UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO REDUCED SEISMIC CRITERIA METHODOLOGY

COMMONWEALTH EDISON COMPANY

BYRON NUCLEAR POWER STATION, UNITS 1 AND 2

BRAIDWOOD NUCLEAR POWER STATION, UNITS 1 AND 2

DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3

LASALLE COUNTY STATION, UNITS 1 AND 2

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

ZION NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. STN 50-454, STN 50-455, STN 50-456, STN 50-457, 50-237, 50-249, 50-373, 50-374, 50-254, 50-265, 50-295 AND 50-304

1.0 INTRODUCTION

By letter dated March 23, 1994, Commonwealth Edison Company (ComEd, the licensee) responded to staff questions raised during the inspection process regarding the subject of seismic loading for evaluation of temporary conditions. On April 28, 1994, the staff met and discussed the issue with the representatives of ComEd. By letter dated August 8, 1994, ComEd provided its response to six staff questions raised during the meeting along with its Technical Information Document that controls the evaluation of seismic loading for temporary conditions (SLTC). The licensee also provided assessments of the SLTC criteria performed for ComEd by independent consultants. On September 15, 1995, the NRC issued its response letter to ComEd regarding the application of reduced seismic criteria for temporary conditions. This assessment discusses the staff's preliminary findings related to the SLTC criteria.

2.0 ASSESSMENT

ComEd implemented a quantitative procedure for using site-specific seismic hazard curves to determine reduced acceleration levels for evaluating temporary conditions of estimated short durations ranging from several days to months. The procedure utilizes the plant design-basis safe shutdown earthquake (SSE) and operational basis earthquake accelerations to determine

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corresponding accelerations for seismic adequacy for temporary conditions with estimated short durations.

Key elements of the licensee's procedure are: (1) for a given temporary condition, applicable short duration t_d is selected followed by selection of a reduced acceleration such that the probability of exceeding this acceleration in t_d equals the probability of exceeding the plant SSE in 1 year; (2) seismic hazard curves from both Lawrence Livermore National Laboratory and Electric Power Research Institute studies are used to determine the reduced acceleration; and (3) temporary conditions are evaluated for the duration-dependent acceleration using final safety analysis report (FSAR) allowables. The licensee also uses a method for calculating a "No-Seismic-Limit-Duration (NSLD)" corresponding to each hazard curve such that for durations smaller than the NSLD, seismic effects do not have to be considered as a load case. As a part of this approach, the licensee uses an acceleration threshold of 0.02g as one which is acceptably small so as not to require a specific seismic evaluation.

The reduced accelerations for various short durations are said to be insensitive to the choice of hazard curves and are, in general, dependent on the shape or the slope of the hazard curves. The procedure models the occurrence of earthquakes as a Poisson process and assumes that separate events occur independently of each other. In order to avoid possible abuse of the method by intentionally selecting an unjustifiably short duration to reduce seismic loads, the procedure imposes a penalty by using durations cumulatively, if an extension of a temporary duration is required.

The staff reviewed the licensee's submittals and identified the following technical concerns.

The basis for computing the reduced accelerations for temporary conditions as indicated in the submittals was said to maintain the same level of safety during the temporary condition as provided by the plant licensing design-basis. The definition of quantitative measure of safety or risk has traditionally been associated with frequency or events per unit time. Use of the probability of exceeding some seismic capacities as a measure of equivalent safety may not be totally appropriate. Since the frequency of exceeding the SSE for a given site is constant and independent of the duration, and the frequency of exceeding a less than SSE acceleration value (a reduced seismic load) for a site would obviously be higher than that of exceeding the SSE for the same site (refer to any hazard curve), the risk (as measured by frequency of exceeding the structural capacity per unit time) associated with temporary conditions for structures and components designed for a less than SSE seismic load would be higher than that of safety-related structures, systems, and components (SSC) designed for the SSE. It should be recognized that the use of ComEd's procedure involves acceptance of a higher risk for the temporary structures for a shorter period than that for the SSCs for 1 year. The concept of interpreting "the maintenance of the same probability of exceeding a reduced seismic load during a temporary condition as the probability of exceeding SSE during one year," as achieving the same

level of safety is inconsistent with the traditional definition of safety or risk and is considered a weakness of the procedure.

The approach of risk averaging over time, proposed by one of the licensee's consultants, is judged to be a more reasonable one than ComEd's approach. The risk-averaging method is based on a limit on time-averaged frequency and it is this approach that forms the main technical basis for the staff's assessment of the procedure.

The use of Poisson distribution of earthquake occurrence assumption does not consider certain aspects of seismicity (e.g., earthquake swarms or after shocks). Furthermore, the assumption of memory-less behavior of earthquake occurrences by Poisson processes is not physically consistent with the elastic rebound theory, which implies that a zone of recent past activity is less likely to be the source of the next earthquake than a previously active locality which has been relatively dormant for some time. The assumption of constant averaged-occurrence rate of earthquake ignores some time-dependent aspects of the phenomena. Additionally, the development of the associated hazard curves may have been based on unrealistic assumptions (e.g., the equal likelihood of occurrence of earthquake along a fault line or within an homogeneous activity source). The curves are also known to possess a large amount of uncertainty due to lack of data or knowledge. Therefore, the quantitative aspects of the hazard data as well as the results of SLTC evaluation can not and should not be used without application of sound engineering judgment and appropriate conservatism. The unrestricted use of the results of the licensee's procedure, which is based in part on unverified assumptions and on data which contains large uncertainties, is a major concern.

Because of the above concern, the following limitations should be imposed on the application of the SLTC method.

The application of the licensee's procedure to reduce seismic loads for temporary conditions should be such that its application would not simultaneously compromise or permit seismic capacity reduction of components in both of the two dedicated seismic success paths (refer to EPRI NP-6041, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin," dated October 1988), each of which is pre-selected and verified to be able to achieve an independent safe shutdown of the plant under design-basis conditions including the occurrence of the SSE. Additionally, if in any one calendar year, both success paths are compromised, the accumulated temporary duration of both paths should be used in computing the permitted seismic load reduction factor.

Good engineering practice would also dictate that each temporary condition should be evaluated by a qualified structural engineer with respect to the applicability of the potential interaction between non-seismic Category I versus seismic Category I SSCs, i.e., the seismic II/I consideration. If the evaluation reveals that a legitimate II/I issue exists, then the proposed seismic load reduction factor should not be applied and the II/I evaluation

criteria of the Standard Review Plan (SRP) Section 3.7 should be fully implemented.

A limit for the maximum seismic load reduction should be applied for a group of temporary conditions directly affecting the configurations, loads, boundary conditions, support geometries, system stiffness, and dynamic response characteristics of safety-related SSCs. For this subset of temporary conditions (e.g., rigging loads on safety-related structural members, lead blankets placed on SSCs for temporary radiation shielding, removal of snubbers or supports from piping or components for testing and maintenance, temporary structures to support maintenance and modifications of SSCs), any temporary condition with a computed reduced seismic load, based on the SLTC procedure, of less than 0.1g should be adequately verified by a "simplified static analysis" using an acceleration of 0.1g horizontal seismic load in combination with other applicable loads and the results should be properly documented by a qualified structural engineer. The use of pre-engineered charts or tables to expedite implementation of the 0.1g static qualification for this group of temporary conditions may be considered.

With respect to the use of the "No-Seismic-Limit-Duration (NSLD) concept," the staff acknowledges that temporary structures and supports do possess some inherent seismic capacity. However, when the proposed activities involve safety-related SSCs of nuclear facilities, for which the consequences of their unexpected failures may be extremely severe, an indiscriminate application of the NSLD to temporary conditions is judged by the staff as lacking prudence and proper conservatism. It is the staff's position that application of the NSLD provision be limited to a group of less safety significant temporary conditions (e.g., temporary scaffolds for human access, temporary cables/power line supports for maintenance and repair, unanchored temporary equipment (e.g., mobile tool carts, air compressor, or drilling units)). The proposed 0.02g as basis for determining the NSLD is considered reasonable for use with this second group of temporary conditions.

Formal management review and approval procedures should be developed and installed to control the proper application of the methodology. The provisions of Appendix B to 10 CFR Part 50 should apply to the procedures to be implemented. Additionally, the hazard curves which were used in estimating the reduced seismic loading for temporary conditions for each of the listed ComEd plants are not part of the licensing bases for the plants. These plant-specific hazard curves should be properly incorporated into the facility FSARs as part of the plants' licensing data bases via formal amendment of pertinent licensing basis documents.

Not withstanding the above concerns, the staff agrees that a well-governed program that includes temporary reductions in seismic requirements could be implemented without an unacceptable reduction in plant safety. However, as stated in the Office of Nuclear Reactor Regulation's (NRR) letter to ComEd, dated September 15, 1995, given the complexities of this issue and the inherant potential for such programs to reduce seismic capabilities to an undesirable level, NRC review and approval is considered appropriate and

necessary. Accordingly, it has been determined that the submittal of a license amendment in accordance with 10 CFR 50.59(c) and 10 CFR 50.90 would be the most efficient method to pursue in order to achieve the desired flexibility in dealing with temporary conditions, while ensuring compliance with applicable NRC regulations and the licensing basis of the facility as described in the Updated Final Safety Analysis Report. However, until such time as the staff reviews and approves an alternate methodology, ComEd should evaluate temporary conditions such that design-basis seismic capability is maintained or the operability of affected SSCs should be evaluated in accordance with the guidance provided in Generic Letter 91-18, "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded And Nonconforming Conditions and on Operability."

This preliminary assessment of the SLTC procedure is limited to the plants listed in the ComEd submittals.

3.0 CONCLUSIONS

The licensee's procedure for evaluation of seismic loading for temporary conditions for the ComEd plants listed in the submittals, should consider the following elements:

1. The application of the procedure should not simultaneously compromise or permit seismic capacity reduction of components in both of the two dedicated seismic success paths.

2. The procedure should not apply if such application would create or result in II/I seismic-induced interference concerns.

3. For a group of safety significant temporary conditions directly affecting SSCs, a minimum 0.1g static seismic qualification of the conditions should be used rather than the results derived from the application of the procedure. Also, the NSLD part of the procedure should not apply to this group.

4. For the remainder of temporary conditions that do not directly affect the integrity of SSCs and are less safety significant, application of the entire SLTC procedure, including the NSLD provision, is reasonable.

5. Formal management review and approval of procedures reflecting the above-stated limitations should be developed and installed to control the legitimate application of the methodology. The plant-specific hazard curves should be incorporated into the facility FSARs.

6. This assessment of the SLTC procedure is limited to the plants listed in the ComEd submittals.

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Dated: October 30, 1995