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MFN 06-260 Supplement 6

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U.S. Nuclear Regulatory Commission  
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Subject: **Revised Response to Portion of NRC Request for Additional  
Information Letter No. 41 Related to ESBWR Design  
Certification Application - Reactor Coolant Pressure Boundary -  
RAI Number 5.2-36 S01**

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) supplemental response to the subject NRC RAI originally transmitted via the Reference 1 letter, and supplemented by NRC requests for clarification via e-mail and a teleconference specified in Reference 2. This revised supplemental response supersedes the previous responses to this RAI.

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

Sincerely,

James C. Kinsey  
Vice President, ESBWR Licensing

References:

1. MFN 06-220, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 41 Related to ESBWR Design Certification Application*, July 10, 2006
2. NRC/GEH (C. Patel /T. Childress) teleconference on March 26, 2008 regarding proposed revisions to RAI 5.2-36 S01 response

Enclosure:

1. MFN 06-260, Supplement 6, Enclosure 1, Revised Response to Portion of NRC Request for Additional Information Letter No. 41 Related to ESBWR Design Certification Application, Reactor Coolant Pressure Boundary, RAI Number 5.2-36 S01

cc: AE Cubbage USNRC (with enclosures)  
DH Hinds GEH (with enclosures)  
GB Stramback GEH/San Jose (with enclosure)  
RE Brown GEH (with enclosures)  
eDRF 0000-0076-8816 (section)

**Enclosure 1**

**MFN 06-260 Supplement 6**

**Revised Response to Portion of NRC Request for  
Additional Information Letter No. 41  
Related to ESBWR Design Certification Application**

**Reactor Coolant Pressure Boundary**

**RAI Number 5.2-36 S01**

**NRC RAI 5.2-36:**

*SRP Section 5.2.3, Revision 2, July 1981 states that the specifications be reviewed for pressure-retaining ferritic materials, nonferrous metals and austenitic stainless steels, including weld materials, that are used for each component (e.g., vessels, piping, pumps, and valves) of the reactor coolant pressure boundary. DCD Tier 2, Table 5.2-1 is not complete because it does not list components in systems that are considered to be part of the reactor coolant pressure boundary (RCPB). There are inconsistencies in materials listed in DCD Tier 2 Tables 5.2-4 and 6.1-1 for the isolation condenser. Provide material type, specification and grade, for all pressure boundary materials, including weld material specifications and grades that make up the RCPB.*

**NRC RAI 5.2-36 S01:**

*In GE's response to RAI 5.2-36 (MFN 06-260), GE did not provide material specifications for isolation and check valves used in the Class 1 portion of the feedwater system. The staff requests the applicant to perform a complete review of the reactor coolant pressure boundary (RCPB) system and compare it to DCD, Tier 2, Revision 1, Table 5.2-4 and verify that all materials used as a pressure boundary for reactor coolant are included in Table 5.2-4.*

**GEH Revised Response:**

This revised supplemental response supersedes the previous responses to this RAI. The intent of DCD Tier 2, Table 5.2-4 is to provide an outline of the materials used for fabrication of components of the reactor coolant pressure boundary (RCPB) in accordance with NUREG-0800, Standard Review Plan (SRP) Section 5.2.3. A full table revision has been made to address the issues raised in this request.

This table revision lists the material specifications expected to be used based upon most recent plant construction experience. The table format is the same as that used in DCD Tier 2, Revision 4, but is expanded for completeness to address the extent of the RCPB scope of components. These systems and portions of systems that form the RCPB are categorized as Quality Group A and built to ASME Code, Section III, Subsection NB (Class 1) requirements. Overlap with DCD Tier 2, Table 6.1-1 for Class 2 and 3 portions of the ESBWR design, has been deleted from Table 5.2-4 to remove potential conflicts and confusion.

DCD Tier 2, Table 6.1-1 is addressed separately under the response to RAI 6.1-2 S02. That response addresses the overlap items in Table 6.1-1 that are designed and built in accordance with ASME Code, Section III, Subsection NB, and are covered by Table 5.2-4 material specification listings.

**DCD Impact:**

DCD Tier 2, Table 5.2-4, will be revised as shown in the attached markup.

ESBWR

26A6642AR Rev. 05

Design Control Document/Tier 2

**Table 5.2-4**  
**Reactor Coolant Pressure Boundary Materials**

Component	Form	Material <sup>(1)</sup>	Specification <sup>(2)</sup> (ASTM/ASME)
<b>Main Steam Isolation Valves (MSIVs)</b>			
Valve Body	Cast	Carbon steel	SA352- <del>LCB</del> Grade LCB
Cover	Forged	Carbon Steel	SA350- <del>LF2</del> Grade LF2 <u>Class 1</u>
Poppet	Forged	Carbon Steel	SA350- <del>LF2</del> Grade LF2 <u>Class 1</u>
Valve stem <u>guides<sup>(3)</sup></u>	Rod <u>or Bar</u>	Precipitation- hardened steel	SA564 <sup>(2)</sup> Gr 630 <del>(H1100)</del> <u>or XM-13; SA479</u> <u>Type XM-19 or 410</u> <u>Condition 2</u>
Body bolt	Bolting	Alloy steel	SA540 Gr B23 CL5
Hex nuts	Bolting Nuts	Alloy steel	SA194 Gr 7
<b>Safety Relief and Depressurization Valves</b>			
Body (SRV)	Forging or Casting	Carbon steel Carbon steel	<del>ASME-SA350 Gr LF2</del> <u>Class 1</u> ASME-SA352 Gr LCB
Body (DPV)	Forging or Casting	Stainless Steel	SA182 <u>or SA336</u> , Gr F304L or F316L
Bonnet (yoke)	Forging or Casting	Carbon steel Carbon steel	<del>ASME-SA350 Gr LF2</del> <del>ASME-SA352 Gr LCB</del>
Nozzle (seat)	Forging or Casting	Stainless steel Carbon steel	ASME-SA182 Gr F316 <del>ASME-SA350 Gr LF2</del> <u>Class 1</u>
Body to bonnet stud	Bar/rod	Alloy steel	<del>ASME-SA193 Gr B7</del>
Body to bonnet nut	Bar/rod	Alloy steel	<del>ASME-SA194 Gr 7</del>

ESBWR

26A6642AR Rev. 05

Design Control Document/Tier 2

**Table 5.2-4**  
**Reactor Coolant Pressure Boundary Materials**

Component	Form	Material <sup>(1)</sup>	Specification <sup>(2)</sup> (ASTM/ASME)
Disk	Forging or Casting	Nickel alloy Stainless steel	ASME SA637 Gr 718 SB637 UNS N07718 ASME-SA351 Gr CF3 or CF3A
<del>(Deleted) Spring washer and Adjusting Screw or Setpoint adjustment assembly</del>	Forging	Carbon steel  Martensitic Stainless Steel  Carbon and alloy steel parts	ASME SA105  ASME SA193 Gr B6  Multiple specifications
<del>(Deleted) Spindle (stem)</del>	Bar	Precipitation- hardened steel	ASTM A 564 Gr 630 (H1100)
<del>(Deleted) Spring</del>	Wire or Bellville washers	Steel Alloy steel	ASTM A 304 Gr 4161 N 45 Cr Mo V67
<b>Main Steam Piping</b>			
Pipe	Seamless  Forged & Bored	Carbon steel <u>Low Alloy</u> <u>Low Alloy</u>	SA333 Gr 6 <u>SA335 Grade P22</u> <u>SA369 Gr FP22</u>
Contour nozzle	Forging	Low alloy steel	SA508 Grade <u>Gr 3, Class 1</u>
200 mm 1500 lb. large groove flange	Forging	Carbon steel	SA350 Gr LF2 <u>Class 1</u>
50 mm special nozzle	Forging	Carbon steel	SA350 Gr LF2 <u>Class 1</u>
Elbow	Seamless Fitting	Carbon steel	SA420 Gr WPL-6, <u>SA508 Gr 1</u>

ESBWR

26A6642AR Rev. 05

Design Control Document/Tier 2

**Table 5.2-4**  
**Reactor Coolant Pressure Boundary Materials**

Component	Form	Material <sup>(1)</sup>	Specification <sup>(2)</sup> (ASTM/ASME)
Head fitting/penetration piping	Forging	Carbon steel	SA350 Gr LF2 Class 1
<u>Other Fitting</u>	<u>Forging</u>	<u>Low Alloy</u>	<u>SA234 Gr WP22</u> <u>SA336 Grade F22</u>
<b>Control Rod Drives<sup>RD</sup></b>			
Middle flange	Forging	Stainless steel	SA182 or SA336 Grades F304/F304L/F316/F316L
Spool piece	Forging	Stainless steel	SA182 or SA336 Grades F304/F304L/F316/F316L
Mounting bolts	Bolting	Alloy steel	SA193 Grade B7
<b>Reactor Pressure Vessel</b>			
Shells and Heads	Plate	Mn-1/2 Mo-1/2 Ni Low Alloy Steel	SA533 Grade B, Class 1
	Forging	3/4 Ni-1/2 Mo-Cr-V Low Alloy Steel	SA508 Grade 3, Class 1
Shell and Head Flange	Forging	3/4Ni-1/2 Mo-Cr-V Low Alloy Steel	SA508 Grade 3, Class 1
Main Closure Bolting	Bolting	Low Alloy Steel	SA540 Grade B23 or B24, Class 3
Standard Flange Bolting	Bolting	Low Alloy Steel	SA193 Grade B7 or SA540 Grade B23, Class 3
Nozzles	Forging	3/4 Ni-1/2 Mo-Cr-V Low alloy steel	SA508 Grade 3, Class 1

ESBWR

26A6642AR Rev. 05

Design Control Document/Tier 2

**Table 5.2-4**  
**Reactor Coolant Pressure Boundary Materials**

Component	Form	Material <sup>(1)</sup>	Specification <sup>(2)</sup> (ASTM/ASME)
Nozzle Safe Ends	Forging	Carbon Steel <u>Low Alloy Steel</u>	SA350 Grade LF2 or SA508 Grade 1 <u>SA508 Grade 3, Class 1</u>
Drain Nozzles	Forging	Cr-Ni-Mo Stainless steel	SA182 or SA336 Grades F304/F304L/F316/F316L
Instrumentation Nozzles	Forging <u>Bar</u> <u>Seamless Pipe</u> <u>Forging</u>	Cr-Ni-Mo Stainless steel and Ni-Cr-Fe	SA182 or SA336 Grades F304/F304L/F316/F316L and <u>Code Case N-580-1 with</u> <u>Base Material = SB-166,</u> <u>SB-167 or SB-564</u>
Stub Tubes	<u>Bar, Smls.</u> <u>Pipe</u> <u>Pipe</u> Forging	Ni-Cr-Fe	<u>Code Case N-580-1 with</u> <u>Base Material = SB-166,</u> <u>SB-167 or SB-564</u>
<b>Isolation Condenser</b>			
Steam pipe	Seamless	Carbon steel	SA333 Grade 6
Steam pipe fittings	Forging or Fitting	Carbon Steel  Carbon Steel	SA350 Grade LF2 or SA508 Grade 1 SA420 Grade WPL-6
<u>Valves</u>	<u>Forging or</u> <u>Casting</u>	<u>Carbon Steel</u> <u>Carbon Steel</u>	<u>SA350 Gr LF2 Class 1</u> <u>SA352 Gr LCB</u>
<u>Disc</u>	<u>Forging</u> <u>Casting</u>	<u>Carbon Steel</u> <u>Carbon Steel</u> <u>Stainless Steel</u>	<u>SA350 Gr LF2 Class 1</u> <u>SA352 Gr LCB</u> <u>SA351 Gr CF3 or CF3A</u>
<u>Valve Stem<sup>(3)</sup></u>	<u>Rod or Bar</u>	<u>Precipitation-</u> <u>hardened Steel</u>	<u>SA564<sup>(2)</sup> Gr 630 or</u> <u>XM-13; SA479 Type</u> <u>XM-19 or 410 Condition 2</u>



ESBWR

26A6642AR Rev. 05

Design Control Document/Tier 2

Table 5.2-4  
Reactor Coolant Pressure Boundary Materials

Component	Form	Material <sup>(1)</sup>	Specification <sup>(2)</sup> (ASTM/ASME)
Condensate pipe	Seamless	Stainless steel	<del>Type 316L</del> SA312 or SA376 Grades 304/304L/316/316L
Condensate pipe fittings	Forging or Fitting	Stainless Steel	SA182 or SA336 Grades 304/304L/316/316L or SA403 Grades WP 304/304L/316/316L
<u>Valves</u>	<u>Forging or Casting</u>	<u>Stainless Steel</u> <u>Stainless Steel</u>	<u>SA182 Gr F304, F304L,</u> <u>F316 or F316L;</u> <u>SA351 Gr CF3 or CF3A</u>
<u>Disc</u>	<u>Forging or Casting</u>	<u>Stainless Steel</u> <u>Stainless Steel</u>	<u>SA182 Gr F304, F304L,</u> <u>F316 or F316L;</u> <u>SA351 Gr CF3 or CF3A</u>
<u>Valve Stem<sup>(3)</sup></u>	<u>Rod or Bar</u>	<u>Precipitation-Hardened Steel</u>	<u>SA564<sup>(2)</sup> Gr 630 or XM-13;</u> <u>SA479 Type XM-19 or 410</u> <u>Condition 2</u>
<b>Feedwater Piping</b>			
Pipe	Seamless <u>Forged &amp; Bored</u>	Low Alloy <u>Low Alloy</u>	SA335 Grade P22 <u>SA369 Gr FP22</u>
Fittings	Forging	Low Alloy	<u>SA234 Gr WP22;</u> SA336 Grade F22
<u>Valves</u>	<u>Forging or Casting</u>	<u>Low Alloy</u> <u>Low Alloy</u>	<u>SA336 Gr F22 or</u> <u>SA352 Gr LC1</u>
<u>Disc</u>	<u>Forging</u> <u>Casting</u>	<u>Low Alloy</u> <u>Low Alloy</u> <u>Stainless Steel</u>	<u>SA336 Gr F22 or</u> <u>SA352 Gr LC1</u> <u>SA351 Gr CF3 or CF3A</u>

ESBWR

26A6642AR Rev. 05

Design Control Document/Tier 2

Table 5.2-4  
Reactor Coolant Pressure Boundary Materials

Component	Form	Material <sup>(1)</sup>	Specification <sup>(2)</sup> (ASTM/ASME)
<u>Valve Stems</u> <u>Guides<sup>(3)</sup></u>	<u>Bar, Rod</u>	<u>Low Alloy</u> <u>Stainless Steel</u>	<u>SA739 Gr B22</u> <u>SA564<sup>(2)</sup> Gr 630, XM-13;</u> <u>SA479 Type XM-19 or</u> <u>Type 410 Condition 2</u>
<u>Valve Seat Rings</u>	<u>Forging or</u> <u>Casting</u>	<u>Low Alloy</u> <u>Stainless Steel</u> <u>Low Alloy</u>	<u>SA182 or SA336 Gr F22</u> <u>SA182 Gr F304, F304L,</u> <u>F316 or F316L</u> <u>SA426 Gr CP22</u>
<b>Reactor Water Cleanup/Shutdown Cooling Piping</b>			
Cleanup Piping	Seamless Pipe	Carbon steel	SA333 Grade 6
Fittings	Forging or Fitting	Carbon steel	SA350 Grade LF2 or SA508 Grade 1 SA420 Grade WPL-6
<u>Valves</u>	<u>Forging or</u> <u>Casting</u>	<u>Carbon Steel</u> <u>Carbon Steel</u>	<u>SA350 Gr LF2 Class 1</u> <u>SA352 Gr LCB</u>
<u>Disc</u>	<u>Forging</u> <u>Casting</u>	<u>Carbon Steel</u> <u>Carbon Steel</u> <u>Stainless Steel</u>	<u>SA350 Gr LF2 Class 1</u> <u>SA352 Gr LCB</u> <u>SA351 Gr CF3 or CF3A</u>
<u>Valve Stem<sup>(3)</sup></u>	<u>Rod or Bar</u>	<u>Precipitation-</u> <u>hardened Steel</u>	<u>SA564<sup>(2)</sup> Gr 630 or</u> <u>XM-13; SA479 Type</u> <u>XM-19 or 410 Condition 2</u>
Drain Line Piping	Seamless Pipe	Stainless steel	SA312 or SA376 Grades 304/304L/316/316L
Fittings	Forging or Fitting	Stainless steel	SA182 or SA336 Grades 304/304L/316/316L SA403, Grades WP 304/304L/316/316L

ESBWR

26A6642AR Rev. 05

Design Control Document/Tier 2

**Table 5.2-4**  
**Reactor Coolant Pressure Boundary Materials**

Component	Form	Material <sup>(1)</sup>	Specification <sup>(2)</sup> (ASTM/ASME)
<u>Valves</u>	<u>Forging or</u>	<u>Stainless Steel</u>	<u>SA182 Gr F304L or</u> <u>F316L</u>
	<u>Casting</u>	<u>Stainless Steel</u>	<u>SA351 Gr CF3 or CF3A</u>
<u>Disc</u>	<u>Forging or</u>	<u>Stainless Steel</u>	<u>SA182 Gr F304, F304L,</u> <u>F316 or F316L;</u>
	<u>Casting</u>	<u>Stainless Steel</u>	<u>SA351 Gr CF3 or CF3A</u>
<u>Valve Stem<sup>(3)</sup></u>	<u>Rod or Bar</u>	<u>Precipitation-</u> <u>hardened Steel</u>	<u>SA564<sup>(2)</sup> Gr 630 or</u> <u>XM-13; SA479 Type</u> <u>XM-19 or 410 Condition 2</u>
<b>Gravity Driven Cooling (See Table 6.1-1)</b>			
<u>Piping</u> <u>Downstream of</u> <u>Check Valves</u>	<u>Seamless Pipe</u>	<u>Stainless Steel</u>	<u>SA312 or SA376 Gr 304,</u> <u>304L, 316 or 316L</u>
<u>Check Valves</u>	<u>Forging or</u>	<u>Stainless Steel</u>	<u>SA182 Gr F304, F304L,</u> <u>F316 or F316L;</u>
	<u>Casting</u>	<u>Stainless Steel</u>	<u>SA351 Gr CF3 or CF3A</u>
<u>Squib-activated</u> <u>Valves</u>	<u>Forging or</u>	<u>Stainless Steel</u>	<u>SA182 Gr F304, F304L,</u> <u>F316 or F316L;</u>
	<u>Casting</u>	<u>Stainless Steel</u>	<u>SA351 Gr CF3 or CF3A</u>
<u>Disc</u>	<u>Forging or</u>	<u>Stainless Steel</u>	<u>SA182 Gr F304, F304L,</u> <u>F316 or F316L;</u>
	<u>Casting</u>	<u>Stainless Steel</u>	<u>SA351 Gr CF3 or CF3A</u>
<u>Valve Stem</u> <u>Guides<sup>(3)</sup></u>	<u>Bar, Rod</u>	<u>Stainless Steel</u>	<u>SA564<sup>(2)</sup> Type 630 or</u> <u>XM-13; SA479 Type</u> <u>XM-19 or 410 Cond.-2</u>
<u>Valve Seat Ring</u>	<u>Forging or</u> <u>Casting</u>	<u>Stainless Steel</u> <u>Stainless Steel</u>	<u>SA564<sup>(2)</sup> Type 630 or</u> <u>XM-13; SA479 Type</u> <u>XM-19 or 410 Cond.-2</u> <u>SA351 Gr CF3 or CF3A</u>

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26A6642AR Rev. 05

Design Control Document/Tier 2

**Table 5.2-4**  
**Reactor Coolant Pressure Boundary Materials**

Component	Form	Material <sup>(1)</sup>	Specification <sup>(2)</sup> (ASTM/ASME)
<b><u>SLC Standby Liquid Control</u></b>			
<u>Piping</u>	<u>See Table 6.1-1 Seamless Pipe</u>	<u>Stainless Steel</u>	<u>SA312 Gr 316L</u>
<u>Valves</u>	<u>Forging or Casting</u>	<u>Stainless Steel</u> <u>Stainless Steel</u>	<u>SA182 Gr F304L or F316L</u> <u>SA351 Gr CF3 or CF3A</u>
<u>Disc</u>	<u>Forging or Casting</u>	<u>Stainless Steel</u> <u>Stainless Steel</u>	<u>SA182 Gr F304, F304L, F316 or F316L</u> <u>SA351 Gr CF3 or CF3A</u>
<u>Valve Stem<sup>(3)</sup></u>	<u>Rod or Bar</u>	<u>Precipitation- hardened Steel</u>	<u>SA564<sup>(2)</sup> Gr 630 or XM-13; SA479 Type XM-19 or 410 Condition 2</u>
<b><u>Additional Bolting Material</u></b>			
<u>Flanges, Covers and Bonnets</u>	<u>Stud or Bolting</u>	<u>Alloy &amp; Stainless Steels</u>	<u>SA354, SA449</u>
<b><u>Welding Filler Metals</u></b>			
Base Material	Filler Metal Type	SFA Number	AWS Classification
Carbon Steel P1, G1	Covered Electrodes or Filler Wire	SFA-5.1 SFA-5.18	E7018 ER70S-2 ER70S-3 ER70S-6
Carbon Steel and Low Alloy Steel (C, Mn, Si, Cb) P1, G2	Covered Electrodes or Filler Wire	SFA-5.1 SFA-5.18 SFA-5.28	E7018 ER70S-2 ER80S-D2
Low Alloy Steel P3, G1 (C, 1/2 Mo)	Covered Electrodes or Filler Wire	<u>SFA-5.1</u> <u>SFA-518</u> <u>SFA-528</u>	<u>E7018</u> <u>ER70S-2</u> <u>ER80S-D2</u>

ESBWR

26A6642AR Rev. 05

Design Control Document/Tier 2

**Table 5.2-4**  
**Reactor Coolant Pressure Boundary Materials**

Component	Form	Material <sup>m</sup>	Specification <sup>401</sup> (ASTM/ASME)
Low Alloy Steel P3, G3 <u>(3/4 Ni, 1/2 Mo, 1/3 Cr, V)</u>	Covered Electrodes or Filler Wire	SFA-5.5 SFA-5.1 SFA-5.28 SFA-5.18	E8018-C3 <del>E8018-G</del> E7018 ER80S-D2 ER70S-2
Low Alloy Steel P5A, G1 (2-1/4 Cr, 1 Mo)	Covered Electrodes or Filler Wire	SFA-5.5 SFA-5.1 SFA-5.28 SFA-5.18	E9016-B3 E9018-B3 <del>E9018-B3L</del> E7018 ER90S-B3 <del>ER90S-B3L</del> ER70S-2
<del>(Deleted) Low Alloy Steel P5C, G1 (2-1/4Cr, 1Mo)</del>	<del>Covered Electrodes or Filler Wire</del>	<del>SFA-5.5 SFA-5.1 SFA-5.28 SFA-5.18</del>	<del>E9016-B3 E9018-B3 E9018-B3L E7018 ER90S-B3 ER90S-B3L ER70S-2</del>
Stainless Steel P8, G1	Covered Electrodes or Filler Wire	SFA-5.4 SFA-5.9	E308L-16 E309L-16 E316L-16  ER308L ER309L ER316L
Nickel Alloy P43	Filler Wire	SFA-5.14	ERNiCr-3

26A6642AR Rev. 05

ESBWR

Design Control Document/Tier 2

Notes:

- ±(1) Carbon content of all RCPB wrought austenitic stainless steel (304/304L/316/316L) is 0.02% maximum.
- (2) SA564 Type 630 or XM-13 material used for other than RCPB applications shall be in Condition H1100 or H1150, unless specifically approved by GEH. Where mechanically installed and replaceable parts requiring wear resistance (as substitutes for cobalt bearing alloys) require additional precipitation/age hardening, valve guides or other parts may be formed down to Condition H900 for Type 630 material and down to Condition H950 for Type XM-13 material, subject to demonstrated mechanical reliability.
- (3) Items fabricated from these materials are wetted by reactor coolant, but are not required to be part of the design ASME Code pressure-boundary. Therefore, some of the specific material specifications or material specification grades identified under this category are not required to be listed in the ASME Code, Section II, Part D, Table 2A.