

## **NRC Feedback for Section 3.9.2.2.14**

### **1.0 NRC Feedback**

In review of the applicant response and the attached example calculation in ERR, the staff found that the method used in Seismic Analysis of Mechanical Tanks was based on the reference technical report "Vibration Studies and Tests of Liquid Storage Tanks, Earthquake Engineering and Structural Dynamics," 1983 by M. A. Haroun. Therefore, the reference technical report may be included in Section 3.9.10 References (say Reference 66) and can be referred for the basis for the methodology in DCD Section 3.9.2.2.14.

Additional information of the analysis is necessary added to DCD Section 3.9.2.2.14 to describe the modelling of the liquid, the fluid-structural-interaction, sloshing effects and the supports that affect the natural frequency and stresses.

The applicant's arguments for using 33 Hz as cut off frequency for rigid / flexible determination is not acceptable. Why it's 33 Hz why not 25 Hz or other frequency? The frequency after the beginning of ZPA is considered the rigid range. For APR1400, the frequency of 50 Hz is considered the ZPA and can be used to determine the structure being rigid or flexible. The use of 33 Hz is to be non-conservative and requires justification.

### **KHNP Response**

The DCD will be revised to include Technical Report (M.A Haroun) as a reference. The equipment whose lowest natural frequency is greater than the frequency value at the start of the zero period acceleration (ZPA) or the cut off frequency of the applicable response spectrum. APR 1400 will apply 50Hz instead of 33Hz for cutoff frequency.

### **2.0 NRC Feedback**

The applicant's arguments for using 33 Hz as cut off frequency for rigid / flexible determination is not acceptable. Why it's 33 Hz why not 25 Hz or other frequency? The frequency after the beginning of ZPA is considered the rigid range. For APR1400, the frequency of 50 Hz is considered the ZPA and can be used to determine the structure being rigid or flexible. The use of 33 Hz is to be non-conservative and requires justification.

### **KHNP Response**

For the purpose of qualification of equipment, the rigid range is defined as having a natural frequency greater than 50 Hz. If the equipment is not sensitive to response levels caused by high frequency ground motions, rigid is defined as equipment with a natural frequency greater than 33 Hz.

In case of the line-mounted equipment such as valves, the most critical seismic loading condition for line-mounted components will occur as a result of the response of the line(piping) in which the component is located. This most critical condition provides as input motion to the component that is predominantly single frequency, that is, the natural frequency of the line in the vicinity of the component.

In general piping design, most of the natural frequencies of the line obtained by treating the supported valves and operator assemblies as rigid, are lower than 22.5 Hz. Thus, the valves are not sensitive to response levels caused by high frequency ground motions - rigid is defined as valves with a natural frequency greater than 33 Hz. In addition, Section 3.7.3.8 and Appendix D of AP1000 DCD indicate that the cutoff frequency for piping and valve rigidity assessment were based on 33 Hz frequency.

In conclusion, for the purpose of qualification of equipment, the rigid range is defined as having a natural frequency greater than 50 Hz. The cutoff frequency of the line-mounted equipment such as valves will be 33 Hz as rigid based on structure's filtering effect and an expectation that it will not be sensitive to response levels caused by high frequency ground motions.