Date: 2/15/83

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In The Matter of	)	
	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454 OL
	)	50-455 OL
	)	
(Byron Nuclear Power Station,	)	
Units 1 & 2)	)	

SUMMARY OF TESTIMONY OF ANAND K. SINGH

Dr. Singh is a structural engineer employed by Sargent and Lundy, the Byron Station architect-engineer. Dr. Singh is a specialist in the area of seismic design of nuclear power plants, and has worked extensively on the seismic design of the Byron Station. His testimony is offered in response to that portion of League Contention 106 which challenges the appropriateness of the ground acceleration values selected for the Byron design.

Dr. Singh begins his testimony by describing his background and qualifications. (pp. 1-2). He then explains what is meant by the terms "safe shutdown earthquake" and "operating basis earthquake." (pp. 3-4). Dr. Singh's testimony goes on to explain the basis for his opinion that the ground acceleration values selected for Byron are appropriate. This explanation consists of a discussion of the manner in which the MM VIII intensity value of the design basis earthquake was selected and how that intensity value was translated into a ground motion value which is appropriate for the Byron site conditions. To show that the .2g ground motion value is appropriate, Dr. Singh compared it with the site specific spectrum generated for the Sequoyah Nuclear Power Plant site, and determined that for the frequency range of interest, the Byron design basis response spectrum closely corresponds to the Sequoyah site specific spectrum. The Sequoyah site specific spectrum is based upon real accelerograms of earthquakes of similar magnitude as the Byron design basis earthquake recorded at rock sites. Thus, Dr. Singh concludes that use of the Sequoyah site specific spectrum was appropriate. (pp. 4-6).

Finally, Dr. Singh explains why the operating basis earthquake selected for Byron is appropriate. Instead of selecting a ground acceleration value equal to one half the safe shutdown earthquake value, Edison demonstrated through recurrence interval studies that it is not reasonable to expect an earthquake greater than an MM VI intensity earthquake with an acceleration value of .09 during the operating life of the plant. This is precisely the value selected for the operating basis earthquake. (pp. 6-7).

TESTIMONY OF

ANAND K. SINGH

Q1 Please state your name.

A1 Anand K. Singh.

Q2 By whom are you employed?

A2 Sargent and Lundy Engineers.

Q3 In what capacity?

A3 I am Assistant Head of the Structural Analytical Division.

Q4 Please describe your educational and professional background.

A4 I have a Doctor in Philosophy and Master of Science degree in Structural Engineering from the University of Illinois at Champaign-Urbana. These degrees were awarded in 1972 and 1970 respectively. I am a registered professional engineer and a registered structural engineer in the State of Illinois. I am a member of the American Society of Civil Engineers (ASCE), and a member of the Seismic Analysis Committee of the ASCE Nuclear Structures and Materials Committee, a member of the Working Group on the Seismic Analysis of Safety Class Structures of the ASCE Nuclear Standards Committee and a member of the ASCE Committee on Turbine Foundations. I have published numerous technical papers in the area of seismic and dynamic analysis of structures and piping. A list of my publications is attached to my testimony.

I joined Sargent and Lundy in 1972 as a Senior

Engineering Analyst. I was responsible for the development and maintenance of computer programs for seismic and dynamic analyses of structures and piping and for performing and/or reviewing seismic analyses of nuclear power plant structures. In 1975, I was promoted to the position of Supervisor of the Dynamic Analysis Section responsible for seismic and dynamic analysis of structures and the development of computer programs for dynamic and seismic analysis. In 1979, I was promoted to the position of Assistant Division Head. In that capacity, I supervise and coordinate the work of the Structural Analysis Section in preparation of analytical studies, special problem analyses, and computer program development. In 1980, I was made an associate of Sargent and Lundy.

Q5 What are your responsibilities with respect to the Byron Plant?

A5 Since 1974, I have been involved in the seismic analysis and review of the Byron Station. In particular, I have been involved in determining the appropriate seismic input for the design of the Byron Station, and review of the plant structure models and analysis methods.

Q6 To which contention is this testimony addressed?

A6 League Contention 106. In particular that portion of the contention which asserts "recent evidence from the central portion of the United States shows that neither the Byron designated safe shut down earthquake peak ground acceleration value of 0.20(g) nor the operating basis earthquake peak ground acceleration value of 0.09(g) are sufficiently conservative. Ground acceleration significantly greater than both of these values are possible at the Byron site."

Q7 What are the peak ground acceleration values which were selected for the seismic design of the Byron Station?

A7 The peak ground acceleration values for Byron are as stated in the League's Contention, that is, .20g for the safe shutdown earthquake and .09g for the operating basis earthquake.

Q8 Please define what is meant by safe shutdown and operating basis earthquake.

A8 As set forth in the NRC's regulations, 10 CFR Part 100, Appendix A, the safe shutdown earthquake, also commonly referred to as the design basis earthquake, is that earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is the earthquake that produces the maximum vibratory ground motion for which the structures, systems, and components which are necessary to enable a reactor to shut down and avoid major offsite exposures are designed to withstand.

The operating basis earthquake is that earthquake which, considering the regional and local geology and seismology and specific characteristics of local subsurface material, could reasonably be expected to affect the plant site during the operating life of the plant. It is the earthquake which produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional. If the vibratory ground motion exceeding that of the operating basis earthquake occurs during the life of the plant, the Commission's regulations require that the plant be shut down and that prior to resuming operations, it is demonstrated that no functional damage has occurred to those features of the plant necessary for the continued operation without undue risk to the health and safety of the public.

Q9 How were the ground acceleration values for Byron selected?

A9 The selection of ground acceleration values is closely connected to the determination of the intensity of the earthquake for which a facility is designed. Since it was determined that the faults in the Byron area are not capable faults, we were required to consider the intensities of earthquakes which had been experienced in the Byron region, and based upon a consideration of the geology of the area, postulate the occurrence of an earthquake near the Byron site with an intensity at least as great as that experienced in the Byron region. The controlling earthquake for Byron was determined to be the 1937 Anna, Ohio MM VII-VIII earthquake. Since an MM VII earthquake was experienced in the Northern Illinois area, the NRC Staff required that the design basis earthquake be a MM VIII earthquake. This value was selected for reasons of conservatism; no MM VIII earthquake has ever been recorded in the Byron area.

To justify the selection of .2g surface ground motion we first determined the relation between the postulated MM VIII earthquake and its expected magnitude. Using studies which considered the intensity versus magnitude of earthquakes experienced in the Central United States we ultimately selected a magnitude value of 5.8. This value is conservative due to the fact that the studies indicate that for earthquakes in the Central United States an MM VIII intensity earthquake corresponds to an earthquake with a magnitude of 5.75. Moreover, the magnitude of the 1937 Anna, Ohio earthquake is estimated to range from 5.0 to 5.3, and the magnitude of the largest historical earthquake in the Byron area, the May, 1909 Northern Illinois earthquake is estimated to be 5.1.

We could then have computed a site specific response spectrum to attempt to demonstrate that the .2g ground motion value is appropriate for the Byron site. However, based upon a review of a site specific response spectrum which was calculated for the Tennessee Valley Authority's Sequoyah Nuclear Power Plant, it was determined that such an effort was not required. The Sequoyah site specific spectrum was generated for a 5.8 magnitude earthquake, based on real accelerograms of earthquakes recorded at rock sites, at epicentral distances of less than 25 km. A Byron site specific spectrum would have utilized these same parameters. Thus, we compared the Sequoyah spectrum to the Byron design basis ground motion. The comparison demonstrates that the Byron design basis response spectrum closely corresponds to the Sequoyah site specific spectrum in the frequency range of interest and is therefore appropriate for the Byron site.

In determining the ground acceleration value for the operating basis earthquake, we focused on the earthquake, and associated ground acceleration, which could reasonably be expected to affect the plant site during the operating life of the plant. The earthquake selected was an MM VI earthquake with a corresponding ground acceleration value of .09g. To determine whether such an earthquake could reasonably be expected to occur sometime during the 40 year life of the Byron plant, we calculated its expected recurrence interval. Edison calculated its recurrence interval to be approximately 2150 years. Lawrence Livermore National Laboratories, acting as a consultant to the NRC, also performed a recurrence interval calculation, and concluded that the recurrence interval for the .09g earthquake was in the 200 to 1000 year range.

Q10 Does the difference in the Commonwealth Edison Company and Lawrence Livermore Lab conclusions regarding the recurrence interval affect your opinion regarding the appropriateness of the .09g level selected for the operating basis earthquake?

A10 No, for two reasons. First, even if you accept the Lawrence Livermore conclusion, the 200 year to 1000 year range is still conservative regarding whether such an earthquake could reasonably be expected to affect the Byron plant. Second, and more importantly, since the Byron plant is designed to withstand a design basis earthquake of .2g and would be required to shut down in the event an earthquake with a ground acceleration in excess of .09 occurs during its operating life and be inspected and demonstrated to be operable before it is permitted to resume operations, the public health and safety will be adequately protected.

Q11 Dr. Singh, are you aware of any new information which would lead you to question whether the ground acceleration values chosen for Byron are adequately conservative?

A11 No, I believe these acceleration values to be conservative.

ANAND K. SINGH

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ANAND K. SINGH

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"An Integrated and Interactive Piping Analysis and Design Information System", coauthor C. A. Podczerwinski, Proceedings of the General Engineering Conference, March 1982, Chicago, Illinois