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Subject: **Response to NRC Request for Additional Information Letter No. 36 Related to ESBWR Design Certification Application – Steam and Power Conversion System and Radioactive Waste Management – RAI Numbers 10.3-1 through 10.3-9 and 11.1-1 through 11.1-3**

Enclosures 1 and 2 contain GE's response to the subject NRC RAIs transmitted via the Reference 1 letter. This completes GE's response to RAI letter No. 36.

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 06-200, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 36 Related to ESBWR Design Certification Application,* June 22, 2006

Enclosures:

1. MFN 06-219 – Response to NRC Request for Additional Information Letter No. 36 Related to ESBWR Design Certification Application – Steam and Power Conversion System – RAI Numbers 10.3-1 through 10.3-9
2. MFN 06-219 – Response to NRC Request for Additional Information Letter No. 36 Related to ESBWR Design Certification Application – Radioactive Waste Management – RAI Numbers 11.1-1 through 11.1-3

cc:	WD Beckner	USNRC (w/o enclosures)
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	LA Dudes	USNRC (w/o enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	eDRFs	0000-0055-8382 and 0000-0055-0279

ENCLOSURE 1

MFN 06-219

Response to NRC Request for Additional Information Letter No. 36 Related to ESBWR Design Certification Application – Steam and Power Conversion System RAI Numbers 10.3-1 through 10.3-9

NRC RAI 10.3-1

DCD Section 10.3.1 states that the main steam system (downstream of the seismic restraint) is analyzed, fabricated and examined to ASME Code Class 2 requirements, classified as Non-seismic, and subject to pertinent quality assurance requirements of Appendix B, 10 CFR 50. Main steam piping from the seismic interface restraint to the main stop valves and main turbine bypass valves (including the steam auxiliary valves) is analyzed to demonstrate structural integrity under safe shutdown earthquake (SSE) loading conditions.

However, this is not consistent with the seismic design requirements of Standard Review Plan (SRP) 10.3, Criterion III.3.b, which require that the subject portions of the main steam supply system are designed to seismic Category I. Provide a justification for not meeting the guidelines of the SRP.

GE Response

The portion of the Main Steam piping inside the containment, including the inboard Main Steam Isolation Valves, the containment penetrations, outboard Main Steam Isolation Valves and piping up to the seismic restraints is classified as seismic Category I and meets the requirement of the Standard Review Plan 10.3, Criterion III.3.b. This portion of the main steam piping is considered part of the Nuclear Boiler System (B21). Down stream of the seismic restraint, located in the main steam tunnel, the main steam piping transitions to the Turbine Main Steam System (N11). The Turbine Main Steam System (TMSS) piping portion of the main steam piping is a non-safety system in a non-safety building that is designed to seismic Category II and is analyzed to demonstrate structural integrity under safe shutdown earthquake (SSE) loading conditions. The N11 TMSS piping is analyzed, fabricated and examined to ASME Code Class 2 requirements, classified as Non-safety, Seismic Category II, and subject to the pertinent QA requirements of Appendix B, 10 CFR 50. In-service inspection shall be performed in accordance with ASME Section XI requirements for Code Class 2 piping. ASME authorized nuclear inspector and ASME Code stamping is not required.

See the attached 'draft' Rev. 02, Tier 2, DCD Subsection 10.3.1.1 and DCD Tier 2, Table 3.2-1, Section N11.

NRC RAI 10.3-2

SRP 10.3 Criterion III.5.c specifies that means such as temperature and/or pressure sensors be provided to detect leakage in the event of a steam line break. DCD Section 15.4.5 states that the plant is designed to immediately detect large steam line breaks outside containment, initiate isolation of all main steam lines including the broken line and actuate the necessary protective failures.

Provide a detailed description of the means and methods to detect and control leakage during such event as described in the SRP.

GE Response

The Leak Detection and Isolation System (LD&IS) provide leakage detection and control measures for the TMSS as referenced in Table 7.3-5 for pressure and temperature. Please refer to DCD Subsection 5.2.5.1.2 for a discussion of leakage detection designed in plant areas external to the drywell. This includes LD&IS sensors in the main steam tunnel and the turbine building, which will be used to detect and control leakage in the event of a main steam line break.

No Tier 2 change will be made in response to this RAI.

NRC RAI 10.3-3

Rev. 01 of the DCD Section 10.3.2.1 states that the allowable main steam isolation valve (MSIV) leakage is required to be less than or equal to the valve used in Section 15.4 for Main Steam Line Break Outside Containment analysis. Section 15.4.4.5.2.3 describes the basis for relying on the main steam lines and drain line complex downstream of the reactor building as mitigative factors in the analysis of the loss-of-coolant accident (LOCA) leakage. The DCD section states that the main steam lines and drain lines are required under normal conditions to function to loads at temperatures and pressures far exceeding the loads expected from a safe shutdown earthquake (SSE).

(A) Demonstrate that the main steam piping, drain line, and bypass line in the turbine building are protected from the collapse of any non-seismic Category I structure in the event of a SSE.
(B) Provide the safety margin for the main steam line and drain lines based on the difference between normal operating loads and those expected during a SSE.
(C) Provide a relative comparison of expected leakage across the MSIV during LOCA events inside containment and a main steam line break downstream of the MSIVs.
(D) Provide detailed drawings that show the MSIV alternate leakage path lines including the condenser, all applicable connections to the system their seismic classification.

GE Response

(A) The Turbine Building (TB) is designed as a seismic Category II structure, as indicated in RAI 10.3-1. It is designed to maintain it's structural integrity under safe shutdown earthquake loading conditions.
(B) The piping stress analysis and support design for the TMSS piping in the TB will be completed during the detailed design phase of the project. The TMSS piping and drains of 2 ½" and larger, as required by SRP 10.3 I, will be designed and analyzed to demonstrate the ability to withstand an SSE. The piping analysis will show the adequacy of the installation to meet the SSE requirements.
(C) The MSIV leak rate during a LOCA is provided in DCD Chapter 15, Table 15.4-5, Section II.D. The mass of coolant released during a MSLBA is provided in DCD Chapter 15, Table 15.4-11.
(D) GE will provide to the NRC, under a separate cover letter, those Power Cycle System P&ID's that are available at this stage of design. These P&ID's will include the Turbine Main Steam System and Main Condenser and Auxiliaries System.

No Tier 2 change will be made in response to this RAI.

NRC RAI 10.3-4

Section 10.3.6 indicates that the steam and feedwater component materials that are within the reactor coolant boundary (RCPB) are addressed in Section 5.2 but the material specifications and grades for the steam and feedwater system components that are outside of the RCPB are not listed in 10.3.6 nor 10.4.7. Please provide a complete list of all material specifications and grades that are used in steam, feedwater and condensate systems by component types including weld filler metal. Specify the Code Class for all portions of both systems.

GE Response

Please refer to DCD Chapter 1, Table 1.7-1 for the material types used in the steam, feedwater and condensate system. Code classifications, if applicable, are listed in Table 3.2-1. Weld filler material, as agreed during our telephone conversation, will not be specified in the DCD/COLA but will be identified in the site construction contractors welding program.

No Tier 2 change will be made in response to this RAI.

NRC RAI 10.3-5

Subsection 10.3.6.2 indicates that Regulatory Guide (RG) 1.71 is applicable to all components but states that as an alternative method, positions documented in Reference 10.3-1 could be used. Regarding reference 10.3-1, identify what portions of the alternative do not meet the guidance of RG 1.71. Please provide the answer in a global context as it applies to the entire ESBWR design.

GE Response

The ESBWR design does comply to Regulatory Guide 1.71 as shown in DCD Chapter 5, Section 5.2.3.4.2, Pages 19 and 20, and utilizes the alternative approach detailed in the attached pages (see attached Rev. 2 of DCD Tier 2, Section 5.2.3.4.2, updated to include Section VIII).

NRC RAI 10.3-6

Describe the mitigation steps taken in the ESBWR design related to: 1) Utilization of erosion/corrosion resistant materials, 2) specification of an adequate corrosion allowance and 3) consideration on minimizing the effects of erosion/corrosion in the design of all ESBWR feedwater, steam and condensate system piping from effects such as fluid velocity, bend locations and flash points.

GE Response

The TMSS piping is designed to consider the effects of erosion/corrosion for a 60 year life expectancy. Piping containing dry, single phase steam is constructed of carbon steel. Piping exposed to wet, two-phase steam is constructed of erosion/corrosion resistant low alloy steel. Velocities in the TMSS piping to the high pressure turbine are limited to reduce the potential for pipe erosion. Low point drains are provided for collecting and draining moisture and to help reduce the potential for water carryover to the high and low pressure turbines. In addition to material selection, pipe size and layout may also be used to minimize the potential for erosion/corrosion in systems containing water or two-phase flow.

Section 10.3.6 Steam and Feedwater System Material, references Section 5.2 which contains Table 5.2-4. This table shows that Carbon Steel, SA-333, GR 6 will be used for the main steam piping and Low Allow, SA-335, Grade P22 will be used for the feedwater piping.

No Tier 2 change will be made in response to this RAI. DCD Table 5.2-4, Rev. 01 will be included for ease of review.

NRC RAI 10.3-7

10.3.1.1 indicates that ASME authorized nuclear inspector (ANI) and ASME Code stamping is not required. Provide a basis for the exclusion of ANI and Code stamping.

GE Response

This RAI is answered by, RAI 10.3-1. "The Turbine Main Steam System (TMSS) piping portion of the main steam piping is a non-safety system in a non-safety building that is designed to seismic Category II and is analyzed to demonstrate structural integrity under safe shutdown earthquake (SSE) loading conditions. The N11 TMSS piping is analyzed, fabricated and examined to ASME Code Class 2 requirements, classified as Non-safety, Seismic Category II, and subject to the pertinent QA requirements of Appendix B, 10 CFR 50. In-service inspection shall be performed in accordance with ASME Section XI requirements for Code Class 2 piping. ASME authorized nuclear inspector and ASME Code stamping is not required."

NRC RAI 10.3-8

Does the licensee intend on following the guidance provided in American National Standards Institute (ANSI) N45.2.1 as referenced in RG 1.37. If not, provide a description of the alternative.

GE Response

Please refer to DCD Tier 2, Subsection 5.2.3.4.1 for Regulatory Guide 1.37 commitment. GE intends on following the guidance in RG 1.37.

No Tier 2 change will be made in response to this RAI.

NRC RAI 10.3-9

Given the history of failure of components in systems such as feedwater and condensate, which can effect safety related equipment and threaten personnel safety, provide a description of augmented inspection programs for ALL condensate, feedwater and steam piping.

GE Response

Please refer to DCD Tier 2, Chapter 1, Table 1C-1 for Generic Letter 89-08, as discussed in Subsection 6.6.7 of the DCD Tier 2. This section commits the license holder to the guidance in Generic Letter 89-08.

No Tier 2 change will be made in response to this RAI.

10.3 TURBINE MAIN STEAM SYSTEM

The function of the Turbine Main Steam System (TMSS) is to convey steam generated in the reactor to the turbine plant. The TMSS is bounded by, but does not include, the seismic interface restraint, turbine stop valves and turbine bypass valves. Steam supply lines to other services, up to and including their isolation valves are also part of the TMSS.

The main steamline Safety Relief Valves (SRVs), main steamline flow restrictors, main steamline isolation valves (MSIVs), and main steam piping from the reactor nozzles through the outboard MSIVs to the seismic interface restraint are described in Subsections 5.2.2, 5.4.4, 5.4.5 and 5.4.9, respectively.

10.3.1 Design Bases

10.3.1.1 Safety (10 CFR 50.2) Design Bases

The TMSS is not required to perform or support any safety-related function. However, the supply system is designed:

(1) To accommodate operational stresses such as internal pressure and dynamic loads without failures.

(2) To provide a seismically analyzed fission product leakage path to the main condenser.

(3) With suitable accesses to permit in-service testing and inspections.

(4) To close the steam auxiliary valve(s) on an MSIV isolation signal. These valves fail closed on loss of electrical power to the valve actuating solenoid or on loss of pneumatic pressure.

The Turbine ~~main~~ Main ~~steam~~ Steam ~~system~~ System (TMSS) piping consists of four lines from the seismic interface restraint to the main turbine stop valves. The header arrangement upstream of the turbine stop valves allows them to be tested online, and supplies steam to the power cycle auxiliaries, as required. *

The ~~main steam system~~TMSS is analyzed, fabricated and examined to ASME Code Class 2 requirements, classified as Non-~~seismic~~safety, Seismic Category II, and subject to pertinent QA requirements of Appendix B, 10 CFR 50. In-service inspection shall be performed in accordance with ASME Section XI requirements for Code Class 2 piping. ASME authorized nuclear inspector and ASME Code stamping is not required.

~~Main steam~~TMSS piping from the seismic interface restraint to the main stop valves and main turbine bypass valves (including the steam auxiliary valves) is analyzed to demonstrate structural integrity under safe shutdown earthquake (SSE) loading conditions.

10.3.1.2 Non-Safety Power Generation Design Bases

The system is designed to deliver steam from the reactor to the turbine-generator system for a range of flows and pressures varying from warm-up to rated conditions. It also provides steam to the re-heaters, the steam jet air ejectors, the turbine gland seal system, the offgas system and the de-aerating section of the main condenser and the turbine bypass system.

Table 3.2-1

Classification Summary

Principal Components[1]		Safety Design.[2]	Location[3]	Quality Group[4]	QA Req.[5]	Seismic Category[6]	Notes
1.	Mechanical modules (including supports)	N	RB, RW	D (see note)	E	NS	See note for K10 item 1.
2.	Electrical modules and cabling	N	RB, RW	(see note)	E	NS	See note for K10 item 1.
K30	**Offgas System (OGS)**	N	TB	D (see note)	E	NS	**Offgas System** – A quality assurance program meeting the guidance of NRC Regulatory Guide 1.143 is applied to radioactive waste management systems during design and construction. On fluid containing portions this requires Quality Group D plus other requirements.
N	**POWER CYCLE SYSTEMS**						
N11	**Turbine Main Steam System (TMSS)**						
1.	Turbine Main Steam System (TMSS) consists of the piping (including supports) for the MSL from the seismic interface restraint (or seismic guide) to the turbine stop valves and the connecting branch lines up to and including their isolation valves.	N	TB	B	E	NS	**Main Steam Lines** – TMSS lines having diameter equal to or larger than 63.5 mm (2.5 inches) are designed to ASME Section III Code, Class 2, Non-Safety (installed in Seismic Category II building) and analyzed using a dynamic seismic analysis method to satisfy the Safe Shutdown Earthquake (SSE) design loads in combination with other appropriate loads. TMSS piping is not code stamped and does not require ASME authorized inspection.
2.	Other mechanical and electrical modules	N	TB	D	E	NS	

stainless steel components are avoided by carefully controlling all cleaning and processing materials which contact the stainless steel during manufacture, construction, and installation.

Special care is exercised to insure removal of surface contaminants prior to any heating operations. Water quality for cleaning, rinsing, flushing, and testing is controlled and monitored. Suitable protective packaging is provided for components to maintain cleanliness during shipping and storage. The degree of surface cleanliness obtained by these procedures meets the requirements of Regulatory Guides 1.37 and 1.44.

Cold-Worked Austenitic Stainless Steels

Cold worked austenitic stainless steels are not used for RCPB components. Cold work controls are applied for components made of austenitic stainless steel. During fabrication, cold work is controlled by applying limits in hardness, bend radii and surface finish on ground surfaces.

5.2.3.4.2 Control of Welding

Avoidance of Hot Cracking

Regulatory Guide 1.31 describes the acceptable method of implementing requirements with regard to the control of welding when fabricating and joining austenitic stainless steel components and systems.

Written welding procedures that are approved by GE are required for all primary pressure boundary welds. These procedures comply with the requirements of Sections III and IX of the ASME Code and applicable NRC Regulatory Guides.

All austenitic stainless steel weld filler materials are required by specification to have a minimum delta ferrite content of 8 FN (ferrite number) and a maximum of 20 FN determined on undiluted weld pads by magnetic measuring instruments calibrated in accordance with AWS Specification A4.2.

Regulatory Guide 1.34: Electroslag Welds

See Regulatory Guide 1.34 in Subsection 5.2.3.3.2.

Regulatory Guide 1.71: Welder Qualification for Areas of Limited Accessibility *

Regulatory Guide 1.71 requires that weld fabrication and repair for wrought low-alloy and high-alloy steels or other materials such as static and centrifugal castings and bimetallic joints comply with fabrication requirements of Sections III, VIII and IX of the ASME Code. It also requires additional performance qualifications for welding in areas of limited access.

All ASME Section III welds are fabricated in accordance with the requirements of Sections III and IX of the ASME Code. There are few restrictive welds involved in the fabrication of ESBWR components. Welder qualification for welds with the most restrictive access is accomplished by mockup welding. Mockups are examined by sectioning and radiography (or UT).

(Attachment to RAI 10.3-5)

The Acceptance Criterion II.3.b.(3) of SRP Subsection 5.2.3 is based on Regulatory Guide 1.71. The ESBWR design meets the intent of this regulatory guide by utilizing the following alternate approach.

NOTE: Alternative approach follows on Pages 19 & 20, of DCD, Rev. 02.
NO CHANGES WERE REQUIRED

(Ref: RAI 10.3-5) Alternate Approach *
Continued: 5.2.3.4.2, with NO CHANGE REQUIRED

When access to a non-volumetrically examined ASME Section III production weld (1) is less than 300 mm in any direction and (2) allows welding from one access direction only, such weld and repairs to welds in wrought and cast low alloy steels, austenitic stainless steels and high nickel alloys and in any combination of these materials shall comply with the fabrication requirements specified in ASME Code Section III and with the requirements of Section IX invoked by Section III, supplemented by the following requirements:

- The welder performance qualification test assembly required by ASME Section IX shall be welded under simulated access conditions. An acceptable test assembly will provide a Section IX welder performance qualification required by this Regulatory Guide.
- If the test assembly weld is to be judged by bend tests, a test specimen shall be removed from the location least favorable for the welder. If this test specimen cannot be removed from a location prescribed by Section IX, an additional bend test specimen is required. If the test assembly weld is to be judged by radiography or UT, the length of the weld to be examined shall include the location least favorable for the welder.
- Records of the results obtained in welder accessibility qualification shall be as certified by the manufacturer or installer, shall be maintained and shall be made accessible to authorized personnel.
- Socket welds with a 50A nominal pipe size and under are excluded from the above requirements.
- For accessibility, when restricted access conditions obscure the welder's line of sight, the use of visual aids such as mirrors shall be used. The qualification test assembly shall be welded under the more restricted access conditions using the visual aid required for production welding.
- Surveillance of accessibility qualification requirements is performed along with normal surveillance of ASME Section IX performance qualification requirements.

5.2.3.4.3 Nondestructive Examination of Tubular Products

For discussion of nondestructive examination of tubular products, refer to Subsection 5.2.3.3.3.

5.2.4 Preservice and Inservice Inspection and Testing of Reactor Coolant Pressure Boundary

This subsection describes the preservice and inservice inspection and system pressure test programs for NRC Quality Group A, AMSE. B&PV Code, Class 1 items. It describes these programs implementing the requirements of Subsection IWB of the ASME. B&PV Code Section XI.[1]

The design to perform preservice inspection is based on the requirements of the ASME Code, Section XI, 2001 Edition with 2003 Addenda. The development of the preservice and inservice inspection program plans is the responsibility of the Combined Operating License (COL) applicant and shall be based on the ASME Code, Section XI, Edition and Addenda specified in accordance with 10 CFR 50, Section 50.55a. The COL applicant is responsible for specifying

[1] Items as used in this subsection are products constructed under a certificate of authorization (NCA-3120) and material (NCA-1220). See Section III, NCA-1000, footnote 2.

(Ref: RAI 10.3-6)

Table 5.2-4

Reactor Coolant Pressure Boundary Materials

Component	Form	Material	Specification (ASTM/ASME)
Spring washer and Adjusting Screw or Setpoint adjustment assembly	Forging Forgings	Carbon steel Alloy steel Carbon and alloy steel parts	ASME SA 105 ASME SA 193 Gr B6 Multiple specifications
Spindle (stem)	Bar	Precipitation-hardened steel	ASTM A564 Gr 630 (H1100)
Spring	Wire or Bellville washers	Steel Alloy steel	ASTM A304 Gr 4161 N 45 Cr Mo V67
Main Steam Piping			
Pipe	Seamless	Carbon steel	SA 333 Gr. 6
Contour nozzle	Forging	Low alloy steel	SA 508 Class 3
200 mm 1500 lb. large groove flange	Forging	Carbon steel	SA 350 LF 2
50 mm special nozzle	Forging	Carbon steel	SA 350 LF 2
Elbow	Seamless	Carbon steel	SA 420
Head fitting/penetration piping	Forging	Carbon steel	SA 350 LF 2

CRD			
Middle flange	Forging	Stainless steel	SA-182, Type or SA-336, Class F304/F304L/F316/F316L
Spool piece	Forging	Stainless steel	SA-182, Type or SA-336 Class F304/F304L/F316/F316L

(*)

(Ref: RAI 10.3-5)

Mounting bolts	Bolting	Alloy steel	SA-193, Grade B7
Reactor Pressure Vessel			
Shells and Heads	Plate	Mn-1/2 Mo-1/2 Ni	SA-533, Type B, Class 1
	Forging	3/4 Ni-1/2 Mo-Cr-V Low alloy steel	SA-508, Grade 3, Class 1
Shell and Head Flange	Forging	3/4Ni-1/2Mo-Cr-V Low alloy steel	SA-508, Grade 3, Class 1
Nozzles	Forging	3/4Ni-1/2Mo-Cr-V Low alloy steel	SA-508, Grade 3, Class 1
Drain Nozzles	Forging	Cr-Ni-Mo Stainless steel	SA-182, Type or SA-336, Class F304/F304L/F316/F316L
Instrumentation Nozzles	Forging	Cr-Ni-Mo Stainless steel and Ni-Cr-Fe	SA-182, Type or SA-336, Class F304/F304L/F316/F316L and Code Case N-580-1
Stub Tubes	Bar, Smls. Pipes Forging	Ni-Cr-Fe	Code Case N-580-1
Isolation Condenser			
Steam pipe	Seamless	Carbon steel	SA-333, Grade 6
Condensate pipe	Seamless	Stainless steel	Type 316L
Feedwater Piping			
Pipe	Seamless	Low Alloy	SA-335, Grade P22 (*)
Fittings	Forging	Low Alloy	SA-336, Grade F22

ENCLOSURE 2

MFN 06-219

Response to NRC Request for Additional Information Letter No. 36 Related to ESBWR Design Certification Application Radioactive Waste Management RAI Numbers 11.1-1 through 11.1-3

NRC RAI 11.1-1

Address, or identify the relevant DCD sections that do address, the following criteria, in DCD Tier 2, Section 11.1:

A. *The parameters used to calculate concentrations of radioactive materials in primary and secondary coolant are consistent with those given in NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors" (BWR-GALE code).*
B. *All normal and potential sources of radioactive effluents delineated in Subsection I of standard review plan (SRP) Section 11.1 are considered.*
C. *For each source of liquid and gaseous waste considered in Subsection I of SRP Section 11.1, the volumes and concentrations of radioactive material given for normal operation and anticipated operational occurrences (AOOs) are consistent with those given in NUREG-0016.*
D. *Decontamination factors (DFs) for in-plant control measures used to reduce gaseous effluent releases to the environment, such as iodine removal systems and high-efficiency particulate air (HEPA) filters for building ventilation exhaust systems and containment internal cleanup systems, are consistent with those given in RG 1.140. The building mixing efficiency for containment internal cleanup is consistent with that in NUREG-0016.*
E. *DFs for in-plant control measures used to reduce liquid effluent releases to the environment, such as filters, demineralizers, and evaporators, are consistent with those in NUREG-0016.*
F. *Effluent concentration limits at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to 10 CFR Part 20.*
G. *The source terms result in meeting the design objectives for doses in an unrestricted area, as set forth in Appendix I to 10 CFR Part 50.*
H. *The applicant provides in the DCD the relevant information required by 10 CFR Part 50.34a. This technical information should include all the basic data listed in Appendix B to RG 1.112 needed to calculate the releases of radioactive material in liquid and gaseous effluents. The Gaseous and Liquid Effluent (GALE) computer code, along with the source term parameters given in NUREG-0016, is an acceptable method to perform this calculation.*
I. *If the calculational technique or any source term parameter differs from that given in NUREG-0016, the applicant should describe these differences in detail, as well as the bases for the method and parameters used.*

GE Response

A. The parameters used to calculate concentrations of radioactive materials for environmental releases are addressed in DCD Tier 2, Subsection 12.2.2. It should be noted that this DCD subsection currently does not contain all the applicable parameters; this issue is being addressed in the responses to RAI 12.2-9 and RAI 12.2-10.

B. The normal and potential sources of radioactive effluents delineated in SRP 11.1 Subsection I are as follows:

   BWR gaseous wastes:
   - offgas from the main condenser evacuation and turbine gland sealing systems
   - steam and liquid leakage to containment, radwaste, fuel handling and aux. buildings
   - ventilation systems exhausts from buildings having potential for rad. materials

   BWR liquid wastes:
   - leakage to equipment and floor drains
   - contaminated liquids produced by plant operations
   - detergent wastes

   These sources are addressed in DCD Tier 2, Section 12.2, as well as in the responses to RAI 12.2-9 and RAI 12.2-10.

C. The information is addressed in DCD Tier 2, Section 12.2.

D. Gaseous effluent releases to the environment are discussed in DCD Tier 2, Subsections 12.2.2.1 and 12.2.2.2 and the applicable tables.

E. Liquid effluent releases to the environment are discussed in DCD Tier 2, Subsections 12.2.2.3 and 12.2.2.4 and the applicable tables.

F. Effluent concentration limits at the unrestricted area boundary and the comparison to Table 2 of 10 CFR 20 Appendix B are provided in DCD Tier 2, Section 12.2. DCD Table 12.2-17 addresses the airborne effluent concentrations, and DCD Table 12.2-19b addresses the liquid effluent concentrations.

G. The unrestricted area doses due to effluents are provided in DCD Tier 2, Section 12.2. DCD Table 12.2-18b addresses the doses from airborne releases, and DCD Table 12.2-20b addresses the dose from liquid releases.

H. DCD Tier 2, Section 12.2 contains some of the information listed in Appendix A of Regulatory Guide 1.112; this section is to be revised based on the pending responses to RAI 12.2-9 and RAI 12.2-10.

I. Any deviations in the calculational technique of NUREG-0016 are to be identified in DCD Tier 2, Section 12.2.

NRC RAI 11.1-2

Provide the realistic source term for fission, activation, and corrosion products in the reactor water and steam used to demonstrate compliance with:

A. 10 CFR Part 20, as it relates to limits on doses for persons in unrestricted areas; and

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

The realistic source term is the expected average concentrations of the principal radionuclides in the primary reactor coolant and steam that may be anticipated over the life of a BWR.

GE Response

The tables in DCD Tier 2, Section 11.1 are to be updated in the next DCD revision to include the normal operational (realistic) concentrations. It should be noted that DCD Tables 11.1-2, 11.1-4, 11.1-5, and 11.1-7 (which provide design basis concentrations) will be renumbered as Tables 11.1-2a, 11.1-4a, 11.1-5a, and 11.1-7a. DCD Tables 11.1-2b, 11.1-4b, 11.1-5b, and 11.1-7b will be added to the next revision of the DCD and will provide normal operational radionuclide concentrations. Revisions of the DCD tables are provided below, with additions highlighted by red text, and deletions highlighted by blue strikethrough text:

Table 11.1-1

Source Term Design Basis Parameters

Parameter	Value
Total of the design basis release rates of the 13 noble gases (30minute decay reference, t30)	3700 MBq/sec (100,000 µCi/sec)
Normal operational noble gas release rate (t30)	740 MBq/sec (20,000µCi/sec)
Design basis I-131 radioiodine core release rate	26 MBq/sec (700 µCi/sec)
Expected I-131 radioiodine core release rate	3.7 MBq/sec (100- µCi/sec)
I^{131} concentration scale factor	5
Reactor core exit N^{16} concentration (design basis same as normal operation)	1.85 MBq/gm (50 µCi/gm) w/o HWC 9.25 MBq/gm (250 µCi/gm) w/HWC
Design Basis $Argon^{41}$ release rate	2.0 MBq/sec (~~53~~ 54 µCi/sec)
Normal operational $Argon^{41}$ release rate	0.4 MBq/sec (11 µCi/sec)

Table 11.1-2b

Normal Operational Noble Radiogas Source Terms in Steam

Isotope	Decay Constant (per hour)	Steam Concentration (MBq/gm)	Steam Concentration (µCi/gm)	Source Term at t=30min (MBq/sec)	Source Term at t=30min (µCi/sec)
Kr-83m	3.73E-1	1.1E-05	2.9E-04	2.2E+01	5.9E+02
Kr-85m	1.55E-1	1.8E-05	4.9E-04	4.1E+01	1.1E+03
Kr-85	7.37E-6	7.3E-08	2.0E-06	1.8E-01	4.8E+00
Kr-87	5.47E-1	6.0E-05	1.6E-03	1.1E+02	3.0E+03
Kr-88	2.48E-1	6.0E-05	1.6E-03	1.3E+02	3.5E+03
Kr-89	1.32E+1	3.8E-04	1.0E-02	1.3E+00	3.5E+01
Xe-131m	2.41E-3	6.0E-08	1.6E-06	1.5E-01	3.9E+00
Xe-133m	1.30E-2	8.9E-07	2.4E-05	2.2E+00	5.8E+01
Xe-133	5.46E-3	2.6E-05	6.9E-04	6.2E+01	1.7E+03
Xe-135m	2.72E+0	8.0E-05	2.2E-03	5.0E+01	1.4E+03
Xe-135	7.56E-2	6.9E-05	1.9E-03	1.6E+02	4.4E+03
Xe-137	1.08E+1	4.7E-04	1.3E-02	5.1E+00	1.4E+02
Xe-138	2.93E+0	2.7E-04	7.4E-03	1.5E+02	4.2E+03
Totals		1.5E-03	3.9E-02	7.4E+02	2.0E+04

Table 11.1-4b

Normal Operational Iodine Radioisotopes in Reactor Water and Steam

	Decay Constant	**Water Concentration**		**Steam Concentration**	
Isotope	(per hour)	(MBq/gm)	(μCi/gm)	(MBq/gm)	(μCi/gm)
I-131	3.59E-3	5.6E-05	1.5E-03	1.1E-06	3.0E-05
I-132	3.03E-1	5.3E-04	1.4E-02	1.1E-05	2.8E-04
I-133	3.33E-2	3.8E-04	1.0E-02	7.6E-06	2.0E-04
I-134	7.91E-1	9.7E-04	2.6E-02	1.9E-05	5.2E-04
I-135	1.05E-1	5.5E-04	1.5E-02	1.1E-05	3.0E-04

Table 11.1-5b

Normal Operational Non-volatile Fission Products In Reactor Water

Isotope*	Decay Constant (per hour)	Concentration (MBq/gm)	Concentration (µCi/gm)
Rb-89	2.74E+0	9.9E-05	2.7E-03
Sr-89	5.55E-4	2.4E-06	6.4E-05
Sr-90	2.81E-6	1.7E-07	4.5E-06
Y-90	2.81E-6	1.7E-07	4.5E-06
Sr-91	7.31E-2	9.1E-05	2.5E-03
Sr-92	2.56E-1	2.2E-04	5.9E-03
Y-91	4.93E-4	9.5E-07	2.6E-05
Y-92	1.96E-1	1.3E-04	3.6E-03
Y-93	6.80E-2	9.2E-05	2.5E-03
Zr-95/Nb-95	4.41E-4	1.9E-07	5.1E-06
Mo-99/Tc-99m	1.05E-2	4.7E-05	1.3E-03
Ru-103/Rh-103m	7.29E-4	4.7E-07	1.3E-05
Ru-106/Rh-106	7.83E-5	7.1E-08	1.9E-06
Te -129m	8.65E-4	9.5E-07	2.6E-05
Te-131m	2.31E-2	2.3E-06	6.3E-05
Te-132	8.89E-3	2.4E-07	6.4E-06
Cs-134	3.84E-5	6.4E-07	1.7E-05
Cs-136	2.22E-3	4.3E-07	1.1E-05
Cs-137/Ba-137m	2.63E-6	1.7E-06	4.6E-05
Cs-138	1.29E+0	2.0E-04	5.4E-03
Ba-140/La-140	2.26E-3	9.4E-06	2.6E-04
Ce-141	8.88E-4	7.1E-07	1.9E-05
Ce-144/Pr-144	1.02E-4	7.1E-08	1.9E-06
Np-239	1.24E-2	1.9E-04	5.1E-03

* Nuclides shown as pairs are assumed to be in secular equilibrium. The parent decay constant and concentration are shown.

Table 11.1-6

Design Basis* N^{16} Concentrations in Reactor Water and Steam**

Isotope	Half-Life	Steam Concentration* (MBq/gm)	Steam Concentration* (μCi/gm)	Reactor Water Concentration** (MBq/gm)	Reactor Water Concentration** (μCi/gm)
N-16	7.13 sec	1.85	50	2.2	60

* During operation with hydrogen water chemistry, increase this value by a factor of five.

** Valid at core exit.

*** Normal operational concentrations are the same as design basis concentrations.

Table 11.1-7b

Normal Operational Non-coolant Activation Products in Reactor Water

	Decay Constant	**Concentration**	
Isotope	(per hour)	(MBq/gm)	(µCi/gm)
Na-24	4.63E-2	4.6E-05	1.2E-03
P-32	2.02E-3	9.4E-07	2.6E-05
Cr-51	1.04E-3	7.1E-05	1.9E-03
Mn-54	9.53E-5	8.3E-07	2.2E-05
Mn-56	2.69E-1	5.4E-04	1.5E-02
Fe-55	3.04E-5	2.4E-05	6.4E-04
Fe-59	6.33E-4	7.1E-07	1.9E-05
Co-58	4.05E-4	2.4E-06	6.4E-05
Co-60	1.50E-5	4.7E-06	1.3E-04
Ni-63	7.90E-7	2.4E-08	6.4E-07
Cu-64	5.42E-2	6.9E-05	1.9E-03
Zn-65	1.18E-4	2.4E-05	6.4E-04
Ag-110M	1.16E-4	2.4E-08	6.4E-07
W-187	2.90E-2	7.0E-06	1.9E-04

<u>NRC RAI 11.1-3</u>

Provide all calculational parameters used to determine the realistic source term provided in RAI 11.1-2 above.

<u>GE Response:</u>
Based on the values provided in DCD Table 11.1-1, the realistic noble gas (and argon) source term is a factor of five (5) lower than the design basis source term (20,000 μCi/sec normal vs. 100,000 μCi/sec design basis). Similarly, based on the values provided in DCD Table 11.1-1, the realistic radioiodine source term is a factor of seven (7) lower than the design basis source term (100 μCi/sec normal vs. 700 μCi/sec design basis). The realistic source term for all other isotopes (fission products and activation products) is also a factor of seven (7) lower than the design basis source term. The only exception is N-16, where the design basis and realistic source terms are identical.