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MFN 06-226

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Subject: **Response to NRC Request for Additional Information Letter No. 32 Related to ESBWR Design Certification Application – Hydrological Engineering – RAI Numbers 2.4-3 through 2.4-31**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter. This completes GE's response to RAI Letter No. 32.

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-174, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 32 Related to ESBWR Design Certification Application,* June 7, 2006

Enclosure:

1. MFN 06-226 – GE Response to NRC Request for Additional Information Letter No. 32 for the ESBWR Design Certification Application – Hydrological Engineering – RAI Numbers 2.4-3 through 2.4-31

cc:

WD Beckner	USNRC (w/o enclosures)
AE Cubbage	USNRC (with enclosures)
LA Dudes	USNRC (w/o enclosures)
GB Stramback	GE/San Jose (with enclosures)
eDRF	0000-0056-0811

Enclosure 1

MFN 06-226

GE Response to NRC Request for Additional Information Letter No. 32 for the ESBWR Design Certification Application Hydrological Engineering RAI Numbers 2.4-3 through 2.4-31

NRC RAI 2.4-3

ESBWR design control document (DCD) Tier 2, Table 2.0-1 and DCD Tier 1, Table 5.1-1 show the maximum ground water level at 0.61 m (2.0 ft) below grade and the probable maximum flood (PMF) to be at 0.3 m (1.0 ft) below grade. Therefore, during incidences of flooding, the ground water level will exceed the maximum ground water level specified in the ESBWR DCD. The applicant should clarify that the maximum hydrostatic head of the groundwater has been used in their computation of lateral pressure and buoyancy effects in the subsequent analysis of foundations in DCD Tier 2, Section 3.8.5. It is also necessary to incorporate the highest groundwater level for leak tightness of all accesses and openings below grade.

GE Response

Design flood level and design ground water levels are provided in DCD Table 3.4-1 based on parameters from DCD Table 2.0-1. The design basis flood level is 0.3 m (1 ft) below plant grade, and the design groundwater level is 0.61 m (2 ft) below plant grade. They are also included in DCD Table 3G.1-2 for the foundation analysis.

Buoyancy effect takes into account the maximum flood level, 0.3 m (1 ft) below plant grade, for load combinations in DCD Appendix 3G, Subsections 3G.1.5.3, 3G.2.5.3 and 3G.3.5.3.

DCD Figures 3G.1-19 and 3G.2-10 in Appendix 3G show that the maximum hydrostatic head of the groundwater is considered for computation of lateral pressure.

See DCD Subsection 3.4.1.2, where the criteria for flood protection and leaktightness below flood and groundwater levels are provided, as well as the details for flood protection of Seismic Category I buildings.

DCD Table 2.0-1 Item 2.4.10 and Subsection 2.4.10 will be revised in the next update, as noted in the attached markups.

NRC RAI 2.4-4

The applicant should clarify that the maximum flood level has been used as the hydrostatic head in determining the stability of subsurface materials, foundation and slopes in DCD Tier 2, Sections 2.5.4 and 2.5.5.

GE Response

The maximum flood level, 0.3 m (1 ft) below plant grade, has been used in determining the stability of foundations (See DCD Figures 3.G.1-19 and 3G.2-10 for lateral pressure determination, and DCD Appendix 3G, Subsections 3G.1.5.3, 3G.2.5.3, 3G.3.5.3, 3G.1.5.5, 3G.2.5.5 and 3G.3.5.5. for stability assessment and buoyancy effect).

DCD Subsections 2.5.4 and 2.5.5, which discuss stability of subsurface materials and slopes, will be clarified in the next update as noted in the attached markups.

NRC RAI 2.4-5

Revise DCD tier 2, Table 2.0-1 to reflect the appropriate hydrologic design parameters for the reference ESBWR plant siting. The hydrologic design parameters are:

- *Design maximum groundwater table level*
- *Design maximum flooding level (all sources considered)*
- *Design probable maximum precipitation (PMP)*
- *Water Demand for normal and accident conditions*
- *Effluent Inventory.*

GE Response

Design ground water and design flood levels are addressed in DCD Table 3.4-1, and are shown in DCD Table 2.0-1 as envelope parameters for ESBWR design. The PMP is addressed in Item 2.3.1 of Table 2.0-1.

The main water demand for normal conditions is the makeup for Plant Service Water Cooling Towers and Circulating Water Cooling Towers (during power operation). These are site-dependent and outside of the ESBWR Standard Plant scope. The main effluent inventory is the blowdown rate of these cooling towers.

The makeup of the Plant Service Water and Circulating Water cooling towers for normal operation is between approximately 4900 and 25,700 m^3/hr (21,500 and 113,000 gpm), while their effluent inventory is between approximately 600 and 21,400 m^3/hr (2,600 and 94,000 gpm). These values are provided for reference purposes because the cooling tower final performance, makeup and effluent inventory depend on site conditions such as station (raw) water quality or meteorological data.

Since the makeup and effluent inventory flows are site dependent and outside of the ESBWR Standard Plant scope, these parameters are not provided in the DCD.

During accident conditions in the ESBWR design, the ultimate heat sink (UHS) is the atmosphere, which receives steam generated by boiling in the Isolation Condenser / Passive Containment Cooling (IC/PCC) pools and Spent Fuel Pool. A separate safety-related service water system with a dedicated UHS reservoir and the corresponding makeup is not required. The water volumes needed to ensure operation of the IC and PCC Systems and to keep the Spent Fuel Pools filled for cooling are discussed in DCD Subsection 9.2.5, Ultimate Heat Sink.

During accident conditions, makeup water is not required for the first 72 hours, and the effluent inventory is null. The volume required within the first 72 hours after the initiating event is approximately 6,280 m^3 (222,000 ft^3) and is provided by the reactor well and IC/PCC pools. For the Spent Fuel Pool the volume required within the first 72 hours after the initiating event is approximately 770 m^3 (27200 ft^3). See response to RAI 2.4-22 for further details on makeup water requirements after 72 hours.

DCD Subsection 9.2.5 will be revised in the next update, as noted in the attached markup.

NRC RAI 2.4-6

Update DCD Tier 2, Table 2.0-1 and Table 1.10-1 to reflect a COL action item for adequate site drainage design to accommodate the design basis PMP without exceeding the flood level at 1 ft. below grade.

GE Response

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. The design flood level is 0.3 m (1 ft) below plant grade and the design ground water level is 0.61 m (2 ft) below plant grade. The COL applicant requirements are provided in DCD Subsection 2.4.2, in the portion of the text that is renumbered as Subsection 2.4.2.1 in the attached markup.

Compliance with DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.2 and DCD Subsection 2.4.2 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-7

Update DCD Tier 2, Table 1.10-1 to include flood protection requirement as a COL action item related to protection of below grade penetrations and openings.

GE Response

See DCD Subsection 3.4.1.2, which provides the criteria for flood protection below flood and groundwater levels as well as the details of flood protection for Seismic Category I buildings.

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. The COL applicant requirements are provided in DCD Subsection 2.4.10, in the portion of the text that is renumbered as Subsection 2.4.10.1 in the attached markup.

Compliance with DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.10, Table 1.10-1 and DCD Subsection 2.4.10 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-8

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect the COL requirement to ensure that the plant PMF design basis requirement is met as a result of overflow from streams and rivers.

GE Response

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. It also reflects the PMF design parameter that is applicable to overflow from streams and rivers, which is 0.3 m (1 ft) below plant grade. The COL applicant requirements are provided in DCD Subsection 2.4.3, in the portion of the text that is renumbered as Subsection 2.4.3.1 in the attached markup.

Compliance with DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.3 and DCD Subsection 2.4.3 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-9

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect the COL requirement to ensure that the plant PMF design basis requirement is met as a result of seismic dam failure.

GE Response

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. It also reflects the PMF design parameter that is applicable to potential seismically induced dam failures, which is 0.3 m (1 ft) below plant grade. The COL applicant requirements are provided in DCD Subsection 2.4.3, in the portion of the text that is renumbered as Subsection 2.4.3.1 in the attached markup.

Compliance with DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.4 and DCD Subsection 2.4.4 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-10

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect the COL requirement to ensure that the plant PMF design basis requirement is met as a result of maximum surge and seiche flooding.

GE Response

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. It also reflects the PMF design parameter that is applicable to surge and seiche flooding, which is 0.3 m (1 ft) below plant grade. The COL applicant requirements are provided in DCD Subsection 2.4.5, in the portion of the text that is renumbered as Subsection 2.4.5.1 in the attached markup.

Compliance with DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.5 and DCD Subsection 2.4.5 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-11

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect the COL requirement to ensure that the plant PMF design basis requirement is met as a result of tsunami flooding.

GE Response

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. It also reflects the PMF design parameter that is applicable to tsunami flooding, which is 0.3 m (1 ft) below plant grade. The COL applicant requirements are provided in DCD Subsection 2.4.6, in the portion of the text that is renumbered as Subsection 2.4.6.1 in the attached markup.

Compliance with DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.6, Table 1.10-1 and DCD Subsection 2.4.6 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-12

The applicant should elaborate how the requirements of GDC 44 are met by the ESBWR standard plant design. The applicant should identify the water load for the safety function associated with the removal of the combined head load of systems, structures and components (SSCs) under normal operating and accident conditions. Provisions for additional water to provide a safe margin in the estimation of the water requirement should also be identified.

GE Response

Agreed, DCD Subsections 2.4.8, 2.4.9 and 2.4.11 as well as Items 2.4.8, 2.4.9 and 2.4.11 in DCD Table 2.0-1 will be revised in the next update, as noted in the attached markup. These changes provide information and cross references regarding GDC 44 in this context.

NRC RAI 2.4-13

Update DCD Tier 2, Section 2.5.4.12, Table 2.0-1 and Table 1.10-1 to reflect the need of an external water source and its transportation to meet the UHS needs for post-72 hours passive containment cooling.

GE Response

The note in DCD Subsection 2.5.4.12 under the discussion of Regulatory Guide 1.27 will be revised in the next update, as noted in the attached markup.

Items 2.4.8, 2.4.9 and 2.4.11 in DCD Table 2.0-1 will be revised in the next update, as noted in the attached markup.

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. Therefore, the discussion regarding Regulatory Guide 1.27 provided in DCD Subsection 2.5.4.12 is not applicable to DCD Table 2.0-1 Item 2.5.4.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-14

Even if an internal storage is utilized to provide the safety-related water demand, the applicant should address whether or not additional volume of water is needed to accommodate the potential for ice formation or the potential of low water conditions from the ice formation.

GE Response

During accident conditions in the ESBWR design, the ultimate heat sink (UHS) is the atmosphere, which receives steam generated by boiling in the Isolation Condenser / Passive Containment Cooling (IC/PCC) pools and Spent Fuel Pool. The water volumes needed to ensure operation of the IC and PCC Systems and to keep the Spent Fuel Pools filled for cooling are discussed in DCD Subsection 9.2.5, Ultimate Heat Sink. Since these pools are indoors, and their function is achieved by boiling, there are no low water considerations regarding ice formation.

See also response to RAI 2.4-5 for further clarification.

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

NRC RAI 2.4-15

The applicant should provide an estimate of the water flow rate/volume needed from the external source accounting for loss due to ice formation and other loss from exposure.

GE Response

There are no low water considerations regarding ice formation and other loss from exposure (see response to RAI 2.4-14).

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

NRC RAI 2.4-16

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect that water flow rate or water volume required for post-72 hours is a COL action item to ensure that design basis requirement is met.

GE Response

After 72 hours, the only function required for maintaining the plant in a safe shutdown condition is to provide makeup water to the Isolation Condenser/Passive Containment Cooling (IC/PCC) pools and Spent Fuel Pool (see DCD Subsections 6.2.2 and 6.3.2 for details of PCC and IC systems).

Permanently installed piping is included in the Fuel and Auxiliary Pools Cooling System (FAPCS), which is connected directly to the site Fire Protection System (FPS) and to external reactor building connections. These connections enable the pools to be filled with water to continue decay heat removal nearly indefinitely.

The FPS has access to enough water on-site to provide makeup water to extend the cooling period from 72 hours through 7 days (see DCD Subsections 9.1.3 and 9.5.1 for details of FAPCS and FPS). After 72 hours, on-site or off-site sources can be relied upon to provide additional makeup water to the IC/PCC and spent fuel pools.

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

NRC RAI 2.4-17

Identify the flow requirements (gallons per hour) of the delivery channels to meet the post-72 hours UHS water needs and normal cooling water needs.

GE Response

The Fire Protection System (FPS) has access to enough water on-site to provide post-72 hours makeup water. Permanently installed safety-related piping is included in the Fuel and Auxiliary Pools Cooling System (FAPCS), which is connected directly to the site FPS and to external reactor building connections (see DCD Subsections 9.1.3 and 9.5.1 for FAPCS and FPS details). After 72 hours, on-site or off-site sources can be relied upon to provide additional makeup water to the IC/PCC and spent fuel pools.

See responses to RAI 2.4-5, RAI 2.4-15 and RAI 2.4-23 for further clarification and requested flow rate.

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

NRC RAI 2.4-18

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect that channel flow rate is a COL action item to ensure that design basis requirement is met.

GE Response

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. The ESBWR plant design does not have any safety-related service water systems that would require transport and impoundment of plant cooling water. The COL applicant requirements are provided in DCD Subsection 2.4.8, in the portion of the text that is renumbered as Subsection 2.4.8.1 in the attached markup.

Compliance with DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.8 and DCD Subsection 2.4.8 will be revised in the next update, as noted in the response to RAI 2.4.1-1 that was previously provided in GE letter MFN 06-001 (ML060060082), dated January 3, 2006, as well as in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-19

The applicant should address the potential adverse effects of a loss of flood protection and any action required during a subsequent COL application should be identified as a COL Action Item in DCD Tier 2, Section 2.4.10.

GE Response

See DCD Subsection 3.4.1.2, which provides the criteria for flood protection below flood and groundwater levels as well as the details of flood protection for Seismic Category I buildings.

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. The COL applicant requirements are provided in DCD Subsection 2.4.10, in the portion of the text that is renumbered as Subsection 2.4.10.1 in the attached markup.

Compliance with the DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.10 and DCD Subsection 2.4.10 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-20

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect that this loss of protection from flooding is a COL action item to ensure that design basis requirement is met.

GE Response

See DCD Subsection 3.4.1.2, which provides the criteria for flood protection below flood and groundwater levels as well as the details of flood protection for Seismic Category I buildings.

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. Compliance with the DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR.

See response to RAI 2.4-19 for further clarification.

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

NRC RAI 2.4-21

Question Summary: "Design parameter satisfaction of cooling water need and its transport as COL action."
Full Text: "Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect that this is a COL action item to ensure that design basis requirement is met."

GE Response

See responses to RAI 2.4-16 and RAI 2.4-5.

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

NRC RAI 2.4-22

DCD Tier 2, Section 3.1.4.15 cites the isolation condenser (IC)/passive containment cooling (PCC) pools as performing the UHS function. Section 1.2.2.4.1 states that the IC/PCC pool have an installed capacity of 72 hours of reactor heat decay removal beyond which makeup water from a water supply outside the reactor building is utilized. The applicant should identify this safety related source and associated water transport system. Any action required during subsequent COL application should be identified as a COL Action Item in Section 2.5.1.

GE Response

After 72 hours, the only function required for maintaining the plant in a safe shutdown condition is to provide makeup water to the Isolation Condenser/Passive Containment Cooling (IC/PCC) pools and Spent Fuel Pool (see DCD Subsections 6.2.2 and 6.3.2 for details of PCC and IC systems).

Permanently installed safety-related piping is included in the Fuel and Auxiliary Pools Cooling System (FAPCS), which is connected directly to the site Fire Protection System (FPS) and to external reactor building connections. These connections enable the pools to be filled with water to continue decay heat removal nearly indefinitely.

Onsite equipment and supplies provide support for the long term (post-72 hours) that is readily available for connection and protected from natural phenomena, including seismic events. The FPS has access to enough water on-site to provide makeup water to extend the cooling period from 72 hours through 7 days (see DCD Subsections 9.1.3 and 9.5.1 for details of FAPCS and FPS).

The FAPCS portions that establish the flow paths necessary for supply of emergency makeup water to the Spent Fuel Pool and IC/PCC pools following an accident and the FAPCS containment isolation function are safety-related.

After 72 hours, on-site or off-site sources can be relied upon to provide additional makeup water to the IC/PCC and spent fuel pools.

DCD Subsections 2.4.11 and 2.5.4.12 will be modified to state that the FPS is designed to provide makeup water from 72 hours to 7 days.

NRC RAI 2.4-23

The applicant should define the volume and the minimum delivery rate of the cooling water that would be required to be stored and delivered by the external water source.

GE Response

The main water demand for normal conditions is the makeup for Plant Service Water Cooling Towers and Circulating Water cooling towers (during power operation). These are site-dependent and outside of the ESBWR Standard Plant scope.

During accident conditions, there are no water supply requirements within 72 hours after an initiating event. After 72 hours, the only function required for maintaining the plant in a safe shutdown condition is to provide makeup water to the Isolation Condenser/Passive Containment Cooling (IC/PCC) pools and Spent Fuel Pool. The required volume from 72 hours through 7 days is approximately 5,600 m^3 (198,000 ft^3), and the maximum required delivery rate is approximately 70 m^3/h (305 gpm) at 72 hours.

See responses to RAI 2.4-5 and RAI 2.4-22 for further clarification.

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

NRC RAI 2.4-24

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect the COL requirement to ensure that the plant design basis requirement for the hydrogeologic regime is met.

GE Response

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. The COL applicant will describe the major hydrological features in accordance with DCD Subsection 2.4.1. The COL applicant requirements are provided in DCD Subsection 2.4.1, in the portion of the text that is renumbered as Subsection 2.4.1.1 in the attached markup.

Compliance with the DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.1 and DCD Subsection 2.4.1 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

NRC RAI 2.4-25

Based on DCD Tier 1, Section 3.1, the ESBWR plant design life is 60 years. Since the design groundwater elevation is 2 ft. below grade, foundations of safety related structures and other safety related embedded structures and components will be subject to degradation from contaminants, such as chlorides, in the groundwater. Specify limits on groundwater contaminants that ESBWR design is suitable for. Alternatively, describe any measures that the COL applicant must take to prevent degradation through groundwater contaminants.

GE Response

The ESBWR is designed taking into account that the plant could be located at ocean sites. Specific characteristics of the concrete in harsh environmental conditions are discussed in DCD Subsection 3.8.1.6.

In addition, the Seismic Category I structures below plant grade are protected against groundwater contaminants by a waterproofing system. The concrete is thus sealed and protected against penetration of water or liquid, as well as being resistant to harsh environmental conditions.

DCD Table 2.0-1 Item 2.4.1 will be revised in the next update, as noted in the attached markups.

NRC RAI 2.4-26

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect the COL requirement to ensure that the plant design basis requirement for radionuclide transport characteristics is met.

GE Response

See response to RAI 2.4-29.

NRC RAI 2.4-27

In DCD Tier 2 the applicant has taken credit for the design of the Radwaste storage vaults for non-leakage, or at least the reduction of leakage during all events, including seismic events. DCD Tier 1 identifies the Radwaste building as a non-seismic category structure. This difference should be explained.

GE Response

See response to RAI 2.4-29.

NRC RAI 2.4-28

Identify the source terms that have a potential for leakage into the groundwater during any of the operations considered in the design of the Radwaste building operation.

GE Response

Potential leakage into the groundwater during normal operations in the Radwaste Building is addressed in DCD Subsections 12.2.2.3 and 12.2.1.4.

Leakage into the groundwater from the Radwaste Building during accident conditions is addressed in DCD Subsection 15.3.16, and further supported by the response to RAI 2.4-29.

See response to RAI 2.4-29 for further details.

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

NRC RAI 2.4-29

The ESBWR design uses a Radwaste Building designed to RG 1.143; therefore, failure of Radwaste Building and the Radwaste storage tanks due to safe shutdown earthquake (SSE) cannot be precluded. Discuss what measures must be taken by the COL applicant in the event of a total release of the entire Radwaste inventory at the site.

GE Response

The ESBWR Radwaste Building, along with the structures, systems and components (SSCs) it contains, are assigned a classification of RW-IIa according to Regulatory Guide (RG) 1.143. Table 2 of this RG requires that a ½·SSE be utilized for design of SSCs with this classification. RG 1.143 Table 3 spells out the load combinations to be used in the design. RG 1.143 Table 1 lists the Design Codes to be used, which in combination with RG 1.143 Table 4 contain applicable acceptance criteria.

RG 1.143 Section B, last paragraph, indicates that if this RG is implemented then exposures to the public are expected to be as low as is reasonably achievable. Therefore, it is not necessary to postulate the failure of the entire Radwaste Building and its contents (SSCs) when designing to RG 1.143 Category RW-IIa requirements. The COL applicant does not need to take any further measures.

DCD Subsections 2.4.13, 3.8.4, 3.8.4.1.5, 12.2.1.4 and 15.3.16 will be revised in the next update, as noted in the attached markup.

NRC RAI 2.4-30

Update DCD Tier 2, Table 1.10-1 and Table 2.0-1 to reflect the COL requirement to ensure that the plant design basis requirement for radionuclide transport mechanism effects on future water users is met.

GE Response

See response to RAI 2.4-29.

NRC RAI 2.4-31

Identify a COL Action Item that requires the development of any hydrological condition limiting plant operations related to water elevation at reservoirs, or indications from monitoring wells, etc, that depend on site specific conditions.

GE Response

DCD Table 2.0-1 only reflects the envelope used for the ESBWR generic design. The maximum groundwater level is 0.61 m (2 ft) below plant grade and the probable maximum flood during any design flood event is at least 0.3 m (1 ft) below plant grade. The COL applicant requirements are provided in DCD Subsection 2.4.14, in the portion of the text that is renumbered as Subsection 2.4.14.1 in the attached markup.

Compliance with the DCD Table 2.0-1 requirement satisfies the design envelope for the ESBWR. DCD Table 2.0-1 Item 2.4.14 and DCD Subsection 2.4.14 will be revised in the next update, as noted in the attached markups.

DCD Table 1.10-1 is also affected by this RAI response, but a markup of DCD Table 1.10-1 is not attached to this response at this time. The version of Table 1.10-1 in DCD Revision 1 is considered to be preliminary because the DCD Revision 1 production schedule did not allow time for it to be fully updated to include all COL action items throughout Revision 1 of the DCD. A final complete version of DCD Table 1.10-1 that summarizes all COL action items will be produced after all DCD sections have been updated to Revision 2 status.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.3.4	Short-Term Diffusion Estimates for Accidental Atmospheric Releases	ESBWR DCD: Exclusion Area Boundary X/Q: 0-2 hours 1.00E-03 s/m^3 Low Population Zone X/Q: 0-8 hours 1.35E-04 s/m^3 8-24 hours 1.00E-04 s/m^3 1-4 days 5.40E-05 s/m^3 4-30 days 2.20E-05 s/m^3 Control Room X/Q: 1.00E-03 s/m^3 for entire accident duration COL applicant to supply site-specific information in accordance with the SRP 2.3.4 to show that the site meteorological dispersion values as calculated in accordance with Regulatory Guides 1.145 and 1.194, and compared to dose values given in Chapter 15, result in doses less than stipulated in 10 CFR 50.34(a) and the applicable portions of SRP Sections 11 and 15.
2.3.5	Long-Term Diffusion Estimates	ESBWR DCD: X/Q: 2.0E-06 s/m^3 D/Q: 4.0E-09 m^{-2} COL applicant to supply site-specific information in accordance with the SRP 2.3.5.
2.4.1	Hydraulic Description Maximum Ground Water Level	ESBWR DCD: 0.61 m (2 ft) below plant grade. COL applicant to supply site-specific information in accordance with the Subsection 2.4.1.1.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.4.2	Floods	ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels. No further action is required for sites within the bounds of this ESBWR parameter. Penetrations and access openings below grade shall be watertight. COL applicant to supply site-specific information in accordance with the Subsection 2.4.2.1.
2.4.3	Probable Maximum Flood on Streams and Rivers	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is 0.3 m (1 ft) below plant grade or less. No further action is required for sites within the bounds of this ESBWR parameter. COL applicant to supply site-specific information in accordance with the Subsection 2.4.3.1.
2.4.4	Potential Dam Failures Seismically Induced	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is at least 0.3 m (1 ft) below plant grade. No further action is required for sites within the bounds of this ESBWR parameter. COL applicant to supply site-specific information in accordance with the Subsection 2.4.4.1.
2.4.5	Probable Maximum Surge and Seiche Flooding	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is at least 0.3 m (1 ft) below plant grade. No further action is required for sites within the bounds of this ESBWR parameter. COL applicant to supply site-specific information in accordance with the Subsection 2.4.5.1.
2.4.6	Probable Maximum Tsunami Flooding	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is at least 0.3 m (1 ft) below plant grade. No further action is required for sites within the bounds of this ESBWR parameter. COL applicant to supply site-specific information in accordance with the Subsection 2.4.6.1.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.4.7	Ice Effects	ESBWR DCD: None; the plant design has no safety-related service water system to be affected by ice flooding or blockage. COL applicant to supply site-specific information in accordance with the Subsection 2.4.7.1.
2.4.8	Cooling Water Canals and Reservoirs	ESBWR DCD: None; the plant design has no safety-related service water system that would require transport and impoundment of plant cooling water. In the ESBWR design, the ultimate heat sink (UHS) is the atmosphere, which receives steam generated by boiling in the Isolation Condenser (IC) and Passive Containment Cooling (PCC) System pools and the Spent Fuel Pool. A separate safety-related service water system with a dedicated UHS reservoir is not required. The water volumes needed to ensure operation of the IC and PCC systems and to keep the Spent Fuel Pools filled for cooling are discussed in Subsection 9.2.5, Ultimate Heat Sink. COL applicant to supply site-specific information in accordance with the Subsection 2.4.8.1.
2.4.9	Channel Diversion	ESBWR DCD: None; the plant design has no safety-related service water system that would be adversely affected by natural stream channel diversion. In the ESBWR design, the ultimate heat sink (UHS) is the atmosphere, which receives steam generated by boiling in the Isolation Condenser (IC) and Passive Containment Cooling (PCC) System pools and the Spent Fuel Pool. A separate safety-related service water system with a dedicated UHS reservoir is not required. The water volumes needed to ensure operation of the IC and PCC systems and to keep the Spent Fuel Pools filled for cooling are discussed in Subsection 9.2.5, Ultimate Heat Sink. COL applicant to supply site-specific information in accordance with the Subsection 2.4.9.1.

Table 2.0-1

Envelope of ESBWR Reference Plant Site Design Parameters, Considerations and/or Limits

Subsection	Subject	Parameters/Considerations/Limits
2.4.10	Flooding Protection Requirements	ESBWR DCD: None; the probable maximum flood (PMF), as defined in ANSI/ANS 2.8, is at least 0.3m (1 ft) below plant grade. No further action is required for sites within the bounds of this ESBWR parameter. COL applicant to supply site-specific information in accordance with the Subsection 2.4.10.1.
2.4.11	Cooling Water Supply	ESBWR DCD: None; the plant design has no safety-related service water system that would require that a water supply exist to operate the plant or maintain safe shutdown under normal and emergency conditions during the first 72 hours after initiation of an emergency. Post 72-hour emergency makeup to the IC/PCC and spent fuel pools is provided onsite by the Fire Protection System (see Subsections 9.2.5 and 9.5.1 for Ultimate Heat Sink requirements and Fire Protection System details). During normal operation, the nonsafety-related Station Water System provides makeup water to the nonsafety-related Plant Service Water System cooling towers (see Subsection 9.2.1). COL applicant to supply site-specific information in accordance with the Subsection 2.4.11.1.
2.4.12	Groundwater	ESBWR DCD: At least 0.61 m (2 ft) below plant grade. COL applicant to supply site-specific information in accordance with the Subsection 2.4.12.1.
2.4.13	Accidental Releases of Liquid Effluents in Ground and Surface Waters	ESBWR DCD: See DCD Tier-2 Chapter 15 "Liquid Containing Tank Failure" COL applicant to supply site-specific information in accordance with the Subsection 2.4.13.1.
2.4.14	Technical Specifications and Emergency Operation Requirement	ESBWR see DCD Tier-2 Chapters 16 and 18. COL applicant to provide site-specific information in accordance with Subsection 2.4.14.1.
2.5.1	Basic Geologic and Seismic Information	ESBWR DCD: See subsections 2.5.2-2.5.5 of this table for ESBWR bounding parameters. COL applicant to provide site-specific information in accordance with SRP 2.5.1.

2.4 HYDROLOGIC ENGINEERING

2.4.1 Hydrologic Description

The ESBWR hydrologic description is presented in Subsection 2.4.1 of Table 2.0-1.

2.4.1.1 Combined License Information

In accordance with SRP 2.4.1, in this subsection the COL applicant presents the following site-specific information:

- Identification of the interface of the plant with the hydrosphere.
- Identification of hydrologic causal mechanisms that may require special plant design bases or operating limitations with regard to floods and water supply requirements.
- Identification of surface and groundwater uses that may be affected by plant operation.

2.4.1.1.1 Site and Facilities

In this subsection the COL applicant compares the independently verified or derived hydrologic design bases (see subsequent sections of 2.4) with the critical elevations of safety-related structures and facilities.

2.4.1.1.2 Hydrosphere

In this subsection the COL applicant presents the hydrologic characteristics of streams, lakes (e.g., location, size, shape, drainage area), shore regions, the regional and local groundwater environments, and existing or proposed water control structures (upstream and downstream) influencing the type of flooding mechanisms which may adversely effect safety aspects of plant siting and operation. The COL applicant provides site-specific information on the hydrogeologic regime, chemical groundwater control programs and allowable limits for contaminants.

2.4.1.2 Regulatory Guidance

Acceptance criteria for SRP 2.4.1 relate to the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes, floods, tsunami, and seiches.
- 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site.

2.4.2 Floods

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1. No further action is required for sites within the bounds of the ESBWR parameters.

2.4.2.1 Combined License Information

In this subsection of the safety analysis report (SAR) the COL applicant identifies historical flooding (defined as occurrences of abnormally high water stage or overflow from a stream, floodway, lake, or coastal area) at the proposed site or in the region of the site. The COL applicant summarizes and identifies the individual types of flood-producing phenomena, and

combinations of flood-producing phenomena, considered in establishing the flood design bases for safety-related plant features. It also covers the potential effects of local intense precipitation. Although topical information may appear in COL SAR Subsections 2.4.3 through 2.4.7, the types of events considered and the controlling event are reviewed in this section of the COL SAR.

The flood history and the potential for flooding are presented for the following sources and events. Factors affecting potential runoff (such as urbanization, forest fire, or change in agricultural use), erosion, and sediment deposition are considered in the presentation.

- Stream flooding
  - Probable Maximum Flood (PMF) with coincident wind-induced waves, considering dam failure potential due to inadequate capacity, inadequate flood discharge capability, or existing physical condition.
  - Ice jams, both independently and coincident with a winter probable maximum storm.
  - Tributary drainage area PMF potential.
  - Combinations of less severe river floods, coincident with surges and seiches.
- Surges
  - Probable Maximum Hurricane (PMH) at coastal sites.
  - PMH wind translated inland and resulting wave action coincident with runoff-induced flood levels.
  - Probable maximum wind-induced (non-hurricane) storm surges and waves.
  - Combinations of less severe surges, coincident with runoff floods.
- Seiches
  - Meteorologically induced in inland lakes (e.g., Great Lakes and harbors) and at coastal harbors and embayments.
  - Seismically induced in inland lakes.
  - Seismically induced by tsunami (seismic sea waves) on coastal embayments.
  - Combinations of less severe surges and seiches, coincident with runoff floods.
- Tsunami
  - Near field, or local, excitation.
  - Far field, or distant, excitation.
- Seismically induced dam failures (or breaches) and maximum water level at site from:
  - Failure of dam (or dams) during Safe Shutdown Earthquake (SSE) coincident with 25-year flood.
  - Failure during other earthquakes, coincident with runoff, surge, or seiche floods where the coincidence is at least as likely as for failure of a dam (above).
- Flooding caused by landslides

- Flood waves.
- Backwater effects due to stream blockage.

- Ice loadings from water bodies

To meet the requirements of the hydrologic aspects of the acceptance criteria in Section 2.4.2.2, the following specific investigations and criteria are used:

2.4.2.1.1 Flood History

In this subsection the COL applicant presents the potential flood sources and flood response.

2.4.2.1.2 Flood Design Considerations

In this subsection the COL applicant presents an estimate of controlling flood levels.

2.4.2.1.3 Effects of Local Intense Precipitation

In this subsection the COL applicant estimates the local Probable Maximum Precipitation (PMP) and the capacity of site drainage facilities (including drainage from the roofs of buildings and site) relating to the potential for any adverse effects of blockage of site drainage facilities by debris, ice, or snow based upon conservative assumptions of storm and vegetation conditions likely to exist during storm periods. If a potential hazard does exist, the COL applicant shall document and justify his local PMP basis and analysis and design of any affected facilities.

2.4.2.2 Regulatory Guidance

Acceptance criteria for SRP 2.4.2 relate to the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes, floods, tsunami, seiches.
- 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site.

Appropriate sections of the following documents are used to develop the COL applicant's data and analyses in meeting the requirements of GDC 2 and 10 CFR Part 100. Regulatory Guide 1.59 provides guidance for estimating the design basis for flooding considering the worst single phenomenon and combinations of less severe phenomena.

Regulatory Guide 1.29 identifies the safety-related structures, systems, and components, and Regulatory Guide 1.102 describes acceptable flood protection to prevent the safety-related facilities from being adversely affected. Publications of the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Soil Conservation Service (SCS), Corps of Engineers, applicable State and river basin authorities, and other similar agencies are used to verify the applicant's data relating to hydrologic characteristics and extreme events in the region. SRP subsections 2.4.3 through 2.4.7 discuss methods of analysis to determine the individual flood-producing phenomena.

2.4.3 Probable Maximum Flood on Streams and Rivers

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1. No further action is required for sites within the bounds of the ESBWR parameters.

2.4.3.1 Combined License Information

In accordance with SRP 2.4.3, in this subsection of the safety analysis report (SAR), the site-specific hydrometeorological design basis is developed by the COL applicant to determine the extent of any flood protection required for those structures, systems, and components necessary to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition. The areas of presentation include the probable maximum precipitation (PMP) potential and precipitation losses over the applicable drainage area, the runoff response characteristics of the watershed, the accumulation of flood runoff through river channels and reservoirs, the estimate of the discharge rate trace (hydrograph) of the PMF at the plant site, the determination of PMF water level conditions at the site, and the evaluation of coincident wind-generated wave conditions that could occur with the PMF. Included is a presentation of the details of design bases for site drainage (which is summarized in COL SAR Subsection 2.4.2); a review of the runoff for site drainage areas adjacent to the plant site, including the roofs of safety-related structures, resulting from potential PMP; and a presentation of the potential effects from erosion and sedimentation. The analyses involve modeling of physical rainfall and runoff processes to estimate the upper level of possible flood conditions adjacent to and on site.

2.4.3.2 Regulatory Guidance

Regulatory Guide 1.59 describes two positions with respect to flood protection for which a PMF estimate is required to determine the controlling design basis conditions. If Regulatory Guide 1.59 Position 1 is chosen, all safety-related systems, structures, and components must be capable of withstanding the effects from the controlling flood design basis. Regulatory Guide 1.59 Position 2 limits the presentation to specific safety-related structures, systems, and components necessary for cold shutdown and maintenance thereof.

Acceptance criteria for SRP 2.4.3 is based on meeting the, requirements of the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of floods.
- 10 CFR Part 100 as it relates to evaluating hydrologic characteristics of the site.

2.4.4 Potential Dam Failures

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1. No further action is required for sites within the bounds of the ESBWR parameters.

2.4.4.1 Combined License Information

In accordance with SRP 2.4.4, in this section of the safety analysis report (SAR) the COL applicant develops the hydrogeologic design basis to assure consideration in plant design of any potential hazard to the safety-related facilities due to the failure of upstream and downstream water control structures. The areas of presentation include consideration of flood waves from severe breaching of upstream dams and the potential loss of water supply due to failure of a downstream dam, domino-type failures of dams, landslides, and effects of sediment deposition and erosion.

When data are provided to show that seismic events will not cause failures of upstream dams that could produce the governing flood at the plant, this section may be updated to contain additional data and other information to support a contention that the dams are equivalent to seismic Category I structures and will survive a local equivalent of the safe shutdown earthquake (SSE).

Where analyses are provided in support of either a conclusion that a probable maximum flood (PMF) should be the design basis flood for a stream, or that a postulated or arbitrarily assumed dam failure flood is the design basis flood for a stream, the areas of review consist of the following:

- Conservatism of modes of assumed dam failure and deposition of debris downstream.
- Consideration of flood control reservoirs at full pool level.
- Conservatism of coincident flow rates and levels depending on whether failure is postulated with an equivalent SSE coincident with a 25-year flood.
- Flood wave attenuation to downstream dams, or to the site, whichever would be encountered first.
- Potential for multiple dam failures; flood wave effects and potential for failure of downstream dams.
- Hydraulic failure as a result of overtopping for any reason.
- Dynamic effects of possible waves on exposed plant facilities.
- Conservative flow conditions for downstream dam failures that can influence safety-related water supplies.
- Applicability and conservatism of models used to predict the effects of dam failure floods including breach shape and rate of failure.

2.4.4.2 Regulatory Guidance

Acceptance criteria are based on meeting the requirements of the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems and components important to safety being designed to withstand floods.
- 10 CFR Part 100 as it relates to evaluating hydrologic features of the site.
- 10 CFR Part 100, Appendix A as it relates to establishing the design basis flood due to seismic dam failure.

2.4.5 Probable Maximum Surge and Seiche Flooding

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1. No further action is required for sites within the bounds of the ESBWR parameters.

2.4.5.1 Combined License Information

In accordance with SRP 2.4.5, in this section of the safety analysis report (SAR) the COL applicant develops the hydrometeorological design basis to determine the extent of flood protection required for safety-related plant systems. The areas of review include the characteristics of the assumed probable maximum hurricane or other probable maximum wind

storms and the techniques, methodologies, and parameters used in the determination of the design surge and/or seiche. Antecedent water levels, storm tracks, methods of analysis, coincident wind-generated wave action and wave runup on safety-related structures, potential for wave oscillation at the natural periodicity, and the resultant design bases for surge and seiche flooding are also presented.

2.4.5.2 Regulatory Guidance

Acceptance criteria are based on meeting the requirements of the following regulations:

- General Design Criteria 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes and seiches.
- 10 CFR Part 100 as it relates to evaluating the hydrologic characteristics of the site.

2.4.6 Probable Maximum Tsunami Flooding

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1. No further action is required for sites within the bounds of the ESBWR parameters.

2.4.6.1 Combined License Information

In accordance with SRP 2.4.6, the COL applicant develops the geohydrological design basis of the plant (discussed in Regulatory Guide 1.59) in this section of the safety analysis report (SAR) to determine the extent of plant protection required for tsunami flooding and drawdown (outlined in Regulatory Guide 1.102). The areas of presentation include the hydrologic characteristics of the maximum locally and distantly generated tsunami and the techniques, methodologies and parameters, including the geoseismic parameters of the generators, used in the determination of the design basis tsunami.

Hydrologic analysis techniques, including tsunami formation, propagation and shoaling models, and coincident water levels, including astronomical tide, storm surges and waves, are presented.

The presentation will include the geologic and seismic characteristics of potential tsunamic faults. Areas of presentation include earthquake magnitude, focal depth, source dimensions, fault orientation, and vertical displacement.

2.4.6.2 Regulatory Guidance

Acceptance criteria relate to the following regulations:

- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of tsunami.
- 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site.
- 10 CFR Part 100, Appendix A as it relates to investigating the tsunami potential at the site and determining the design bases for tsunami flooding.

2.4.7 Ice Effects

ESBWR DCD: None; the plant design has no safety-related service water system to be affected by ice flooding or blockage.

2.4.7.1 Combined License Information

In accordance with SRP 2.4.7, the COL applicant develops the hydrometeorologic design basis in this section of the safety analysis report (SAR) to assure that safety-related facilities and water supply are not affected by ice flooding or blockage. The areas of presentation include:

- The regional history and types of historical ice accumulations (i.e., ice jams, wind-driven ice ridges, floes, etc.).
- The potential for ice-produced forces on, or blockage of, safety-related facilities.
- The potential effects of ice-induced high or low flow levels on safety related facilities and water supplies.

If there is evidence of potential structural effects, they shall be properly considered in the structural design basis for the plant; similarly, if there is evidence of potential mechanical effects, they shall be properly considered in the mechanical design basis for the plant.

2.4.7.2 Regulatory Guidance

Acceptance criteria are based on meeting the requirements of the following regulations:

- 10 CFR Part 50, §50.55a as it requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.
- General Design Criterion 2 (GDC 2) as it requires structures, systems, and components important to safety to be designed to withstand the effects of natural phenomena.
- 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site.

Appropriate sections of the following documents are used to assure that the Commission regulations identified above are met:

- Regulatory Guide 1.59 provides guidance for developing the hydrometeorological design basis;
- Regulatory Guide 1.29 identifies the safety-related structures, systems, and components;
- Regulatory Guide 1.102 describes acceptable flood protection to prevent the safety-related facilities from being adversely affected; and
- Regulatory Guide 1.27 describes the ultimate heat sink capabilities that apply. For the ESBWR, the ultimate heat sink is the atmospehere, which receives steam generated by boiling in the Isolation Condenser/Passive Containment Cooling (IC/PCC) pools that are located inside the Reactor Building where they are not subject to icing effects.

2.4.8 Cooling Water Canals and Reservoirs

ESBWR DCD: None; the plant design has no safety-related service water system that would require transport and impoundment of plant cooling water. In the ESBWR design, the ultimate heat sink (UHS) is the atmosphere, which receives steam generated by boiling in the Isolation Condenser (IC) and Passive Containment Cooling (PCC) system pools and Spent Fuel Pool. A separate safety-related service water system with a dedicated UHS reservoir is not required. The water volumes needed to ensure operation of the IC and PCC systems and to keep the Spent Fuel Pools filled for cooling are discussed in Subsection 9.2.5, Ultimate Heat Sink.

2.4.8.1 Combined License Information

In accordance with SRP 2.4.8, this section of the COL applicant's SAR presents the basis for the hydraulic design of canals and reservoirs used to transport and impound plant cooling water. In addition, the hydraulic design basis for protection of structures (e.g., riprap) is presented. For canals, the areas of discussion include the design basis for capacity, protection against wind waves, erosion, sedimentation buildup, and freeboard, and (where applicable) the ability to withstand a Probable Maximum Flood (PMF), surges, etc. For reservoirs, the areas of discussion include the design basis for capacity, PMF design basis, wind wave and runup protection, discharge facilities (low level outlet, spillway, etc.), outlet protection, freeboard, and erosion and sedimentation processes.

2.4.8.2 Regulatory Guidance

Acceptance criteria relate to the following regulations:

- 10 CFR Part 50, §50.55a requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.
- General Design Criterion 2 (GDC 2) requires structures, systems, and components important to safety to be designed to withstand the effects of floods.
- General Design Criterion 44 (GDC 44) requires an ultimate heat sink capable of accepting the plant's heat load under normal and accident conditions.
- 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.

2.4.9 Channel Diversions

ESBWR DCD: None; the plant design has no safety-related service water system that would be adversely affected by natural stream channel diversion. In the ESBWR design, the ultimate heat sink (UHS) is the atmosphere, which receives steam generated by boiling in the Isolation Condenser (IC) and Passive Containment Cooling (PCC) system pools and Spent Fuel Pool. A separate safety-related service water system with a dedicated UHS reservoir is not required. The water volumes needed to ensure operation of the IC and PCC systems and to keep the Spent Fuel Pools filled for cooling are discussed in Subsection 9.2.5, Ultimate Heat Sink.

2.4.9.1 Combined License Information

In accordance with SRP 2.4.9, in this section of the COL applicant's safety analysis report (SAR), the geohydrologic design basis is developed to assure that the plant and essential water supplies will not be adversely affected by natural stream channel diversion, or that in such an event, alternate water supplies are available to safety-related equipment.

The subsection includes:

- Historical channel diversions, including cutoffs and subsidence.
- Regional topographic evidence that suggests future channel diversion may or may not occur (used in conjunction with evidence of historical diversions).
- Alternate water sources and operating procedures (COL SAR Section 2.4).

2.4.9.2 Regulatory Guidance

Acceptance criteria relate to the following regulations:

- General Design Criterion 2 (GDC 2) requires that structures, systems, and components important to safety be designed to withstand floods.
- General Design Criterion 44 (GDC 44) requires an ultimate heat sink capable of accepting the plant's heat load under normal and accident conditions.
- 10 CFR Part 100 requires that hydrological characteristics be considered in the evaluation of the site.

2.4.10 Flooding Protection Requirements

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1. No further action is required for sites within the bounds of the ESBWR parameters. The criteria for flood protection are provided in Subsection 3.4.1.2.

2.4.10.1 Combined License Information

In accordance with SRP 2.4.10, the COL applicant describes the locations and elevations of safety-related facilities and of structures and components required for protection of safety-related facilities are compared with the estimated static and dynamic effects of design basis flood conditions identified in safety analysis report (SAR) Subsection 2.4.2.2, to determine whether flood effects need be considered in plant design or emergency procedures.

If flood protection is required, the type of flood protection ("hardened facilities", sandbags, flood doors, bulkheads, etc.) is presented. Any emergency procedures required to implement flood protection and warning times available for implementation thereof are discussed, based on the flood conditions identified in other sections.

If there is evidence of potential structural effects, these effects are presented in the structural design bases for the plant; similarly, these effects are also considered in the systems design bases for the plant.

2.4.10.2 Regulatory Guidance

Acceptance criteria relate to the following regulations:

- 10 CFR Part 50, §50.55a requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.
- General Design Criterion 2 (GDC 2) requires structures, systems, and components important to safety to be designed to withstand the effects of floods.
- 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.

2.4.11 Cooling Water Supply

ESBWR DCD: None; the plant design has no safety-related service water system that would require that a water supply exist to operate the plant or maintain safe shutdown under normal and emergency conditions within 72 hours after an initiating event. Post-72 hours, emergency

makeup is provided onsite by the Fire Protection System (FPS) and by external reactor building connections (see Subsections 9.2.5 and 9.5.1 for Ultimate Heat Sink and FPS details). During normal operation, the Station Water System provides makeup to the Plant Service Water System cooling towers (see Subsection 9.2.1).

2.4.11.1 Combined License Information

In accordance with SRP 2.4.11, this section of the COL applicant's safety analysis report (SAR) shall identify natural events that may reduce or limit the available cooling water supply, and to assure that an adequate water supply will exist to operate the plant or maintain safe shutdown under normal and emergency conditions.

Depending on the site, the areas of consideration include:

- The worst drought considered reasonably possible in the region.
- Low water (setdown) resulting from surges, seiches, or tsunami.
- Low water resulting from icing.
- The effect of existing and proposed water control structures (dams, diversions, dam failures, etc.).
- The intake structure and pump design basis in relation to the events described in COL SAR Subsections 2.4.11.1, 2.4.11.2, 2.4.11.3 and 2.4.11.4.
- The use limitations imposed or under discussion by Federal, state, or local agencies authorizing the use of the water.
- The range of water supply required by the plant, including minimum operating and shutdown flows, compared to availability.
- The effects of potential blockage of intakes by sediment and littoral drift.
- The capability of the ultimate heat sink to provide adequate cooling water under normal and emergency conditions.

2.4.11.1.1 Low Flow in Rivers and Streams

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.1.2 Low Water Resulting from Surges, Seiches or Tsunami

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.1.3 Historical Low Water

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.1.4 Future Controls

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.1.5 Plant Requirements

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.1.6 Heat Sink Dependability Requirements

COL applicant to provide site-specific information in accordance with SRP 2.4.11.

2.4.11.2 Regulatory Guidance

Acceptance criteria for this SRP section relate to the following regulations:

- General Design Criterion (GDC) 2 requires that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena.
- General Design Criterion (GDC) 44 requires an ultimate heat sink capable of accepting the plant's heat load under normal and accident conditions. For ESBWR, this ultimate heat sink consists of the IC/PCC pools.
- 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.
- 10 CFR Part 100, Appendix A requires, in part, that consideration of river blockages or diversion or other failures which may block the flow of cooling water, tsunami runup and drawdown, and dam failures be included in the evaluation of the adequacy of the emergency cooling water supply.

2.4.12 Groundwater

ESBWR DCD: None; the plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

2.4.12.1 Combined License Information

In accordance with SRP 2.4.12, in this subsection of the SAR the COL applicant presents data on local and regional groundwater reservoirs to establish the effects of groundwater on plant foundations. Other areas presented under this subsection include identification of the aquifers and the type of onsite groundwater use, the sources of recharge, present and future withdrawals, monitoring and protection requirements, and design bases for groundwater levels and hydrodynamic effects of groundwater on safety-related structures and components. Flow rates, travel time, gradients, other properties pertaining to the movement of accidental contamination, and groundwater levels beneath the site are presented, as are seasonal and climatic fluctuations, or those caused by man, that have the potential for long-term changes in the local groundwater regime.

2.4.12.1.1 Regional and local groundwater aquifers, sources, and sinks

COL applicant to supply site-specific information in accordance with SRP 2.4.12.

2.4.12.1.2 Present and projected local and regional groundwater use

COL applicant to supply site-specific information in accordance with SRP 2.4.12.

2.4.12.1.3 Need for and extent of procedures and measures to protect present and projected groundwater users

COL applicant to supply site-specific information in accordance with SRP 2.4.12.

2.4.12.1.4 Design bases for groundwater-induced loadings on subsurface portions of safety-related structures, systems, and components

COL applicant to supply site-specific information in accordance with SRP 2.4.12.

2.4.12.2 Regulatory Guidance

Acceptance criteria for this subsection relate to the following regulations:

- 10 CFR Part 50, §50.55 requires that significant deficiencies in construction of or significant damage to a structure, system, or component which will require extensive redesign, or extensive repair to meet the criteria of the construction permit be reported to the Commission.
- 10 CFR Part 50, §50.55a requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.
- General Design Criterion 2 requires structures, systems, and components important to safety to be designed to withstand the effects of natural phenomena.
- General Design Criterion 4 requires structures, systems, and components important to safety to be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation and postulated accidents.
- General Design Criterion 5 requires that structures, systems, and component important to safety not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions.
- 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.
- 10 CFR Part 100, Appendix A sets forth the criteria to determine the suitability of plant design bases with respect to seismic characteristics of the site. It also requires that the adequacy of the cooling water supply for emergency and long-term shutdown decay heat removal be assured, taking into account information concerning the physical, including hydrological, properties of the materials underlying the site.

2.4.13 Accidental Releases of Liquid Effluents in Ground and Surface Waters

ESBWR DCD: See Section 15.3 "Liquid Containing Tank Failure".

2.4.13.1 Combined License Information

In accordance with SRP 2.4.13, in this subsection the COL applicant presents site-specific information including the ability of the ground and surface water environment to delay, disperse, dilute, or concentrate accidental radioactive liquid effluent releases for buildings outside of the ESBWR Standard Plant scope, as applicable, with emphasis on relating the effects of such releases to existing and known future uses of ground and surface water resources. (Note that effects of normal releases and of the more likely accidents are discussed in the COL applicant's environmental report and the Limiting Radiological Release Accidents are presented in Chapter 15 of the COL applicant's SAR).

2.4.13.2 Regulatory Guidance

Acceptance criteria for this subsection relate to 10 CFR Part 100 as it requires that hydrologic characteristics of the site be evaluated with respect to the consequences of the escape of radioactive material from the facility.

To meet the requirements of 10 CFR Part 100 with respect to accidental releases of liquid effluents, the following specific criteria are used.

- Radionuclide transport characteristics of the groundwater environment with respect to existing and future users are described. Estimates and bases for coefficients of dispersion, adsorption, groundwater velocities, travel times, gradients, permeabilities, porosities, and groundwater or piezometric levels between the site and existing or known future surface and groundwater users must be described and be consistent with site characteristics. Potential pathways of contamination to groundwater users must also be identified. Sources of data must be described and referenced.
- Transport characteristics of the surface water environment with respect to existing and known future users must be described for conditions which reflect worst case release mechanisms and source terms so as to postulate the most pessimistic contamination from accidentally released liquid effluents. Estimates of physical parameters necessary to calculate the transport of liquid effluent from the points of release to the site of existing or known future users must be described. Potential pathways of contamination to surface water users must be identified. Sources of information and data must be described and referenced. Acceptance is based on the credibility of the applicant's computational methods and the apparent completeness of the set of parameters necessary to perform the analysis.
- Mathematical models are acceptable to analyze the flow field and dispersion of contaminants in ground and surface waters, providing that the models have been verified by field data and that conservative site-specific hydrologic parameters are used. Furthermore, conservatism must be the guide in selecting the proper model to represent a specific physical situation. Radioactive decay and sediment adsorption may be considered, if applicable, providing that the adsorption factors are conservative and site-specific. Regulatory Guide 1.113 provides guidance in selecting and using surface water models.

2.4.14 Technical Specification and Emergency Operation Requirements

ESBWR DCD: See DCD Tier-2 Chapters 16 and 18; the ESBWR plant grade elevation is located above flood and groundwater levels as noted in Table 2.0-1.

2.4.14.1 Combined License Information

In accordance with SRP 2.4.14, the purpose of this subsection of the COL applicant's SAR is to identify the technical specifications and emergency procedures required to implement flood protection for safety-related facilities, to assure an adequate water supply for shutdown and cooldown purposes and to detect hydrologic phenomena of very low probability that exceed the design flood level for flood protection of safety-related facilities.

If there is evidence of potential structural effects, the COL applicant will demonstrate that these effects are properly considered in the structural design bases for the plant; similarly, the COL

applicant will demonstrate that these effects are properly considered in the systems design bases for the plant.

2.4.14.2 Regulatory Guidance

Acceptance criteria for this subsection are based on meeting the relevant requirements of the following regulations:

- 10 CFR Part 50, §50.36 as it relates to requiring technical specifications to be derived from safety evaluations.
- General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of hurricanes, floods, tsunami, and seiches.

To meet the requirements of the hydrologic aspects of 10 CFR Part 50, §50.36 and General Design Criterion 2 with respect to Technical Specifications and emergency operation requirements the following specific criteria are used:

If the hydrologic design bases developed in preceding sections do not necessitate technical specifications or emergency procedures to ensure safety-related plant functions (i.e., Position 1 of Regulatory Guide 1.59 is met), this section should so state. If Technical Specifications or emergency procedures in compliance with position 2 of Regulatory Guide 1.59 are necessary this section will be acceptable if the following are identified.

- The controlling hydrologic events, as developed in the preceding sections of COL SAR Chapter 2.
- The actions to be taken, and the effect of such actions on the protection of safety-related facilities and water supplies.
- The appropriate water levels and conditions at which action is to be initiated.
- The appropriate emergency procedures, and the amount of time required to implement each procedure. Regulatory Guide 1.102, position 2 provides guidance in establishing appropriate procedures.

Note: In the ESBWR design, passive decay heat removal systems provide the ultimate heat sink (UHS) function so a separate reservoir is not needed during the first 72 hours after an initiating event. Post 72-hour emergency make-up is provided on-site by the Fire Protection System (FPS), which has sufficient onsite capacity for at least 7 days. The ESBWR UHS is discussed in Section 9.2.5.

- Regulatory Guide 1.28, "Quality Assurance Program Requirements (Design and Construction)." This guide describes a method acceptable to the staff for complying with the Commission's regulations with regard to 10 CFR Part 50, Appendix B, overall quality assurance program requirements during design and construction of nuclear power plants.
- Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants." This guide describes programs of site investigations related to geotechnical engineering aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundation and earthworks under anticipated loading conditions including earthquake in complying with 10 CFR Part 100. It provides general guidance and recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, the spacing and depth of borings and sampling.
- Regulatory Guide 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants." This guide describes laboratory investigations and testing practices acceptable for determining soil and rock properties and characteristics needed for engineering analysis and design for foundations and earthwork for nuclear power plants in complying with 10 CFR Part 100.

2.5.5 Stability of Slopes

ESBWR design assumes stable slopes.

In accordance with SRP 2.5.5, this subsection of the COL applicant's SAR presents information, including analyses and substantiation, concerning the stability of all earth and rock slopes both natural and man-made (cuts, fills, embankments, dams, etc., whose failure, under any of the conditions to which they could be exposed during the life of the plant, could adversely affect the safety of the plant. The following subjects will be evaluated using the applicant's data in the COL SAR and information available from other sources and taking into account the maximum flood level as hydrostatic head.

2.5.5.1 Slope characteristics

COL applicant to provide site-specific information in accordance with SRP 2.5.5.

2.5.5.2 Design criteria and design analyses

COL applicant to provide site-specific information in accordance with SRP 2.5.5.

2.5.5.3 Results of the investigations including borings, shafts, pits, trenches, and laboratory tests

COL applicant to provide site-specific information in accordance with SRP 2.5.5.

Item	Specification
Pool wall plate	ASTM A572 or A709 HPS 70W with A-240 Type 304L Clad
Structural support beam	ASTM A572 or A709 HPS 70W, ASTM A572 or A709 HPS 70W with A-240 Type 304L Clad

3.8.3.6.6 Miscellaneous Platforms

The materials conform to all applicable requirements of ANSI/AISC N690 for safety related and AISC-ASD or AISC-LFRD for nonsafety-related and comply with the following:

Item	Specification
Structural steel and connections	ASTM A36
High strength structural steel plates	ASTM A572
Bolts, studs, and nuts (dia.>19mm)	ASTM A325
Bolts, studs, and nuts (dia.≤ 19mm)	ASTM A307

3.8.3.7 Testing and In-service Inspection Requirements

A formal program of testing and in-service inspection is not planned for the internal structures except the diaphragm floor, and vent wall. The other internal structures are not directly related to the functioning of the containment system; therefore, no testing or inspection is performed.

Testing and in-service inspection of the diaphragm floor and vent wall are discussed in Subsection 3.8.1.7.

3.8.3.8 Welding Methods and Acceptance Criteria for Structural and Building Steel

Welding activities are performed with written procedures, combining with the requirements of the American Institute of Steel Construction (AISC) Manual of Steel Construction. The visual acceptance criteria comply with American Welding Society (AWS) Structural Welding Code D1.1 and Nuclear Construction Issue Group (NCIG) Standard, "Visual Weld Acceptance Criteria for Structural Welding at Nuclear Plants", NCIG-01.

3.8.4 Other Seismic Category I Structures

Other Seismic Category I structures which are not inside the containment and which constitute the ESBWR Standard Plant are Reactor Building (RB), Control Building (CB), Fuel Building (FB) and Emergency Breathing Air System (EBAS) Building. Figure 1.1-1 shows the spatial relationship of these buildings. Although the Radwaste Building (RW) that houses non safety-related facilities is not a Seismic Category I structure, it is designed to meet the requirements of Regulatory Guide 1.143 under Safety Class RW-IIa. The RB and FB are built on a common foundation mat and structurally integrated into one building. The other structures in close

3.8.4.1.5 Radwaste Building

The Radwaste Building (RW) is shown in Section 1.2.

The Radwaste Building (RW) is a reinforced concrete box type structure consisting of walls and slabs and is supported on a foundation mat. The key dimensions of the RW are summarized in Table 3.8-8.

The RW houses the equipment and floor drain tanks, sludge phase separators, resin hold up tanks, detergent drain tanks, a concentrated waste tank, chemical drain collection tank, associated pumps and mobile systems for the radioactive liquid and solid waste treatment systems.

The RW is a Non-Seismic Category (NS) structure. The RW is designed according to the safety classifications defined in Regulatory Guide 1.143 Category RW-IIa.

3.8.4.2 Applicable Codes, Standards, and Specifications

3.8.4.2.1 Reactor Building

The major portion of the Reactor Building outside Containment structure is not subjected to the abnormal and severe accident conditions associated with a containment. Applicable documents for the RB design are shown in Table 3.8-9, except items 4, 11, 30 and 32.

3.8.4.2.2 Control Building

Applicable documents for the CB design are same as the RB, which are listed in Table 3.8-9. In addition, NRC Rules and Regulations Title 10, Chapter 1, Code of Federal Regulations, Part 73.2 and 73.55 shall be met.

3.8.4.2.3 Fuel Building

Applicable documents for the FB design are same as the RB, which are listed in Table 3.8-9.

3.8.4.2.4 Radwaste Building

Applicable codes, standards, specifications and regulations used in the design and construction of RW are items 1, 2, and 32 listed in Table 3.8-9.

3.8.4.2.5 Welding of Pool Liners

Welding activities conform to the AWS Structural Welding Code, Dl.l. All welds are visually inspected before to start any other NDE method. The visual weld acceptance criteria is defined in AWS D1.1. In accordance with approved procedures the welded seams of the liner plate are spot radiographed where accessible, liquid penetrant and vacuum box (ASME Section V) examined after fabrication to ensure that the liner does not leak. Any evidence of leaking is repaired. The acceptance criteria for these examinations conform to the acceptance criteria stated in Subsection NE-5300 of Section III of the ASME Code.

elevated differential pressure across the module or total flow through the system. No regeneration of mixed bed modules is performed on-site.

Storage and Transfer Subsystem

The flow path of the storage and transfer subsystem of the MWS is from the MWS demineralized water storage tank, through a MWS transfer pump, to the interface systems. One pump operates continuously to maintain the system pressure. Increased demand or primary transfer pump failure automatically starts the second transfer pump.

9.2.3.3 Safety Evaluation

The MWS does not have any safety-related functions except for containment isolation. Failure of the MWS does not compromise any safety-related system or component nor does it prevent a safe shutdown. If available, MWS can be used to provide makeup water to the IC/PCC pools following an AOO. However, this MWS function is not assumed or modeled in any safety analysis.

9.2.3.4 Testing and Inspection Requirements

Initial preoperational acceptance testing of the MWS is performed to demonstrate proper system and component functioning. MWS operability is continuously demonstrated during normal plant operation. MWS containment isolation components are designed to meet the in-service inspection requirements of ASME Section XI.

9.2.3.5 Instrumentation Requirements

Instrumentation provided for the MWS includes pressure, flow, level, conductivity, silica, chloride, and sodium. These parameters are monitored and recorded at the appropriate locations in the system. Monitoring and control of the MWS operation are provided on a local panel. Monitoring of storage tank water level is provided in the MCR.

Controls and interlocks are provided for the maintenance of MWS water quality and system equipment protection. Demineralizer effluent water quality and quantity is monitored and recorded. Out-of-specification water is automatically recirculated back to the source water storage tank and alarmed on the local control panel. Pumps are protected by a low tank level alarm on the suction side and minimum flow recirculation piping on the discharge side. Automatic controls are provided with manual backup.

9.2.4 Potable and Sanitary Water Systems

This is beyond the ESBWR Standard Plant Scope. Refer to Subsection 9.2.9 for COL license information requirements of Potable and Sanitary Water Systems.

9.2.5 Ultimate Heat Sink

In the event of an accident, the UHS is the atmosphere with the Isolation Condenser / Passive Containment Cooling System (IC/PCCS) pools and Spent Fuel Pool providing the heat transfer mechanism. Subsection 6.2.2 provides a discussion of the Passive Containment Cooling System. If one individual IC or PCCS pool compartment is not available, the remaining IC/PCCS

12.2.1.3 Turbine Building Source Terms

This section provides a summation of the significant radioactive source terms found in the ESBWR turbine 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

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.

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.

Post-Accident Radioactive Sources

Potential releases in the radwaste building are contained by isolating the radwaste building atmosphere and sealing any water releases in the building. The radwaste building is seismically designed in accordance with Regulatory Guide 1.143 and the tank area concrete is provided with a sealant, as described in Subsection 15.3.16.1, to prevent any potential water releases from high activity areas.

Systems Operation

This event assumes normal functioning of the plant instrumentation and controls, specifically the operation of the pressure regulator and water level control systems.

15.3.15.3 Core and System Performance

The opening of one SRV allows steam to be discharged to the suppression pool. The sudden increase in the rate of steam flow leaving the reactor vessel causes a depressurization transient, with the vessel pressure slowly decreasing until reaching atmospheric pressure. The SRV steam discharge also results in a slight heating of the suppression pool.

Thermal margins decrease only slightly through the transient and no fuel damage is predicted for this event.

15.3.15.4 Barrier Performance

As presented previously, the transient resulting from a stuck open relief valve is the total depressurization of the pressure vessel, which is within the range of normal plant operation and therefore has no significant effect on RCPB and containment design pressure limits.

15.3.15.5 Radiological Consequences

While the effect of this event does not result in fuel failure, it does result in the discharge of normal coolant activity to the suppression pool. Because this activity is contained in the primary containment, there is no exposure to operating personnel. Because this event does not result in an uncontrolled release to the environment, the plant operator can choose to leave the activity "bottled up" in the containment, use FAPCS to remove radioactivity from the pool, or discharge it to the environment in a controlled manner. If purging of the containment is chosen, the release shall be done in accordance with the plant's Technical Specifications. Consequently, this event, at the worst, would only result in a small increase in the yearly integrated exposure level.

15.3.16 Liquid Containing Tank Failure

15.3.16.1 Identification of Causes

An unspecified event causes the complete release of the radioactive inventory in all tanks containing radionuclides in the liquid radwaste system. Postulated events that could cause a release of the inventory of a tank are sudden unmonitored cracks in the vessel or operator error. Small cracks and consequent low level releases are bounded by this analysis and should be contained without any significant release.

The ESBWR Radwaste Building is designed to seismic requirements as specified in Subsection 3.8.4. In addition, the concrete walls of all compartments containing high level liquid radwaste are provided with a sealant up to a height capable of containing the release of all the liquid radwaste in the compartment. Because of these design capabilities, it is considered remote that any major event involving the release of liquid radwaste into these volumes would result in the release of these liquids to the environment via the liquid pathway. Releases as a result of major cracks would instead result in the release of the liquid radwaste to the compartment and then to the building sump system for containment in other tanks or emergency tanks. A complete

description of the liquid radwaste system is found in Section 11.2, except for the tank inventories, which are found in Section 12.2.

A liquid radwaste release caused by operator error is also considered a remote possibility. Operating techniques and administrative procedures emphasize detailed system and equipment operating instructions. A positive action interlock system is also provided to prevent inadvertent opening of a drain valve. Should a release of wastes occur, the sealed concrete walls would contain the release until the floor drain sump pumps in the building capture and contain such spills.

The probability of a complete tank release is considered low enough to warrant this event as an Infrequent Event.

15.3.16.2 Sequence of Events and Systems Operations

Following a failure, the area radiation alarms would be expected to alarm at one minute with operator intervention following at approximately five minutes after release. However, the rupture of a waste tank would be contained and allow the operator time to develop and setup a means to process the contained waste. Gases would be processed through the Radwaste Building HVAC system as described in Subsections 9.4.3, 11.5.3.2.8 and 12.3.3.2.4.

Liquid release would be contained within the sealed concrete walls and would present no immediate threat to the environment leaving the operator sufficient time (on the order of hours) in which to recover systems to pump the release into holding tanks or emergency tanks.

15.3.16.3 Results

A single pathway is considered for release of fission products to the environment via airborne releases. The liquid pathway is not considered because of the mitigation capabilities of the Radwaste Building.

For the airborne pathway, volatile iodine species in the tank using the inventories in Section 12.2 are considered. These inventories are based upon the design basis release rates found in Section 12.2. Although isolation is expected within minutes of the occurrence, release of 10% of the iodine inventory is conservatively assumed over a two-hour period. Specific parameters for this analysis are found in Tables 15.3-12 and 15.3-13.

No liquid or significant (from airborne species) ground contamination is expected. Airborne doses are given in Table 15.3-14 and are a fraction of 10 CFR 100 criteria.

15.3.17 COL Information

COL Applicant: Confirm the applicability of the Startup control rod withdrawal error analysis to the initial core design.

COL Holder: Confirm the applicability of the generic radiological dose assessment for misloaded fuel bundles to the site meteorological characteristics.

15.3.18 References

15.3-1 GE Nuclear Energy, "General Electric Standard Application for Reactor Fuel--United States Supplement," NEDE-24011-P-A-US, (Latest approved revision).

15.3-2 GE Nuclear Energy, "Radiological Accident Evaluation—The CONAC04A Code," NEDO-32708, August 1997.

15.3-3 FLN–2004–026, "GESTAR I Amendment 28 Revision 1, Misloaded Fuel Bundle Event Licensing Basis Change to Comply with Standard Review Plan 15.4.7," Margaret E. Harding to Mel B. Fields August 23, 2004

15.3-4 J. Paone and J. A. Woolley, "Rod Drop Accident Analysis for Large Boiling Water Reactors, Licensing Topical Report," March 1972 (NEDO-10527, Supplements 1 and 2).