 1.143. The staff reviewed the revised table attached to the applicant's response letter, and in Revision 3 of the DCD Tier 2. The staff found that the applicant retained a footnote that adds the use of fiberglass reinforced tanks that are constructed in accordance with the requirements or American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Section X. This is not consistent with the guidance in RG1.143. BPVC Section X does not have any specific guidance on the use of fiberglass tanks in radiation zones or for the retention of radioactive liquids. 10 CFR 50.34(h)(3) states that the applicant must present justification for deviation from the established review criteria, as published in the applicable SRP section. Therefore, the staff requests that the applicant either provide documentation to demonstrate that the use of fiberglass reinforced plastic tanks for retention of liquids containing radioactive waste is acceptable, that this will not pose a risk to the health and safety of the public or the plant workers; or that the provision to use fiberglass reinforced plastic tanks be removed.

GE-H Response:

Note 3 on DCD Table 11.2-1 will be deleted.

DCD Impact:

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

NRC RAI 11.2-11

DCD Tier 2, Figure 11.2-1, "Liquid Waste Management System Process Diagram," does provide sufficient detail to assess the system's adequacy. Locations of components relative to other plant components and buildings are not shown. Update the diagram to include sufficient detail to identify all sources of liquid input volumes (e.g., condensate storage tank collection berm and individual building sumps), the points of collection of liquid waste, the flow paths of liquids through the system including all bypasses, and the specific points of release of liquid effluents to the environment (e.g., interface COL item with circulating water system), consistent with the guidance of Standard Review Plan (SRP) Section 11.2, Rev. 2, July 1981, Review Criterion III.1.

GE Response

DCD Tier 2 Chapter 11 will be revised to include a new Figure 11.2-2, "Liquid Waste Management System Process Stream Information Directory." Additionally, a description of Figure 11.2-2 has been added in Section 11.2. These attached improvements to the DCD are consistent with the guidance of Standard Review Plan (SRP) Section 11.2, Rev.2, July 1981, Review Criterion III.1.

NRC RAI 11.2-11 S01:

In RAI 11.2-11, the staff requested additional detail to be provided for Figure 11.2-1, "Liquid Waste Management System Process Diagram." For example, the diagram did not show sufficient detail to identify all sources of liquid input volumes, the points of collection of liquid waste, the flow paths of liquids through the system including all bypasses, and the specific point of release of liquid effluents to the environment. The level of details should be sufficient to allow staff review in accordance with the guidance of SRP Section 11.2, Rev. 2, July 1981, Review Criterion III.1. In its response the applicant stated that the DCD Tier 2 would be revised to include a new Figure 11.2-2, "Liquid Waste Management System Process Stream Information Directory." Additionally, a description of Figure 11.2-2 was added in Section 11.2. The staff reviewed the revised figures in Revision 3 of the DCD Tier 2, and still could not find the specific point(s) of release of liquid effluents to the environment (e.g., interfacing with the circulating water system).

GE-H Response:

The DCD will be revised to identify the specific release points to the environment.

DCD Impact:

DCD Tier 2, Subsections 11.2.3, 11.2.2.2, Figures 11.2-1 and 11.2-2 will be revised as noted on the attached markup in Enclosure 2.

NRC RAI 11.2.3-1

The listed decontamination factors are not consistent with NUREG-0016 guidance.

The decontamination factors (DF) listed in Table 11.2-3 are not consistent with NUREG-0016. No DF value is given for tritium. See related RAI No. 12.2.2.3-1. Without this information, the staff cannot independently confirm the annual doses reported in Table 12.2-20.

GE Response:

The DF for tritium is one, which is consistent with Section 1.5.2.8.2 of NUREG-0016. A revised version of Table 11.2-3 will be included in DCD Revision 01 to be issued January 31st, 2006. A pdf file of the DRAFT DCD Revision 01, page 11.2-12 is included in Enclosure 2. The revised Table 11.2-3 follows:

Subsystems*	Filter	Reverse Osmosis	Ion-Exchanger	Total DF
Equipment (low conductivity)				
Drain Subsystem:				
Halogens	1	-	100 (10)**	1,000
Cs, Rb	1	-	10 (10)**	100
Other nuclides	1	-	100 (10)**	1,000
Floor (high conductivity)				
Drain Subsystem:				
Halogens	1	10	100 (10)**	10,000
Cs, Rb	1	10	2 (10)**	200
Other nuclides	1	10	100 (10)**	10,000
A DF of 1 is used for tritium.				
Chemical Drain Subsystem				
Chemical drain is processed in Floor Drain Subsystem.				
Detergent Drain Subsystem:				
A DF of 1 is used for the detergent drain filter for all radionuclides				

* From NUREG-0016 Revision 1, Table 1-5.

** For two ion exchangers in series, the DF for the second unit is given in parenthesis

NRC RAI 11.2.3-1 S01:

In RAI 11.2.3-1, 11.2.3-2, and 11.2.2-4, the staff requested the applicant to clarify the basis of the decontamination factors (DF) listed in DCD Tier 2, Rev. 1, Table 11.2-3, and their applications in deriving the estimated radioactive liquid effluent source term identified in DCD, Rev. 3, Section 12.2.2.3. DCD Rev. 3, Table 12.2-3 presents updated decontamination factors assigned by types of liquid wastes and groupings of radionuclides. The revised DFs are consistent with those presented in NUREG-0016 for general purpose ion-exchange and adsorbent media and filtration systems. However, DCD Rev. 3, Section 11.2.6 does not commit the COL applicant to the description and performance of installed mobile processing equipment with that described in DCD Tier 2, Rev. 3, Tables 11.2-2c and 11.2-3. For example, a COL applicant referencing the ESBWR certified design should identify ion-exchange and adsorbent media and filtration systems it plans to use depending upon the expected characteristics of liquid process and effluent streams.

GE-H Response:

The DCD will be revised to state that the ion-exchange and absorbent media meets or exceeds the decontamination factors provided in Table 11.2-3.

DCD Impact:

DCD Tier 2, Section 11.2.2 will be revised as noted on the attached markup. A note is added to Table 11.2-3 to clarify that the absorbent media purchased will meet or exceed the decontamination factors in Table 11.2-3. Refer to Enclosure 2 for the attached markup pages.

NRC RAI 11.3-3

DCD Tier 1, Table 2.10.3-1 states that the offgas system (OGS) is designed to withstand internal hydrogen explosions. Describe how the design pressure of the components was selected to provide this capability. Provide numerical performance criteria for the hydrostatic test demonstrating this capability.

GE Response

The ESBWR offgas system is designed similar to offgas systems at other licensed BWRs designed since 1971 and specifically similar to the offgas system at Grand Gulf Nuclear Power Station.

The ESBWR offgas system design used the methodology outlined in GE report, NEDE-11146 "Pressure Integrity Design Basis for New Gas Systems", to establish hydrogen explosion pressure integrity in offgas piping. NEDE-11146 has been previously submitted and approved by the NRC to evaluate and establish design pressure integrity for the Grand Gulf offgas system during internal hydrogen explosions. The Grand Gulf UFSAR, Section 11.3.2.2.1.9, which references the use of NEDE-11146 to establish hydrogen explosion pressure integrity in offgas piping, is attached for your reference. DCD Tier 2 Chapter 11 Section 11.3.2.2 will be revised as shown in the attached markup to indicate that the hydrogen explosion pressure integrity of the ESBWR offgas piping was designed and analyzed using the methodology outlined in NEDE-11146 and that this analysis demonstrated the ability of the ESBWR offgas piping to sustain an explosion without loss of integrity.

NRC RAI 11.3-3 S01:

In RAI 11.3-3, the staff requested the applicant to describe how the OGS design pressure of the components was selected to provide the capability to withstand an internal hydrogen explosion. In addition, the staff asked the applicant to provide numerical performance criteria for the hydrostatic test demonstrating this capability. In its response the applicant stated that the ESBWR offgas system design used the methodology outlined in GE report, NEDE-11146 "Pressure Integrity Design Basis for New Gas Systems," to establish hydrogen explosion pressure integrity in offgas piping. NEDE-11146 has been previously submitted and approved by the NRC to evaluate and establish design pressure integrity for the Grand Gulf offgas system during internal hydrogen explosions. The staff finds this methodology to be adequate, and Section 3.2.2 of DCD Tier 2, Revision 3, does reference the NEDE report. In addition, the applicant identified a COL Item in Section 11.3.8 of the DCD Tier 2, Revision 2. The OGS design parameters, major equipment items as well as other system data, as shown in DCD Tier 2, Table 11.3-2, are to be defined by the COL applicant. This COL Action Item addressed a portion of the RAI, and was identified as COL Information item 11.3.8-1. Based on the methodology and COL action item, RAI 11.3-3 was resolved. However, in Revision 3 of the DCD Tier 2, COL Information item 11.3.8-1 was removed. The removing of this COL item is not acceptable.

GE-H Response:

The COL item was removed because the offgas system is a GEH permanent plant designed system without mobile systems that are used in the liquid and solid radioactive waste system designs. Table 11.3-2 in DCD Tier 2, Revision 3 is the final OGS major equipment design parameters. If a COL Applicant chooses to make changes to the GEH permanent plant offgas system design, a departure with justification and design details will be required in the COL application.

DCD Impact:

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

NRC RAI 11.5-23:

A review of DCD Tier 2, Revision 1, Sections 10.4.2, 11.3, 11.5, 12.3.1, and 12.3.2 indicates that there is no discussion addressing plant design features to mitigate radiation exposures and doses to members of the public associated with the production of N-16 and sky-shine out of the turbine building in the context of 10 CFR Parts 20.1302 and 20.1301(e) and 40 CFR 190. Provide:

(A) a description of turbine building features (placement of main steam pipes, shielding, construction materials used for the turbine building walls and roof, etc.) that are designed to mitigate radiation fields and sky-shine in plant environs;

(B) an estimate of the dose to a postulated member of the public located at or beyond the EAB (800 m) in complying with 10 CFR Parts 20.1302 and 20.1301(e) and 40 CFR 190; and

(C) describe how site-specific conditions will be considered in assessing radiation exposures and doses to members of the public, and how such information and operational considerations would be addressed by the COL applicant in the offsite dose calculation manual.

GE Response:

(A) The N16 source and sky-shine is discussed in DCD Tier 2, Revision 3, Subsection 12.2.1.3. Necessary biological shielding is provided for equipment in the Turbine Building and is considered in the design of the Turbine Building. Shielded equipment is described in DCD Tier 2, Revision 3, Sections and subsections 10.1, 10.2.4, 10.4.1.1.1, 10.4.1.3 and 10.4.2.3.

(B) The estimated doses of N16 source and sky-shine in the Turbine Building were provided in response to RAI 12.3-5 and 12.3-5 S01 (RAI 12.3-5 response is provided in GE letter MFN 06-477, Supplement 1 dated February 6, 2007).

(C) A new paragraph 11.5.7.2 will be added to DCD Tier 2, Revision 4, to require the COL Holder consider site-specific conditions and requirements in assessing radiation exposure and doses to the members of the public in the Offsite Dose Calculation Manual (ODCM) in accordance with the requirements of 10 CFR 20.1301(e) and 10 CFR 20.1302.

DCD Impact:

(A) For this item, no DCD changes will be made in response to this RAI.

(B) For this item, no DCD changes will be made in response to this RAI.

(C) A new paragraph will added in the DCD Tier 2, Revision 4 as noted on the attached markup in Enclosure 2.

NRC RAI No. 11.5-23 S01:

In Revision 3 of the DCD, Tier 2, Section 12.2.1.3 fails to refer to the use of a specific computer code used to calculate doses. A review of the applicant's response to RAI 11.5-23 and revised text in Rev. 3 DCD Section 12.2.1.3 indicates that of the two computer codes used to calculate doses at and beyond the EAB, one is not included in DCD Table 12.3-1. Accordingly, the applicant should revise Table 12.3-1 to include the "SKYIII-PC" computer code along with all other listed codes.

GE-H Response:

DCD Tier 2, Subsection 12.2.1.3 and Table 12.3-1 will be revised to include the "SKYIII-PC" computer code.

In addition, the proposed DCD markups associated with the response to RAI 12.3-5 S01 (MFN 06-477, Supplement 1, dated February 10, 2007) were not fully integrated into DCD Tier 2, Revision 3, Section 12.2.1.3. The N-16 skyshine discussion in Section 12.2.1.3 will be revised to reflect the correct wording.

DCD Impact:

DCD Tier 2, Subsection 12.2.1.3 and Table 12.3-1 will be revised as noted on the attached markups in Enclosure 2.

NRC RAI 11.5-24:

The DCD does not address acceptance criteria and guidance of SRP Section 9.3.2.II (NUREG-0800) on the process sampling system (PSS) and post-accident sampling system (PASS). A review of DCD Tier 2, Revision 1, Section 11.5 and 9.3.2 indicates that there are no discussions on whether the acceptance criteria and guidance of SRP Section 9.3.2.II Revision 2 July 1981, on the process sampling system and post accident sampling system were considered in the design. The criteria include: General Design Criteria 1, 2, 13, 14, 26, 41, 60, 63,and 64; 10 CFR Part 20.1101(b); and 10 CFR Parts 50.34(f)(2)(viii) and 50.34(2)(xxvi). The guidance includes Regulatory Guides 1.21, 1.26, 1.29, 1.33, 1.56, 1.97, and 8.8; and ANS/HPS 13.1-1999. Accordingly: A) Provide discussions addressing how the applicable requirements of SRP Section 9.3.2.II were met in DCD Tier 2, Sections 11.5.5 and 9.3.2 for gaseous / liquid process and effluent streams; B) Update the text of DCD Tier 2, Sections 11.5.5 and 9.3.2 and Tables 11.5-1 and 9.3-1 to reflect the applicable criteria of SRP Section 9.3.2.II; C) Update the text in DCD Tier 2, Section 11.5.5 by adding internal cross references to DCD Tier 2, Section 9.3.2 and; D) Describe operational considerations that would be addressed by the COL applicant in DCD Tier 2 Sections 11.5.7 and 9.3.2.

GE Response:

The Process Sampling (PSS) design is described in DCD Tier 2 Subsection 9.3.2. A cross reference to DCD Tier 2, Revision 3, Subsection 9.3.2 was made in a new DCD Subsection 11.5.5.9 entitled ""Process and Post-Accident Sampling Programs – Regulatory Compliance" in order to indicate that DCD Subsection 9.3.2 contains information pertaining to the sampling of certain selected streams and processes. The extraction of samples pertaining to the Process and Effluent Radiation Monitoring System (PRM), are primarily taken at the PRM skid or panel associated with each subsystem and therefore, do not have an interconnection with the Process Sampling System (PSS). Please note that the Post Accident Sampling (PASS) function is separate and distinct from Process and Effluent Radiation Monitoring, and under normal circumstances would be described in DCD Sections 1A, 7.4.3.2, 7.5.2.2, 7.9.2.5, 9.3.2, and 16. However, the response to RAI 16.2-68 (GE MFN 06-431 dated November 13, 2006) discusses, and provides justification for, the elimination of the Post Accident Sampling equipment. Post Accident Sampling in the DCD will be limited to information required per the SER accompanying NEDO-32991, Revision 0, "Regulatory Relaxation For BWR Post Accident Sampling Stations (PASS)," and the associated NRC Safety Evaluation dated June 12, 2001." Compliance with SRP Section 9.3.2 for the Process and Effluent Radiation Monitoring System is provided in the new DCD Subsection 11.5.5.9 stating, "In addition, where practicable, provisions will be made to include the ability to collect samples at central sample stations in order to reduce leakage, spillage, and radiation exposures to operating personnel. The Process Radiation Monitoring subsystem will be designed to maintain radiation exposures ALARA in accordance with 10 CFR Part 20.1101 (b). Attached TABLE 1, DCD 9.3.2 Process Sampling System SRP Compliance, provides the applicable Standard Review Plan inspection criteria and how the Process Sampling System (DCD 9.3.2) complies with these requirements.

(A) The new Subsection 11.5.5.9 reflects the criteria mentioned in the response to (A) above, i.e., maintaining radiation exposure ALARA, and reducing leakage and spillage as part of the Process and Effluent Radiation Monitoring system.

(B) The new Subsection 11.5.5.9 mentioned in response (A) above includes a cross reference to DCD Section 9.3.2 and SRP Section 9.3.2 compliance with respect to Chapter 11.5 [see responses to (A) and (B) above.]

(C) Additional statements were added in Revision 3 to the DCD Tier 2 Process Sampling Subsection 9.3.2 documenting that the Process Sampling system design is consistent with the criteria set forth in subsection 9.3.2, "Process and Post-Accident Sampling Systems" of the Standard Review Plan.

(D) There are no known operational considerations for the Process and Effluent Radiation Monitoring subsystems that need to be addressed in Subsections 11.5.7 or 9.3.2.

DCD Impact:
A cross reference was made in a new DCD Subsection 11.5.5.9 entitled **"Process and Post-Accident Sampling Programs – Regulatory Compliance"** that indicates that DCD Section 9.3.2 contains information pertaining to the sampling of certain selected streams and processes. Additional statements were added in DCD Subsection 9.3.2, Process Sampling, to provide justification of the acceptability of the design of the process sampling system based on specific general design criteria and regulatory guides stating that the design of the process sampling system is consistent with the criteria set forth in Section 9.3.2, "Process and Post-Accident Sampling Systems" of the Standard Review Plan. The Process Sampling System is in conformance with the relevant requirements and criteria that are stipulated in the codes and standards identified below:

- 10 CFR 20.20 & 20.1101(b)
- 10 CFR 50, Appendix A, GDC 1, 2, 13, 14, 26, 41, 60, 63, and 64
- 10 CFR 50.34(f)(2)(viii) and 50.34(2)(xxvi)
- Regulatory Guides (RG) 1.21, 1.26, 1.29, 1.33, 1.56, 1.97, and 8.8
- NUREG-0737, Item II.B.3 and
- ANSI/HPS N13.1

The following statement was added in Revision 3 of DCD Tier 2, Subsection 9.3.2.2: "ALARA is considered in station layout and design".

NRC RAI 11.5-24S01:

In Revision 3 of the DCD, Tier 2, the applicant proposed responses refer to a non-existent DCD Section and incomplete NRC regulations.

In its response to RAI 11.5-24, the applicant refers to specific sections of the DCD where information may be found on the PASS. Among several citations, the response refers to a non-existent section of the DCD, namely Sect. 7.9.2.5. Accordingly, the applicant should revise its response by referring to the proper DCD section. In its response to the RAI and proposed revised text for Rev. 3 DCD Section 9.3.2 (p.9.3-1), the applicant refers to an incomplete citation of Part 20, namely "Part 20.20 & 20.1101(b)". Accordingly, the applicant should update the text in its RAI response and DCD Section 9.3.2 for the purpose of citing the correct section of 10 CFR Part 20.

GE-H Response:

The Part 20.20 reference is a typographical error and will be revised to indicate Part 20 & 20.1101(b), accordingly.

DCD Impact:

DCD Tier 2 Subsection 9.3.2 will be revised to reflect the correction of the typographical error as indicated on the attached DCD markup in Enclosure 2.

Enclosure 2

MFN 07-371

Markup of Supporting DCD Revision 3 Pages

RAI Numbers	Attached Markup Pages
11.2-4 S01	Table 11.2-1
11.2-11 S01	Sections 11.2.3, 11.2.2.2,Figures 11.2-1 and 11.2-2
11.2.3-1 S01	Section 11.2.2 and Table 11.2-3
11.3-3 S01	NA
11.5-23 S01	Section 12.2.1.3 and Table 12.3-1
11.5-24 S01	Section 9.3.2

Table 11.2-1

Equipment Codes (from Table 1, RG 1.143)

Component	Design and Construction	Materials[1]	Welding	Inspection and Testing
Pressure Vessels and Tanks (>15 psig)	ASME Code BPVC Div. 1 or Div.2	ASME Code Section II	ASME Code Section IX	ASME Code Section VIII, Div. 1 or Div.2
Atmospheric Tanks	API 650	ASME Code[3] Section II	ASME Code Section IX	API 650
0-15 psig Tanks	API 620	ASME Code[3] Section II	ASME Code Section IX	API 620
Heat Exchangers	TEMA STD, 8th Edition ; ASME Code BPVC Section VIII, Div. 1 or Div. 2	ASTM B359-98 or ASME Code Section II	ASME Code Section IX	ASME Code Section VIII, Div. 1 or Div. 2
Piping and Valves	ANSI/ASME B31.3[5, 6, 4, 5]	ASME Code Section ~~II~~[7]II[6]	ASME Code Section IX	ANSI/ASME B31.3
Pumps	API 610; API 674; API 675; ASME BPVC Section VIII, Div.1 or Div.2	ASTM A571-84 (1997) or ASME Code Section II	ASME Code Section IX	ASME BPVC Code[2] Section III, Class 3
Flexible Hoses and Hose Connections for ~~MRWP~~[4]MRWP[3]	ANSI/ANS-40.37	ANSI/ANS-40.37	ANSI/ANS-40.37	ANSI/ANS-40.37

Notes for Table 11.2-1:

1. Manufacturer's material certificates of compliance with material specifications may be provided in lieu of certified material test reports as discussed in Regulatory Position 1.1.2 of Regulatory Guide 1.143.
2. ASME Code stamp, material traceability, and the quality assurance criteria of ASME BPVC, Section III, Div.1, Article NCA are not required. Therefore, these components are not classified as ASME Code Section III, Class 3.
~~3. Fiberglass-reinforced plastic tanks may be used in accordance with appropriate articles of Section 10 of the ASME Boiler and Pressure Vessel Code for applications at ambient temperature.~~
43. Flexible Hoses should only be used in conjunction with Mobile Radwaste Processing Systems (MRWP).
~~5~~4. Class RW-IIa and RW-IIb Piping Systems are to be designed as category "M" systems.
~~6~~5. Classes RW-IIa, RW-IIb and RW-IIc are discussed in Regulatory Position 5 of Regulatory Guide 1.143.
~~7~~6. ASME BPVC Section II required for Pressure Retaining Components.

environment. The radioactivity removed from the liquid waste is concentrated in unit operation and chemical reactor active components, such as filter media, ion exchange resins and concentrated waste. The decontamination factors (DFs) that are listed in Table 11.2-3 are in accordance with NUREG-0016 (Reference 11.2-7), but are considered conservative values. The filter sludge, ion exchange resins and concentrated waste are sent to the SWMS for further processing. 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 through a discharge line to the circwater system. Prior to discharging to the environment the contents of the tank being released will be 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. The discharge line will have a radiation monitor which will provide an automatic closure signal to a valve in this line.

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 (3mrem) to the whole body and 0.1 mSv (10mrem) 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.

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.

Dilution Factors

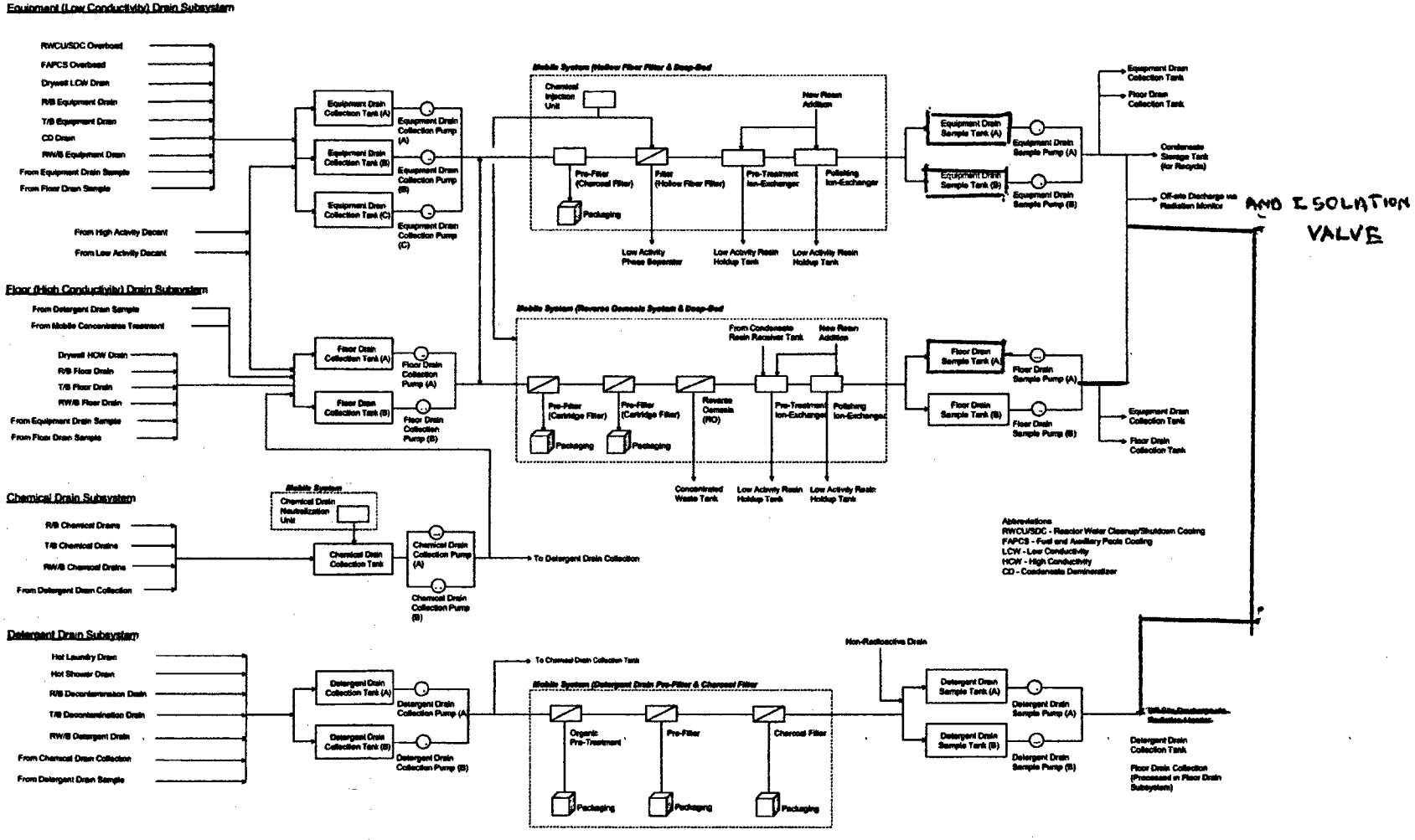
Refer to Section 12.2 for dilution factors used in evaluating the release of liquid effluents.

11.2.4 Testing and Inspection Requirements

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

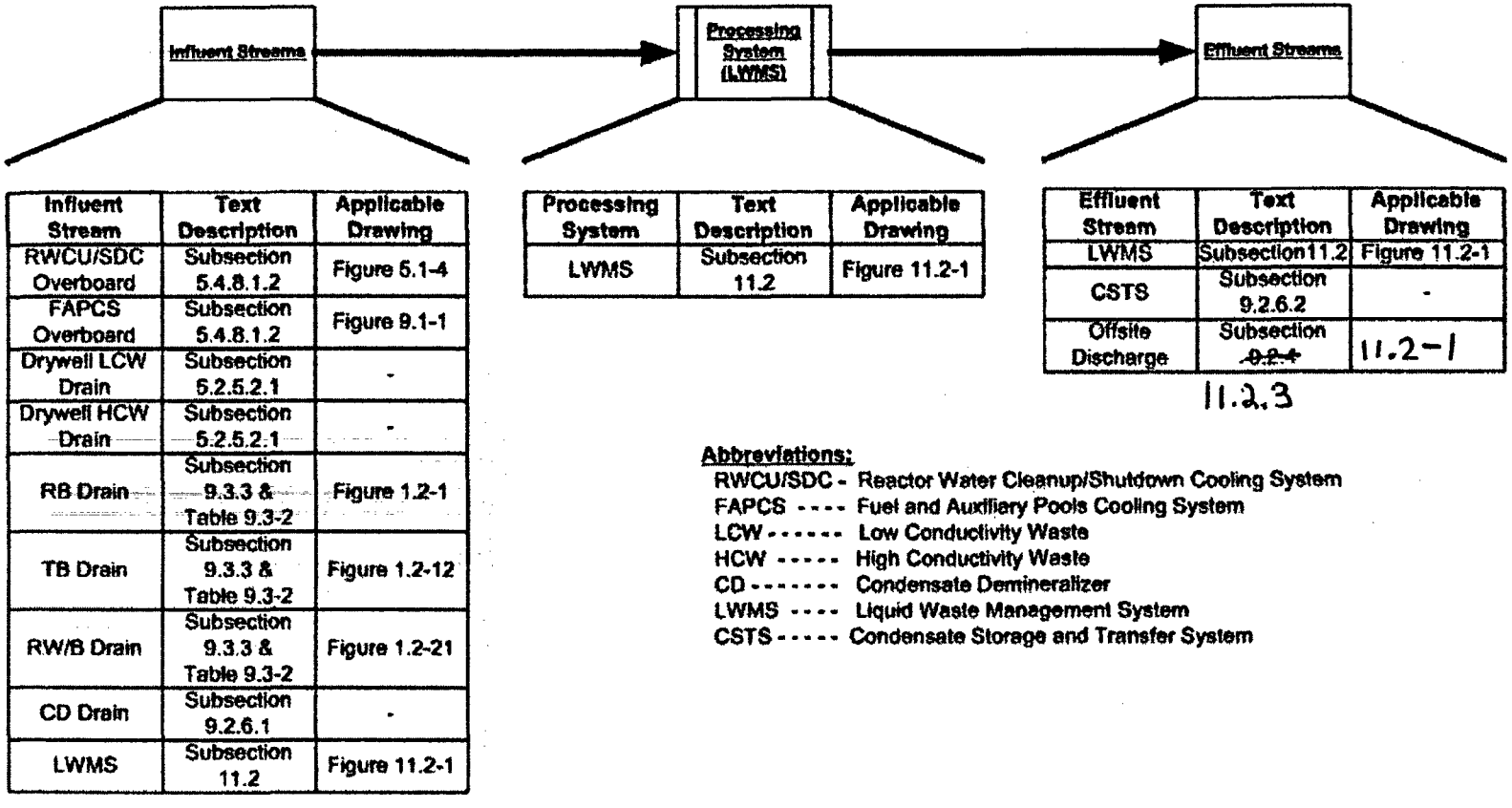
During initial testing of the system, the pumps and mobile systems are performance tested to demonstrate conformance with design flows and process capabilities. An integrity test is performed on the system upon completion.

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.



AND ISOLATION VALVE

Figure 11.2-1. Liquid Waste Management System Process Diagram*
*Similar to or Similar



Influent Stream	Text Description	Applicable Drawing
RWCU/SDC Overboard	Subsection 5.4.8.1.2	Figure 5.1-4
FAPCS Overboard	Subsection 5.4.8.1.2	Figure 9.1-1
Drywell LCW Drain	Subsection 5.2.5.2.1	-
Drywell HCW Drain	Subsection 5.2.5.2.1	-
RB Drain	Subsection 9.3.3 & Table 9.3-2	Figure 1.2-1
TB Drain	Subsection 9.3.3 & Table 9.3-2	Figure 1.2-12
RW/B Drain	Subsection 9.3.3 & Table 9.3-2	Figure 1.2-21
CD Drain	Subsection 9.2.6.1	-
LWMS	Subsection 11.2	Figure 11.2-1

Processing System	Text Description	Applicable Drawing
LWMS	Subsection 11.2	Figure 11.2-1

Effluent Stream	Text Description	Applicable Drawing
LWMS	Subsection 11.2	Figure 11.2-1
CSTS	Subsection 9.2.6.2	-
Offsite Discharge	Subsection ~~9.2.4~~ 11.2.3	11.2-1

Abbreviations:

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

Figure 11.2-2. Liquid Waste Management System Process Stream Information Directory

11.2.2 System Description

11.2.2.1 Summary Description

The LWMS collects, monitors, processes, stores, and disposes of potentially radioactive liquid waste collected throughout the plant.

The equipment and floor drainage systems are described in Section 9.3.

Potentially radioactive liquid wastes are collected in tanks located in the radwaste building. System components are designed and arranged in shielded enclosures to minimize exposure to plant personnel during operation, inspection, and maintenance. Tanks, processing equipment, pumps, valves, and instruments that may contain radioactivity are located in controlled access areas.

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 will be designed to meet or exceed the decontamination factors in Table 11.2-3.

11.2.2.2 System Operation

The LWMS consists of the following four process subsystems:

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 (typically consisting of a collection of unit operations, reaction systems and their support equipment, such as filtration systems, Deep-Bed Ion Exchanger systems, organic material pre-treatment equipment, possibly an intermediate tank/pump and the associated plumbing, instrumentation and electrical systems as required), and two sample tanks and sample pumps. 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 system for floor drain treatment.

A strainer or filter is typically 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

Table 11.2-3

Decontamination Factors

Subsystems*	Filter	Reverse Osmosis	Ion-Exchanger	Total DF
Equipment (low conductivity) Drain Subsystem:				
Halogens	1	-	100 (10)**	1,000
Cs, Rb	1	-	10 (10)**	100
Other nuclides	1	-	100 (10)**	1,000
Floor (high conductivity) Drain Subsystem:				
Halogens	1	10	100 (10)**	10,000
Cs, Rb	1	10	2 (10)**	200
Other nuclides	1	10	100 (10)**	10,000
A DF of 1 is used for tritium.				
Chemical Drain Subsystem: Chemical drain is processed in Floor Drain Subsystem.				
Detergent Drain Subsystem: A DF of 1 is used for the detergent drain filter for all radionuclides.				

* From NUREG-0016 Revision 1, Table 1-5.

** ~~Per RG1.143, tank design and fabrication are in accordance with ASME Section III, Class 3; API 620; API 650 or AWWA D-100, depending on design requirements.~~The decontamination factor for the second demineralizer in series is 10 per ANSI 55.6. Liquid radwaste processing equipment will meet or exceed these decontamination factors.

Normal Operating Sources

N^{16} in the steam flow from the pressure vessel. is the primary turbine building source of radioactivity. The N^{16} source results in significant gamma shine from the main steam lines and steam bearing components on the order of 0.2-0.5 Gy/hr (20-50 rad/hr) contact. Other major sources of radiation in the turbine building are the Offgas System (Section 11.3) and the Condenser and Feedwater System. The Offgas System consists of the steam jet air ejector, recombiner, offgas condenser, and offgas charcoal tanks. Table 12.2-10 provides the sources for the Offgas System. The sources for the turbine condenser and feedwater filter/demineralizer system are given in Tables 12.2-11 and 12.2-12.

N^{16} Skyshine Offsite Dose Contribution

The ESBWR design takes into account the hydrogen and/or noble metal injection chemistry, having conservatively used ~~9.25 MBq/g~~ 11.1 MBq/g as the specific N^{16} activity in the vessel nozzle outlet steam. This is equivalent to using a value ~~five times~~ six times the normal value of 1.85 MBq/g.

The N^{16} skyshine contribution to offsite dose as calculated using the SKYIII-PC code is provided in Table 12.2-21.

Post-Accident Radioactive Sources

The turbine building contains no major sources of releasable radioactivity (discounting N^{16} because of the 7.7 second half-life) and potential releases are limited to liquid releases of low activity water from the feedwater and condenser systems. Two other sources exist which contain radioactive species but in a form not amenable for release. The potential for accident releases from these two sources, the offgas system, and the condenser demineralizers, is reduced due to heavy shielding and compartmentalizing of the components.

12.2.1.4 Radwaste Building Source Terms

This section provides a summation of the significant radioactive source terms found in the ESBWR radwaste building. These source terms consist of those elements which are found to contain significant quantities of radioactive materials but do not include sources due to incidental contamination such as sources in valves due to deposition of corrosion or fission products species on the surfaces of the components.

Normal Operating Sources

Tables 12.2-13a through 12.2-13g and 12.2-14a through 12.2-14b provide source inventories for the major radwaste components for operation. These sources are based upon the stream concentrations given in Section 11.1 and represent sources for shielding calculations. These inventories should not be construed to represent sources for offsite release. A complete description of the ESBWR radwaste system is given in Sections 11.2 through 11.4.

Table 12.3-1

Computer Programs Used in Shielding Design Calculations

Computer Code	Description
QADF	A multi-group, multi-region, point kernel gamma radiation code for calculating the flux and dose rate at discrete locations within a complex source geometry configuration.
GGG	A multi-group, multi-region, point kernel code for calculating the contributions due to gamma ray scattering in a heterogeneous three-dimensional space.
DORT	A discrete ordinates two-dimensional transport code. Multi-group, multi-region neutron or gamma transport.
QAD CGGP 1.0	"Quick and Dirty Combinatorial Geometry – Geometric Progression". A multi-group, multi-region, point kernel gamma radiation code for calculating the flux and dose rate at discrete locations within a complex source geometry configuration
SKYIII-PC	A Monte Carlo skyshine code designed to aid in the evaluation of the effects of structure geometry on the gamma-ray dose rate at given detector positions outside of a building housing N-16 gamma-ray sources.

9.3 PROCESS AUXILIARIES

9.3.1 Compressed Air Systems

Compressed air systems include the Instrument Air System (IAS), the Service Air System (SAS), the Containment Inerting System (CIS) and the High Pressure Nitrogen Supply System (HPNSS). The IAS is discussed in Subsection 9.3.6; the SAS is discussed in Subsection 9.3.7. The Containment Inerting System and the HPNSS are described in Subsections 9.4.9 and 9.3.8, respectively. The CIS and the HPNSS provide nitrogen gas for instruments and valve operators within the inerted containment.

9.3.2 Process Sampling System

9.3.2.1 Design Bases

Safety (10 CFR 50.2) Design Bases

The Process Sampling System (PSS) does not perform or ensure any safety-related function. Therefore, this system has no safety-related design basis. The post-accident monitoring program uses sample point parameters and key sample locations as described in this Subsection and Subsections 7.5.1 and 7.5.2. Relative to the Process Sampling System (PSS), this subsection addresses applicable requirements of General Design Criteria as are discussed in Standard Review Plan Section 9.3.2.II.

PSS is in conformance with the relevant requirements and criteria that are stipulated in the codes and standards that are identified below:

- 10 CFR 20 & 20.1101(b);
- 10 CFR 50, Appendix A, GDC 1, 2, 13, 14, 26, 41, 60, 63, and 64;
- 10 CFR 50.34(f)(2)(viii) and 50.34(2)(xxvi);
- Regulatory Guides (RG) 1.21, 1.26, 1.29, 1.33, 1.56, 1.97, and 8.8;
- NUREG-0737, Item II.B.3; and
- ANSI/HPS N13.1.

Power Generation Design Bases

The Process Sampling System (PSS) collects representative liquid samples for analysis and provides the analytical information required to monitor plant and equipment performance and changes to operating parameters.

The PSS is designed to function during all plant operational modes under individual system requirements. Design guidelines related to PSS capabilities, the attainment of representative samples, and safety are described in the following paragraphs and in Table 9.3-1.