May 12, 1997

Mr. Neil P. Smith, Chairman
Seismic Qualification Utility Group
c/o MPR Associates, Inc.
320 King Street
Alexandria, Virginia 22314

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING THE SEISMIC QUALIFICATION UTILITY GROUP PROCEDURE FOR EVALUATING THE ACCEPTABILITY OF NEW EARTHQUAKE EXPERIENCE DATA (TAC NO. M40580)

Dear Mr. Smith:

By letter dated December 19, 1996, the Seismic Qualification Utility Group (SQUG) submitted the "SQUG Procedure for Gathering and Evaluating New (Post 1985) Earthquake Experience Data." The NRC staff has performed a preliminary review of this document and determined that additional information is needed before the staff can conduct a detailed review of the submittal. The needed information is described in the enclosed Request for Additional Information.

In order to support the staff's review schedule, you are requested to provide the necessary information within 60 days of receipt of this letter. If you need additional time or if you have any questions about this request, please contact Mr. Dan Dorman at (301) 415-1429.

Sincerely,

Original signed by
John F. Stolz, Lead Project Director
Project Directorate I-2
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosure: Request for Additional Information

cc w/encl: Mr. R. Kassawara, EPRI
Program Manager
3412 Hillview Avenue
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REQUEST FOR ADDITIONAL INFORMATION

SEISMIC QUALIFICATION UTILITY GROUP REPORT (SQUG)

"GATHERING AND VALIDATING NEW (POST 1985) EARTHQUAKE EXPERIENCE DATA"

GENERAL COMMENTS

In general, there should be two separate procedures for providing an acceptable, well-controlled document on the use of earthquake experience data for any purpose:

I. The procedure for the establishment of an earthquake experience database; and

II. The procedure for screening, assessing, and applying the earthquake experience database.

SQUG's December 19, 1996, submittal, entitled "Gathering and Validating New (Post 1985) Earthquake Experience Data" is to address the first procedure stated above. With respect to the second procedure, for USI A-46 purposes, SQUG has developed GIP-2, and for the purpose of future seismic qualification of equipment, the industry is developing a "First of a Kind Engineering" (FOAKE) procedure. The staff has not reviewed the FOAKE procedure. In the resolution of the USI A-46 program, although the staff has approved the use of GIP-2 with some restrictions, the staff has not reviewed the details or approved the earthquake experience database, contrary to SQUG's statement in Section 1.0 (Purpose). SQUG's December 19, 1996, submittal, seems to contain both Procedures (I) and (II), although the title of the submittal is for Procedure (I) only. Therefore, the staff will review the information concerning Procedure (I) and will review only the areas in Procedure (II) that are pertinent to USI A-46 applications.

Although the staff has no intention to review any areas relating to the FOAKE project applications at this time, we noted, however, on Page 8 in Section 4.6.2 of the referenced SQUG's submittal, your statement that "A detailed review, including independent estimates of ground motion at the Reference sites, was prepared by David Boore of USGS...." We note that, of the 25 sites for which Boore prepared estimates, his estimate of the average spectral acceleration in the frequency range of 3 to 8 Hertz for 14 of the sites is less than that of the FOAKE Project Team estimates. Potentially, your statement could be subjected to misinterpretation and could lead to the assumption that Boore agreed with the FOAKE Project Team estimates.

For the earthquake experience-based approach, in the collection of the database information, one needs to define the characteristics of the actual earthquake and input motion to the equipment, the dynamic characteristics of equipment, and resulting performance of the equipment. Sufficient information of this kind, when compiled and evaluated, will then serve as a basis for qualifying a candidate equipment by satisfying excitation and physical similarity principles.

The database equipment items should have been closely inspected post-earthquakes. Their seismic responses should have been adequately estimated and evaluated based on the information collected at the site. Any equipment damages caused by the earthquake should have been recorded in detail. Any equipment malfunction or anomalies that occurred during and after the earthquake should also have been documented, with the root causes properly evaluated. These damages and anomalies, when compiled and evaluated, are essential in establishing the caveats and in applying the excitation and physical similarity principles for the qualification of each equipment class or individual equipment items.

SPECIFIC COMMENTS

1. One page 1, acronyms (i.e., FOAKE, USGS, CDMG) should be spelled out before they are used.

2. On page 6, the database should include "description of anomalies, damage and failure," location of equipment (including the building) relative to the location where the ground motion was measured or estimated and "estimated g level."

3. On page 10, "education background" should be included in the requirements of the qualified personnel.

REQUESTED INFORMATION

The following is the staff's request for additional information (RAI):

1. Explain why you state, in the first paragraph on page 1 of the Procedure, "The experience data from sites subjected to strong ground motion earthquakes up to the 1985 time frame have been reviewed by the Senior Seismic Review and Advisory Panel (SSRAP) and approved as a part of the USI A-46 program efforts by the USNRC," when only a part of your data base was reviewed by SSRAP, and some of the data submitted as part of the USI A-46 program to NRC was rejected based on overestimation of the ground motion. In addition, many of the ground motion estimates in the earthquake experience data in the Topical Report "BWROG Report for Increasing MSIV Leakage Rate Limits and Elimination of Leakage Control Systems" submitted by the BWR Owners' Group are similar to the data provided in Table 1 of your current submittal and this data is being questioned by the NRC. (NRC letter from E. H. Trottier to T. A. Green of GE Nuclear Energy, dated March 29, 1995.) In Section II.5 of its Supplemental Safety Evaluation Report No. 2 (SSER No. 2) dated May 22, 1992, the staff indicated that it had not reviewed one of the SQUG's database summary reports. Identify and provide the specific quotes from the SSRAP and NRC documents which you asserted to support your statement.

2. Explain the apparent discrepancy where on page 2 in Section 3.0, you state that in Table 1, 87 of the 124 sites in the database are post-1985 sites, while in Table 1 you indicate that only 16 of the sites listed

have ground motion that were measured by an instrument at the site. Also, it is not clear how far these instruments were from the facility. These statements can mislead the reader to think that all 87 sites have accurate ground motions. Clarify and justify your statement so that it is evident to the reader how much dependable ground motion information is available.

3. On page 2 in Section 3.0, the seismic experience database was briefly described. However, the definition and scope of the experience database were not clearly described. An acceptable experience database should contain a well-organized and controllable document that can be referenced and tracked. Thus, the earthquake experience database should start from the raw data that is collected following an earthquake database site investigation. Then, the data should be screened, studied, and validated for the acceleration spectrum that was claimed for the equipment capacity. In order for the staff to evaluate the adequacy of the procedure for gathering and validating the earthquake experience data, the details of the database have to be reviewed and evaluated by the staff. Therefore (1) define clearly the scope of the so-called "Earthquake Experience Data Base," (2) describe the details of the equipment items in a referable and controllable report or electronic database, and (3) submit the report or electronic database for the staff's review. (The database may be divided into two or three groups to include those data from pre-1985, post-1985, and future collections).

4. It is stated in Section 3.0 (page 3) that the peak acceleration of the ground motion of a data base site could be as low as 0.10g to 0.15g. It is further stated that "a much larger and diverse set of equipment has been subjected to the lower level motion than the higher level motion." The merit of all experience data including those from the low-level ground motion is acknowledged. However, this merit can be realized only if the data are properly applied. One application is for direct comparison with site-specific equipment items. On the other hand, the equipment capacity estimation could be erroneous and unconservative if the low- and high-level data are combined such that data could be used to define the diversity of equipment and the high-level ground motion data are used to define the capacity of equipment. Specify the use of such low-motion data and, if they are combined with the high-level ground motion data to develop generic capacity levels, justify why they could not produce unconservative results.

5. On the top of page 3 you make the statement that "Measured or estimated ground accelerations for data base sites range from approximately 0.10g to 0.70g." Also, Table 1 of the report contains a list of about 125 earthquake-facility pairs with estimates of the average of the two horizontal components of peak ground acceleration (PGA) at the facility for 115 pairs. Of these 115 earthquake-facility pairs, the table indicates that for 20 of the facilities the PGA estimated is based on a measurement by an instrument at the site. For the other 95 earthquake-facility pairs the table indicates that the PGA estimate is based on the nearest accelerographs with no statement as to the distance between the

facility and the accelerographs. Furthermore, Section 4.2 (Ground Motion Estimates) of the report states that "Sites with no available instruments within a reasonable distance require estimation of average peak acceleration (a site response spectrum is unavailable for those sites). These ground motion estimates are made based upon review of motion estimates by recognized agencies (e.g. USGS, CDMG, etc)."

The ground motion from an earthquake at a particular site is a function of the earthquake source characteristics such as the magnitude, focal mechanism, radiation pattern, stress drop, location of asperities and fault rupture propagation history, and depth and orientation of the fault. It is also a function of the distance of the facility to the fault and the propagation properties of the rocks between them. The geology immediately under the facility site can also have an especially large effect on the amplitude and frequency content of the ground motion at the facility. It has been observed from numerous earthquakes that the variation of ground motion values within short distances can be substantial. Therefore, it is inappropriate to assign ground motion recorded at one location to a facility at another location without a very thorough analysis. The appropriate distance for a free field strong motion recording instrument used to characterize the earthquake ground motion experienced by the structure is on the order of one to two structure diameters from the structure. Even at this distance the foundation material of the structure and the recording instrument should be essentially the same.

In view of this, to enable the NRC staff to perform its review of the Procedure, for each of the earthquake-facility pairs in the experience data base provide the following information:

a. The name, location (latitude and longitude or street address or nearest highway intersection), and foundation geology (i.e., rock, deep soil, shallow soil) of the facility for which the ground motion estimate was made.

b. The name, date, time, epicenter, magnitude of the earthquake and distance of the facility to the closest part of the earthquake fault rupture.

c. The 5 percent of critical damping response spectra of the ground motion estimated for each horizontal component at the facility from the earthquake.

d. The method used to estimate the ground motion at the facility. If the ground motion is based on actual ground motion recordings, provide the location (latitude and longitude or street address or nearest highway intersection) and foundation geology of the recording station and its distance from the facility and its distance to the closest part of the fault rupture. If the estimation is based on a method other than an actual recording of the earthquake ground motion or if the recording station is not

collocated with the facility (distance from structure to instrument greater than 200 meters), describe the method used to estimate the ground motion in detail and provide any ground motion attenuation equations which may have been used to obtain the estimate. For ground motion estimates based "... upon review of motion estimates by recognized agencies (e.g. USGS, CDMG, etc)," provide copies of the material upon which your estimate is based.

6. On page 3 of the Procedure you state that "the data obtained at the lower level of ground motion sites was used as confirmatory data in support of the conclusions which could be reached based on equipment performance at the highest level sites." It is not clear what this statement means. Provide a detailed description of the analysis that was performed and the justification for the quoted statement.

7. Section 4.1 states that "any damage or failures that would result in changes to any of the SQUG methodology are incorporated into a revision of the GIP..." Are there any examples of equipment failures, significant or insignificant, in the post-1985 experience data, leading to the potential GIP changes? If so, provide detailed examples including data on equipment damage/failures so that the effectiveness of the procedure can be evaluated.

8. As implied in Section 4.2, the ground motion estimates are made from "instruments available on-site, instruments available within several Km," or "no recordings at all." The practical difficulties, e.g., unavailability of recording instruments, information concerning the soil conditions, etc., are recognized. But, a question still remains regarding the reliability of such ground motion estimates and was reviewed by a group of independent experts (e.g., the SSRAP), and expert judgements played a major role in this usage. It appears from the procedures described in the document that similar expert review and judgements are not a requirement any longer. Justify the reliability of the ground motion estimates, given the uncertainties, without a commitment to receive expert assistance.

   Furthermore, on page 7 in Section 4.6.1 of the Procedure you state "New earthquake experience data receives a peer review by the SQUG Steering Group members and by selected industry experts who are consultants to the Steering Group." Are any of the members of the Steering Group or the consultants seismologists knowledgeable in strong ground motion estimation? If yes, provide their names. By using the SQUG Steering Group members as the peer reviewers, you lose the independent nature of the peer review. The peer review group should conduct independent reviews.

9. A threshold spectral acceleration or reduction factor of 0.75 was presented in the last paragraph of Section 4.2. Provide the technical bases for the number (i.e., 0.75).

10. On page 9 in Section 5.0 you state, "Data base sites which have several ground motion recordings beyond 3 km proximity can use a carefully applied triangulation averaging approach as described in Section 4." However, Section 4 does not describe that approach, it just has the same statement as Section 5.0 (that a triangulation approach can be used). Provide a detailed description of your triangulation approach with actual case histories including the input data used and the ground motion estimate obtained. Explain how this approach considers such factors as focal mechanism radiation pattern, differences in site geology, different distances to the fault, etc which can lead to large uncertainty in strong ground motion estimates as noted in Question 5 above.

11. If information from new earthquakes indicates that equipment previously assumed to be able to survive a certain ground motion level has been damaged at a lower ground motion level, will the equipment be removed from the GIP and will the utilities and the NRC be notified pursuant to Part 21 of Title 10 of the Code of Federal Regulations?