HLWYM HEmails

From: Luis Ibarra
Sent: Thursday, December 08, 2005 5:42 PM
To: Mahendra Shah; John Stamatkos
Cc: Asadul Chowdhury; Biswajit Dasgupta; Michael Waters; Marissa Bailey; Mysore Nataraja; Yong Kim
Subject: RE: Response to DOE letter - Attachment
Attachments: Luis Preclosure Seismic Design Dec08.wpd

Follow Up Flag: Follow up
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Raj,

Although you did not ask me this morning to write comments independently, I may like to address some issues. Then, please see the attached file.

Luis

Hearing Identifier: HLW_YuccaMountain_Hold_EX
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Subject: RE: Response to DOE letter - Attachment
Sent Date: 12/8/2005 5:42:17 PM
Received Date: 12/8/2005 5:42:00 PM
From: Luis Ibarra

Created By: libarra@cnwra.swri.edu

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Files	**Size**	**Date & Time**
MESSAGE	167	12/8/2005 5:42:00 PM
Luis Preclosure Seismic Design Dec08.wpd	263748	

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I did not perceive a common understanding about the NRC/CNWRA position in the meeting of this morning. Then, I have the following comments that not necessarily represent the opinion of the CNWRA:

1. The outcome of this Seismic Meeting (Nov 30 - Dec 01) was that NRC can accept the overall DOE seismic methodology, and that NRC does not need to ask for a consequence analysis or PRA. However, there is no a win-win scenario for reconciling DOE approach and Part 63. The following are some options that NRC may accept:

A. Acceptance based solely on the SMA method as proposed by the DOE (option accepted by concensus):

PROS: - straightforward solution
- reasonable solution based on precedents (63.102f is satisfied)
- NRC is being consistent in the extent and complexity of the analyses required for YM surface facilities and for nuclear facilities with similar risk

CONS: - SMA cannot be used to compute probability of failure. Then, SMA will never be able to completely fulfill 63.111
- NRC may need to take some proactive action to detail what was the intend of the regulation (63.111)
- The CDFM approach used to compute HCLPF becomes more relevant because performance is exclusively based on this "simplified" methodology

B. Requesting a PRA in addition to the SMA

PROS: - PRA is the most complete solution and fulfills entirely Part 63, particularly the performance-based risk-informed philosophy

CONS: - PRA involves several additional analysis currently not included in DOE proposal, such as (a) extending the hazard curve up to 10-6, (b) performing nonlinear structural analysis for earthquake levels associated to very low MAPEs, and (c) carrying out the convolution (numerical integration)
- NRC would be requesting much more analyses than those demanded for nuclear facilities with similar risk to YM facilities

C. Requesting a Consequence Analyses in addition to the SMA

PROS: - Consequence analysis is an alternative to fulfill part 63

CONS: - If the DOE selects to evaluate the consequences only in the event of complete collapse of the facilities, DOE would not estimate a probability of failure. Instead, DOE would consider the worst case scenario independently of the

performance of the building, which undermines the performance evaluation.
- The uncertainty in the release dose when the building collapses is going to be very large
- NRC would be requesting much more analyses than those demanded for nuclear facilities with similar risk to YM facilities

I personally consider that accepting the SMA as presented by DOE and without asking for anything else is acceptable if DOE can show that the risk is comparable to facilities currently designed for an earthquake level associated to the 2000 year return period. However, as the regulatory part, NRC is free to request any of these three options to DOE. All of them can be justified using Part 63, and even the more flexible option (only SMA) can be defended based on precedents. NRC staff has to keep in mind that all the above options have shortcomings that need to be addressed.

2. Comments on Mike's table

a) Mike's write up states that "it is unreasonable to examine seismic events with a lower than 10-4 exceedance probability (i.e., 10-5, 10-6, etc...), because such low-probability, higher magnitude events represent accidents and event sequences that are often beyond the design-basis of other licensed nuclear power reactors and ISFSIs..." I think that the unreasonableness has to be linked to the inherent risk of the facility (in this case the low risk of YM facilities). Although is unlikely to have a 10-5 seismic event, new NPPs probably will have to show performance at these levels because the occurrence of such events is not unreasonable, and the potential consequences of NPP failures are significant.

b) About Mike's:

Hypothetical Example Table 1

Probability of exceedance (yr^{-1})	Hypothetical SSC Failure Probability (per event)	Hypothetical Release Probability (yr^{-1})	Chance of Release During 100-yr Period
$1x10^{-3}$	$4x10^{-4}$	$4x10^{-7}$	1/25,000
$5x10^{-4}$	$1x10^{-3}$	$5x10^{-7}$	1/20,000
$1x10^{-4}$	$8x10^{-3}$	$8x10^{-7}$	1/12,500
$5x10^{-5}$	$2.5x10^{-2}$	$1.25x10^{-6}$	**1/8,000**

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$1x10^{-5}$	$4x10^{-1}$	$4x10^{-4}$	**1/2,500**
$5x10^{-6}$	1.0	$5x10^{-4}$	**1/2,000**
$1x10^{-6}$	1.0	$1x10^{-4}$	**1/10,000**
$5x10^{-7}$	1.0	$5x10^{-5}$	1/20,000
$1x10^{-7}$	1.0	$1x10^{-5}$	1/100,000

a) The table considers probability of exceedance as probability of occurrence, and uses this information to compute a hypothetical release probability. This release probability cannot be computed with a single-point initiating event. See Appendix.

b) Even though the table indicates that the failure probabilities are hypothetical, I would not throw numbers like the ones presented in the table, and say that the failure probability is 1.0 below 5x10-6. This leads to the perception that failure is unavoidable for strong seismic events and this is not necessarily true. The system has large overstrength and we do not know the hazard curve below 1x10-4 (which may get saturated and present a sudden drop). In this case, the contribution to failure after 1x10-4 would be very small.

Also, in a performance-based approach, different earthquake levels have to be associated to different failure modes. That is to say, the building performance would be poor if large cracks appeared after a common seismic event, such as 1x10-3. However, large cracks may be acceptable under seismic events with low MAPE, such as 1x10-6.

c) There are arithmetic errors in some of the hypothetical release probabilities.

3. Mahendra's Comments

Mahendra has indicated that we may ask for "simplified" PRAs in addition to the SMA methodo. These PRAs may be useful to have a better idea of the order of magnitude of the potential risk. However, they may lead to some problems:

a) NRC may have to demand a full PRA if the probability of failure based on a simplified PRA that uses "conservative" assumptions is larger than 1x10-6. On the other hand, if the probability of failure is less than 1x10-6, it may be easy to contest that the utilized assumptions were not "so conservative" after all.
b) Using the HCLPF capacity (from the CDFM) to generate the fragility curve is theoretically correct. However, the use of the tail (1% probability of failure) may not be adequate because

this is the most sensitive part of the fragility curve. Also, CDFM does not compute the composite variability and a β value has to be assumed, which has to be clearly conservative (definitely larger than $\beta = 0.6$)

Furthermore, the HCLPF capacity at 1x10-4 considers a failure mode that may be excessively conservative for lower MAPEs.

Also, instead of generating fragility curves based on the simplified CDFM method, NRC should demand to DOE the use the fragility analysis to compute HCLPF capacity. It would be a much cleaner approach.

c) Extending the hazard curve by extrapolating a straight line in a log-log space is a reasonable procedure. Nevertheless, there is no way of predicting how conservative the curve is. It is expected to be conservative because nonlinear behavior of the soil is likely to cause a drop on the curve, but not even this expected conservatism is assured.

In short, if NRC considers that risk has to be accounted for, it may be better to directly ask for a complete PRA. There will be a lot of questions on this simplified approach. Unless DOE uses very conservative assumptions (that no one may contest) and still obtains probabilities of failure substantially lower than 1x10-6.

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APPENDIX

1. Hazard curves show the probability of exceeding different ground motion values at a site. For the example hazard curve of the below figure, a mean annual probability of exceedance (MAPE), $\upsilon = 1x10^{-4}$, indicates that there is a chance of 1/10,000 of exceeding a peak ground acceleration PGA = 1.0 g in a given year. Then, $\upsilon = 1x10^{-4}$ is only a point in the hazard curve that cannot be associated with the probability of experiencing a seismic event. In fact, the probability of having exactly PGA = 1.0 g at any given year is zero. What can be said is that the probability of experiencing a PGA between 1.0 and 1.5 g's is $3x10^{-4}$.

Note that the terminology is presented in terms of the probability of exceedance, which can be misinterpreted to imply that the design or performance ground motions are unbounded. This leads to a contradiction because if $\upsilon = 1x10^{-4}$ is the probability of exceeding say 1.0g, then, why we design only for 1g? This misunderstanding vanishes if we define the earthquake levels in terms of the probability of non-exceedance. For instance, $\upsilon = 1x10^{-4}$ is equivalent to a non-exceedance probability of 0.9999. That is to say, the probability of not exceeding PGA of 1.0 g is 0.9999.

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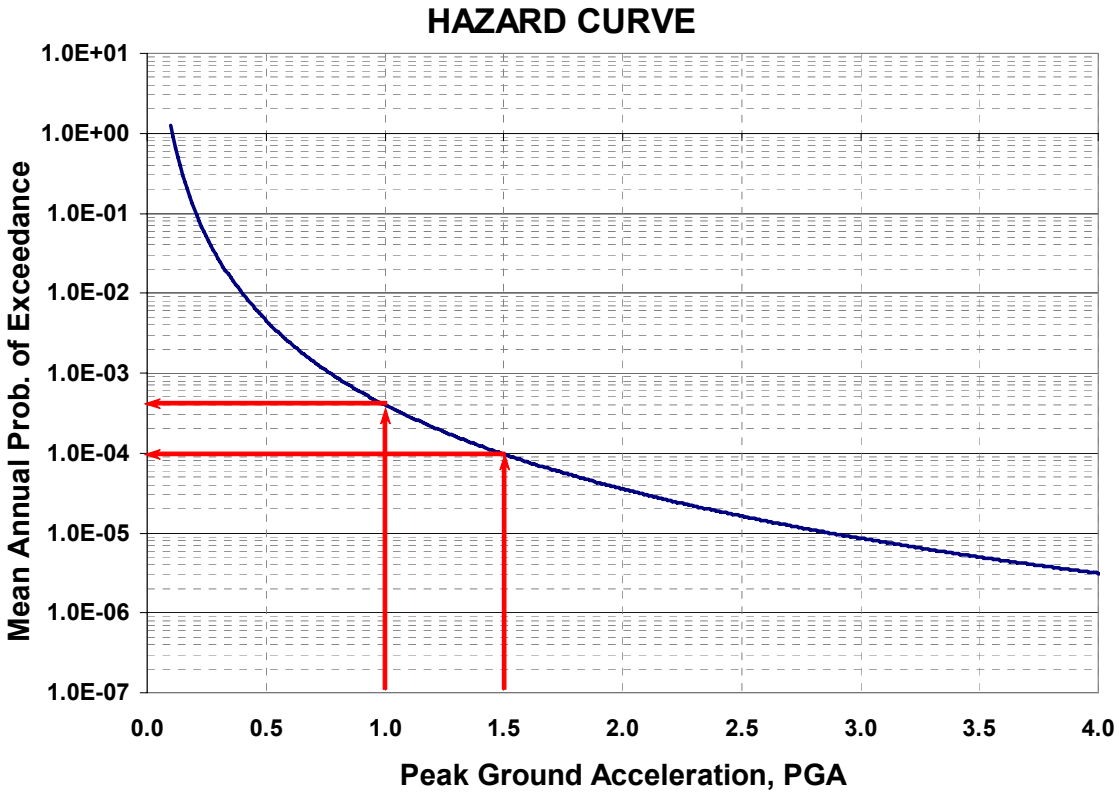
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