



UNITED STATES
NUCLEAR REGULATORY COMMISSION
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URS/BLUM ENGINEERS

MEMORANDUM FOR: Leon Reiter, Acting Chief
Geosciences Branch
Division of Engineering

FROM: Jeff Kimball, Seismologist
Seismology Section
Geosciences Branch, DE

SUBJECT: UPDATED LIST OF REACTOR DESIGN EARTHQUAKE INPUT

As requested, enclosed is an up-to-date list of the seismic design basis input for all nuclear power plants. The list includes both OBE and SSE peak accelerations, type of response spectrum, and general foundation conditions. This list can be given to the operations center for their general use in determining the significance of earthquakes that may affect reactor sites.


Jeff Kimball, Seismologist
Seismology Section
Geosciences Branch
Division of Engineering

cc: J. Knight
L. Reiter
S. Brocoum
GSB Staff

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A. OPERATING REACTORS

<u>PLANT</u>	<u>SSE</u>	<u>OBE</u>	<u>SPECTRUM</u>	<u>FOUNDATION</u>	<u>REVIEWER</u>
Arkansas 1	0.20g	0.10g	Housner	Rock	Giese-Koch
2	0.20g	0.10g	Newmark		
Beaver Valley 1	0.12g	0.06g	Newmark*	Soil	Giese-Koch
Big Rock Pt.	0.05g	None	UBC	Soil	Kimball
	0.10g		SEP#		
Browns Ferry 1-3	0.20g	0.10g	Mod. Housner*	Rock	Ibrahim
Brunswick	0.16g	0.09g	Newmark*	Soil	Pothman
Callaway	0.20g	0.10g	R.G. 1.60	Rock	Rothman
Calvert Cliffs 1-2	0.15g	0.08g	Housner	Soil	Kimball
Cook 1-2	0.20g	0.10g	Housner*	Soil	Rothman
Cooper	0.20g	0.10g	Housner*	Soil	Giese-Koch
Crystal River	0.10g	0.05g	Housner*	Rock	Ibrahim
Davis-Besse	0.15g	0.08g	Newmark	Rock	Giese-Koch
Dresden 2-3	0.10g	0.067g	Housner*	Rock	Rothman
	0.12g		SEP#		
Duane Arnold	0.18g	0.09g	Housner*	Soil	Rothman
	0.12g	0.06g		Rock	
Farley	0.10g	0.05g	Newmark	Rock	Kimball
Fermi 1-2	0.15g	0.08g	Housner	Rock	Kimball
	0.15g		SSSP**	Rock	
Fitzpatrick	0.15g	0.08g	Housner*	Soil	Giese-Koch
Ft. Calhoun	0.17g	0.08g	Housner*	Soil	Kimball
Ft. St. Vrain	0.10g	0.05g	Housner*	Soil	Sobel

A. OPERATING REACTORS

<u>PLANT</u>	<u>SSE</u>	<u>OBE</u>	<u>SPECTRUM</u>	<u>FOUNDATION</u>	<u>REVIEWER</u>
Ginna	0.20g 0.17g	0.10g	Housner SEP#	Rock	Giese-Koch
Grand Gulf	0.15g	0.07g	Newmark	Soil	Kimball
Haddam Neck	0.17g 0.20g	0.09g	Housner* SEP#	Rock	Sobel
Hatch 1 2	0.15g	0.08g	Housner* Mod. Newmark	Soil	Sobel
Indian Pt. 2-3	0.15g	0.10g	Housner	Rock	Ibrahim
Kewaunee	0.12g	0.06g	Housner	Soil	Ibrahim
LaCrosse	0.12g 0.10g	None	Newmark* SEP#	Soil	Kimball
LaSalle	0.20g	0.10g	Newmark	Soil	Rothman
Maine Yankee	0.10g	0.05g	Housner***	Rock	Rothman
McGuire 1 & 2	0.15g	0.08g	Newmark	Rock	Giese-Koch
Millstone 1	0.17g 0.18g	0.07g	Housner* SEP#	Rock	Kimball
2	0.17g	0.09g	Newmark*		
Monticello	0.12g	0.06g	Housner*	Rock	Giese-Koch
Nine Mile Pt.	0.11g	0.06g	Housner*	Rock	Rothman
North Anna 1-2	0.12g 0.18g	0.06g 0.08g	Newmark*	Rock Soil	Giese-Koch
Oconee 1-3	0.15g 0.10g	0.05g 0.05g	El Centro	Soil Rock	Sobel
Oyster Creek	0.22g 0.16g	0.11g	Housner* SEP#	Soil	Kimball
Palisades	0.20g 0.10g	0.10g	Housner SEP#	Soil	Rothman

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<u>PLANT</u>	<u>SSE</u>	<u>OBE</u>	<u>SPECTRUM</u>	<u>FOUNDATION</u>	<u>REVIEWER</u>
Peach Bottom 1-3	0.12g	0.06g	Housner*	Rock	Ibrahim
Perry	0.15g	0.08g	R.G. 1.60	Rock	Ibrahim
Pilgrim	0.15g	0.08g	Housner*	Soil	Giese-Koch
Point Beach	0.12g	0.06g	Housner*	Soil	Kimball
Prairie Island	0.12g	0.06g	Housner*	Rock	Ibrahim
Quad Cities	0.24g	0.12g	Housner*	Rock	Ibrahim
Rancho Seco	0.25g	0.13g	Housner	Soil	Giese-Koch
Robinson 2	0.20g	0.10g	Housner	Soil	Sobel
Salem 1-2	0.20g	0.10g	Housner	Soil	Kimball
St. Lucie 1 2	0.10g	0.05g	Housner R. G. 1.60	Soil	Rothman
San Onofre 1 1 2-3	0.50g 0.67g 0.67g	0.25g 0.34g	Housner SEP Mod. Housner** Mod. Newmark	Soil	Rothman
Sequoyah	0.18g 0.215g	0.09g	Mod. Housner	Rock SSSP**	Rothman
Summer	0.15g 0.25g 0.20g 0.35g	0.10g 0.15g	Mod. Newmark	Rock Soil Normal RISSRock+Soil ShallowRISSRock+Soil	Sobel
Susquehanna	0.15g 0.10g	0.08g 0.05g	Taft	Soil Rock	Sobel
Surry 1-2	0.15g	0.07g	Housner*	Soil	Giese-Koch
Three Mile Island-1	0.12g	0.06g	Newmark*	Rock	Ibrahim
Trojan	0.25g	0.13g	Housner	Rock	Kimball
Turkey Pt. 1-3	0.15g	0.05g	Housner	Rock	Rothman
Vermont Yankee	0.14g	0.07g	Housner*	Rock	Ibrahim

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<u>PLANT</u>	<u>SSE</u>	<u>OBE</u>	<u>SPECTRUM</u>	<u>FOUNDATION</u>	<u>REVIEWER</u>
Waterford	0.10g	0.05g	R.G. 1.60	Soil	Kimball
WNP-2	0.25g 0.31g	0.13g	R.G. 1.60 Swarm	Soil	Kimball
Yankee Rowe	0.05g 0.19g	None	UBC SEP#	Soil	Kimball
Zion	0.17g	0.08g	Housner	Soil	Rothman

B. PLANTS WITH OL SER'S

<u>PLANT</u>	<u>SSE</u>	<u>OBE</u>	<u>SPECTRUM</u>	<u>FOUNDATION</u>	<u>REVIEWER</u>
Braidwood	0.20g	0.09g	R.G. 1.60	Rock Soil	Rothman
Byron	0.20g	0.09g	R.G. 1.60	Rock Soil	Rothman
Catawba 1-2	0.15g	0.08g	Newmark	Rock	Giese-Koch
Clinton	0.25g	0.10g	R.G. 1.60	Soil	Giese-Koch
Comanche Peak	0.12g	0.06g	R.G. 1.60	Rock	Kimball
Diablo Canyon 1&2	0.40g 0.75g	0.20g 0.20g	Mod. Housner Mod. Newmark##	Rock	Rothman
Shearon Harris	0.15g	0.075g	R.G. 1.60	Rock	Sobel
Limerick	0.15g	0.075g	Newmark	Rock	Ibrahim
Midland 1-2	0.12g 0.12g	0.06g	Mod. Housner SSSP**	Soil	Kimball
Palo Verde	0.20g	0.10g	R.G. 1.60	Soil	Sobel
River Bend	0.10g	0.05g	R.G. 1.60	Soil	Kimball
Seabrook	0.25g	0.13g	R.G. 1.60	Rock	Ibrahim
Shoreham	0.20g	0.10g	Mod. Housner	Soil	Rothman
Watts Bar	0.18g 0.215g	0.09g	Mod. Newmark SSSP**	Rock	Rothman
Wolf Creek	0.20g 0.12g 0.15g	0.10g 0.06g	R.G. 1.60 R.G. 1.60 SSSP**	Rock SNUPPS Rock Other	Sobel

C. PLANTS WITH DSER'S

<u>PLANT</u>	<u>SSE</u>	<u>OBE</u>	<u>SPECTRUM</u>	<u>FOUNDATION</u>	<u>REVIEWER</u>
Beaver Valley 2	0.12g	0.06g	R.G. 1.60	Soil	Giese-Koch
Hope Creek 1	0.20g	0.10g	R.G. 1.60	Soil	Sobel
Millstone 3	0.17g	0.09g	Newmark	Rock	Kimball
Nine Mile 2	0.15g	0.08g	R.G. 1.60	Rock	Rothman

D. PLANTS WITH Q's OR PCP'S

Bellefonte	0.18g 0.215g	0.09g	R.G. 1.60 SSSP**	Rock	Rothman
Cherokee 1-3	0.15g	0.08g	R.G. 1.60	Rock	Giese-Koch
South Texas	0.10g	0.05g	R.G. 1.60	Soil	Ibrahim
Vogle 1-2	0.20g	0.12g	R.G. 1.60	Soil	Ibrahim
WNP-3	0.32g	0.16g	R.G. 1.60	Rock	Kimball

E. PLANTS CANCELLED AS OF 3/15/84

Zimmer - Yellow Creek - Bailey - Black Fox - Hartsville - Phipps Bend -
Clinch River - Pebble Springs - Skagit/Hanford - Marble Hill

F. PLANTS INDEFINITELY SHUTDOWN

Humboldt Bay - Three Mile Island 2

Notes

- * Identified by visual inspection only
- ** Site Specific Spectrum using real time histories. If this spectrum was found to exceed SSE spectrum a seismic margin analysis was performed.
- *** Currently being re-evaluated
- # Some SEP utilities actually re-evaluated the plant to a higher spectrum compared to the SEP spectrum.
- ## Reanalysis Spectrum
- \$ Both used as re-evaluation spectrum

MEMORANDUM

TO: James H. Conran, Sr.

FROM: SQUG Steering Group

DATE: December 6, 1991

RE: Staff Supplemental Safety Evaluation Report No. 2 on the SQUG Generic Implementation Procedure

Based on our discussions with the NRC Staff regarding its concerns with the GIP, Revision 2 (dated June 28, 1991), we understand Supplemental SER No. 2 may contain Staff positions and clarifications which may differ substantially from those set forth in the GIP. Some of these possible differences raise serious concerns, among other things, about the future usefulness of the GIP by A-46 plants for determining the seismic adequacy of new and replacement equipment and parts - one of the major reasons why SQUG members participated in development of the GIP and continue to support the USI A-46 resolution program.

SQUG understood that this and other issues had been resolved. In fact, Revision 2 of the GIP was "corrected" on June 28 to incorporate these resolutions, in many cases using the Staff's own words. We have not seen a copy of the draft SSER, but we discussed with the Staff some of its new concerns regarding the GIP on December 3, 1991. During this discussion, it appeared that the Staff was retreating from its past positions and would no longer assure A-46 plants that adherence to the GIP would ensure compliance with applicable regulations for seismic adequacy, including qualification. If true, this will completely undermine SQUG's efforts.

Over the past decade, SQUG has worked closely with the Staff to address USI A-46. Some of the most experienced and qualified seismic experts in the world have been involved in this effort and have fully endorsed the GIP methodology. Now, at the eleventh hour, it seems that the Staff may be backing away from its prior efforts and those of industry with regard to this issue, and intends to include some "clarifications" of the GIP in SSER No. 2. SQUG desires to move forward expeditiously, but will not do so at the expense of gutting the program's benefits. To obtain a clear and unequivocal statement of Staff intent regarding the few major points of apparent confusion of which SQUG is aware, we have prepared questions and expected answers (Attached) which SQUG requests CRGR discuss with the Staff, for the purpose of establishing on the record the Staff's intent in incorporating these clarifications in SSER No. 2. These on-the-record questions and answers would, we hope, be made a part of the CRGR minutes.

Attachment 4

Attachment

1. **Question.** Will application of A-46 methodology, i.e., the GIP, to new and replacement equipment suffice to meet all Commission regulations for demonstrating the seismic adequacy (including qualification) of equipment for A-46 plants?

Answer. Yes. By following the guidelines set forth in the GIP, Revision 2, for seismic verification of new and replacement equipment, A-46 licensees need not perform additional qualification tests or analyses to demonstrate the seismic adequacy, including qualification, of equipment, thereby meeting the seismic requirements of applicable regulations, such as GDC-2 and 10 C.F.R. Part 100.

2. **Question.** We understand that the Staff considers the A-46 procedure, as embodied in the GIP, to be seismic verification, not qualification or analysis as set forth in 10 C.F.R. Part 100, Appendix A, section VI. Does this mean that A-46 licensees using the GIP for seismic verification will not comply with Part 100?

Answer. As the Staff stated at page 7 in SSER No. 1 on Revision 1 of the GIP, "this is an approved alternative method for satisfying the pertinent equipment seismic requirements of GDC-2 for identified equipment in the affected plants."

Part 100, Appendix A, section VI, requires that "[t]he engineering method used to insure [seismic adequacy] . . . shall involve the use of either a suitable dynamic analysis or a suitable qualification test The analysis or test shall take into account soil-structure interaction effects and the expected duration of the vibratory motion." Although the Staff has said in SSER No. 2 that the GIP is not a qualification methodology, seismic verification as set forth in the GIP, Revision 2, is an acceptable form of analysis and qualification testing, as will be shown below. If this were not the case, Staff endorsement of the GIP in an SER would not suffice to exempt A-46 licensees from the requirements of Part 100.

The seismic experience data base generally comprises qualification test data from two sources: (1) laboratory data from seismic testing in accordance with approved industry standards, and (2) test data resulting from exposure of installed equipment to actual ground vibratory motion, i.e., earthquakes. The latter source of data being superior in many ways to laboratory simulations. Demonstration of seismic adequacy of a piece of equipment based on seismic experience and/or tests of hundreds of similar items under a wide range of conditions provides assurance at least comparable to individual, component-specific analyses or tests, or equally acceptable analyses of the similarity of a component to a tested component.

Analysis of substantial amounts of seismic experience data from both earthquakes and tests, and use of these data in a systematic manner as

described in the GIP is a legitimate analysis process which is consistent with applicable seismic regulations, such as Part 100, Appendix A.

Further, as stated at page 1-4 of NUREG 1030, Seismic Qualification of Equipment in Operating Nuclear Power Plants, "seismic experience data supplemented by existing seismic test data, applied in accordance with the guidelines developed, can be used to verify the seismic adequacy of mechanical and electrical equipment in operating nuclear plants. Explicit seismic qualification should be required only if seismic experience data or existing test data on similar components can not be shown to apply."

Thus, the GIP methodology is consistent with and meets the requirements of applicable NRC regulations, such as Part 100, as applied to engineering methods to demonstrate the seismic adequacy, including qualification, of equipment in A-46 plants.

3. **Question.** Can the Staff, in the SSER, determine generically that substitution of the GIP for an existing plant-specific seismic qualification methodology is an unreviewed safety question? *NSAC/125-344-71*

Answer. No. Changes to the safety analysis report under 10 C.F.R. § 50.59 are the domain of "the holder of a license authorizing operation of a production or utilization facility." Section 50.59(a)(1). The Staff may subsequently disagree with the licensee's analysis, and the disagreement should be resolved within the guidelines of, among other things, NSAC/125, Guidelines for 10 CFR 50.59 Safety Evaluations.

4. **Question.** Can the Staff SSER modify 10 C.F.R. § 50.59 to preclude a non-A-46 licensee's use of this regulation in altering its SAR commitments related to seismic requirements?

Answer. No. This would amount to de facto rulemaking that cannot be accomplished by means other than those set forth in the Administrative Procedure Act, e.g., by notice and comment rulemaking.

Licensees are free to alter their SARs, including commitments related to seismic issues, within the framework of regulations provided for this purpose, e.g., 10 C.F.R. § 50.59. The SSER may not set forth restrictions in conflict with these regulations.

SSER No. 2 applies only to A-46 plants. Accordingly, other licensees may not use the SSER as a basis for modifying commitments, and the Staff would be justified in expressly stating this. However, to attempt to generically preclude licensee use of section 50.59 amounts to de facto rulemaking contrary to the Administrative Procedure Act.

5. **Question.** Is a requirement for A-46 plants with Housner design spectra to use 2% damping for all GIP evaluations a change of Staff position in light of prior Staff positions which accepted 5% damping? Is such conservatism warranted?

Answer. Generic Letter 87-02 at pages 8 and 9 specifies the use of 5% damping. The original GIP, Revision 0 (dated June 1988) explicitly requires the use of 5% damping for comparison of seismic demand with seismic capacity for A-46 evaluations. (See page 4-8.) The GIP, Revision 0, was subsequently endorsed by a Staff SER, dated July 1988, without exception to the specified damping values.

Although the GIP, Revision 0, at page 4-9 refers to original plant licensing basis SSE spectra and damping values, this applies to the selection of the appropriate SSE spectra for use in A-46 and the appropriate damping for civil structural modeling. In general, the original licensing basis for seismic qualification of equipment, including damping values for equipment qualification, were not specified for A-46 plants.

GIP guidelines for damping to be used in seismic capacity determinations have been approved by SSRAP and are consistent with current seismic qualification standards such as IEEE 344. Furthermore, the overall GIP evaluation process contains sufficient conservatism for both Housner and non-Housner plants, and a change to 2% damping for Housner plants will not result in a significant safety improvement, but could introduce substantial additional costs -- either as a result of additional outlier evaluations or the need to generate new in-structure response spectra.

6. **Question.** The "rule of the box" (GIP Part II, section 3.3.3) for verifying the seismic adequacy of all components mounted within larger items of equipment was considered to be an acceptable method by SSRAP and previous Staff reviewers of the GIP. The Staff now appears to be imposing a requirement for reviewers to confirm, on a component-by-component basis, that the components mounted within major pieces of equipment are included within the earthquake experience data. Is this a new Staff position? What is the justification for this new position?

Answer. This issue was discussed with SQUG during a conference call on December 6 and it was decided that the rule-of-the-box as it appears in GIP, Revision 2, should be retained, not only because it has been approved by SSRAP and previous Staff reviewers, but because the large variety and scope of equipment and components in the earthquake experience data base renders it unnecessary to make a one-for-one verification of the components mounted within this equipment. It would be very difficult, if not impossible, to make one-for-one comparisons since (1) detailed information on all the components mounted inside the equipment was not collected with the earthquake

experience data and (2) extensive, detailed reviews of components mounted within the equipment would substantially increase the scope and effort to implement the GIP.

7. **Question.** The NRC Staff, SSRAP and SQUG concluded during prior reviews that relay capacity need only be evaluated at the peak of the response spectra (4 to 16 Hz.), and that it was not necessary to check the Zero Period Acceleration. Rather, relays sensitive to high frequency excitation would be addressed by the "bad actors" relay list. What is the justification for the new Staff position that relay capacity must also be evaluated at the ZPA as well as at 4 to 16 Hz?

Answer. (To be provided by Staff.)