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

Subject: **Response to Portion of NRC RAI Letter No. 328 Related to ESBWR Design Certification Application – Piping Design; RAI Number 3.12-3 S04 Revision 1**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) revised response to a portion of the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) letter number 328 sent by NRC letter dated April 16, 2009 (Reference 1).

Reference 2 transmitted our initial response to the subject RAI but after interactions with the staff it was necessary to revise our reponses for clarity. RAI Number 3.12-3 S04 Revision 1 is addressed in Enclosure 1.

Enclosure 2 contains the DCD changes to Tier 2 as a result of GEH's response to this RAI. Verified DCD changes associated with this RAI response are identified in the enclosed DCD markups by enclosing the text within a black box.

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

Sincerely,

FOR

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 09-273 Letter from U.S. Nuclear Regulatory Commission to Jerald G. Brown, GEH, *Request For Additional Information Letter No. 328 Related to ESBWR Design Certification* dated April 16, 2009

2. MFN 09-319 Letter from Richard E. Kingston, GEH to U.S. Nuclear Regulatory Commission *Partial Response to NRC RAI Letter No. 328 Related to ESBWR Design Certification Application – Piping Design; RAI Numbers 3.12-3 S04 and 3.12-39* dated May 19, 2009

Enclosure:

1. Response to portion of NRC RAI Letter No. 328 Related to ESBWR Design Certification Application – Section 3.12 - Piping Design; RAI Number 3.12-3 S04 Revision 1
2. Response to portion of NRC RAI Letter No. 328 Related to ESBWR Design Certification Application – DCD Tier 2 Markups for RAI Numbers 3.12-3 S04 Revision 1

| | | |
|---|---|---|
| cc: | AE Cubbage | USNRC (with enclosures) |
| | JG Head | GEH/Wilmington (with enclosures) |
| | DH Hinds | GEH/Wilmington (with enclosures) |
| | eDRF Section | 0000-0101-5570 R1(RAI 3.12-3 S04 R1) |

**Enclosure 1**

**MFN 09-319 Revision 1**

**Response to Portion of NRC Request for**

**Additional Information Letter No. 328**

**Related to ESBWR Design Certification Application**

**Section 3.12 – Pipng Design**

**RAI Number 3.12-3 S04[1] Revision 1**

[1] Response to RAI 3.12-3 S03 previously submitted under MFN 06-119 S05 is included to provide historical continuity during review.

**<u>NRC RAI 3.12-3 S03</u>**

*NRC Summary:*

*GEH's use of SRSS of group responses in the application of Independent Support Motion (ISM) response spectrum analysis does not meet the current staff position.*

*NRC Full Text:*

*GEH uses SRSS of group responses in its application of Independent Support Motion (ISM) response spectrum analysis. The staff position in NUREG-1061, Volume 4 specifies absolute sum. GEH provided the results of a study performed to justify its use of SRSS for group responses in its September 13, 2007, letter. The study compares the results from a sample of two piping runs analyzed using multi-support time history (a method acceptable to the staff) with the proposed GEH*

*use of ISM with SRSS of group responses. The study indicated that multi-support time history responses exceeded the ISM responses at several locations in the feedwater system, the maximum being 8%. As a consequence, the staff recommends that GEH increase the piping stresses and loads by 10% when using the ISM SRSS method. Alternatively, GEH should follow the staff position in NUREG-1061, Volume 4.*

**<u>GEH Response</u>**

GEH accepted the NRC's recommendation and agreed to increase the piping stresses and loads by 10% when using the ISM SRSS method. The following paragraph was added to the DCD Tier 2, Subsection 3.7.3.9.

'To use the SRSS method for independent support response spectrum (ISM) analysis, it is required to include 10 percent margin in the design requirements for piping stress and piping support loads to address the uncertainties that may exist from the use of the SRSS method rather than the absolute sum method (ABS) for the group combination method when performing an ISM analysis'.

Based on this response, DCD Tier 2 Subsections 3.7.3.9 and 3.7.3.12 were revised.

**<u>DCD Impact</u>**

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

**NRC RAI 3.12-3 S04**

*Provide justification to demonstrate that the selected piping system for ESBWR inside containment could be considered as representative for the ESBWR Class 1, 2, and 3 piping for all building. Clarification on the SRSS method.*

*Section 3.7.3.9 of ESBWR DCD stated that the independent support motion (ISM) response spectrum method of analysis combines responses of different support groups by the SRSS procedure for component and equipment and additional 10 percent margin for piping stress and piping support loads. Section II.9 of SRP 3.7.3 states that if the ISM method is utilized, all of the criteria presented in NUREG-1061 related to the ISM method must be followed. NUREG-1061 states that group responses for each direction should be combined by the absolute sum method. NUREG-1061 also states that unless the groups are from different structures or if from the same structure, they can be shown to be phase uncorrelated, then SRSS should be used. In RAI 3.12-3 S02, the staff requested the applicant to demonstrate that time histories from different support groups can be shown to be phase uncorrelated, and therefore, SRSS combination can be used. The applicant provided an alternative by performing a dynamic analysis for SSE earthquakes by two different procedures for two typical piping systems for ESBWR inside containment. The staff is requesting the applicant to provide justification to demonstrate that the selected piping system for ESBWR inside containment could be considered as representative for the ESBWR Class 1, 2, ad 3 piping for all building.*

*The staff also notes that Figure B-3-5 of the GEH study report, MFN 06-119, Supplement 2, (ML072680480) showed phase correlation in the vertical direction. How does this justify the use of the SRSS method?*

**GEH Response**

It is GEH experience that using ABS group responses for ISM will result in very conservative results; and as such, it is not likely that GEH will use ISM when the ABS combination is required. For ESBWR the ISM method using the SRSS combination will be used under the following conditions:

1. For piping within the RCCV (see bases provided in the remainder of the RAI response).
2. For piping outside the RCCV, the SRSS method will be used if it is established. that the support motions are reasonably phase uncorrelated; otherwise, the absolute sum procedure is required if ISM is used as the analysis method.

The use of this criteria is supported by the Consultant Position Paper by R. P. Kennedy in NUREG-1061. In section 2.1.1 on page B-51, it states that: “Only if one can demonstrate that the responses are reasonably phase uncorrelated should group responses be combined SRSS. Reasonable phase uncorrelation is likely between different structures." Reinforcement of this statement is then reflected in Table 3 on page B-79 where the following revision for combining responses using the ISM response spectrum analysis method was suggested:

"A. Inertial or Dynamic Components (primary)

1. For each mode and for each input motion direction:
   Combine group response; by absolute sum (ABS) or preferably, by actual relative phasing if structural phasing information is retained. If it can be shown that group responses are reasonably phase uncorrelated (such as responses between different structures). then an SRSS combination may be used.
2. For each response quantity and each input motion direction:
   Combine modal responses by the Double Sum (DSC) or CQC method with provisions for high frequency modes.
3. For each response quantity:
   Combine input motion direction on responses by SRSS or Equivalent method."

The justification for using the SRSS procedure in conjunction with the ISM method by demonstrating that it is phase uncorrelated for piping inside the RCCV is shown as follows:

The selections of piping systems for the response spectrum analysis, the time history analysis and the comparisons have been performed according to the agreement reached between NRC, BNL and GE during the January 2007 audit meeting. The selected piping systems are representative for ESBWR piping inside the containment.

The NRC, in response to RAI 3.12-3 S03, has reviewed the detailed piping analysis results for the analyzed representative piping systems. The analysis results have demonstrated that SRSS combination of group responses yields conservative results for all the components in the main steam piping system and feedwater piping system, except for the six (6) node point locations in the feedwater piping analysis The maximum ratio for these 6 locations is 1.08. All these 6 locations are the low stress node points and they do not control the design. The maximum stress for the feedwater system is at the sweepolet node point 973. For this point the ratio is only 0.79. The table of the stress comparisons is attached with this response (Excerpted from report).

Additional time histories plots for the RPV nozzle and vent wall in the horizontal directions, North-South (N-S) and East-West (E-W), are plotted to demonstrate that there will be no correlation in the horizontal direction when the piping is not supported by the same structure. These plots are presented with this RAI response: It is noted that the time period selected for the plots is between 7.5

sec. to 8.0 sec. This is because during this period, the accelerations are the maximum in the 20 second of the seismic time history.

Figure B-3-5 (a) - Acceleration Time Histories for Vent Wall 701, and RPV Nozzle in N-S Direction from Time 7.5 sec. to 8.0 sec. (Not Correlated)

Figure B-3-5 (b) - Acceleration Time Histories for Vent Wall 701, and RPV Nozzle in E-W Direction from Time 7.5 sec. to 8.0 sec. (Not Correlated)

Figure B-3-2 (a) - Acceleration Time Histories for Containment Node 206 and RPV Nozzle in N-S direction, from time 7.5 sec. to 8.0 sec.(Not Correlated)

Figure B-3-2 (b) - Acceleration Time Histories for Containment Node 206 and RPV Nozzle in E-W direction, from time 7.5 sec. to 8.0 sec. (Not Correlated)

The above four figures illustrate that in the horizontal direction the N-S and E-W time histories at the RPV nozzle and the vent wall are not correlated. Additional plots for Nodes 206 and 807 in the horizontal direction are also provided for reference. The necessary conditions to have correlated time histories are:

(1) support points are on the same floor, that have exact the same mode shape and natural frequencies, or,
(2) on the same concrete slab plus the member to the support points are rigid, such as the RPV wall and the vent wall are rigid in vertical direction.

Since the vertical direction for the cases evaluated in the study met these conditions, the comparison plots show that phase correlation was present, but since the other two directions were not correlated, the results of the study still demonstrates that the SRSS method was valid when the 10% adder was applied.

Therefore, it is concluded that using SRSS group responses for ISM dynamic analysis using the support group suggested guidelines as shown in NUREG-1061 will produce conservative results. This particular study demonstrated that an SRSS combination of group responses yields conservative results for all the components in the main steam piping system and feedwater water piping system, except, at 6 node points in the feedwater system. The maximum ratio for these 6 points is 1.08 that occurs at a low stress location.

SRP 3.7.2 Paragraph II 1. (iii) States,

> (iii) Use adequate number of masses or degree of freedoms. The number is considered adequate when additional degree of freedom do not results in more than 10% increase in response.

(iv) Investigation of sufficient number of modes to ensure participation of all modes. The criterion for sufficiency is that the inclusion of additional modes does not result in more than 10 percent increase in responses.

Although this modeling requirement for the 10% rule is different then the SRSS group responses, it indicates that there are tolerances allowed in the dynamic methodology. In addition, ESBWR has committed to add a 10% margin to all piping analysis when ISM analysis is used. This further insures that all the analysis results are conservative.

In conclusion, the study demonstrates that using SRSS with the 10% increase in response is conservative for use for the main steam and feedwater lines, and that these represent typical results that can be expected for all piping within containment.

DCD Impact

DCD Tier 2 Section 3.7.3.9 will be revised as noted in the attached markup.

## APPENDIX C-2 Feedwater Lines

Piping Stress Analysis Comparison

**ESBWR Feedwater Class 1 Lines**
**From Penetration to Header**

| NO. NODE | SIZE O.D. | COMP TYPE | ISM, SRSS (ISM) Mpa | Time History (TH) Mpa | TH/ISM |
|---|---|---|---|---|---|
| | | | **(B)** | **(A)** | **(A)/(B)** |
| 26 | 558.8 | MPEN-0 | 101.67 | 77.23 | 0.76 |
| 26 | 558.8 | TRANSI | 84.73 | 64.36 | 0.76 |
| 29 | 558.8 | ELBOW | 0.04 | 0.04 | 1.00 |
| 101 | 558.8 | ST PIP | 69.12 | 60.86 | 0.88 |
| 103 | 558.8 | ST PIP | 15.39 | 14.18 | 0.92 |
| 103 | 558.8 | ST PIP | 15.39 | 14.18 | 0.92 |
| 103 | 558.8 | ST PIP | 15.39 | 14.18 | 0.92 |
| 104 | 558.8 | ST PIP | 46.31 | 34.95 | 0.75 |
| 104 | 558.8 | ST PIP | 46.31 | 34.95 | 0.75 |
| 607 | 558.8 | ELBOW | 25.71 | 21.31 | 0.83 |
| 607 | 558.8 | ELBOW | 25.71 | 21.31 | 0.83 |
| 608 | 558.8 | ELBOW | 0.96 | 0.70 | 0.73 |
| 608 | 558.8 | ELBOW | 0.96 | 0.70 | 0.73 |
| 617 | 558.8 | ELBOW | 73.97 | 59.71 | 0.81 |
| 617 | 558.8 | ELBOW | 73.97 | 59.71 | 0.81 |
| 618 | 558.8 | ELBOW | 46.59 | 32.40 | 0.70 |
| 618 | 558.8 | ELBOW | 46.59 | 32.40 | 0.70 |
| 627 | 558.8 | ELBOW | 29.93 | 19.58 | 0.65 |
| 627 | 558.8 | ELBOW | 29.93 | 19.58 | 0.65 |
| 628 | 558.8 | ELBOW | 49.58 | 37.97 | 0.77 |
| 628 | 558.8 | ELBOW | 49.58 | 37.97 | 0.77 |
| 637 | 558.8 | ELBOW | 0.92 | 0.67 | 0.73 |
| 638 | 558.8 | ELBOW | 22.85 | 21.21 | 0.93 |
| 638 | 558.8 | ELBOW | 22.85 | 21.21 | 0.93 |
| 788 | 558.8 | ELBOW | 1.72 | 1.24 | 0.72 |
| 792 | 558.8 | ELBOW | 54.21 | 40.24 | 0.74 |
| 798 | 558.8 | ELBOW | 26.94 | 23.09 | 0.86 |
| 800 | 558.8 | ELBOW | 32.07 | 20.48 | 0.64 |
| 801 | 558.8 | ELBOW | 85.64 | 70.91 | 0.83 |
| 817 | 558.8 | ELBOW | 23.89 | 22.50 | 0.94 |
| 817 | 558.8 | ELBOW | 23.89 | 22.50 | 0.94 |
| 820 | 558.8 | ELBOW | 47.45 | 36.07 | 0.76 |

| ESBWR Feedwater Class 1 Lines<br>From Penetration to Header | | | | | |
|---|---|---|---|---|---|
| NO.<br>NODE | SIZE<br>O.D. | COMP<br>TYPE | ISM,<br>SRSS<br>(ISM)<br>Mpa | Time<br>History<br>(TH) Mpa | TH/ISM |
| | | | **(B)** | **(A)** | **(A)/(B)** |
| 954 | 558.8 | TRANSI | 65.04 | 65.03 | 1.00 |
| **955** | **558.8** | **TRANSI** | **74.45** | **80.19** | **1.08** |
| **956** | **558.8** | **TRANSI** | **65.22** | **69.72** | **1.07** |
| 958 | 558.8 | ST PIP | 33.36 | 30.33 | 0.91 |
| **960** | **558.8** | **ST PIP** | **58.36** | **60.58** | **1.04** |
| 966 | 558.8 | ST PIP | 38.20 | 31.84 | 0.83 |
| 966 | 558.8 | ST PIP | 38.20 | 31.84 | 0.83 |
| 967 | 558.8 | TEE SM | 100.77 | 84.09 | 0.83 |
| 967 | 558.8 | TEE SM | 66.77 | 51.87 | 0.78 |
| 967 | 558.8 | TEE SM | 152.74 | 111.84 | 0.73 |
| 968 | 558.8 | ELBOW | 37.55 | 23.35 | 0.62 |
| 968 | 558.8 | ELBOW | 37.55 | 23.35 | 0.62 |
| 969 | 558.8 | ELBOW | 24.70 | 21.49 | 0.87 |
| 969 | 558.8 | ELBOW | 3.08 | 2.24 | 0.73 |
| 969 | 323.9 | SWEEPO | 120.34 | 103.46 | 0.86 |
| 970 | 558.8 | ELBOW | 30.90 | 20.54 | 0.66 |
| 970 | 558.8 | ELBOW | 30.90 | 20.54 | 0.66 |
| 971 | 558.8 | ELBOW | 25.64 | 18.81 | 0.73 |
| 971 | 558.8 | ELBOW | 25.64 | 18.81 | 0.73 |
| 972 | 558.8 | ELBOW | 0.04 | 0.04 | 1.00 |
| 973 | 558.8 | ELBOW | 31.90 | 20.70 | 0.65 |
| 973 | 558.8 | ELBOW | 38.90 | 29.23 | 0.75 |
| **973** | **323.9** | **SWEEPO (Max stress)** | **201.47** | **158.92** | **0.79** |
| 974 | 558.8 | ELBOW | 82.73 | 68.15 | 0.82 |
| 974 | 558.8 | ELBOW | 82.73 | 68.15 | 0.82 |
| 975 | 558.8 | ELBOW | 65.31 | 52.01 | 0.80 |
| 975 | 558.8 | ELBOW | 65.31 | 52.01 | 0.80 |
| 976 | 558.8 | ELBOW | 56.96 | 44.58 | 0.78 |
| 976 | 558.8 | ELBOW | 56.96 | 44.58 | 0.78 |
| 977 | 558.8 | ELBOW | 22.28 | 21.12 | 0.95 |
| 977 | 558.8 | ELBOW | 2.96 | 2.15 | 0.73 |
| 977 | 558.8 | ELBOW | 25.44 | 24.10 | 0.95 |
| 977 | 323.9 | SWEEPO | 109.06 | 101.49 | 0.93 |
| 978 | 558.8 | ELBOW | 30.32 | 22.15 | 0.73 |

| ESBWR Feedwater Class 1 Lines<br>From Penetration to Header | | | | | |
|---|---|---|---|---|---|
| NO.<br>NODE | SIZE<br>O.D. | COMP<br>TYPE | ISM,<br>SRSS<br>(ISM)<br>Mpa | Time<br>History<br>(TH) Mpa | TH/ISM |
| | | | **(B)** | **(A)** | **(A)/(B)** |
| 978 | 558.8 | ELBOW | 30.32 | 22.15 | 0.73 |
| 979 | 558.8 | ELBOW | 24.13 | 19.10 | 0.79 |
| 982 | 558.8 | ST PIP | 52.02 | 42.82 | 0.82 |
| 982 | 558.8 | ST PIP | 52.02 | 42.82 | 0.82 |
| 986 | 558.8 | ST PIP | 65.72 | 51.34 | 0.78 |
| 986 | 558.8 | ST PIP | 65.72 | 51.34 | 0.78 |
| 990 | 558.8 | ELBOW | 22.00 | 19.20 | 0.87 |
| 990 | 558.8 | ELBOW | 22.00 | 19.20 | 0.87 |
| **962F** | **558.8** | **ELBOW** | **114.34** | **118.73** | **1.04** |
| **962N** | **558.8** | **ELBOW** | **107.31** | **108.45** | **1.01** |
| 963F | 558.8 | ELBOW | 82.65 | 81.29 | 0.98 |
| **963N** | **558.8** | **ELBOW** | **108.37** | **111.12** | **1.03** |
| 964F | 558.8 | ELBOW | 106.77 | 98.53 | 0.92 |
| 964N | 558.8 | ELBOW | 84.02 | 82.75 | 0.98 |
| 964N | 558.8 | ELBOW | 84.03 | 82.75 | 0.98 |
| 965F | 558.8 | ELBOW | 81.92 | 75.93 | 0.93 |
| 965F | 558.8 | ST PIP | 43.08 | 39.94 | 0.93 |
| 965N | 558.8 | ELBOW | 104.01 | 94.97 | 0.91 |
| **Average & Ratio:** | | | 54.50 | 46.75 | 0.84 |

| ESBWR Feedwater Class 1 Lines From Header to RPV nozzles | | | | | |
|---|---|---|---|---|---|
| NO. NODE | SIZE O.D. | COMP TYPE | ISM, SRSS (ISM) Mpa | Time History (TH) Mpa | TH/ISM |
| | | | **(B)** | **(A)** | **(A)/(B)** |
| 37 | 323.9 | ST PIP | 147.46 | 131.61 | 0.89 |
| 47 | 323.9 | ST PIP | 67.32 | 64.14 | 0.95 |
| 47 | 323.9 | ST PIP | 67.32 | 64.14 | 0.95 |
| 48 | 323.9 | ST PIP | 95.85 | 91.82 | 0.96 |
| 48 | 323.9 | TAPER< | 95.85 | 91.82 | 0.96 |
| 52 | 323.9 | ST PIP | 126.76 | 108.81 | 0.86 |
| 52 | 323.9 | ST PIP | 126.76 | 108.81 | 0.86 |
| 65 | 323.9 | ST PIP | 81.01 | 81.21 | 1.00 |
| 65 | 323.9 | ST PIP | 81.01 | 81.21 | 1.00 |
| 66 | 323.9 | ST PIP | 114.34 | 114.50 | 1.00 |
| 66 | 323.9 | TAPER< | 114.34 | 114.50 | 1.00 |
| 70 | 323.9 | ST PIP | 112.85 | 105.79 | 0.94 |
| 70 | 323.9 | ST PIP | 112.85 | 105.79 | 0.94 |
| 83 | 323.9 | ST PIP | 77.68 | 67.91 | 0.87 |
| 83 | 323.9 | ST PIP | 77.68 | 67.91 | 0.87 |
| 84 | 323.9 | ST PIP | 110.15 | 97.44 | 0.88 |
| 84 | 323.9 | TAPER< | 110.15 | 97.44 | 0.88 |
| 388 | 323.9 | ST PIP | 69.34 | 55.95 | 0.81 |
| 553 | 323.9 | ST PIP | 70.56 | 54.72 | 0.78 |
| 771 | 323.9 | ST PIP | 58.01 | 47.53 | 0.82 |
| 771 | 323.9 | ST PIP | 58.01 | 47.53 | 0.82 |
| 969 | 323.9 | ST PIP | 139.41 | 121.03 | 0.87 |
| 977 | 323.9 | ST PIP | 125.87 | 118.88 | 0.94 |
| 039F | 323.9 | ELBOW | 120.02 | 113.50 | 0.95 |
| 039F | 323.9 | ELBOW | 120.02 | 113.50 | 0.95 |
| 039N | 323.9 | ELBOW | 110.10 | 95.57 | 0.87 |
| 039N | 323.9 | ST PIP | 47.90 | 41.58 | 0.87 |
| 046F | 323.9 | ELBOW | 115.20 | 108.16 | 0.94 |
| 046F | 323.9 | ST PIP | 50.12 | 47.06 | 0.94 |
| 046N | 323.9 | ELBOW | 98.36 | 92.76 | 0.94 |
| 046N | 323.9 | ELBOW | 98.36 | 92.76 | 0.94 |
| 054F | 323.9 | ELBOW | 135.04 | 128.14 | 0.95 |
| 054F | 323.9 | ELBOW | 135.04 | 128.14 | 0.95 |

| ESBWR Feedwater Class 1 Lines<br>From Header to RPV nozzles | | | | | |
|---|---|---|---|---|---|
| NO. NODE | SIZE O.D. | COMP TYPE | ISM, SRSS (ISM) Mpa | Time History (TH) Mpa | TH/ISM |
| | | | **(B)** | **(A)** | **(A)/(B)** |
| 054N | 323.9 | ELBOW | 145.35 | 138.71 | 0.95 |
| 064F | 323.9 | ELBOW | 137.97 | 134.59 | 0.98 |
| 064F | 323.9 | ST PIP | 60.02 | 58.55 | 0.98 |
| 064N | 323.9 | ELBOW | 105.21 | 93.75 | 0.89 |
| 064N | 323.9 | ELBOW | 105.21 | 93.75 | 0.89 |
| 072F | 323.9 | ELBOW | 116.58 | 113.21 | 0.97 |
| 072F | 323.9 | ELBOW | 116.58 | 113.21 | 0.97 |
| 072N | 323.9 | ELBOW | 121.64 | 119.68 | 0.98 |
| 072N | 323.9 | ST PIP | 52.55 | 52.06 | 0.99 |
| 082F | 323.9 | ELBOW | 123.78 | 104.79 | 0.85 |
| 082F | 323.9 | ST PIP | 53.84 | 45.59 | 0.85 |
| 082N | 323.9 | ELBOW | 83.60 | 74.21 | 0.89 |
| **Average & Ratio:** | | | 99.85 | 92.08 | 0.92 |

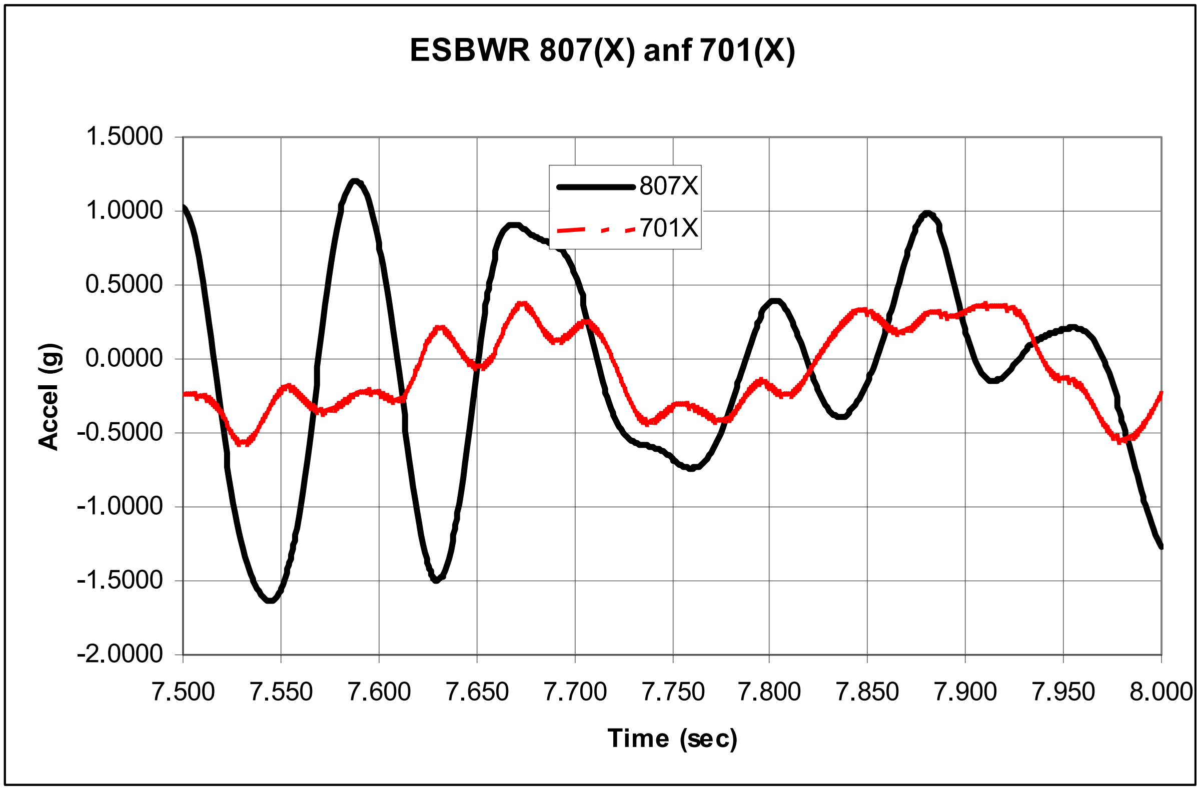


**Figure B-3-5(a) Acceleration Time Histories for Vent Wall 701, and RPV Nozzle in N-S Direction from Time 7.5 sec. to 8.0 sec. (Not Correlated)**

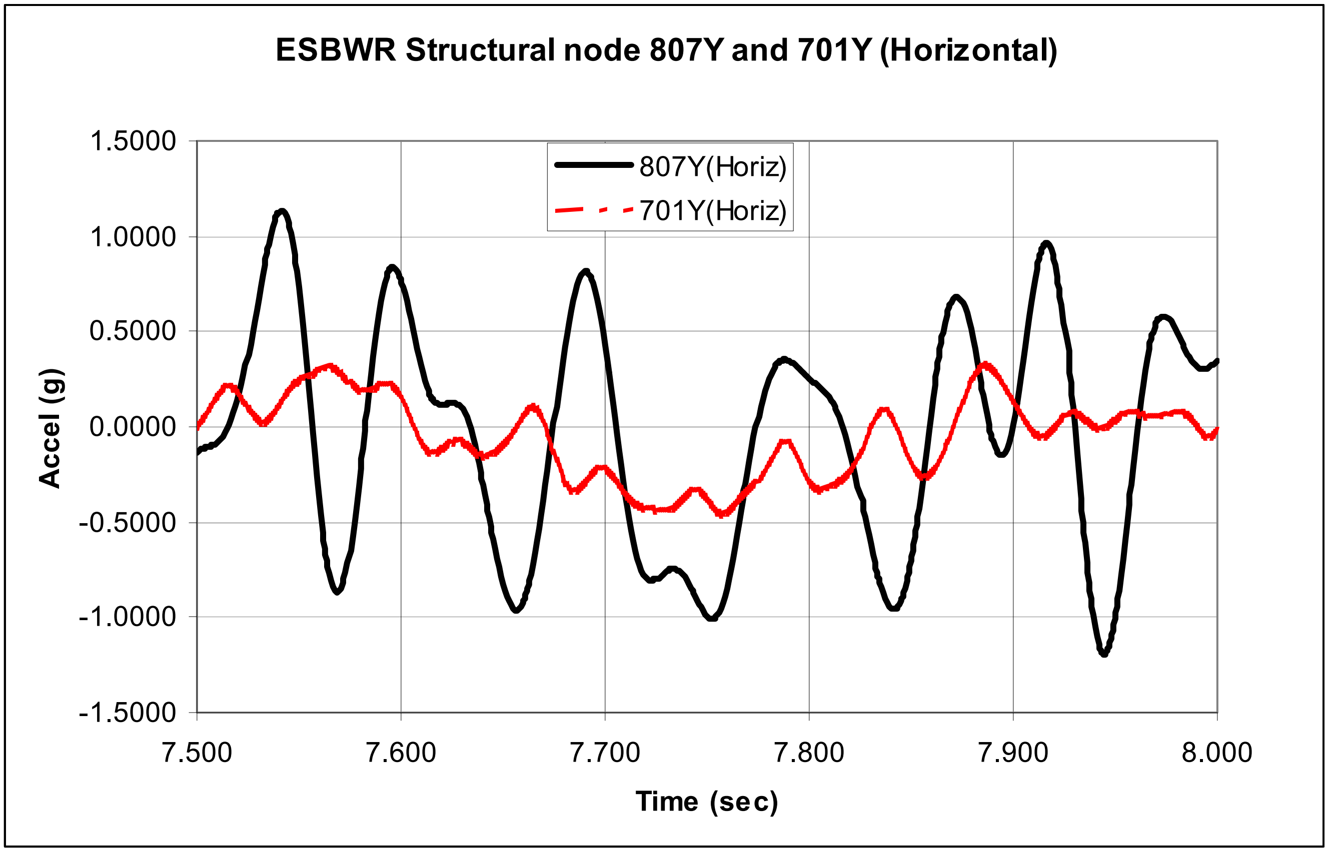


**Figure B-3-5(b) Acceleration Time Histories for Vent Wall 701, and RPV Nozzle in E-W Direction from Time 7.5 sec. to 8.0 sec. (Not Correlated)**

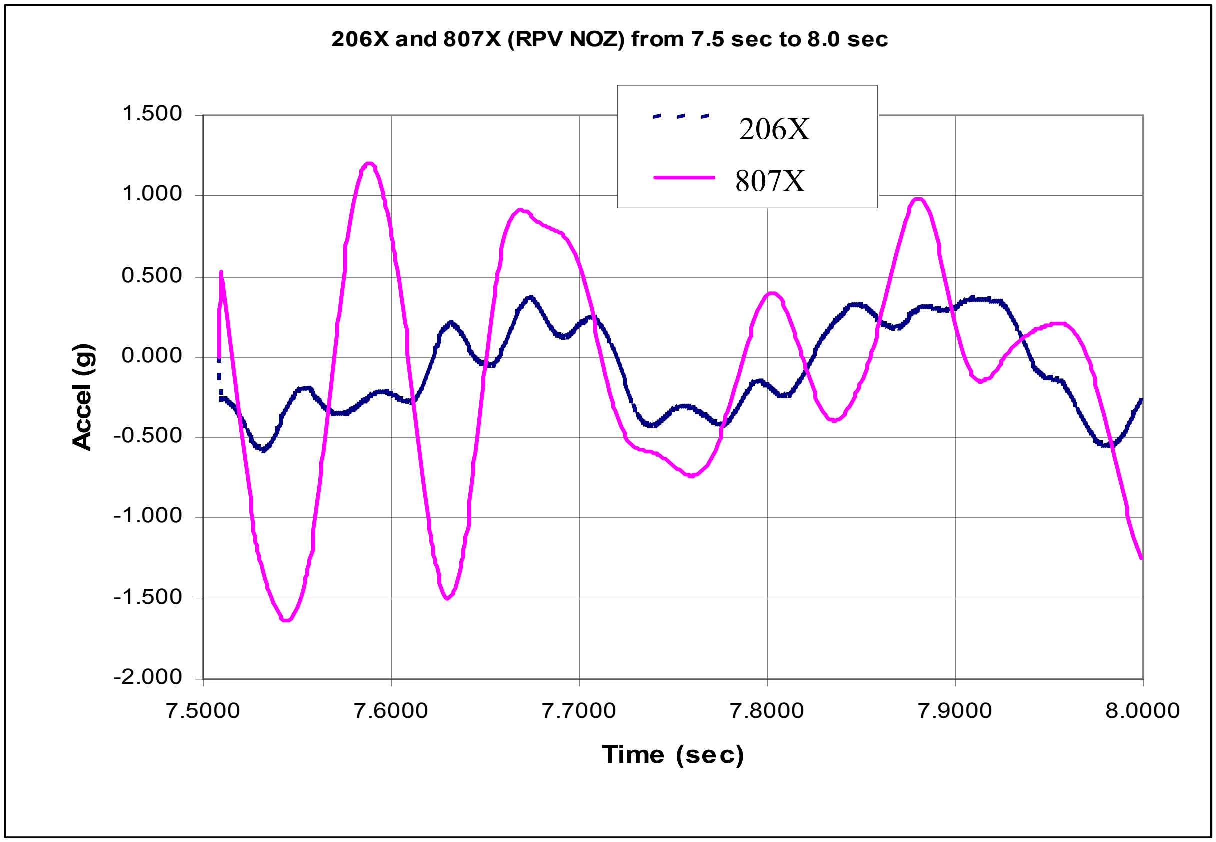


**Figure B-3-2 (a) Acceleration Time Histories for Containment Node 206 and RPV Nozzle in N-S direction, from time 7.5 sec. to 8.0 sec.(Not Correlated)**

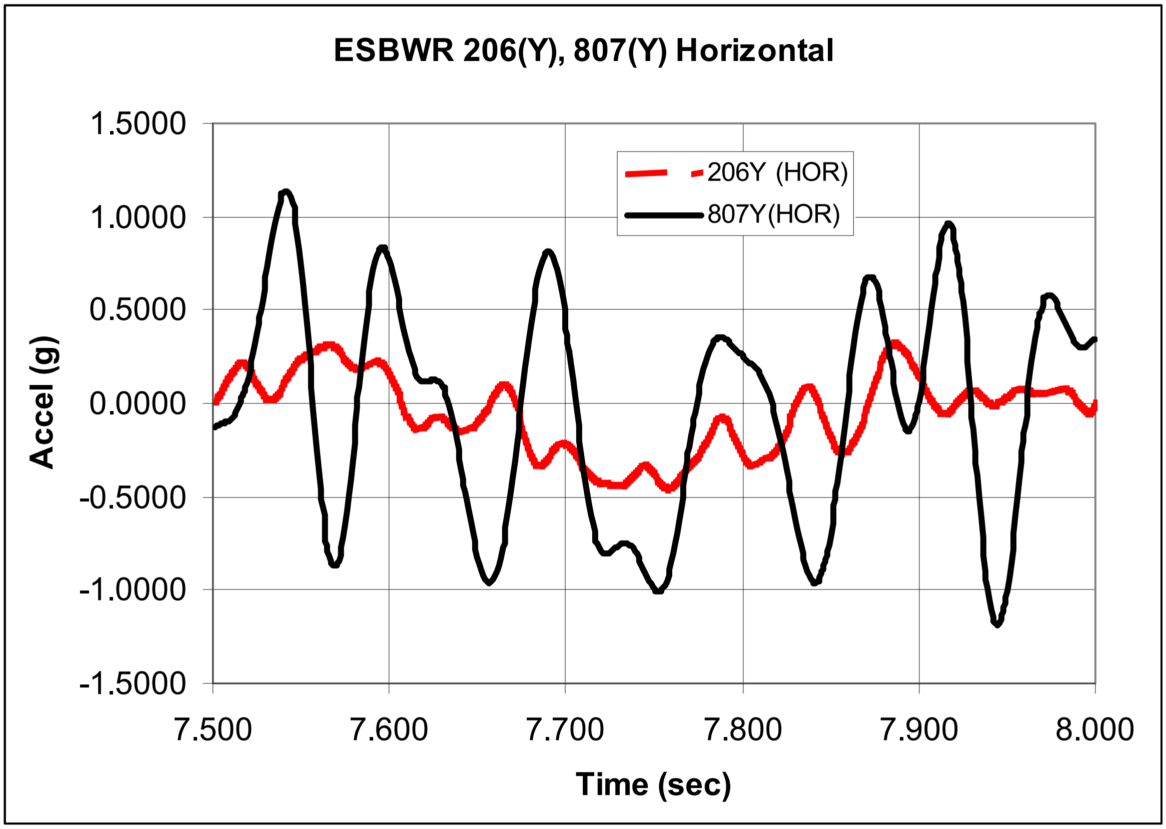


**Figure B-3-2 (b) Acceleration Time Histories for Containment Node 206 and RPV Nozzle in E-W direction, from time 7.5 sec. to 8.0 sec. (Not Correlated)**

# ENCLOSURE 2

# MFN 09-319 Revision 1

# Response to NRC RAI Letter No. 328
# Related to ESBWR Design Certification Application

# DCD Section 3.12 – Piping Design

# DCD Tier 2 Markups

# for RAI Number 3.12-3 S04 Revision 1

- Envelope response spectrum with USM applied at all support points for each orthogonal direction of excitation; or
- ISM response spectrum at each support for each orthogonal direction of excitation.

When the ISM response spectrum method of analysis (Subsection 3.7.2.1.2) is used, a support group is defined by supports that have the same time-history input. This usually means all supports located on the same floor, or portions of a floor, of a structure. For piping inside the RCCV, Tthe responses caused by motions of supports in two or more different groups are combined by the SRSS procedure. For piping outside the RCCV, the SRSS method can be used if it is established that the support motions are reasonably phased uncorrelated; otherwise, the aboslute sum procedure shall be used.

[*To use the SRSS method for independent support response spectrum analysis, it is required to include 10 percent margin in the design requirements for piping stress and piping support loads to address the uncertainties that may exist from the use of the SRSS method rather than the absolute sum method for the group combination method when performing an ISM analysis.*]*

In addition to the inertial response discussed above, the effects of relative support displacements are considered. The maximum relative support displacements are obtained from the dynamic analysis of the building, or as a conservative approximation, by using the floor response spectra. For the latter option, the maximum displacement of each support is predicted by $S_d = S_a g/\omega^2$, where $S_a$ is the spectral acceleration in "g's" at the high-frequency end of the spectrum curve (which, in turn, is equal to the maximum floor acceleration), g is the gravity constant, and ω is the fundamental frequency of the primary support structure in radians per second. The support displacements are imposed on the supported systems in a conservative (i.e., most unfavorable combination) manner and static analysis is performed for each orthogonal direction. The resulting responses are combined with the inertia effects by the SRSS method. Because the OBE design is not required, the displacement-induced SSE stresses due to seismic anchor motion are included in Service Level D load combinations.

In place of the response spectrum analysis, the ISM time history method of analysis is used for multi-supported systems subjected to distinct support motions, in which case both inertial and relative displacement effects are already included.

* Text sections that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior NRC approval is required to change.

### *3.7.3.10 Use of Equivalent Vertical Static Factors*

[*Equivalent vertical static factors are used when the requirements for the static coefficient method in Subsection 3.7.2.1.3 are satisfied.*]*

*Text sections that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior NRC approval is required to change.

### *3.7.3.11 Torsional Effects of Eccentric Masses*

[*Torsional effects of eccentric masses are included for subsystems similar to that for the piping systems discussed in Subsection 3.7.3.3.1.*]*