NRC PDR

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

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MEMORANDUM FOR: L. C. Shao, Assistant Director
for General Reactor Safety Research
Division of Reactor Safety Research, RES

FROM: K. S. Herring, Seismic Coordinator
Engineering Branch
Division of Operating Reactors

THRU: V. S. Noonan, Chief
Engineering Branch
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SUBJECT: ENGINEERING BRANCH SEISMIC ISSUES

In response to your recent request, Attachment 1 contains a list of the on going seismic projects in The Engineering Branch, Division of Operating Reactors, NRR; and Attachment 2 contains a discussion of our findings thus far in our review of the safety related piping system reanalyses for plants for which the intramodal codirectional responses to multiple earthquake input components were combined algebraically rather than by a more appropriate technique (SRSS or absolute summation).

I hope that this information satisfies your needs. If additional information is required, please do not hesitate to contact me.

for K. S. Herring
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Enclosures: As stated

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Attachment 1

SEISMIC REVIEWS IN PROGRESSS IN
THE ENGINEERING BRANCH
DIVISION OF OPERATING REACTORS

1. The General Electric Test Reactor (GETR):

   Review of the facility considering seismic input in excess of that considered in its original design.

2. Trojan Nuclear Plant:

   Review of the Control/Auxiliary/Fuel Building complex modifications required to restore the originally intended safety margins for the structure, piping, equipment, and components which were reduced as a result of deficiencies in the initial design and construction of the facility.

3. a) Beaver Valley Unit 1
   b) Surry Units 1 and 2
   c) Fitzpatrick
   d) Brunswick Units 1 and 2
   e) Indian Points Units 2 and 3
   f) Nine Mile Point Unit 1
   g) Zion Units 1 and 2
   h) Point Beach Units 1 and 2
   i) Ginna
   j) Millstone Unit 1
   k) Cooper
   l) D. C. Cook Units 1 and 2
   m) Salem Unit 1

   Review of the seismic reanalyses of safety related piping systems for which the intramodal codirectional responses to multiple earthquake input components were combined algebraically rather than by a more appropriate technique (SRSS or absolute summation).

4. a) Crystal River Unit 3
   b) Nine Mile Point Unit 1
   c) Cooper

   Review of the seismic qualification of equipment.

5. Beaver Valley Unit 1

   Review of the structural aspects of their liquefaction reanalysis

6. a) D. C. Cook
   b) Crystal River Unit 3
   c) Dresden Units 2 and 3
   d) Fitzpatrick
   e) LaCrosse
   f) Yankee Rowe
   g) Zion Units 1 and 2
   h) Big Rock Point
   i) Maine Yankee
   j) Salem Unit 1

   Review of seismic analyses required for spent fuel pool modifications.

7. Palisades:

   Review of the structural/seismic aspects of the steam generator replacement program.

8. Millstone Unit 2

   Review of the Enclosure Building seismic design

9. Coordination of the technical assistance contract with LLL regarding the comparison of "stick" model seismic analysis results to finite element model seismic analysis results.

10. Humboldt Bay

    Review of seismic upgrading of the facility

11. Review of LLL Seismic Conservatism reports for input into TAP A-40, "Seismic Design Criteria".

12. Review of reports concerning the Seismic Safety Margins Research Program (SSMRP)

13. Review of snubber (mechanical & hydraulic) performance under seismic loadings.

14. Post-OBE inspection requirements.

Attachment 2

SUMMARY OF FINDINGS IN THE REVIEW OF SAFETY RELATED PIPING REANALYSES FOR PLANTS FOR WHICH THE INTRAMODAL CODIRECTIONAL RESPONSES TO MULTIPLE EARTHQUAKE INPUT COMPONENTS WERE COMBINED ALGEBRAICALLY

BACKGROUND

On March 13, 1979, Orders to Show Cause were issued to the licensees' operating Beaver Valley Unit 1, Surry Units 1 and 2, Fitzpatrick and Maine Yankee nuclear plants. These Order's were issued as a result of information presented to the NRC by Stone and Webster Engineering Corporation which indicated that the technique used to combine codirectional responses to multiple earthquake input components, namely an algebraic intramodal summation, for the original seismic analyses of a large number of safety related piping systems, yielded stresses in the piping which were significantly lower than those which would have been predicted had a more appropriate technique (SRRS or absolute summation) been used. In fact, the information presented at that time indicated that for systems originally analyzed using the algebraic summation technique and found to be within allowable stress limits, reanalysis with a more appropriate technique could result in the prediction of stresses well in excess of the allowable stress limits for the SSE condition, for a large number of safety related piping systems.

I&E BULLETIN 79-07

Subsequent to the issuance of these Orders, I&E Bulletin 79-07 was sent to all power reactor license and construction permit holders to determine whether or not an inappropriate seismic response combination technique had been used for the design of safety related piping systems in other facilities. To date, licensees of twenty-five (25) power reactors have acknowledged the use of this algebraic summation technique to varying degrees. No determination regarding the use of this technique has been made as yet on five (5) other licensed power reactors, namely Fort St. Vrain, Indian Point Unit 1, LaCrosse, and Three Mile Island Units 1 and 2. Reanalyses of the affected safety related piping for plants which used the algebraic summation technique are in various stages of completion and review by the NRC. However, the overall reanalysis effort to date has provided useful insights for the NRC.

SUMMARY OF FINDINGS

In the course of reviewing the reanalysis results for a large number of different piping systems for many different plants, it has come to our attention that, in general, the use of the algebraic summation technique in itself does not result in the large widespread levels of nonconservatism originally suspected for typical piping systems. The initial reanalysis effort by Stone and Webster, which led to the issuance of the five (5) Orders to Show Casue on March 13, 1979, has since been found to contain other nonconservative deficiencies which affected the results. Some similar deficiencies in piping analyses have also been noted to varying degrees in other plants. These deficiencies are not due to the initial use of the albegraic summation technique in the original analyses and are discussed in detail later in this summary.

An additional concern which surfaced during the review of the safety related piping system seismic analysis was the use of one dimensional earthquake inputs in the initial seismic analyses. Further investigations of potential non-conservatisms inherent in the use of this technique for piping seismic design have indicated that there is not a large level of nonconservatism associated with the use of this method for the analysis of typical piping systems found in nuclear plants.

In order to minimize the extent of modifications required for Beaver Valley Unit 1, and Surry Units 1 and 2, seismic inputs for the piping systems (i.e., seismic anchor movements and amplified floor response spectra) were regenerated in light of current state-of-the-art soil/structure interaction (SSI) techniques. This effort was undertaken to quantify the conservatisms inherent in the initial considerations of SSI. A study of the results of the SSI reanalysis for these plants indicates that the initial consideration of SSI was generally conservative as compared to what is required by the current state-of-the-art techniques.

The review of the piping reanalyses has indicated that an area in which more stringent NRC requirements than those of the past are necessary is that of computer code verification. A high degree of reliance has been placed on the results of computer programs in the seismic design of nuclear power plants. Therefore, it is essential that we have a high degree of confidence in the adequacy of the results of the large number of computer codes which have been used and are in use for seismic analyses. A computer code verification program has been instituted by the NRC for the computer codes used for the seismic re-analyses of safety related piping systems for which the algebraic summation technique was used for the initial analyses. A course of action has not yet been finalized for the verification of other computer codes used for the analysis/design of operating plants. There have been no gross, nonconservative deficiencies indicated by our verification of the various computer codes to date. Although we recognize the importance of computer code verification, experience to date indicates that there is sufficient time in which to formulate a scope for an overall computer code verification program in a well thought out yet timely fashion. The manner in which this program will be administered (e.g., through an I&E Bulletin, a generic letter, etc) will also have to be determined.

As mentioned previously, deficiencies which are not attributed to the initial use of the algebraic summation technique have surfaced in the course of the piping reanalyses review. These are: (1) deviation of the as-built configuration of the piping systems from that assumed in the original analyses, (2) the initial use of amplified floor response spectra in the piping seismic analyses with peaks not broadened to account for uncertainties in the seismic analysis methodology (this was found in the case of Fitzpatrick), and (3) changes in the seismic response of piping systems dependent on the validity of the flexibility assumptions for the supports.

Of the three items mentioned above, deviation of the as-built piping systems from that assumed in the original analyses seems to be the greatest potential contributor to nonconservatism in piping designs. Deviations that have been identified in the as-built configuration from that analyzed include missing supports, mislocated supports, insufficient support capacity and inadequate directional restraints.

We are planning to recommend the issuance of an I&E Bulletin which would require verification that the as-built configuration of all safety related piping systems, including supports, is consistent with that assumed in their analyses, or that any deviations will not impair the capability of the affected systems to perform their safety related functions.

The second item, failure to broaden the amplified floor response in the seismic analyses of the piping system, can lead to a seismic design which is nonconservative. Based on our experience we do not believe that this approach to be widespread, and coupled with a consideration of seismic conservatisms, we do not feel that there is an immediate threat to public safety. However, we are planning to recommend that an I&E Bulletin be issued which will require verification that appropriate peak broadening of the amplified response spectra was considered in the initial design of safety related components, piping systems and/or equipment; or that any failure to do so would not result in the impairment of the safety functions of the affected components, piping systems, and/or equipment.

It has also been determined that assumptions regarding the flexibility of the piping system supports can result in the shifting of natural frequencies of the piping systems by as much as ten (10) to fifteen (15) percent. This in turn may lead to a nonconservative prediction of seismic stresses if appropriate support stiffnesses were used in the seismic analyses. A preliminary assessment by the Engineering Branch, Division of Operating Reactors, NRR, has been made. Considering the entire seismic analysis/design chain with its inherent conservatisms, we do not feel that any action on this item is warranted at this time. Before any action, if any, is taken a careful assessment of the impact of this potential nonconservatism considering the entire seismic analysis design chain, including any relevant information gained from the Systematic Evaluation Program, should be made and an appropriate course of action taken.