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June 15, 2001

Rules and Directives Branch
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Comments on "Draft Regulatory Guide DG-1105: Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites"**

Dear Sir or Madam:

Thank you for this opportunity to comment on the Draft Regulatory Guide DG-1105. I feel that the solicitation of public comments is an important step in developing a good regulatory guide. My comments are as follows:

a) A summary of the NCEER workshop report will be republished in the October 2001 issue of the *Journal of Geotechnical and Geoenviromental Engineering*. This journal publication provides an important summary of the state-of-the-art in assessing seismic soil liquefaction, and should be referenced in the Regulatory Guide.

b) Page 4.—The shear-wave velocity method recommended by the NCEER workshop should be included as an alternative, and/or supplement, to the penetration-based approaches. Suggestions made by the 20 experts attending the NCEER workshop, as well as responses to comment solicitations sent to over 100 engineers and scientists, were considered in the development of the shear-wave velocity method. The shear-wave velocity method has been validated by laboratory tests, SPT correlations, and field case histories. Measured shear-wave velocities are applicable at most sites, including sites where penetration tests may not be reliable or possible (e.g., gravelly soils, landfills). A National Institute of Standards and Technology (NIST) guideline for evaluating liquefaction resistance using shear-wave velocity measurements will be published shortly.

c) Page 8, lines 1-4.—Currently, the single best reference for the NCEER-recommended shear-wave velocity method is the paper by Andrus and Stokoe (2000) entitled "Liquefaction Resistance of Soils from Shear-Wave Velocity," *Journal of Geotechnical and Geoenviromental Engineering*, ASCE, Vol. 126, No. 11, pp. 1015-1025. Since this paper was published recently, the authors of the Draft Regulatory Guide were probably not aware of it when the draft guide was prepared.

d) Page 8, lines 3-4.—It states: "[Shear-wave] methods, at present, have limited applicability except for soils and conditions represented in the database used in the development of these techniques." While this statement is true, the same should be stated for the SPT and other penetration methods. The SPT and other penetration methods have limited applicability except for soils and conditions represented in the databases used in their development. The Draft Regulatory Guide is misleading by not stating this.

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e) Page 9, Section 1.5.—It states: "A limited data base exists for relating shear-wave velocity to maximum surface acceleration to predict liquefaction potential in soils, particularly for soils >8 meters deep and denser soils shaken by stronger ground motions." While this statement is true, the same should be stated for the SPT and other penetration methods. It should be noted that the shear-wave velocity method recommended by the NCEER workshop was based on 225 case histories. In contrast, the SPT method outlined in Seed et al. (1985) was based on only 125 case histories. There are 14 case histories in the shear-wave velocity database corresponding to depths greater than 10 m (Andrus and Stokoe, 2000). How many case histories are there in the SPT database corresponding to depths greater than 10 m? The Draft Regulatory Guide is misleading by not stating the limitations of the SPT database. It incorrectly implies that the SPT and other penetration methods have been proven for all depths, and denser soils shaken by stronger ground motions. As suggested by Prof. I.M. Idriss at the 1998 NCEER workshop meeting, the database characteristics of each method need to be clearly stated. The Regulatory Guide should include statements describing the database characteristics and limitations of the SPT and other penetration methods.

f) Page 6, lines 5-6.—It states: "Probabilistic methodologies can sometimes be used as a screening technique to identify potentially liquefiable soils." Contrary to this statement, probabilistic methodologies provide a very useful and powerful tool in liquefaction evaluations. Probabilistic methodologies offer a scientific way of quantifying (or calibrating) the deterministic curves, which to date have largely been drawn visually. Investigations by Liao et al. (1988), Youd and Noble (1997), Toprak et al. (1999), and Juang et al. (2000) have shown that the liquefaction resistance curve proposed by Seed et al. (1985) for clean sands corresponds to an average probability of liquefaction of about 30 %. The value of 30 % is a useful quantitative description of the recommended SPT curve. Thus, by adopting the SPT curve as the standard evaluation curve, the Regulatory Guide is also adopting 30 % probability of liquefaction as the standard definition for a factor of safety equal to 1. This should be explicitly stated in the Regulatory Guide. The statement might read as follows: "The recommended SPT evaluation curve corresponds to a factor of safety of 1 and a probability of liquefaction of 30 %. Other evaluation curves may be employed at nuclear power plant sites that have been shown to provide an equivalent evaluation."

g) Page 10, Section 3.2—The Draft Regulatory Guide suggests using values of factor of safety (FS) between 1.1 and 1.4. Based on the relationship proposed by Juang et al. (2000), these FS values correspond to liquefaction probabilities of about 25 % and 12 %, respectively. Probabilities provide a meaningful description of the evaluation criteria, particularly when applying and comparing different evaluation methods, and should be included in the Regulatory Guide.

Again, I appreciate this opportunity to comment on the Draft Regulatory Guide. If further clarification of these comments is need, please contact me at (864) 656-0488.

Sincerely,

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