From: <ken.nicely@exeloncorp.com>
To: <mxb@nrc.gov>
Date: 11/22/04 8:17AM
Subject: FW: RAI- Exelon's May 12, 2004 Submittal - Commitments and PlansRealted to EPU

Maitri,

Here's the e-mail you asked for.

Ken

-----Original Message-----
From: Maitri Banerjee [mailto:MXB@nrc.gov]
Sent: Friday, August 06, 2004 1:01 PM
To: ken.nicely@exeloncorp.com
Cc: Anthony Mendiola; David Terao; Thomas Scarbrough
Subject: RAI- Exelon's May 12, 2004 Submittal - Commitments and Plans
Realted to EPU

A review of the subject document by the NRC staff resulted in some comments and questions. These comments and questions are attached. Please let me know if you would need a phone call to have NRC staff clarify any item or answer any questions that your staff may have.

Please let me know if you think the responses to these questions can be discussed during the meeting currently being scheduled for the week of September 20 or on December 15, 2004.

Maitri Banerjee, PE
Dresden PM, NRC

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Subject:	FW: RAI- Exelon's May 12, 2004 Submittal - Commitments and PlansRealted to EPU
Creation Date:	11/22/04 8:14AM
From:	<ken.nicely@exeloncorp.com>
Created By:	ken.nicely@exeloncorp.com

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MESSAGE	1711	11/22/04 08:14AM
Dresden EPU 5-12-04 Letter.wpd		20007
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COMMENTS ON EXELON JUSTIFICATION SUBMITTED MAY 12, 2004,
FOR CONTINUED EPU OPERATION OF DRESDEN UNITS 2 AND 3

1. In its May 12 submittal, Exelon references its summary of the basis for continued extended power uprate (EPU) operation at the Dresden units provided in an attachment to the licensee's submittal dated April 2, 2004. Comments on the April 2 summary of the basis for continued Dresden EPU operation include:

   (a) Exelon does not provide a quantitative discussion of the structural integrity of the Dresden steam dryers in terms of the forcing function causing the loading on specific locations of the steam dryer or the material strength to avoid steam dryer failure.

   (b) Exelon does not address continued functionality of reactor pressure vessel internals (other than the steam dryers), or the steam and feedwater systems or their components for operation at EPU conditions.

   (c) In discussing the gusset plate installation in Dresden Unit 2, Exelon calculated that the stress level was reduced by the October 2003 repair, but does not address the potential loading that might be sufficient to cause failure.

   (d) Exelon states that action will be taken if an unexplained increase in moisture carryover at or above 0.10% occurs in the Dresden units, but does not address proactive measures, such as application of lessons learned from the Quad Cities units.

   (e) Exelon states that minor and inconsequential cracking might occur in the Dresden steam dryers at the gusset repair locations, but that such cracking would not be a structural concern. However, the licensee does not discuss whether such cracking could generate loose or lost parts in the reactor coolant or steam systems.

2. In Attachment 1 to the May 12 submittal, Exelon provides reports by its contractor Continuum Dynamics, Inc. (CDI) describing the evaluation of the hydrodynamic loading on the Dresden Units 2 and 3 steam dryers. Comments on the CDI study include

   (a) The relationship of the Dresden Unit 2 and 3 reports with a cover date of May 2004 should be compared to the studies referenced in the April 2 submittal by the licensee.

   (b) The reports do not indicate whether the applied methodology would have correctly predicted the damage identified in the Dresden Unit 2 steam dryer in October 2003, or in the Dresden Unit 3 steam dryer in December 2003.

   (c) The reports focus on the occurrence of low frequency loading on the steam dryers (the report states that frequencies are being limited to below 50 Hz). The reasoning for this is vague, and does not explain how this cutoff relates to the ability of the acoustic waves to propagate. The reports do not discuss the basis for eliminating potential damage that might occur as a result of higher frequency loading. For example, the reports provide Power Spectrum Density (PSD) plots of in-plant measured oscillating pressure data and the pressure circuit analysis results for a low frequency range from 0 to 50 Hz only. The licensee should provide the PSD plots at least from 0 to 230 Hz because most of the main steam accelerometer data showed the structural response at Quad Cities Unit 2 at about 160 Hz.

(d) The reports describe an acoustic circuit model for determining the hydrodynamic loading on the Dresden Unit 2 and 3 steam dryers. The model in these reports should be compared to the acoustic modeling performed in GENE-000-0018-3359-P (August 2003) and used to support the determination of the root cause and extent of condition for the steam dryer failure at Quad Cities Unit 2 in June 2003. The capability of the acoustic circuit model described in the May 12 submittal to overcome the weaknesses in the evaluations intended to avoid steam dryer cracking at Quad Cities Unit 1 in November 2003 and Quad Cities Unit 2 in March 2004 should be discussed. In particular, Exelon should provide a quantitative assessment of steam dryer structural integrity regarding the resulting stress in conjunction with the application of the actual measured forcing function. The structural integrity of the steam dryers at Dresden Units 2 and 3 was based on the structural analysis for Quad Cities Unit 2 where the flat pressure spectra was applied statically on the dryers. The use of flat spectra assumes the pressure in the inlet nozzle plenum to be random while acoustic loading may be sinusoidal and low in damping.

(e) The Dresden Unit 2 report indicates that data were collected at only one power level (11.60E6 lbm/hr steam flow). The Dresden Unit 3 report indicates that data were collected at several power levels (9.86E6 to 11.63E6 lbm/hr steam flow). The evaluation of the sensitivity of the acoustic circuit model in calculating hydrodynamic loads at various power levels, including 11.95E6 lbm/hr steam flow, should be discussed. In addition, Exelon should extend the data measurement to the approved EPU level of 11.95E6 lbm/hr, where feasible.

(f) The reports state that the steam line venturi data were used to drive the model to predict the average root mean square (rms) pressure measured at the turbine instrumentation. The validation of the acoustic circuit model to accurately predict hydrodynamic loading at specific locations of the steam dryer should be discussed. In the pressure circuit analysis, the measured venturi data were input into the model, and the frictional damping coefficient was adjusted in the main steam lines until the average rms pressure was predicted at the turbine, consistent with the measured data at the turbine instrument lines. However, the friction coefficient is a function of the Reynold number, pipe inner surface roughness, diffusion, restriction, etc., and may vary in different portions of the steam line. Exelon should benchmark the resulting data at the steam dryer using the measured data at the venturi and the turbine. Exelon should confirm whether any codes used in the pressure circuit analysis were reviewed and approved by the staff in accordance with the requirements of 10 CFR Part 50, Appendix B. Further, Exelon should explain the determination that, at 11.60E6 lbm/hr flow rate, the peak differential pressure at the steam dryer is about 1.3 (or 1.4) psi while the peak oscillating pressure is about 8.0 psi at the venturi and 6 psi at the turbine.

(g) The reports indicate that narrow spikes observed at 20 and 40 Hz in the turbine instrumentation data were eliminated from further analysis based on the determination that these spikes were the result of the electromagnetic field of the turbine generator. The basis for this determination should be discussed.

(h) The reports indicate that the maximum predicted pressure load occurs at the 270° position across the steam dryer cover plate (Figure 7 in the Dresden Unit 2 report and Figure 20 in the Dresden Unit 3 report) when compared to low PSD values predicted by the acoustic circuit model (Figure 6 in the Dresden Unit 2 report and Figure 19 in the Dresden Unit 3 report) in the steam dome of the reactor vessel. The reports state that this indication of steam excitation above and below the steam dryer would be difficult to anticipate by steam dryer inspection and steam dome geometry. The reports also provide PSD traces for other steam dryer locations with extremely low PSD values for some locations. These results should be discussed in comparison to the steam dryer cracking identified at Dresden Unit 2 in October 2003 and at Dresden Unit 3 in December 2003, and at other high stress locations identified in square hood steam dryers.

(i) The reports conclude that the steam dryer loads are largest for components located near the main steam nozzles and decrease for components near the center of the reactor vessel. The applicability of this general conclusion in predicting the potential for steam dryer failure at specific dryer locations should be discussed.

(j) The Dresden Unit 2 (Unit 3) report concludes that the highest peak differential pressure found on any dryer component (270° cover plate) at 11.60E6 (11.63E6) lbm/hr steam flow was 1.3 (1.4) psid instantaneously, and 0.40 (0.38) psid rms. This conclusion should be discussed in relation to whether these pressures are consistent with the steam dryer damage that occurred at Dresden Units 2 and 3 during EPU operation. In addition, it appears that the peak differential pressures for Dresden Units 2 and 3 are higher than the differential pressure of 1.0 psid used for the Quad Cities Unit 2 root cause analysis.

3. <u>Additional Comments on Attachment 1:</u>

(a) The equations developed on pages 2 through 4 seem to be designed for the analysis of piping sections. Is there a precedent for applying these equations to large open cavities like the steam dome?

(b) On the diagram of the model shown on page 5 (Figure 1), there do not appear to be any sections corresponding to the safety relief valve piping. Are the safety relief valves considered in the model? If not, is there justification for neglecting them, in light of the fact that they were originally hypothesized to be a source for acoustic waves?

(c) On page 8, it is stated that the loads may not be bounding for the flow rate of consideration here. Are there any thoughts on how accurately the data can be scaled to higher flow rates?

(d) On page 9, the derivation of the damping coefficients is described. To summarize, there are two sets of data (1 from the turbine instruments and 1 from the venturi instruments) which are used. One set is used to 'drive' the model, and damping coefficients are adjusted until the resulting model matches with the second set of data. Is this summary correct? If so, none of the data is being used to verify the accuracy of the final model. Would it be possible to predict damping coefficients via another method, and use the second set of data to justify the accuracy of the model?

4. <u>Additional Comments on C.D.I. Report No. 04-02, Revision 3 dated May 2004:</u>

(a) On page 8, it is indicated that the pressure oscillations in main steam lines C and D are higher than those in the other 2 lines. Is this difference solely due to the HPCI branch line (C) and the RCIC branch line (D)?

(b) It is stated that data was removed between 19-21 hertz and 39-41 hertz, due to the belief that spikes in the data were being artificially induced by the strong electromagnetic field of the turbine. Were these spikes stationary at 20 and 40 hertz as flow rate was increased? Or were there other indications that the spikes were artificial, other than the fact that they occurred at 20 and 40 hertz?

(c) On page 11, Table 3 indicates that two measurements were taken at $9.86 \cdot 10^6$ lbm/hr. The "Turbine Inlet Measured rms (psid)" for these two measurements varies by 8%. Is this variation due to measurement uncertainty, changes in the system from one test to another, not enough temporal data, etc.?

(d) On page 17, the pressure vs. time data for Figure 4-a demonstrates that there is a frequency mode on the order of 15 seconds. This low frequency mode is not captured because there is only 20 seconds of data. What is the justification for neglecting very low frequency modes?

(e) On page 59, is there a known reason for the large discrepancy between rms pressure for lines C and D at $9.86 \cdot 10^6$ lbm/hr?

(f) For many of the figures (ex. Figure 24 on page 65), there are PSD peaks up to 50 hertz. In light of this, is not reasonable to assume that much of the oscillatory power characterization is being lost due to the fact that the temporal resolution does not resolve frequencies above 50 hertz?