REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**151-8078**
SRP Section:	**3.9.2 – Dynamic Testing and Analysis of Systems Structures and Components**
Application Section:	**SRP 3.9.2**
Date of RAI Issue:	**08/10/2015**

Question No. 03.09.02-10

DCD Tier 2, Section 3.9.2.3.1.1 states that the random hydraulic forcing function is developed by experimental methods and the forcing function is modified to reflect the flow rate and density differences based on an analytical expression found in Reference 45. However, the staff did not find an expression that is physically suitable to modify the random turbulent flow loadings represented by power spectrum density. In accordance with GDC 1 and 10 CFR 52.47, the applicant was requested to provide a description of the experimental methods and the analytical expression that modified the random forcing functions.

Response – (Rev. 1)

The wording used in the DCD Tier 2, Section 3.9.2.3.1.2 was intended to indicate that the random hydraulic forcing function is developed based on the System 80 Comprehensive Vibration Analysis Program (CVAP) test data. A DCD markup is attached to include a more accurate description. Reference 45 used in DCD Tier 2, Section 3.9.2.3.1.2 provides the following expression for the normalized power spectral density (PSD):

$$G_F = \left\{C_R D \left(\frac{1}{2}\rho V_P^2\right)\right\}^2 = D^2 G_P$$

where, G_F: Random force PSD,
C_R: Coefficient,
D: Characteristic length dependent on flow area configuration,
ρ: Density,
V_P: Flow velocity,
G_P: Random pressure PSD.

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Impact on DCD

The DCD Tier 2, Section 3.9.2.3.1.2 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Report.

3.9.2.3.1 Hydraulic Forcing Function

3.9.2.3.1.1 Deterministic Forcing Function

An analysis based on a hydrodynamic model is used to obtain the relationship between RCP pulsations in the inlet ducts and the deterministic pressure fluctuations on the core support barrel. A detailed description of this model and subsequent solution are given in References 41 and 42. The model represents the annulus of coolant between the core support barrel and the reactor vessel. In deriving the governing hydrodynamic differential equation for the model, the fluid is taken to be compressible and inviscid. Linearized versions of the equations of motion and continuity are used. The excitation on the hydraulic model is harmonic with the frequencies of excitation corresponding to pump rotational speeds and blade passing frequencies.

The dynamic force on the upper guide structure assembly is due to flow-induced forces on the tube bank. The deterministic components of these forces are caused by pressure pulsations at harmonics of the pump rotor and blade passing frequencies, and vortex shedding due to crossflow over the tubes.

The in-core instrumentation (ICI) nozzles and the skewed beam supports for the ICI support plate of the lower support structure are excited by deterministic and/or random, flow-induced forces. The deterministic component of this loading is due to pump-related pressure fluctuations and vortex shedding due to crossflow.

Data from the System 80 preoperational test (References 43 and 44) is used to determine the magnitude of these pulsations at the pump rotor and blade passing frequencies and their harmonics.

based on the System 80 preoperational test (Reference 44)

3.9.2.3.1.2 Random Forcing Function

The random hydraulic forcing function is developed ~~by experimental methods~~. The forcing function is represented in the form of power spectral density together with associated coherence area. The forcing function is modified to reflect the flow rate and density differences based on an analytical expression found in Reference 45.