PMSTPCOL PEmails

From:	Tai, Tom
Sent:	Monday, August 15, 2011 12:34 PM
To:	Huang, Jason
Cc:	STPCOL; Spicher, Terri; Dixon-Herrity, Jennifer
Subject:	FW:
Attachments:	RESPONSE SPECTRA081111.pdf

Jason,

Attached for your information are excerpts from the ABWR DCD and from the HCU ERS with clarification notes from NINA. Obviously this information is informal and should be treated as such. If you need anything official from NINA, please let me know and I'll arrange.

Regards

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From: Scheide, Richard [mailto:rhscheide@STPEGS.COM]
Sent: Monday, August 15, 2011 12:23 PM
To: Tai, Tom
Subject:

Tom,

Attached is some additional information that may help your reviewer.

Dick Scheide
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Hearing Identifier: SouthTexas34Public_EX
Email Number: 3018

Mail Envelope Properties (0A64B42AAA8FD4418CE1EB5240A6FED13E6257DEFD)

Subject: FW:
Sent Date: 8/15/2011 12:33:35 PM
Received Date: 8/15/2011 12:33:37 PM
From: Tai, Tom

Created By: Tom.Tai@nrc.gov

Recipients:
"STPCOL" <STP.COL@nrc.gov>
Tracking Status: None
"Spicher, Terri" <Terri.Spicher@nrc.gov>
Tracking Status: None
"Dixon-Herrity, Jennifer" <Jennifer.Dixon-Herrity@nrc.gov>
Tracking Status: None
"Huang, Jason" <Jason.Huang@nrc.gov>
Tracking Status: None

Post Office: HQCLSTR02.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	664	8/15/2011 12:33:37 PM
RESPONSE SPECTRA081111.pdf	569692	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

$$\beta_i = \frac{1}{\omega_i^2} \sum_{j=1}^{N} \left[C_j \left(\phi_i^T K \phi_i \right)_j \right] \quad (3.7\text{-}14)$$

where

β_i = Modal damping coefficient for ith mode

N = Total number of structural elements

ϕ_i = Component of ith mode eigenvector corresponding to jth element

ϕ_i^T = Transpose of ϕ_i defined above

C_j = Percent critical damping associated with element j

K = Stiffness matrix of element j

ω_i = Circular natural frequency of mode i

3.7.3 Seismic Subsystem Analysis

3.7.3.1 Seismic Analysis Methods

This subsection discusses the methods by which Seismic Category I subsystems and components are qualified to ensure the functional integrity of the specific operating requirements which characterize their Seismic Category I designation.

In general, one of the following five methods of seismically qualifying the equipment is chosen based upon the characteristics and complexities of the subsystem:

(1) Dynamic analysis

(2) Testing procedures

(3) Equivalent static load method of analysis

(4) A combination of (1) and (2)

(5) A combination of (2) and (3)

Equivalent static load method of subsystem analysis is described in Subsection 3.7.3.5.

Appropriate design response spectra are furnished to the manufacturer of the equipment for seismic and hydrodynamic qualification purposes. Additional information such as input time history is also supplied only when necessary.

When analysis is used to qualify Seismic Category I subsystems and components, the analytical techniques must conservatively account for the dynamic nature of the subsystems or components.

[*The dynamic analysis of Seismic Category I subsystems and components is accomplished using the response spectrum or time-history approach. Time-history analysis is performed using either the direct integration method of the modal superposition method. The time-history technique described in Subsection 3.7.2.1.1 generates time histories at various support elevations for use in the analysis of subsystems and equipment. The structural response spectra curves are subsequently generated from the time-history accelerations.*][*]

At each level of the structure where vital components are located, three orthogonal components of floor response spectra (two horizontal and one vertical) are developed. The floor response spectrum is smoothed and envelopes all calculated response spectra from different site soil conditions. The response spectra are peak broadened ±15%.

For vibrating systems and their supports, two general methods are used to obtain the solution of the equations of dynamic equilibrium of a multi-degree-of-freedom model. The first is the method of modal superposition described in Subsection 3.7.2.1.2. The second method of dynamic analysis is the direct integration method. The solution of the equations of motion is obtained by direct step-by-step numerical integration. The numerical integration time step, Δt, must be sufficiently small to accurately define the dynamic excitation and to render stability and convergency of the solution up to the highest frequency of significance. [*The integration time step is considered acceptable when smaller time steps introduce no more than a 10% error in the total dynamic response. For most of the commonly used numerical integration methods (such as Newark β-method and Wilson θ-method), the maximum time step is limited to one-tenth of the smallest period of interest.*][*] The smallest period of interest is generally the reciprocal of the analysis cutoff frequency.

[*When the time-history method of analysis is used, the time-history data is broadened plus and minus 15% of Δt in order to account for modeling uncertainties.*][*] For loads such as safety-relief valve blowdown, tests have been performed which confirm the conservatism of the analytical results. Therefore, for these loads the calculated force time-histories are not broadened plus and minus 15% of Δt.

Piping modeling and dynamic analysis are described in Subsection 3.7.3.3.1.

When testing is used to qualify Seismic Category I subsystems and components, all the loads normally acting on the equipment are simulated during the test. The actual mounting of the equipment is also simulated or duplicated. Tests are performed by

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[*] See Subsection 3.9.1.7. The change restriction applies only to piping design.

Jason - These are the spectra from Ref. 3-1-3g (see Note 4 below) that apply to the HCU

(HCU Des. Spec. ERS)

Attachment 1

Dynamic Response Spectra and Load Combinations for Hydraulic Control Unit

1. Location

Reactor Building Floor, STP Elevation -32'-3 1/2" (TMSL -8.2m)
The HCUs are fixed to the Building floor and walls.

2. Response Spectra

For load combinations

Load Case		Node No. (Note.4)	Horizontal (Note 2)		Vertical (Note 3)	
			Spectra No (Note 4).	Acceleration to be used at Cut Off Frequency and above (G) (Note 4)	Spectra No.	Acceleration to be used at Cut Off Frequency and above (G) (Note 4)
Seismic	SSE	88	A1.58	0.31	A2.58	0.37
		94	A1.48		A2.48	
		105	A1.57		A2.57	
Hydro-dynamic	AP	111	B1.56	-	-	-
		110	B1.55	-	-	-
		102	B1.47	-	-	-
	SRV LOCA	126	B2.33	-	B5.21	-
		177	B2.47	-	B5.35	-
		125	B2.32	-	B5.20	-
		137	B2.36	-	B5.24	-
	SRV$_N$OC	126	B3.33	-	B6.21	-
		177	B3.47	-	B6.35	-
		125	B3.32	-	B6.20	-
		137	B3.36	-	B6.24	-
	CHUG	126	B4.33	-	B7.21	-
		177	B4.47	-	B7.35	-
		125	B4.32	-	B7.20	-
		137	B4.36	-	B7.24	-
	CO	126	-	-	B8.21	-
		177	-	-	B8.35	-
		125	-	-	B8.20	-
		137	-	-	B8.24	-

Notes:

1. Use the spectra at 3% damping.
2. For each load case, horizontal response spectra provided in the attachment are to be enveloped (the three nodes) prior to performing any load combinations. The resulting enveloped response spectra shall be used in the spectra combinations listed on page 2 of this Attachment.
3. For each load case, vertical response spectra provided in the attachment are to be enveloped (the three nodes) prior to performing any load combinations. The resulting enveloped response spectra shall be used in the spectra combinations listed on page 2 of this Attachment.

4. Node No. and Spectra No. are the same numbers used in reference document in Paragraph 3.1.3 g. The spectrum in the reference documents shall be used for the HCU analysis. Per Section 3.7 of ABWR Design Control Document (DCD), the cut-off frequency for dynamic analysis is 33 Hz for seismic loads. The acceleration value at the cut-off frequency is considered to be applicable at all frequencies greater than the cut-off frequency.

3. Load Combination

The Load combination criteria are based on ABWR DCD Tire 2, Table 3.9-2. Load shall be combined using the absolute sum method.

Plant Event	ASME Service Level	Load combination
Normal Operation (NO)	A	WT
Plant/System Operating Transients (SOT)	B	$WT + SRV_{NOC}$
SBL	C	$WT+ (SRV_{LOCA}{}^{2}+ CHUG^{2})^{1/2}$
SBL or IBL − SSE	D	$WT + (SRV_{LOCA}{}^{2} + SSE^{2} + CHUG^{2})^{1/2}$
		$WT + (SRV_{LOCA}{}^{2}+ SSE^{2} + CO^{2})^{1/2}$
LBL + SSE	D	$WT - (SSE^{2} + AP^{2})^{1/2}$

Normal (N)	Normal and/or abnormal loads associated with the system operating conditions, including thermal loads, depending on acceptance criteria.
SOT	System Operational Transient
SSE	RBV loads induced by safe shutdown earthquake.
SBL	Loads induced by small break LOCA.
IBL	Loads induced by intermediate break LOCA.
LBL	Loads induced by large break LOCA.
WT	Dead Weight
SRV	RBV loads induced by Safety/relief valve discharge of one or more vibration
SRV_{NOC}	SRV during normal condition
SRV_{LOCA}	SRV during LOCA condition
CHUG	Envelope of all symmetrical and asymmetrical chugging loads
CO	Envelope of all symmetrical condensation oscillation loads
AP	Envelope of all asymmetrical annulus pressurization loads

4. Nozzle Load and Moments to Scram Valve (126 per Figure 1)

HCU shall be maintained in any service conditions with following Nozzle Loads and Moments to the Scram Valves.

Fx = 8660N(1950lbf), Fy = 3510N(789lbf), Fz = 1500N(337lbf),
Mx = 422Nm(3740inch·lbf), My = 246Nm(2180 inch·lbf), Mz = 568Nm(5030 inch·lbf)