UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUN 19 1978

DOCKET NOS. 50-327/50-328
50-390/50-391
AND 50-438/50-439

APPLICANT: TENNESSEE VALLEY AUTHORITY (TVA)

FACILITIES: SEQUOYAH, WATTS BAR AND BELLEFONTE

SUBJECT: SUMMARY OF MEETINGS WITH TVA TO DISCUSS SEISMIC ISSUES RELATING TO SEQUOYAH, WATTS BAR AND BELLEFONTE

The NRC staff met in Bethesda, Maryland with representatives of TVA and its consultants on April 14 and May 16, 1978 to discuss the above subject. Attendees at the two meetings are given in Enclosures 1 and 2. At the April 14 meeting, the applicant described the efforts then underway to generate site-specific seismic response spectra applicable to the three TVA plants. Enclosure 3 is a summary of the material presented by the applicant. At this meeting, the NRC staff indicated that rock-site records from earthquakes in the magnitude range from 5.3 to 6.3, and for distances less than about 20 to 25 kilometers could be selected as representative of the SSE for the three TVA plants. This determination was based on studies of the controlling historical earthquake for the Southern Valley and Ridge tectonic province, the Giles County Virginia earthquake of 1897.

At the May 16, 1978 meeting, the site-specific studies being conducted by TVA were again discussed. TVA indicated that records had been found for five western-U.S. earthquakes that meet the above-described magnitude and distance criteria. The staff recommended that the strong motion records of the Friuli (Italy) earthquake sequence of 1976 be obtained, if possible, to supplement the five earthquakes from the western U.S. At the May 16, 1978 meeting, the staff summarized the results of the work being conducted by the NRC Staff Working Group on the TVA Seismic Issue. The Working Group's final report was subsequently transmitted to TVA by letter dated May 30, 1978.

Harry Rood

Harry Rood
Light Water Reactors
Branch No. 2
Division of Project Management

Enclosures:
As stated

cc w/encls:
See page 2

may
R6

Tennessee Valley Authority
ATTN: Mr. N. B. Hughes
Manager of Power
830 Power Building
Chattanooga, Tennessee 37201

JUN 1 9 1978

cc: Herbert S. Sanger, Jr., Esq.
General Counsel
Tennessee Valley Authority
400 Commerce Avenue, E11B33
Knoxville, Tennessee 37902

Mr. E. G. Beasley
Tennessee Valley Authority
400 Commerce Avenue, W9C 165
Knoxville, Tennessee 37902

Mr. D. Terrill
Licensing Engineer
Tennessee Valley Authority
303 Power Building
Chattanooga, Tennessee 37401

Mr. Dennis Renner
Babcock & Wilcox Company
P. O. Box 1260
Lynchburg, Virginia 24505

Mr. Robert B. Borsum
Babcock & Wilcox Company
Suite 420
7735 Old Georgetown Road
Bethesda, Maryland 20014

Mr. Michael Harding
Westinghouse Electric Corporation
P. O. Box 355
Pittsburgh, Pennsylvania 15230

Mr. David Lambert
Tennessee Valley Authority
303 Power Building
Chattanooga, Tennessee 37401

ENCLOSURE 1

ATTENDANCE LIST
JUNE 14, 1978 NRC-TVA MEETING ON SEISMOLOGY
OF SOUTHEASTERN U.S.

TVA

R. D. Guthrie
R. J. Hunt
Richard Holt - consultant
Gabriel Leblanc
Larry Mills
Mark Wisenburg
Richard Hopkins
Gus Giese-Koch
George C. Klimkiewicz - consultant

NRC - STAFF

H. Rood
S. P. Chan
L. Reiter
P. Sobel
T. J. Bennett
E. Ketchen
E. Reis
C. Woodhead
J. Kane
A. Cardone
H. Silver
J. Rajan
C. Stahle

ENCLOSURE 2

ATTENDANCE LIST
MAY 16, 1978 NRC-TVA MEETING ON
SEISMIC ISSUE

TVA	NRC - STAFF
Mark Wisenburg	H. Rood
Ron Guthrie	C. Woodhead
R. Joe Hunt	S. P. Chan
Bill Seay	L. Reiter
Donald J. Reinbold	T. J. Bennett
G. Giese-Koch	R. Hofmann
Richard Holt	C. Stahle
Gabriel Leblanc	H. Silver
	P. Sobel

ENCLOSURE 3

SEQUOYAH, WATTS BAR, AND BELLEFONTE

NUCLEAR PLANTS

JUSTIFICATION OF SEISMIC DESIGN BASES

Attached is information outlining the approach we plan to follow in developing site specific response spectra at the subject plants. We plan to complete the work and submit a report to you by July 1, 1978. We would like to meet with you April 14, 1978, to discuss the attached information.

EARTQUAKE GROUND MOTION STUDY FOR

SEQUOYAH NUCLEAR SITE

INTRODUCTION

It is recognized that problems exist in the definition of strong ground motion for eastern North American earthquakes, based on a Modified Mercalli intensity versus peak acceleration correlation derived for other tectonic regimes. Some of these problems arise from questionable assumptions, e.g., 1) that the epicentral intensity is an adequate means of defining the energy distribution of an earthquake; 2) that the epicentral intensity is correlated to peak particle acceleration; 3) that ground acceleration at specific sites can be predicted without considering local crustal effects; and 4) that near-field ground motion is similar with respect to spectral content in all tectonic environments. Until these and other assumptions are verified, other methodologies for predicting design strong ground motion induced by eastern earthquakes need to be explored.

The present attempt to predict site-specific spectra for the TVA sites will first include an examination of the ground motions induced by nearby moderate-size earthquakes that have occurred in eastern regions, as close as possible to the sites, and secondly, provide a method for extrapolating the ground motion associated with the design earthquake on the basis of theoretical modeling supported by an experimental study of the ground motion induced by earthquakes of various sizes and types from a more active tectonic environment.

The following are phases of a proposed investigation to estimate site-specific response spectra for an eastern United States design earthquake, such as the 1897 Giles County, Virginia event.

1. SPECIFICATION OF THE DESIGN EARTHQUAKE

The design earthquake is described in terms of its maximum epicentral intensity and its nearest probable approach to a site. The Giles County earthquake is an historic event with no instrumentally determined magnitude. In a first step, the historic event will be assigned a magnitude inferred from an empirical study of magnitude versus felt area relationships. One of these relationships that has exhibited some degree of stability for eastern events correlates magnitude with the area confined by the Intensity IV isoseismal. Available isoseismal maps for the Giles County event will be studied and evaluated to infer a reasonable magnitude for this design earthquake.

2. STUDY OF REGIONAL SEISMIC WAVE TRANSMISSION AND CRUSTAL AMPLIFICATION

The existing technical literature illustrates that seismic energy is anisotropically transmitted through the southern Appalachian region, probably due to the pronounced linear trends of the folded and thrust faulted province.

The propagation of seismic waves as a function of path parallel or transverse to the structural trends, will be investigated. This effort will include: 1) identification of quarrying operations suitable for an attenuation study (in terms of locations, operational periods, blast yields, shot delay used); 2) identification of all well-calibrated seismograph stations operating in the area; 3) identification of small and moderately large earthquakes, magnitude ≥ 3, strategically located in the southern Appalachians since the 1960's; 4) collecting and analyzing existing blast or earthquake seismograms to determine local attenuation characteristics and crustal amplification. Major sources for the seismic data will be the Long Range Seismic Measurement Program (LRSM) and the World Wide Standard Seismograph Network (WWSSN); 5) possible on-site monotoring for particular events.

3. GROUND MOTION INDUCED BY MODERATELY SIZED EARTHQUAKES

The available instrumental seismic data will be thoroughly searched for significant events recorded by nearby stations at distances of about 40 km or less. To be useful, the recording of these events must have preserved the entire dynamic range of the ground motion. Only stations with dual gain or broad dynamic [illegible] magnetic tape recordings, will provide usable recordings. A preliminary scan of the LRSM data indicates that at last one such event exists. Processing of this event (or events) will yield, for known magnitude(s), the corresponding Fourier spectra, describing the energy distribution of the recorded ground motion over various frequencies. The spectra determined in this section for moderate-size earthquakes will be the basis for an extrapolation, using the relations derived in the next section, of the ground motion to be expected from the design event.

It is hoped that the type of earthquake mechanism and the fault orientation of the event(s), as well as those of design earthquakes, may be estimated from the presently available data to place limits on the type of earthquakes to be studied in the next section.

4. GROUND MOTION STUDY OF EARTHQUAKES IN A MORE ACTIVE REGION

Theory indicates that the earthquake source, mechanism, stress drop, focal depth, etc. influence the shape of the source spectrum. The source spectrum, the transmission characteristics of the media, and the path orientation from the source to the stations and local site response subsequently determine the site spectra. Factors that influence the shape and level of the amplitude spectra will be investigated using a combination of theory and experimental data of well-recorded events from active areas such as western North America, or some other parts of the world.

Three principal reasons justify the study of earthquakes from a more active region. First, a better instrumental coverage can be expected, which increases the chances of finding a favorable azimuthal distribution of seismographs around an earthquake epicenter with a known focal mechanism. The effect of fault orientation or local crustal conditions cannot be studied without data gathered by a dense station coverage only realized in some active regions. Secondly, it is expected that the more active environment can provide events within a broader magnitude range, hopefully including both a magnitude and mechanism similar to the event studied in Section 3 and one equal or slightly larger than the design earthquake specified in Section 1.

Finally, studying moderately large earthquakes in an active region increases the likelihood of obtaining, for the same event, both accelerogram and seismogram data which will be used to compare strong motion inferred from seismograms with observed accelerogram strong motion.

Comparative analysis of the spectral similarities and differences, as a function of magnitude, fault orientation, etc., will result in the definition of experimental scaling relationships and parameteric variations to be used in Section 5 to define the ground motion to be expected by the eastern design earthquake.

In the event that the ideal data base just described cannot be obtained, and only partial azimuthal control is available, the distribution of seismic energy could be studied using seismic source modeling techniques.

5. DETERMINATION OF THE DESIGN EARTHQUAKE GROUND MOTION

Using relationships obtained in Section 4, the ground motion to be associated with the design earthquake will be extrapolated from the moderate-size event studied in Section 3. To be fully justified, such an extrapolation, which uses relationships derived from another region, would require that all parameters that govern the scaling laws as a function of magnitude be experimentally proven identical in both regions. Even though a certain control of some parameters can be obtained (e.g., type of mechanism, magnitude, crustal amplification), some others such as stress regime, fault orientation, etc. cannot be equally well determined. To compensate for such an uncertainty, relationships derived in Section 4 will be applied in their most conservative form.

Meeting Summary

Docket File
NRC PDR
Local PDR
TIC
NRR Reading
LWR #2 File
E. Case
R. Boyd
R. C. DeYoung
D. B. Vassallo
D. Skovholt
J. Stolz
K. Kniel
O. Parr
S. Varga
C. Heltemes
R. Houston
L. Crocker
D. Crutchfield
F. J. Williams
R. J. Mattson
H. Denton
D. Muller
Project Manager - H. Rood
Attorney, ELD
IE (3)
J. Lee
J. Knight
D. Ross
L. Rubenstein
W. Haass

R. Tedesco
R. Bosnak
S. Pawlicki
I. Sihweil
P. Check
T. Novak
Z. Rosztoczy
G. Lainas
V. Benaroya
T. Ippolito
V. Moore
R. Vollmer
M. Ernst
F. Rosa
W. Gammill
EP Branch Chief -
D. Bunch
J. Collins
W. Kreger
R. Ballard
B. Youngblood
J. Stepp
L. Hulman
L. Dreher
ACRS (16)
R. Denise
NRC Participants:
S. Chan
L. Reiter
P. Sobel
T. Bennett
E. Ketchen
E. Reis
C. Woodhead
J. Kane
A. Cardone
H. Silver
J. Rajan
C. Stahle
R. Hofmann