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U.S. NUCLEAR REG. COMM.
ADVISORY COMMITTEE ON
REACTOR SAFEGUARDS

Dr. David Okrent
Advisory Committee on Reactor Safeguards
Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, D.C. 20555

Dear Dr. Okrent:

The amount and variety of information and opinion presented to us on June 4th was a bit intimidating for a non-engineer. However, it seems to me that certain conclusions regarding evaluation of seismic risk and applications to engineering came through rather clearly. I will limit my remarks to these aspects.

A major thrust of the day's presentations was directed toward an evaluation of seismic risk in the states lying east of the Rocky Mountains. During the 200-350 year period of written records for this region only two major earthquake sequences have been reported, the New Madrid and Charleston events. A scattering of much less destructive earthquakes have also been recorded but, prior to the present concern with construction of nuclear plants, virtually this entire region was regarded as being aseismic or of very low seismic risk. Consideration of seismic loading was not and is not required in the design of public buildings or industrial plants throughout most of this vast region. Most of the historic seismic events are poorly located, and until quite recently, none could be assigned unequivocally to movement on a known fault. Furthermore, because of the rarity of earthquakes in most areas east of the Rockies, the calculation of maximum expectable seismic acceleration and of return periods for most sites cannot be carried out satisfactorily. I will return to this subject later.

The staff should be commended for the approach they and their consultants are now taking toward evaluation of seismic risks and applications to plant design and construction. I refer to the Systematic Evaluation Program and the Site Specific Spectrum Project. The SEP seeks to evaluate the adequacy of construction, especially with regard to seismic loading, in eleven older plants. The project has taken a practical approach, attempting to determine whether a given plant meets the intent of current seismic criteria, rather than carrying out a complete engineering analysis

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based on modified estimates of seismic risk. A feature of particular value is the requirement that the licensee in one group of plants perform a seismic design evaluation of its own plant prior to visits and examination of the plants by staff members and consultants. It seems to me that this requirement, applied routinely to all plants at some designated time interval, would be the most effective mechanism for identifying potential trouble spots and encouraging licensees to be continually aware of the engineering safety of their plants. (I realize that a similar procedure may already exist). The SEP has identified a special area of concern for all eleven plants, namely apparent widespread deficiences in anchorage and support systems for the electrical components. It is my understanding that the plants have been required to evaluate these aspects of their electrical systems and to correct deficiences by September 1, 1980. I find very convincing the opinion voiced by Mr. Knight that upping g - values for completed plants is not as useful a mechanism for bringing about such desirable changes as is the examination of plants to spot potential trouble areas which can then be corrected individually. However, as he noted, large increases in value would undoubtedly require redesign and extensive modification of the affected plants.

A major problem with evaluation of seismic design of nuclear plants is the paucity of data relating to the behavior of these plants during large earthquakes. There is, therefore, little basis for judging the conservatism of seismic design and construction. The possibility of establishing such a base was suggested by Mr. Rodabaugh's comment that, in the large number of industrial plants which have experienced earthquakes, there were no reported failures of ductile piping (not cast iron) caused by the earthquakes. Certain industrial installations, especially large refineries and chemical plants, have piping, valve, pump, and electrical systems roughly comparable to those in nuclear reactor installations, and furthermore have similar, although perhaps not so drastic, concerns about the corrosion-weakening of piping. It would seem that a program to evaluate, insofar as records permit, the behavior of various components in plants which have been affected by earthquakes would provide a basis for evaluating the seismic "resistance" of standard engineering design practice and construction, and thus would also provide a measure of conservatism in the design and construction of nuclear facilities. In this regard, Dr. Hall also observed that inherent seismic resistance of well designed and constructed systems is much greater than commonly assumed, largely because non-linear behavior is mobilized to limit the imposed forces in accompanying deformations.

The Site Specific Spectrum Project sought techniques that were complementary to Appendix A. One intriguing technique was to formally incorporate the judgment of ten recognized experts in evaluating spectra for sites in the east and midwest. Although differing estimates were given for the seismic characteristics of individual regions being considered, still the compilation of all opinions yielded a reasonable consensus. The impossibility of making satisfactory deterministic evaluations of seismic risk and loading have been demonstrated in the planning and design stages of virtually all nuclear plants in states east of the Rockies. It appears that the synthesis of expert opinion may be a more reliable approach for this region than the physical modeling of conjectural capable faults, as now required.

There seems to be general agreement among the staff and their various consultants that a desirable approach would be to establish a minimum size of seismic event which would govern construction of nuclear facilities through the forty-eight conterminous states, with the most obvious application being to the areas of low seismicity east of the Rocky Mountains. Mr. Reiter suggests a minimum floor for earthquake spectra based on the view that a magnitude 5.3 (intensity VII) could occur anywhere in the U.S., at varying levels of certainty, and he recommends that a 50th percentile of magnitude 5.3 earthquake be accepted as a minimum for the conterminous U.S. The adverse impact of the adoption of this minimum value would apparently be small, and perhaps limited mainly to a few of the older plants. There is much to be said in favor of simplifying seismic design requirements, particularly in the east where adequate deterministic models cannot yet be devised, and especially if, as was indicated by some speakers, seismic loading may not be the dominant factor in plant design at localities with inherently low seismic risk.

I would like to emphasize, however, that the only basis we now have for assigning seismic risk is past seismic experience, and that, as indicated in the Site Specific Spectrum Project, regional differences do exist and should be taken into account in seismic design. At New Madrid the identification of the probable causal fault by seismic reflection work, and the possible identification of a controlling fault at Charleston (where a thick sheet of basalt in the subsurface drastically limits reflection seismograph work) strengthens the concept that earthquakes here, as in the west, should be related to identifiable zones of earth displacement, i.e. faults. Historic earthquakes at New Madrid and Charleston fall within well defined linear trends. Similar trends exist

elsewhere throughout the mid-continent and east coast areas, suggesting that other buried faults or fault zones will eventually be delineated.

It appears that the Appalachians and the mid-continent are characterized by different seismic trends, those in the east being either northwest or northeast and those in the mid-continent dominantly north-south and much more widely scattered. Furthermore, the states bordering the Gulf of Mexico, with exception of the Texas panhandle, have been largely aseismic, as have various other states, or large portions of states, throughout the area. I am not at all convinced that it is reasonable to assign arbitrarily a 5.3 magnitude earthquake as the controlling seismic event in such areas, unless it can be shown that the seismic loading requirements do not greatly increase the design and construction costs related to other loading requirements. However, I like the suggestion by Robert Jackson that a minimum g - value (0.2g horizontal?) be established for the states east of the Rocky Mountains, and that applicants accepting this value could avoid the regional study and justification part of the PSAR preparation. This would alleviate the always troublesome tectonic province problem.

Respectfully submitted,

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