Enclosure 2

MFN 12-055, Revision 2

GEH Final Response to RAI 3.9-284

Public Version

Non-Proprietary Version

This is a non-proprietary version of Enclosure 1, from which the proprietary information has been removed. Portions of the document that have been removed are identified by white space within double brackets, as shown here [[ ]].

NRC RAI 3.9-284

During the audit, the staff inquired about changes made to the SSES ANSYS structural model during the SSES benchmarking effort. Following the exit meeting for the audit, the staff had the opportunity to review DRF 0000-0087- 2787, "SSES Dryer FEM with [[ ]] Representations and Other Modifications", dated 09/20/2008. Based on its review, the staff sheet 4 of the document):

1) *Element Nos. 99 and 199 are specified as [[ ]]. In a subsequent table, the element thicknesses are listed as [[ ]]. There is no information about stiffness or mass associated with these elements. Based on the complete description, it appears that these [[ ]]. The staff requests GEH to (1) describe in detail the purpose of these elements and why they are needed; (2) confirm the thickness and specify the stiffness (E, nu) and mass density; (3) describe in detail the technical basis for determining that these [[ ]] do not affect the structural response of the steam dryer; and (4) if they do affect the structural response, provide the detailed technical basis for why this is acceptable.*

2) *Element No. 5 is specified as [[ ]]and is [[ ]] The staff could not find information about the thickness, stiffness or mass associated with these elements. The staff requests GEH to (1) describe in detail the implementation of this technique to [[ ]] provide the detailed technical basis for why this is acceptable.*

3) *GEH is requested to provide the purpose for utilizing any fictitious [[ ]].*

4) *GEH is requested to specifically describe the extent to which the elements identified in items (1) and (2) above will be implemented in the ANSYS structural analysis of the ESBWR steam dryer. GEH should also discuss any planned changes for ESBWR, and the technical basis for the changes.*

GEH Response

1. In the Susquehanna Steam Electric Station (SSES) replacement steam dryer global Finite Element Model (FEM), there are two types of [[ ]]. These trial studies were investigating changes to the structural FE model that would bring the predictions into closer agreement with the strain gauge measurements taken during the SSES EPU power ascension. [[ ]]. Therefore, this approach was not used beyond the trial studies.

[[

]]. Therefore, these [[ ]] have no impact on the SSES dryer stress calculations.

For both types of [[

]]. Since these [[ ]] were not used in the finite element solution, their material properties do not have any effects on the steam dryer structural response.

[[

]]

Figure 1: [[ ]] in SSES Finite Element Model

2. The steam dryer finite element model is primarily made of shell elements. In SSES replacement dryer global FEM, there are steam dryer components, such as [[

]] However, the solid elements do not have the [[ ]]

In order to properly transfer the moments between the shell elements and solid elements, [[

]] The detail for the overlay shell element modeling is provided in the response to RAI 3.9-280.

[[

]]

Figure 2: Overlay Shell Elements [[ ]] in SSES Finite Element Model

In the SSES global FEM, the overlay shell element [[

]]. It is noted that a very small mass density of the overlay shell elements [[ ]] is necessary in order not to change structural dynamic properties. A sensitivity study was performed to evaluate the impact of large overlay shell mass density on SSES benchmarking results. Table 1 is a comparison of the maximum strain and acceleration at SSES sensor locations for two different mass densities [[ ]] The maximum strain is based on strain time history data, which are extracted from Flow-Induced Vibration (FIV) analysis results. Figure 3 is a typical strain time history plot at S1 sensor location.

Table 1: Effect of Overlay Shell Mass Density on Maximum Strain/Acceleration

[[

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It is shown from Table 1 that structural responses at the sensor locations are insensitive with respect to the mass density of the overlay shell elements in the global FEM. [[ ]]. Therefore, the use of [[ ]] at the gage locations for benchmarking the FEM bias and uncertainty will not be affected by the mass density of the overlay shell elements.

[[

]]

Figure 3: Strain Time History Plot at S1 Sensor Location [[ ]].

3. [[

]]. As stated in the response to item 1, during the acoustic load mapping process, the [[ ]] were used to map the acoustic pressure loads onto the [[ ]]. After mapping, these elements were deleted from the FEM and were not used in the structural solution. Therefore, the [[ ]] do not have any impact on the SSES stresses.

4. If solid elements are used in the ESBWR steam dryer global FEM, the material property of the overlay shell elements for the interface transition between shell and solid elements in ESBWR FEM will be defined as:

   - [[
   -

   ]]. (see RAI 3.9-280)

   If the current procedure for the acoustic load mapping remains the same, the [[ ]] will still be used only for mapping the loads to the solid elements in the ESBWR steam dryer global FEM and then removed from solution, following the process described in the response to Item 1 above.

Additional Questions:

Item 1: *Explain in detail the ANSYS process that deletes the dummy shell elements from solution at each time step, after the instantaneous nodal forces on the solid elements are calculated from the instantaneous pressures on the shell elements.*

GEH R**esponse:**

The FIV analysis procedure is listed in below.

A. [[

B.

C.

D.]]

Item 2: *Shell overlay elements 2 and 4 to enforce rotational compatibility between shell elements and solid elements are described in detail in the response to RAI 280 and are reviewed there.*

GEH Response:

The detail of overlay shell elements is provided in the response of RAI 3.9-280 and is reviewed there.

Licensing Basis Impact:

No change is proposed for the DCD or other licensing basis documents.