UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322
	)	
(Shoreham Nuclear Power Station)	)	

NRC STAFF TESTIMONY OF SANG BO KIM AND ROBERT L. ROTHMAN ON SEISMIC DESIGN

(SOC CONTENTION 19(e))

OUTLINE OF TESTIMONY

SOC alleges that the seismic design for Shoreham is inadequate in that it is not based on the standards in Regulatory Guides 1.60 and 1.61 The design response spectra for Shoreham were not based on Regulatory Guide 1.60; the Staff did not apply Regulatory Guide 1.60 to plants with operating license applications docketed before January 1, 1977. The spectra used in the Shoreham design were, however, found to meet the applicable requirements of 10 C.F.R. Part 50 Appendix A and Part 100 Appendix A. SOC contends that Regulatory Guide 1.61 allows a value of only 4% for damping while the Shoreham design used a value of 5%. Regulatory Guide 1.61 allows a value of 4% for structural damping; the Shoreham design uses a value of 5% for structural and soil damping. Use of the 5% damping value at Shoreham was appropriate and not contrary to anything in Regulatory Guide 1.61.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322
	)	
(Shoreham Nuclear Power Station)	)	

NRC STAFF TESTIMONY OF SANG BO KIM AND
ROBERT L. ROTHMAN CONCERNING SEISMIC DESIGN
ON SOC CONTENTION 19(e)

Q. Please state your respective names and positions with the NRC.

A. (SBK) My name is Sang Bo Kim. I am a Senior Structural Engineer in the Structural Engineering Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. A copy of my professional qualifications is attached.

A. (RLR) My name is Robert L. Rothman. I am employed as a Seismologist in the Geosciences Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. My work includes the technical review and evaluation of the acceptability of proposed and operational nuclear reactor sites with respect to the seismological aspects of the sites. My work includes the use of my expertise in the areas of seismicity, rupture mechanics, seismic wave propagation, and seismic instrumentation. A copy of my professional qualifications is attached.

Q. What is the purpose of this testimony?

A. (SBK, RLR) The purpose of this testimony is to respond to SOC Contention 19(e) which states:

> A major contributing factor in the TMI-2 accident was that operating plants were not required by the NRC Staff (Staff) to be in compliance with current regulatory practices (i.e., Regulatory Guides, Branch Technical Positions, and Standard Review Plans). The TMI-2 accident also demonstrated that the current regulatory practices, practices similar to those being applied by the Staff in their safety evaluation of Shoreham, were in a number of cases not suitably conservative to properly protect the health and safety of the public (i.e. hydrogen generation, radiation shielding, source terms, and single failure criterion).
>
> SOC contends that the NRC Staff has not required LILCO to incorporate measures to assure that Shoreham conforms with the standards or goals of safety criteria contained in recent regulatory guides. As a result, the Staff has not required that Shoreham structures, systems, and components be backfit as required by 10 C.F.R. § 50.55a, § 50.57, and § 50.109 with regard to:
>
> * * * * * * * * * * * * * * * *
>
> (e) Regulatory Guides 1.60 and 1.61. -- The design response spectra for the seismic design of Shoreham are not based on the standards in Regulatory Guide 1.60. Thus, the spectra have not been demonstrated to be sufficiently conservative to comply with 10 C.F.R. Part 50, Appendix A, Criterion 2, and 10 C.F.R. Part 100, Appendix A. In addition, LILCO did not use the Regulatory Guide 1.61 value of damping (4%) for the operating basis earthquake analysis of Category I reinforced concrete structures, but rather utilized a higher value of damping (5%), thereby also violating the regulations just cited.

Q. Please describe the areas each of you will address in your testimony.

A. (SBK) My testimony addresses SOC's contention that the damping value for concrete structures used for the seismic analysis of the Shoreham Plant is higher than that allowed by Regulatory Guide 1.61.

A. (RLR) My testimony deals with the part of Contention 19(e) which states that "[t]he design response spectra for the seismic design of Shoreham are not based on the standards in Regulatory Guide 1.60. Thus, the spectra have not been demonstrated to be sufficiently conservative to comply with 10 C.F.R. Part 50, Appendix A, Criterion 2 and 10 C.F.R. Part 100, Appendix A."

Q. We will first address the question of damping. Mr. Kim, could you please briefly describe damping?

A. (SBK) Two types of damping are involved here, structural damping and soil damping. Structural damping is a measure of energy dissipation of a structure under dynamic excitation. Soil also dissipates energy of structural vibration. The dissipation of energy from a structure to the surrounding soil is known as soil damping. When one investigates the adequacy of the structure for a seismic motion, the response of the structure is calculated by means of the equation of motion which is primarily based on Newton's Law. Damping value is one of several parameters in the equation. The response of the structure decreases as the damping value increases.

Q. What is the basis for justifying the use of a damping value greater than 4% in the seismic design of Shoreham?

A. (SBK) The damping value specified in Regulatory Guide 1.61 for the OBE, 4%, addresses only structural damping. The 5% damping value used by Applicant, as indicated in FSAR Section 3.7.1.3A, consists of a

combination of structural and soil damping. A soil damping value is generally larger than a structural damping value. When combined, the overall damping value (although not a sum of the two separate damping values) is larger than the structural damping value standing alone. The Staff considers the use of 5% overall damping to be acceptable.

Q. We will now address the part of the Contention addressing Regulatory Guide 1.60. Dr. Rothman, does either 10 C.F.R. Part 50 Appendix A or 10 C.F.R. Part 100 Appendix A specify the use of Regulatory Guide 1.60?

A. (RLR) No, neither 10 C.F.R. Part 50 Appendix A nor 10 C.F.R. Part 100 Appendix A specifies the use of Regulatory Guide 1.60.

Q. Could you please describe the role of Regulatory Guide 1.60?

A. (RLR) Regulatory Guide 1.60 is applied as indicated in the NRC's Standard Review Plan (NUREG-0800). Revision 2 (July 1981) of the Standard Review Plan, in discussing the acceptance criteria of seismic design (page 2.5.2-2) states, "The seismic design bases are predicated on a reasonable, conservative determination of the safe shutdown earthquake and the operating basis earthquake. As defined in Section III of 10 C.F.R. Part 100, Appendix A (Ref. 3), the SSE and OBE are based on consideration of the regional and local geology and seismology and on the characteristics of the subsurface materials at the site and are described in terms of the vibratory ground motion which they would produce at the site. No comprehensive definitive rules can be promulgated regarding the investigations needed to establish the seismic design bases; the requirements vary from site to site."

Regulatory Guide 1.60 represents an approach which the staff considers acceptable to establish conformance with the Nuclear Regulatory Commission regulations, but it is not specified as the only acceptable means of meeting the regulations. 10 C.F.R. Part 100 Appendix A Section VI paragraph (a) in discussing the vibratory ground motion for the safe shutdown earthquake states "In view of the limited data available on vibratory ground motions of strong earthquakes, it usually will be appropriate that the response spectra be smoothed design spectra developed from a series of response spectra related to the vibratory motions caused by more than one earthquake." The Regulatory Guide 1.60 response spectrum is a smoothed spectrum which was developed using earthquake acceleration time histories from events with a range of magnitudes and epicentral distances.

Q. Did Applicant use a smoothed design spectrum in designing the Shoreham facility?

A. (RLR) Yes, the Applicant used a modified Housner response spectrum in its design of Shoreham. Like the Regulatory Guide 1.60 spectrum, the Housner spectrum is a smoothed spectrum which was developed from earthquake acceleration time histories from events with a range of magnitude and epicentral distances. These spectra were not specifically designed for use at any one site, but were developed for use with differing reference peak accelerations (anchor points) to estimate different earthquake conditions.

Q. Could you describe the Shoreham response spectrum in more detail?

A. (RLR) The Shoreham response spectrum is a modification of the Housner response spectrum. At frequencies above about 2 Hertz it conincides with the Housner spectrum normalized to a peak ground acceleration of 0.20g. At frequencies below about 1 Hertz the Shoreham response spectrum is about 1.4 times higher than the Housner response spectrum normalized to a peak ground acceleration of 0.20g. At frequencies between 1 and 2 Hertz the Shoreham response spectrum is between these values. As was stated in the staff's Safety Evaluation Report, the Shoreham response spectrum is somewhat more conservative than the Housner spectrum, although it is less conservative than the Regulatory Guide 1.60 spectrum.

Q. Why did the Staff not evaluate the Shoreham facility against the standards adopted in Regulatory Guide 1.60?

A. (RLR) As indicated earlier, the use of Regulatory Guide 1.60 as an acceptance criterion for the adequacy of the seismic design of nuclear plants is identified in Section 2.5.2 of the Standard Review Plan (NUREG-0800, formerly NUREG 75/087). When the Standard Review Plan was first promulgated, the NRC Staff determined that it would be applied to plants with operating license applications which were docketed after January 1, 1977. Shoreham's OL application was docketed in January of 1976.

Q. What were the regulatory requirements used by the NRC Staff in reviewing the seismic design of the Shoreham facility?

A. (RLR) The Shoreham plant was required to meet the requirements of 10 C.F.R. Part 50 Appendix A and 10 C.F.R. Part 100 Appendix A. As mentioned earlier, neither specifies the use of Regulatory Guide 1.60.

Q. Did the Staff accept the use of a modified Housner spectrum anchored at 0.2g for the seismic design basis for the Shoreham site?

A. (RLR) Yes. The Staff's basis for this acceptance is set forth in Section 2.5.2 of the Shoreham SER. As indicated earlier, Appendix A to 10 C.F.R., Part 100 states that "it usually will be appropriate that the response spectra be smoothed design spectra developed from a series of response spectra related to the vibrating motions caused by more than one earthquake." The Housner spectrum is such a smoothed spectrum developed from the strong motion acceleration records of four earthquakes, all of magnitude 6.0 or greater. The Shoreham response spectrum is a modified Housner spectrum in that its spectral values are greater than those of the Housner spectrum at frequencies less than 2 Hertz.

The controlling earthquake for the seismic design of Shoreham is a Modified Mercalli intensity VII. This was characterized in the SER as being equivalent to a magnitude 5-1/2. The Staff now accepts the relationship developed by Professor Otto Nuttli which equates an epicentral Modified Mercalli intensity VII with a magnitude of 5.3. As stated in the SER, the Staff found that because magnitude 5-1/2 earthquakes were adequately represented in determining the spectral shape of the Housner spectrum that the Applicant's spectrum is acceptable. The Staff found that the reference acceleration value of 0.2g is conservative.

Q. Gentlemen, could you please provide brief conclusions to your testimony.

A. (SBK) The Regulatory Guide 1.61 damping value of 4% for the OBE referenced in the contention is a value for structural damping only. The 5% damping value used by Applicant includes both structural and soil damping. Use of this 5% value does not contradict Regulatory Guide 1.61 and is acceptable to the Staff.

A. (RLR) The Staff did not apply Regulatory Guide 1.60 in its review of the Shoreham design response spectrum because Shoreham's applicantion for an operating license was docketed before January 1, 1977. The Staff did apply the requirements of 10 C.F.R. Parts 50 and 100 and found the modified Housner spectrum used in the Shoreham design to be acceptable.

PROFESSIONAL QUALIFICATIONS
SANG BO KIM

My name is Sang Bo Kim. I am a Senior Structural Engineer in the Structural Engineering Branch, Division of Engineering, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission.

I received a B.S. degree in Engineering Mechanics from the University of Illinois in 1960, a M.S. degree in Applied Mechanics from Rensselaer Polytechnic Institute in 1965, and a M.S. in Applied Mathematics from New York University in 1968.

Prior to joing the Nuclear Regulatory Commission, I was a Supervisory Engineer for David Ehrenpreis, Consulting Engineers (1960 - 1963), a Stress Analyst for Combustion Engineering (1963 - 1965); a Senior Engineer for the Singer Company (1965 - 1968), a Senior Engineer for Gulf United Nuclear Fuels Corporation (1968 - 1971), and a Lead Engineer for Nuclear Fuels Service (1971 - 1972).

I joined the NRC in 1972 as a Structural Engineer in the Transportation Branch of the Office of Nuclear Materials Safety and Safeguard. From 1973 to 1979 I was a Reactor Engineer with the Core Performance Branch of the Office of Nuclear Reactor Regulation, from 1979 to the present I have been a Senior Structural Engineer with the Structural Engineering Branch of the Office of Nuclear Reactor Regulation. My present duties include: evaluating the structural and earthquake engineering aspects of safety-related structures, systems and components, as proposed in Safety Analysis Reports, from the standpoint of functional capability and integrity, under normal plant operation, and for safe plant shutdown during normal, transient, accident and environmental conditions; performing independent calculations and engineering analyses to confirm or verify applicants' or vendors' assessment of structural integrity and response under pertinent load combinations, including postulated transient and accident conditions; and performing on-site technical audits of applicants' plant designs for selected structures and systems in the branch's area of responsibility to observe "as built" implementation of NRC Safety criteria.

ROBERT L. ROTHMAN
GEOSCIENCES BRANCH
DIVISION OF ENGINEERING
U. S. NUCLEAR REGULATORY COMMISSION

My name is Robert L. Rothman. I am presently employed as a Seismologist in the Geosciences Branch, Division of Engineering, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

PROFESSIONAL QUALIFICATIONS

I received a B.S. degree in Geology from Brooklyn College and M.S. and Ph.D. degrees in Geophysics from the Pennsylvania State University.

I have been employed by the NRC since October 1979 as a Seismologist in the evaluation of the suitability of nuclear power plant sites. My areas of expertise include seismicity, rupture mechanics, seismic wave propagation and seismic instrumentation. I am now or have been responsible for the seismological safety review of approximately ten nuclear power plant sites.

From 1975 through 1979, I was employed by the U. S. Air Force Technical Applications Center as a Seismologist in the nuclear explosion detection program. I was involved in several projects of this program both as a Technical Project Officer and as a researcher. These projects included the detection of and the discrimination between underground explosions and earthquakes, magnitude and yield relationship studies, seismic network detection and location capability studies, regional and teleseismic wave propagation studies and projects to operate seismic instrument arrays and automatic data processing and communications systems.

From 1965 through 1970 I was employed as a Seismologist by the U. S. Coast and Geodetic Survey. In this position I was involved in studies in the areas of engineering seismology, seismicity and earthquake aftershock sequences. This work was performed as part of a program to investigate seismic hazard in the United States.

From 1959 to 1961 and during 1964-1965 I was an Engineering Geologist with the New York State Department of Public Works. In this position, I conducted geophysical field surveys in support of construction projects such as bridges, buildings and highways.