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June 21, 1989

Dr. C. P. Siess, Chairman
ACRS Subcommittee on Extreme External Phenomena
Advisory Committee on Reactor Safeguards
Nuclear Regulatory Commission
Washington, DC 20555

Subject: Review of Changes to SRP Sections 2.5 and 3.7 in Resolution USI A-40

Dear Chet:

As requested, I have reviewed the material concerning the resolution of A-40 and the revision of Standard Review Plans Sections 2.5 and 3.7 sent to me on 12 June 1989. In general I agree with the changes made to the SRP. However, as you know there have been several activities undertaken by the NRC since 1978 which included consultant and staff studies, reports and workshops which bear on the A-40 issue. In my opinion, many of the issues raised, discussed and recommendations made in these studies, reports and workshops concerning the seismic design of nuclear power plants have not been acted upon by the NRC staff in the resolution of A-40. As an attachment to this letter I have listed several seismic design areas which I believe require further evaluation and consideration by the NRC staff. Therefore, while I believe this staff action may formally resolve the USI-A-40 effort it does not resolve all outstanding nuclear power plant seismic design issues.

I believe there should be a continuing effort to resolve the outstanding issues I have raised plus I am sure there are additional seismic design issues of concern to others, which I have not identified, that need consideration.

Please advise if you require any clarification of this letter.

Sincerely,

John D. Stevenson

John D. Stevenson
President

JDS:ss

Enclosure

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Review of SRP Changes to Resolve A-40

1. The minimum ~~RRS~~ as now defined in Appendix A to SRP 3.7.1 is reasonable, therefore, it is not clear why only 80 percent of it need be exceeded in qualifying a candidate minimum PSD.

2. I believe T_D, the strong motion duration identified in SRP 3.7.1 Appendix A should be more precisely defined. If the time histories were generated by synthesizing sinusoids, T_D will be length of the peak region. However, if the time histories were generated from strong motion records, T_D is not well defined.

3. The forth paragraph of 3.7.1 Appendix A states the comparison of PSD beyond 24 Hz is not required. There are equipment having natural frequencies above 24 Hz. Eventually the Floor Response Spectra generated by the time histories may be used for secondary system qualification. The energy content above 24 Hz, small as it is, may be significant for device responses. I think the requirement should be extended to 33 Hz or otherwise the upper bound of the frequency range for amplified response spectra should be reduced to 24 Hz.

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Recommendations for Future Revisions of Sections
of the Federal Regulations and Standard Review Plan
Dealing with Seismic Design and Evaluation
of Nuclear Power Plants

There have been a number of NRC staff recommendations, consultant reports and NRC research reports and workshops which have made recommendations concerning changes to NRC seismic design requirements covered by 10CFR100 Appendix A, SRP Sections 2.2.5, 3.7.1, 3.7.2, 3.7.3, 3.9.2 and 3.9.3. Many of these recommendations are not contained in the current proposed changes to the SRP Sections 2.2.5, 3.7.1, 3.7.2 and 3.7.3.

In my opinion a number of technical areas covered by SRP Sections 2.2.5, 3.7 and 3.9 still require NRC Staff review to develop safer, more consistent, rational and realistic seismic design and evaluation requirements for structural systems and subsystems.

It must be understood that "conservative" design for inertia seismic loads which is the focus of current NRC seismic design and evaluation requirements covered in SRP Sections 2.2.5 and 3.7 does not necessarily lead to "conservative" overall design.

In general optimum design of elevated temperature, high energy structural subsystems tries to minimize the amount of restraint in such systems in order to minimize stress induced in the system by restraint of free end displacement caused by thermal expansion, support motions and water and steam hammmer and sudden valve operation effects. Conservative design for seismic inertia effects tends to increase restraint hence overall operating stress levels in such systems.

In addition conservatively defined high seismic inertia loads on structural systems (buildings) require use of structural joints designed to transfer large loads. This discourages use of ductile joint details because of the resultant congestion (e.g. ACI 318 Appendix A). Earthquake response experience shows ductile joint detailing to be very effective and necessary to resist significant structural damage in strong motion earthquakes.

In Table 1 is presented a list of technical areas suggested actions and associated referances which should receive continued NRC Staff review to improve the seismic and overall safety related design basis of nuclear power plant systems and subsystems.

Table 1 - Summary of Technical Areas Related to Seismic Design Requiring Further NRC Design Criteria Development

	Area	Action	Reference
1.	Modify (Increase) Seismic Damping Values Used in Design of Subsystems (Piping)	a) Increase Pipe Damping Values to ASME Code Case N-411 b) Minimize Caveats Associated with Use of ASME CC N-411 c) Increase Damping for Heavily Insulated Pipe	1, 2, 3
2.	Decouple OBE from SSE and Eliminate the OBE as a Design Requirement for Low Seismicity Sites	a) Change or Clarify Wording of 10CFR 100 Appendix A to Permit Decoupling of OBE from SSE b) Eliminate OBE as a Design Basis for Low Seismicity Sites (OBE PGA ≤ 0.08g) since Earthquake PGA at this Level and Below have been shown to be Non-damaging to Engineered Industrial Structures and Substructures.	1, 4
3.	Use of a Median or Uniform Hazard Spectra Rather than Variable Mean Plus One Standard Deviation Design Response Spectra	a) R.G. 1.60 Contains a Variable Design Margins as a Function of Frequency with a Median Value Defined at the High Frequency Limit (33Hz) and Mean Plus One Standard Deviation Defined in the Amplified Frequency Range 2-10 Hz b) Item 1 under SRP 2.5.2.6 Requires Generation of Mean Plus Standard Deviation (84 Percentile) Spectra. Item 5 under SRP 2.5.2.6 Requires Generation of Uniform Hazard Spectra at Various Probability Levels. NRC Should Permit Use of a UHS instead of a variable 84th Percentile Spectra at a Probability Level Acceptable to NRC.	5
4.	Permit Limited Amounts of Inelastic Response of Systems and Subsystems	a) Consultants have Recommended Allowing Limited Amounts of Non-linear Response Behavior (Global Ductility > 1.0) in Seismic Design of Systems as a Function of Their Importance to Safety. b) Add Additional Ductility Constraints Based on Ductility Capabilities of Systems	5, 6

Table 1 - Summary of Technical Areas Related to Seismic Design Requiring Further NRC Design Criteria Development (Continued)

Area	Action	Reference
	c) Provide Explicit Global Ductility Limits for Systems and Subsystems as a Function of Importance to Safety and Ductility Capabilities.	
5. Permit Balanced Seismic Design such that Seismic Capacities of Subsystems are Not Required to be Significantly Greater than the Structural System that Houses or Supports Them.	a) Institute a Design Margin Review to Compare Seismic Capabilities of Subsystems to the System Housing or Supporting Them.	
6. Reconcile Results of Recent Seismic Tests of Subsystem (Piping Systems) to Insure Rational Seismic Design Margins are Being Required.	a) Consider Changes in Ductility and Damping Parameters to Assure Rational Seismic Design Margins (e.g. 1.5-2.0 against failure for the SSE) Are Being Maintained.	
7. Use of Bounding or Threshold Damage Seismic Spectra to Design Safety Related and Evaluate Class 2 (2 over 1 Issue) to Assure They Do Not Fail and Endanger Class 1 Components in Their Proximity	a) Pecent Comprehensive Experience Data on the Behavior of Structural Systems and Subsystems in Strong Motion Earthquake and in Tests Indicate That There Are Threshold Spectral Values before Damage Results. Use of These Threshold Damage Spectra Together with Layout and Detailing Caveats Should Be Permitted in Design of Certain Types and Classes of Systems and Subsystems. b) Threshold Damage Spectra Procedures Should Be Allowed in the Evaluation Class 2 Subsystems to Insure They Do Not Fail Under Seismic Loads.	7
8. Redefinition of Seismic Inertia Stresses Induced by High Frequency Accelerations (> 10 Hz) as Secondary or Otherwise Recognize their Limited	a) Permit Limited Application of ASME Code Cases N451 and N462 and to Components Other Than Piping b) Seismic Induced Loads above About 10 Hz Tend to Be Displacement Limited Hence Develop Secondary Stresses.	8,9
9. Permit Use of Vibration Acceptance Criteria in Terms of Velocity or Displacement to Be Applied to Seismic Design Adequacy	a) Permit the Application of ANSI/ASME OM3-1982 Criteria Limits for Vibration Be Extended to Include High Stress Low Cycle Conditions Associated with Earthquake Response	10

Table 1 - Summary of Technical Areas Related to Seismic Design Requiring Further NRC Design Criteria Development (Continued)

	Area		Action	Reference
*10.	Provide Specific Guidance on How Seismic Induced Relative Displacements of Support of Equipment and Distribution Systems are to be Considered in Design.	a)	SRP Section 3.9.3.II.1 Provides Less than One Page of Criteria on How to Consider Seismic Relative Support Motions in Design. The ASME Code Ignores the Stresses Induced by These Motions for the SSE in Design of Components. However, such Motions have been a Leading Cause of Failure of Distribution Systems in Industrial Facilities in Strong Motion Earthquakes. Seismic Design Criteria Should be Refocused to Concentrate on those Phenomena which cause Damage and Failure to Industrial Equipment During Strong Motion Earthquakes.	
*11.	Require Ductile Detailing of Safety Related Concrete and Steel Structures	a)	There is No Current NRC or Industry Requirement for Ductile Design of Connections (eg. ACI 318 - Appendix A) in Safety Related Structure. This should be made a Requirement of Design Preferably as a Trade Off for Reduced Seismic Inertia Loads (Area 4).	

*These activities could be considered as a ratchet of current requirements.

TABLE 1 REFERENCES

(1) Seismic Design Task Group "Report of the U.S. Nuclear Regulatory Commission Piping Review Committee - Summary Piping Review Committee Conclusions and Recommendations," NUREG-1061 Vol. 5 U.S. Nuclear Regulatory Commission, April 1985.

(2) PVRC Committee, "Technical Position on Damping Values for Piping - Interim Summary Report," WRC Bulletin 300, Welding Research Council, December 1984.

(3) Bitner, J.L. et. al. "Technical Position on Damping Values for Insulated Pipe - Summary Report," WRC Bulletin 316, Welding Research Council, July 1986.

(4) Seismic Design Task Group "Report of the U.S. Nuclear Regulatory Commission Piping Review Committee - Evaluation of Seismic Design -A Review of Seismic Design Requirements for Nuclear Power Plant Piping," NUREG-1061 Vol. 2 U.S. Nuclear Regulatory Commission, April 1985.

(5) Newmark, N.M, and Hall, W.J. "Development of Criteria for Seismic Review of Selected Nuclear Power Plants," NUREG/CR 0098, U.S. Nuclear Regulatory Commission, May 1978.

(6) Coats, D.W., "Recommended Revisions to Nuclear Regulatory Commission Seismic Design Criteria," NUREG/CR 1161 Lawrence Livermore Laboratory, May 1980.

(7) Senior Seismic Review and Advisory Panel (SSRAP) "Use of Seismic Experience and Test Data to Show Ruggedness of Equipment in Nuclear Power Plants," (Draft) Seismic Qualification Utility Group and USNRC, August 1988.

(8) ASME Boiler and Pressure Vessel Code Case N-451 "Alternate Rules for Analysis of Piping Under Seismic Loading, Class 1, 1987.

(9) ASME Boiler and Pressure Vessel Code Case N-462, "Alternate Rules for Analysis of Piping Under Seismic Loading, Class 2 and 3," 1983.

(10) ANSI/ASME OM3-1982, "Requirements for Preoperational and Initial Start-up Vibration Testing of Nuclear Power Plant Piping Systems," ASME, 1982.