UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

July 9, 2009

MEMORANDUM TO: ACRS Members

FROM: Edwin M. Hackett, Executive Director ***/RA/***
Advisory Committee on Reactor Safeguards

SUBJECT: TRANSMITTAL OF FOREIGN TRIP REPORT OF ACRS STAFF

Attached is a foreign trip report prepared by Neil Coleman of my staff, regarding the 2009 Joint Assembly of the American Geophysical Union in Toronto, Canada. As part of this meeting, on May 25, 2009, Mr. Coleman chaired a session titled "Role of the Earth Sciences in the Nuclear Renaissance." This trip report represents the views of Mr. Coleman and has not been reviewed by the Full Committee.

Attachment:
As stated

cc:
W. Borchardt, EDO
V. Ordaz, OEDO
B. Sheron, RES
J. Uhle, RES
M. Weber, NMSS
J. Lyons, CRGR
A. Vietti-Cook, SECY
E. Leeds, NRR
M. Johnson, NRO
M. Doane, OIP

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DATE	7/9/09	7/9/09	7/9/09	7/9/09

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TRIP REPORT

2009 Joint Assembly of the American Geophysical Union

Neil Coleman, ACRS Staff

During May 24-27 I attended the 2009 Joint Assembly of the American Geophysical Union in Toronto, Canada. As part of this meeting, on May 25 I chaired session U13A titled "Role of the Earth Sciences in the Nuclear Renaissance." This session was co-chaired by Jeff Ciocco, who is a Senior Project Manager in NRC's Office of New Reactors (NRO). After our lead-off invited speaker withdrew due to medical reasons, Mr. Ciocco prepared and gave an NRO outreach presentation, summarizing the status of new reactor design and siting applications in the United States. We note that Thomas Nicholson of NRC's Office of Research also chaired a session at this meeting, titled "Advances in Modeling of Hydrologic Systems I."

Most of the presentations in our session dealt with seismicity and ground motion issues, relevant to NRC and ACRS reactor siting reviews. Other presentations related to progress in international programs, such as characterization of a proposed Canadian deep geologic repository for low and intermediate level radioactive waste. Key talks from the meeting are summarized below:

- G. Atkinson (University of Western Ontario) discussed earthquake ground-motion issues relevant to the seismic safety of nuclear power plants. These issues include: (i) assessment of hazard and its uncertainty, at low probabilities, for sites in stable continental regions, where large events may have repeat times greatly exceeding the historic record, and where the relationship between seismicity and geological host structures is ambiguous; and (ii) the use of Uniform Hazard Spectra in site evaluation and design of nuclear power plants. The second issue arises chiefly because design of nuclear facilities has traditionally been based on testing of engineering structures and systems against a "standard scaled response spectrum" (sometimes called a Newmark-Hall spectrum after its original authors). This standard shape is contained in both U. S. and Canadian standards for nuclear power plant design. For hard rock sites in eastern North America, this standard shape differs markedly from the shape determined from probabilistic analyses and provided as a Uniform Hazard Spectrum (UHS) for a specified probability level. The UHS for eastern North America rock sites is greatly enriched in high frequency energy (>8 Hz) and depleted in low frequency energy (<3 Hz), relative to standard spectra that have been used for nuclear power plant design.

- R. Woodward et al. (Incorporated Research Institutions for Seismology) described the USArray Transportable Array (TA), a network of 400 seismograph stations that is systematically moving west-to-east across the contiguous United States. This array is part of the National Science Foundation's multidisciplinary EarthScope program, and has already occupied over 700 stations in the western US. It will eventually reach the Atlantic coast before heading for Alaska. The stations use a grid-like deployment with 70 km separation between stations. At any given time there are approximately 400 stations operational, occupying an 800 km by 2000 km "footprint." Each station operates for two years. The Array is now operating in the swath of the country extending from Texas to Montana. From 2010 to 2013 the TA will occupy ~800 sites in the central and eastern US. The array will be centered on the New Madrid, MO region during the bicentennial of the 1811-1812 earthquakes. During the TA deployment every existing or planned nuclear plant in the eastern US will be within 70 km of at least four new seismic

stations. Thus, this station deployment in the eastern U. S. provides unprecedented opportunity for improving source characterization, modeling the regional velocity and attenuation structure, and mapping seismic zones down to low magnitude thresholds.

- M. Jensen (Nuclear Waste Management Organization) discussed the proposal by Ontario Power Generation to develop a deep geologic repository for disposal of its Low and Intermediate Level Radioactive Waste at the Bruce site, located near Tiverton, Ontario, 225 km northwest of Toronto. The repository would be accessed by a vertical shaft and, as now envisioned, could accommodate 200,000 m^3 of waste in emplacement rooms excavated at a depth of 680 m in Ordovician age argillaceous limestone. The investigations have gathered data to develop an understanding of the evolution and stability of the geologic, hydrogeologic, hydrogeochemical and geomechanical environment as it relates to demonstrating repository safety. Scheduled for completion in 2010, the interim results, which included the drilling and testing of 4 deep boreholes, are providing evidence of a predictable geosphere with a deep seated (>400 m), low permeability ($K < 10^{-13}$ m sec^{-1}), low porosity (0.01-0.08), saline (TDS > 250 gm l^{-1}) groundwater regime that is resilient to external perturbations (e.g., glaciation).

- F. Boadu (Dept. of Civil and Environmental Engineering, Duke University) gave a presentation that related engineering and petrophysical properties of unconsolidated sediments to electrical parameters. The methodology predicts engineering properties of soils using non-invasive and cost-effective geophysical measurements. The use of geophysical techniques demands adequate knowledge of how the fundamental petrophysical properties of a soil, which affect its strength and stability, also influence its geophysical response. Measurements of the spectral electrical response (0.01 Hz to 10 kHz) of field samples with wide variability in physical and engineering properties were performed. The analysis focused on textural properties that are easily obtained from grain size distribution analysis including, fractal dimension, pore size parameter and specific surface area of the soil per unit mass and amount of fines (clay and silt) present. Electrical parameters which describe the electrical response of the model were extracted and their variations with the soil properties analyzed.

- M. Takao and H. Mizutani (both with Tokyo Electric Power Co.) submitted an abstract regarding a geological and seismological survey for new design-basis earthquake ground motion at the Kashiwazaki-Kariwa nuclear power station. At about 10:13 on July 16, 2007, a strong earthquake named 'Niigata-ken Chuetsu-oki Earthquake' of M6.8 on Japan Meteorological Agency's scale occurred offshore Niigata prefecture in Japan. All of the nuclear reactors at Kashiwazaki-Kariwa Nuclear Power Station (KKNPS) in Niigata prefecture operated by Tokyo Electric Power Company shut down safely. In other words, automatic safety function composed of shutdown, cooling and containment worked as designed immediately after the earthquake. During the earthquake, the peak acceleration of the ground motion exceeded the design-basis ground motion (DBGM), but the force due to the earthquake applied to safety-significant facilities was about the same as or less than the design basis taken into account as static seismic force. In order to newly assess the safety of nuclear power plants, the authors have evaluated a new DBGM after conducting geomorphological, geological, geophysical, and seismological survey and analyses. In the land area, aerial photograph interpretation was performed at least within the 30 km radius, as part of a geomorphological survey to identify landforms that might represent tectonic relief. Especially investigated was the Nagaoka Plain Western Boundary Fault Zone

(NPWBFZ), which consists of Kakuda-Yahiko fault, Kihinomiya fault and Katakai fault, because NPWBFZ is one of the active faults, which has potential of M8 class in Japan. In addition to the geological survey, seismic reflection prospecting was completed to evaluate the geological structure of the faults and to assess the consecutiveness of the component faults of NPWBFZ. As a result of these surveys, the authors determined that the three component faults of NPWBFZ are independent of each other with respect to geological structure. However, it was decided to take into consideration simultaneous movement of all three faults in seismic design as a case of uncertainty. In the sea area, seismic reflection prospecting with sonic wave was conducted in the area stretching for ~140 km along the coastline and 50 km in the direction perpendicular to the coast. As a result of the seismic reflection survey and analyses, it was determined that five active faults need to be taken into consideration for the seismic design in the sea area. As a result of analyses of the geological survey, data from NCOE, and data from the 2004 Chuetsu Earthquake, it became clear that there are factors that intensify seismic motions in the study area. For each of the two selected earthquake sources, namely NPWBFZ and F-B fault, the authors calculated seismic ground motions on the free surface of the base stratum as the design-basis ground motion (DBGM) using both empirical and numerical ground motion evaluation methods. The peak ground acceleration for DBGM is 2,300 Gal for units 1 to 4 located in the southern part of the KKNPS and 1,050 Gal for units 5 to 7 in the northern part of the site.

- C. Fuller et al. (William Lettis & Associates) discussed regulatory issues and challenges in developing seismic source characterizations for new nuclear power plants in the US. An integral component of the safety analysis for proposed nuclear power plants is a probabilistic seismic hazard assessment (PSHA). Most applications currently under NRC review followed guidance in NRC Regulatory Guide 1.208 (RG 1.208) for developing seismic source characterizations (SSC) for their PSHA. Under RG 1.208 guidance, applicants should: (1) use existing PSHA models and SSCs accepted by the NRC as SSC as a starting point for their SSCs; (2) evaluate new information and data developed since acceptance of the starting model to determine if the model should be updated; and (3) follow guidelines set forth by the Senior Seismic Hazard Analysis Committee (SSHAC) (NUREG/CR-6372) in developing significant updates (i.e., updates should capture SSC uncertainty through representing the "center, body, and range of technical interpretations" of the informed technical community). Major motivations for following this guidance are to ensure accurate representations of hazard and regulatory stability in hazard estimates for nuclear power plants. All current applications with the NRC have used the EPRI-SOG source characterizations developed in the 1980s as their starting point model, and all applicants have followed RG 1.208 guidance in updating the EPRI-SOG model. However, there has been considerable variability in how applicants interpreted the guidance, and thus there has been considerable variability in the methods used to update the SSCs. Much of the variability can be attributed to how different applicants have interpreted the implications of new data, new interpretations of new and/or old data, and new “opinions” of members of the informed technical community. For example, many applicants and the NRC have wrestled with the challenge of whether or not to update SSCs in light of new opinions or interpretations of older data put forth by one member of the technical community. This challenge has been further complicated by: (1) a given applicant's uncertainty in how to revise the EPRI-SOG model, which was developed using a process similar to that dictated by SSHAC for a level 3 or 4 study, without conducting a resource-intensive SSHAC level 3 or higher study for their respective application; and (2) a lack of guidance from the NRC on acceptable methods of demonstrating that new data, interpretations, and opinions are

adequately represented within the EPRI-SOG model. Partly because of these issues, initiative was taken by the nuclear industry, NRC and DOE to develop a new base PSHA model for the central and eastern US. However, this new SSC model will not be completed for several years and does not resolve many of the fundamental regulatory and philosophical issues that have been raised during the current round of applications. To ensure regulatory stability and to provide accurate estimates of hazard for nuclear power plants, a dialog must be started between regulators and industry to resolve these issues. Two key issues that must be discussed are: (1) should new data and new interpretations or opinions of old data be treated differently in updated SSCs, and if so, how?; and (2) how can new data or interpretations developed by a small subset of the technical community be weighed against and potentially combined with a SSC model that was originally developed to capture the “center, body and range” of the technical community?