Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

November 29, 1979

Paul O'Connor, Project Manager
Operating Reactors-SEP Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Comments on the LLL/TERA Reports
NRC Docket 50-10/237

Dear Mr. O'Connor:

Commonwealth Edison requested Fugro to review the LLL/TERA reports and to provide their comments. Attached are Fugro's general comments on the LLL/TERA reports. In addition to the Fugro comments, Commonwealth Edison's general comments are provided in the following paragraphs.

In the type of study performed by LLL/TERA, the usefulness of the results is directly related to the consistancy of the expert opinions. This survey is attempting to determine the state of knowledge on the expected maximum seismic event to occur at a given site. If the expert opinion varies significantly the reasons for the variation must be understood before the opinions can be used. In the LLL/TERA report there is a wide variance in the opinions generated by the experts polled by LLL. Due to the wide variance in the opinions the output of the LLL/TERA program appears to be wrong. As a result, the output is unusable. We believe the three basic reasons for the wide variance in the opinions are: 1) It appears not all the experts properly understood the questions in the survey, 2) the experts were not allowed sufficient time to provide required responses and, 3) in some cases, the experts were commenting on tectonic areas they were not intimately familiar with as to it's seismologic history.

Commonwealth Edison believes for the methology developed by LLL/TERA to be useful, LLL/TERA must go back and examine the causes of the variances in the expert opinion and resolve those areas they find questionable. They should then obtain expert opinion about a particular tectonic area from the expert most familiar with the area. In addition, a feedback mechanism should be established to make certain the experts understand the questions and that they have sufficient time to provide the required answers.

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Please address any questions you may have concerning the matter to this office.

One (1) signed original and thirty-nine (39) copies of this transmittal have been provided for review.

Robert F Janecek

R.F. Janecek
Nuclear Licensing Administrator
Boiling Water Reactor

CRITIQUE OF LLL/TERA REPORTS

ON

SEISMIC HAZARD ANALYSIS

Prepared for:

NUCLEAR SERVICES CORPORATION
1700 Dell Avenue
Campbell, California 95008

Prepared by:

FUGRO, INC.
Consulting Engineers and Geologists
3777 Long Beach Boulevard
Long Beach, California 90807

October 26, 1979

INTRODUCTION

At the request of Commonwealth Edison and Nuclear Services Corporation, Fugro has reviewed the following three draft reports prepared by Lawrence Livermore Laboratory (LLL) and Tera Corporation on Seismic Hazard Analysis:

- o "Seismic Hazard Analysis: A Methodology for the Eastern United States," Tera Corporation, August 23, 1979.
- o "Seismic Hazard Analysis: Solicitation of Expert Opinion," Tera Corporation, August 23, 1979.
- o "Seismic Hazard Analysis: Site Specific Response Sectra Results," by D. L. Bernreuter (LLL), C. P. Mortgat (Tera) and L. H. Wight (Tera), August 23, 1979.

These reports were submitted to the Nuclear Regulatory Commission (NRC) as part of their Safety Evaluation Program (SEP) of older nuclear power plants.

This document presents a critique of these reports. Because of the large amount of material contained in these reports and the limited amount of time available for review, the comments below are mostly general in nature.

CRITIQUE

General. The three LLL/Tera reports basically present: (1) a probabilistic model for estimating uniform risk spectra[1] at a site, (2) the solicitation of expert opinions and the interpre- and incorporation of these opinions in the probabilistic model,

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[1] Uniform risk spectra are response spectra whose ordinates have the same probability of being exceeded during some time period.

and (3) the results of the application of this model to nine nuclear power plant sites included in the NRC's SEP.

The results for each site consist of a set of uniform risk spectra, each spectrum derived using one expert's opinions, and an overall spectrum representing the synthesis of all expert's opinions. Comparisons are also made between the synthesized spectrum and spectra obtained from more deterministic approaches.

The reports make no recommendations as to which spectra are to be used in the SEP or the corresponding performance criteria of structural components and local soils. However, some discussion is given on the merits and limitations of the use of each type of spectrum. An important criticism of uniform risk spectra that was mentioned is that the spectra essentially represent the contribution of all possible earthquakes in the site region. On the other hand the facility has to resist the shaking from only one earthquake at a time. Therefore, the uniform risk spectra may be overly conservative in this regard, and other types of spectra may be more appropriate for the SEP.

The critiques of each of the three reports are given below.

Solicitation of Expert Opinion. Ten experts in the fields of seismology and tectonics responded to specific questions in these areas in order to provide the necessary inputs to the probabilistic model. Ideally, the experts should be very knowledgeable in all the problem areas and have plenty of time to seriously study the questions and all of the relevant data

and respond in an unbiased and objective manner. However, for various reasons, it appears that these ideals were not achieved.

The experts generally were seismologists with some expertise in tectonics. To our knowledge none of the experts has done extensive research on the attenuation of strong ground motion or the response of local soils during earthquake shaking, two important considerations in any site-specific analysis. The limited expertise in the latter area was evidenced by the response to Question 4-20 (p. 11-106), which asked what was the maximum acceleration that various types of soil deposits could sustain. Only three experts responded and their answers indicated a limited knowledge in this area. Some of the experts emphasized their low confidence in their answers. Even within their fields of expertise, the experts are usually most knowledgeable about the seismicity and tectonics in the region in which they are located. In this regard it appeared that the experts concentrated their efforts on the data they were most familiar with and spent little time with other data. Sometimes only two or three experts responded to a particular question or group of questions.

More feedback between the experts and LLL/Tera would have been desireable during the course of the study. The experts did not have a chance to judge the reasonableness of the LLL/Tera interpretations of their responses to the questions, nor did the experts review the methodology or the results of the Tera/LLL probabilistic analyses for each site. The experts may well have

modified their responses to some questions if they had understood the way in which those responses were going to be used.

The method of self-ranking of the experts' opinions and the inclusion of the information by LLL/Tera to weight all of the experts' opinions is questionable. The resulting synthesized spectrum from the application of the weighting technique is biased toward experts who have a high degree of confidence in their opinions. A high self-confidence in one's answer does not necessarily mean that that answer is likely to be correct. Conversely, a lower self-confidence ranking does not necessarily reflect a lesser understanding of the problem. Some type of cross-ranking between the experts might have established whose opinions were most respected.

Methodology for the Eastern United States. The major concern with the methodology was the treatment of the uncertainties associated with input parameters of the probabilistic model, and the impact of these uncertainties of the results. A detailed analysis of the uncertainties in order to fully evaluate their impact was not given. However, LLL/Tera did question whether or not the rather large uncertainties in the attenuation relations based on statistical analysis of empirical data and the uncertainties associated with the expert's opinion were accurate representations of reality. Limited sensitivity studies performed on the attenuation uncertainty showed in one particular example that an 80 percent increase in the standard deviation had a similar increase in the spectral level for a given return period. Although

the uncertainty in the final probabilistic distribution for the response spectral ordinates was not estimated, it is important to know if the model is combining the uncertainties of the input parameters in such a way so as to produce a grossly overestimated uncertainty in the final distribution. If the model is doing this, then at long return periods the corresponding uniform risk spectra will be overestimated.

Site Specific Response Spectra Results. The reasonableness of the results could be better evaluated if a more complete documentation were given on the effects the various input parameters had on the results. For example, the relative contributions of the various earthquake magnitudes, in addition to the seismic sources, would have been useful. More analysis of the effects of the uncertainties of the input parameters, through formal statistical methods and sensitivity studies, would also be useful.

A review of the results for the Dresden nuclear power plant was made based on our knowledge of the seismicity and tectonics of that site region. The LLL/Tera results showed that the New Madrid seismic zone contributed anywhere from 35 to 47 percent to the 1000-year peak ground acceleration while the Central Stable Region seismic source contributed 45 to 61 percent. The relative contribution from the New Madrid zone seems unreasonably high simply because the zone is 300 to 500 km from the site (depending on the expert's choice of the appropriate northern boundary) at its closest approach. Expected peak ground accelerations at these distances from an earthquake of epicentral intensity equal

to XII (MM) should be less than 0.01g according to the formula given on Table 5-5 (p. 5-21) of the LLL/Tera report, "Site Specific Response Spectra Results." The report offers no concrete explanations or presents any analysis to explain why the New Madrid seismic zone should contribute so heavily to the results and, until this is investigated, the reslts for Dresden should be interpreted with reservations.