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Franklin Research Center
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Dr. R. Savio, Staff Engineer
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: ACRS Extreme Phenomena Subcommittee Meeting, June 4, 1980, Washington, DC

Dear Dr. Savio:

Following are the observations and comments related to various topics discussed at this meeting.

SEP evaluation program was not intended to be a review based on a set of given criteria; rather the intent was to use a set of criteria as a basis for the engineering judgement. The level of effort was limited, with no intent to redesign the plants. Best estimate approach (mostly judgemental) was used. No probabilistic assessment of margins was undertaken. Goal of SEP was to assess overall safety, current design criteria was utilized as a yardstick for the judgement. Initial review of dockets and site visits have been completed and it is believed that any serious shortcomings have already been identified. Dresden 2 plant was used to quantify the SEP program results.

Seismic adequacy evaluation of structures (R. P. Kennedy) was a scoping type of effort intended to identify problem areas. Damping values used in this effort appear to be within the limits of experimental evidence, however, the extrapolation from tests at low strain level to high strain level (valid for some components tested) may be in question for the entire system where stress levels vary.

Mechanical and electrical equipment for Dresden 2 was evaluated on a basis of anticipated fragility and by today's ASME Code Criteria. There is a general feeling that much of the older electrical equipment in Dresden 2 has been tested subsequently.

Seismic capacity of piping designed by B31.1 rules appears to adequate for non-nuclear industry piping (Rodabaugh). For existing plants, piping supports are the likely weak elements.

According to previous requirements, hot standby was considered safe end status for a NPP, new requirements (Reg. G. 1.139) consider only the cold shutdown to be safe end state. Accordingly, new requirements are placed on all processes associated with going from hot standby to cold shutdown (RC circulation, depressurization, boration, heat removal). It appears that

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auxiliary pressurizer spray is available from chemical and volume control charging pumps, but the valves are controlled by air system which is a non-category I system (Chuck Graves).

There are about 10 plants which do not have safety grade AFW (Bob Baer). For these plants, it is planned to perform risk analysis with a range of g-levels and to evaluate probability of AFW failure. The objective of this limited study is to buy time until the larger study on AFW is concluded (Task Action Plan, II.E.3.2 and II.E.3.3).

Jesse Ebersole's idea of providing a qualified secondary blowdown (with the attendant capability to lower the pressure in the secondary) as an alternative to safety grade AFW has merit and should be further evaluated.

Jim Knight noted that NRC allows some equipment tested seismically to be installed in the NPP (after inspection). This in effect means that the equipment has to be designed to survive two SSE-s. I believe NRC Staff should further evaluate the implications of this case. Does the seismic test in fact represent a "shakedown cruise" and should one feel relieved when everything works and be happy to put that equipment in the power plant? I do not think so.

On the use of seismic scram I feel more work needs to be done before automatic scram is implemented. In reality, NPP may already have seismic scram built in invirtue of the existing turbine trip due to excessive virbration. Cummings (LLC) commented that in 1976 time frame, utilities did not have such trip mechanism on turbine. SSMRP study indicated further that there is a chance that plant will trip at or above OBE. Utilities are fearing ceramic insulator damage the most. It was observed the BWR must trip reactor in LOCA because it is reflooded with fresh water. In PWR, reflooding is with borated water, hence if anything, BWR should be scrammed if one anticipates LOCA in seismic event (Okrent).

The conclusion of site specific spectra study by Tera Corp. is that probabilistically generated spectra will not result in physically meaningful spectra unless the analysis of structure is continued with probabilistic methods. Integrated risk assessment using all seismic hazards regardless of return time is the way to go (Reiter).

Task Action Plant A-40 "Seismic Design Criteria-Short Term Program" Phase I recommendations were discussed by P. Smith. Following comments are offered in this matter.

Reg. G. 1.61: Damping Values for Seismic Design.

Modification of this Guide associates damping values with stress levels. This is a reasonable approach, however, the following implications should be noted: Stress levels are not known apriori; hence for correct implementation, an iterative structural analysis will be required. Also, different locations of the system (structure) will be at different stress levels, hence further complexity will result.

Reg. Guide 1.92: Combining Modal and Spatial Responses:
Time history analysis approach allows:

a) Separate analyses for X, Y, Z, components
b) Step-by-step analyses for all components simultaneously

Proposed method allows SRSS combination under a) and algebraic sum under b). If the structural models are the same for both, for linear systems both analyses algebraically summed will yield same results. Hence, algebraic sum should be allowed for both. The distinction between a) and b) should be made at the mathematical modelling level instead. If the model is such that only motions in one plane can be represented, SRSS should be required, if the model allows for all degress of freedom at all nodes, algebraic sums should be allowed.

Another important aspect in this matter is how to time phase the X,Y,Z inputs of seismic excitation for time history analysis. This aspect is not addressed in Reg. Guide 1.92, however, the algebraic sum response will strongly depend on time-phasing of the input.

Reg. G. 1.122: Development of In-Structure Design Response Spectra for Seismic Design of In-Structure Supported Equipment and Components.

Proposed guide allows using a suite of real or artificial time historics to generate in-structure response spectra by variation of parameters (by SRP. 3.7.1, Fig. 1 and 2, scheme) without additional peak broadening. The analysis effort required to follow Fig. 1 and 2 (SRP 3.7.1) approach will be quite large and the selected sets of soil and structure properties may not produce the peak broadening to cover the natural frequency changes in the structure due to, for example, unknown effects of non-linearities.

SRP 3.7.2: Seismic System and Subsystem Analysis

Inelastic analysis is acceptable for SSE level earthquake. The amount of inelastic energy absorption is limited by allowable ductility factors for various classes of structures. It is important to note that if inelastic deformations (such as concrete cracking) are allowed, local stored energy releases will occur. Accordingly, the in-structure spectra for component design will be affected by these releases. This aspect does not appear to have been covered in proposed SRP 3.7.2.

Also, the discussion (starting on page 20) of methods for soil structure interaction is too specific and limiting. If is obvious that two specific computer programs are in the back of the author's mind, although not mentioned my name. Discussion of "direct solution" and "substructure technique" is too restrictive and conveys the impression that these two methods represent all that can be done in the field. Instead of these, I recommend that a discussion of minimum requirements in representation of initial conditions, boundary conditions, soil properties and structure and seismic input characterization be given and that no specific detail discussion of the input requirements for any of the currently used methods (LUSH/FLUSH-for direct integration, CLASSI- for substructure method) be addressed in SRP 3.7.2.

Sincerely yours,

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