

**Preliminary Comments on EPRI Report 1012966
 "Effect of Seismic Wave Incoherence on Foundation and Building Response"**

NRC Comment/Question	Resolution
General Comments	
1. The report seems to be written well and different topics of discussion are well laid out.	NA
2. An important gap in this study is the lack of any treatment of kinematic interaction of embedded foundations or any questioning of the validity of the use of the proposed Abrahamson coherency function for those foundations.	D
3. The standard practice of performing SSI analysis using coherent ground motion was based on observation and interpretation of data from down hole arrays that show a large percentage of the power of ground motion comes from vertically propagating waves. It appears that the recommended method of SSI analysis in this report is simply to reduce the amplitudes of ground motion at frequencies generally above 10 Hz, and then apply the reduced motion uniformly (coherently) across the entire foundation.	A
4. This report needs to clearly layout the approach and implementation scheme for using the SSE (design ground motion) derived from a performance-based approach in conducting engineering analyses. Detailed steps of the implementation in carrying out the SSI analysis using the incoherent motion approach, including guidance on soil parameter modeling are needed.	C
5. Complicated equations are described that use rectangular and square matrices, which are appropriately multiplied by column matrices to obtain resulting equations. These are described in text, however a step by step process of converting the matrices using conceptual layout in matrix form will enhance the reader's understanding.	A
6. The ASCE Journal of Geotechnical and GeoEnvironmental Engineering issue of April 2003, Volume 129, Number 4 published an article, "Kinematic Soil-Structure Interaction from Strong Motion Recordings" by Seunghyun Kim and Jonathan Stewart. This article points out that the incoherence parameter is dependent on the site shear wave velocity. This paper also points out that the use of incoherent motion introduces torsional motion.	B
Product Description	
1. Page iv: As discussed here, seismic wave incoherence occurs because of the horizontal spatial variation of both horizontal and vertical ground motions. The variation in the horizontal input motions will result in torsional input at the foundation while the variation in the vertical motions will cause rocking of the base mat. Please discuss in detail the basis for not considering the torsion and rocking effects and state whether these effects will be considered in the individual plant ESP and/or COL applications.	C
2. Page iv: This section states that the seismic response is evaluated for rigid, massless foundations and for example structural models on foundation mats that behave rigidly. Please discuss how the results would be impacted by taking into account the flexibility and mass of the foundation and state whether these effects will be considered in the individual plant ESP and/or COL application. (See also page 1-2 for the same subject).	D, B

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- A. Agree with comment, minor change to the report anticipated.
 B. Clarification or resolution of comment at the May 11-12 meetings.
 C. Agree with comment, more effort will be required and it is either already within our scope or it is a relatively modest effort to add to current scope.
 D. The scope of work suggested is a more challenging effort. Scope, schedule, and resource discussions will need to be discussed at the May 11-12 meetings.

B-19

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Product Description	
3. Page iv: This section states that the incoherency transfer functions depend on the foundation area and are independent of site soil conditions but that the resulting spectral reductions strongly depend on site soil conditions. This seems to be inconsistent. Please explain. (This statement also appears on page ix.)	B
4. Page v: This section describes some of the research activities and uncertainties that have been identified. These include: additional analyses for different and more complex foundation shapes; verification based on foundation responses in real earthquakes; sensitivity study; and validation through peer review. Please discuss the status of these tasks and provide assurance that these tasks will not impact the incoherency functions presented in this report.	B, D
5. Page viii: This page states that in this study, the assumption was made that mat foundations of typical nuclear power plant (NPP) structures behave rigidly. This assumption may not be valid in all cases. Please discuss the effect of mat flexibility on the results reported in this study and whether the mat flexibility will be considered in the individual plant ESP and/or COL application.	D
Section 1: Introduction and Background	
1. Page 1-1: This page states that this study considers both the "local wave scattering" and "wave passage effects" but that the final results are based on "local wave scattering" only. Please provide the basis of excluding "wave passage effects" and state whether the "wave passage effects" will be considered in the individual plant ESP and/or COL applications. See also Page 5-1.	A
Section 2: Study Input Parameters	
1. Page 2-2: It is not clear which equation is plotted in Figures 2-1 and 2-2, and which equation is to be used for "no wave passage effect." Please explain.	A
2. Page 2-3: This section states that the ground motion data analyzed to develop the coherency functions have frequency content of 20 Hz and less but that the trends can be extrapolated to higher frequencies. It is not obvious why and how these trends can be extrapolated. Please explain.	B
3. Page 2-3: This section rightfully states that the mean input ground motion is the goal for the design of NPP structures, and as a result, the goal is to use mean coherency. However, this section further states that the coherency functions stated in the report are median coherency functions. Please provide justification for using the median instead of the mean coherency functions.	A
4. Page 2-3: Tables 2-2 and 2-3 do not seem to be consistent with Figure 2-4. Please explain.	A
5. Page 2-5: This section states that the shear wave velocity of the bedrock is 4300 fps but Table 2-3 indicates a value of 4150 fps. Please explain the discrepancy.	A

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Section 2. Study Input Parameters	
6. Page 2-5 and 2-6: This section quotes the EPRI 1993 Guidelines for Determining Design Basis Ground Motion. Please provide the full reference.	A
7. Page 2-6: This section that the soil damping and shear modulus were determined based on an earthquake strain level of $10^{-2}\%$. This is the same strain value as was stated for rock. Please explain why the strain value for the soil is not higher than that of the rock.	A?
8. The structural model to evaluate kinematic interaction is presented in Figure 2-8. The stick model has mass, stiffness and damping representing a fixed base condition. The use of this model for studying the kinematic interaction should be further explained. Presumably the inertial interaction part is to be evaluated in a separate step. In this context, the use of superstructure with masses hinders the demonstration of kinematic effects.	B
Section 3. Technical Approach	
1. It is stated in the general section that the goal is to obtain an engineering-modified input ground motion accounting for incoherency effects. Presumably, the modified ground motion will be applied as a completely coherent time function in the SSI analysis. It appears that the effect of proposed incoherency effect is only to reduce time histories along three orthogonal directions without any rotational input. This seems to render the very idea of incoherency incongruent.	B
Section 4. Benchmark Problem Comparison	
1. Based on Figures 4-1, the effect of incoherency transfer functions for the vertical and horizontal directions are about a factor of 2 apart. Can this be validated from actual recordings, or is this to be expected in the CEUS region? This effect also shows up later in the report.	B
Section 5. Rigid, Massless Foundation Response	
1. Page 5-4: This section states that to study the effect of foundation shape, square versus rectangular foundations were considered, while different foundation sizes of square foundations were investigated to study the effect of foundation area. Please explain whether you have studied circular foundations, especially in light of the fact that a significant number of NPP containment foundations are circular. Please explain whether this effect will be considered in the individual plant ESP and/or COL application.	B
2. At the end of this chapter it is concluded that the incoherency transfer function (ITF) is independent of the input motion. This would be one of the most important points that would allow the use of the ITF without any dependence on the seismologically (performance-based) obtained ground motion spectrum. The validation of this point needs to be demonstrated by observed behavior.	B

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Section 5: Rigid, Massless Foundation Response	
3. Figures 5-17 and 18 show the reduction effect at PGA, but the reduced vertical PGA (0.15g) is less than the horizontal (0.2g). Can this be validated by observed data?	B
Section 6: SSI & Structural Response	
1. Page 6-10: This section discusses whether correction factors need to be applied to take into account rotational effects of torsion and rocking. Please elaborate on the statement “The exact solution includes rocking induced by consideration of incoherence but the incoherence transfer function (ITF) scaled solution only includes translational input motion”.	B, C
2. This section also states that translational foundation response after SSI when subjected to rotations only were less than 0.01g, and the in-structure response was similarly low. Were these results for a soil or rock site? A soil site may be subject to more rocking. The staff would like to see the details of these results.	B
3. Furthermore, this section states that for the rock condition, no additional consideration of rotations due to ground motion incoherence appears to be warranted. Please explain if additional consideration of rotations due to ground motion incoherence would be warranted for a soil site.	B
4. Page 6-17: This section states that all the analyses in this report are conducted for surface foundations even though many NPP structures have embedded foundations. This section further states that it is anticipated that the effects of embedment and the effects of incoherence are independent of each other but that analyses to demonstrate this relationship have not been performed. Please provide the basis of this assumption and state whether embedment effects will be considered in the individual plant ESP and/or COL application.	D
5. Page 6-17: This section states that “in-structure spectra for one horizontal direction and for a surface founded and embedded model are shown in Figures 6-26 and 6-27, respectively.” It is not clear what these Figures illustrate. Please elaborate.	A
6. PGAs for horizontal and vertical direction are almost a factor of 2 apart, see series of figures marked 6 -1 through 6.	B
7. Figures 6-14 through 25 use the label SSI-CTF, but CTF does not seem to have a definition.	A
Section 7: Summary, Conclusions & Recommendations	
1. Page 7-2: This section states that it was judged to be slightly conservative to not include wave passage effects. Please explain if the wave passage effect might have a bigger impact on rocking and torsion.	B
2. The conclusions are well laid out; however the issue of embedded foundations is not discussed and majority of reactor designs use structures that are embedded to depths between 20 to 60 ft.	B

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