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MEMORANDUM FOR: Gus C. Lainas, Assistant Director for  
Safety Assessment, DL

FROM: James P. Knight, Assistant Director for  
Components & Structures Engineering, DE

SUBJECT: SER INPUT TO SEP TOPIC III-5.B FOR  
THE PALISADES NUCLEAR POWER PLANT



The Mechanical Engineering Branch has completed its review of SEP Topic III-5.B, "HIGH ENERGY LINE BREAK OUTSIDE CONTAINMENT," of the Palisades Nuclear Power plant. Enclosed is our input to the Safety Evaluation Report.

In Section V.B.2 of our SER, we state that the licensee has not addressed the effect of postulated breaks in the auxiliary feedwater system in its SEP evaluation. A high energy line break analysis of this system will be included in the licensee's response to NUREG-0737, item II.E.1.1 which is currently being reviewed by the auxiliary system branch.

In discussions between R. J. Bosnak and W. Russell, it was agreed that the acceptance criteria which was used by the staff in its original review of References 1, 2, 3 and 4 of our SER could be used by the licensee in its response to issues raised in this SER.

James P. Knight, Assistant Director for  
Components & Structures Engineering  
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Enclosure: As stated

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MEB INPUT TO  
SEP EVALUATION  
OF  
PIPE BREAK  
OUTSIDE CONTAINMENT  
TOPIC III-5.B  
FOR  
PALISADES NUCLEAR POWER PLANT

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## I. INTRODUCTION

The safety objective of Systematic Evaluation Program (SEP) Topic III-5.B, "PIPE BREAK OUTSIDE CONTAINMENT", is to assure that pipe breaks would not cause the loss of required function of "safety-related" systems, structures and components and to assure that the plant can be safely shut down in the event of such breaks. The required functions of safety-related systems are those functions required to mitigate the effects of the pipe break and safely shut down the reactor plant.

## II. REVIEW CRITERIA

General Design Criteria 4 (Appendix A to 10 CFR Part 50) requires in part that structures, systems and components important to safety be appropriately protected against dynamic effects, such as pipe whip and discharging fluids, that may result from equipment failures.

The current criteria for review of pipe breaks outside containment are contained in Standard Review Plan 3.6.1, "Postulated Piping Failures in Fluid Systems Outside of Containment", including its attached Branch Technical Position, Auxiliary System Branch 3-1 (BTP ASB 3-1) and Standard Review Plan 3.6.2, "Determination of Break Locations and Dynamic Effects Associated with the Postulated Rupture of Piping", including its attached Branch Technical Position, Mechanical Engineering Branch 3-1 (BTP MEB 3-1).

## III. RELATED SAFETY TOPICS AND INTERFACES

1. This review complements that of SEP Topic VII-3, "Systems Required for Safe Shutdown".
2. The environmental effects of pressure, temperature, humidity and flooding due to postulated pipe breaks are evaluated under Unresolved Safety Issue A-24, "Qualification of Class IE Safety-Related Equipment".
3. The effects of potential missiles generated by fluid system ruptures and rotating machinery where also considered and are evaluated under SEP Topic III-4.C, "Internally Generated Missiles".
4. The original plant design in the areas of seismic input, analysis and design criteria are evaluated under SEP Topic III-6, "Seismic Design Considerations".
5. NRC IE Bulletin 79-14, "SEISMIC ANALYSIS FOR AS-BUILT SAFETY-RELATED PIPING SYSTEMS".
6. NUREG-0737 Item II.E.1.1, "AUXILIARY FEEDWATER SYSTEM EVALUATION"
7. Multi-plant Issue B-11, "SUSCEPTIBILITY OF SAFETY-RELATED SYSTEMS TO FLOODING FROM FAILURE OF NON-CATEGORY I SYSTEMS".

#### IV. REVIEW GUIDELINES

The licensee's break location criteria and methods of analysis for evaluating postulated breaks in high energy piping systems outside containment have been compared with the currently accepted review criteria as described in Section II above. The review relied upon information submitted by the licensee, Consumers Power Company (CPCo), in Reference 1, 2, 3, 4 and 5.

The scope of review under this topic was limited to avoid duplication of effort since some aspects of the topic were previously reviewed by the staff or are included under other SEP topics (see III above).

When deviations from the review criteria are identified, engineering judgement is utilized to evaluate the consequences of postulated pipe breaks to assure that the pipe break would not cause the loss of the required functions of "safety-related" systems, structures and components and to assure that the plant can be safely shutdown in the event of such a break.

#### V. EVALUATION

##### A. BACKGROUND

In December 1972, the staff sent letters (Reference 6) to all power reactor licensees requesting an analysis of the effects of postulated failures of high energy lines outside of containment. In response to our letter, the licensee submitted earlier revisions of Special Report No. 6 (SR-6) dated May 1, 1973, July 13, 1973 and July 27, 1973 (Reference 1, 2 and 3). The staff letters of August 7, 1973 (Reference 7) and October 9, 1973 (Reference 8) to CPCo approved the licensee's program including facility modifications and the augmented inservice inspection programs of selected locations for which modifications were impractical. Since that time, a final revision (Reference 4) has been made to the SR-6 report which summarized the work performed between 1973 and 1975. In the licensee's response to IE Bulletin 79-14 (Reference 9), all safety piping outside containment of the Palisades nuclear plant was reanalyzed (as-built) and modifications (mainly to pipe supports) were made from 1979 through 1981. The licensee's SEP reevaluation of pipe break outside containment (Reference 5), therefore, includes the following:

- a. A comparison of the criteria used in SR-6 with current H criteria.
- b. The effect of piping reanalysis on postulated break points and an evaluation of break points which differ from SR-6.

B. COMPARISON OF THE CRITERIA USED IN SPECIAL REPORT SR-6 WITH CURRENT REVIEW CRITERIA

A review of the criteria used in SR-6 versus the currently accepted review criteria described in Section II shows that the criteria used by SR-6 is the same as current criteria except as follows:

1. In SR-6, the licensee has classified high energy fluid systems as those that are maintained under conditions where both the maximum operating temperature and pressure exceed 200°F and 275 psig respectively. Current criteria define a line as a high energy system if either the pressure or the temperature value is exceeded. The licensee's SEP reevaluation identified two systems which were excluded from consideration by the earlier criteria that would now be considered as high energy systems by current criteria. These systems are the 2" reactor coolant letdown piping (normal temperature 120°, pressure 470 psig) and two branches (10" and 8") of the heating steam and condensate piping, which is designed for maximum service conditions of steam at 15 psig and 250°F. The licensee's assessment of the effects of postulated pipe breaks in these two systems concluded that the effects were not significant.

With respect to the letdown piping, the effect of a break in this line would not be considered significant by the licensee under the size and/or location criteria as discussed on page 7-1 of SR-6. Based on the information currently available, we have determined that the licensee has not adequately addressed this evaluation. Specifically, it is not clear how the licensee has utilized the size and/or location criteria in the letdown piping breaks evaluation to justify its conclusion. The licensee should expand its evaluation to indicate that the full extent of pipe failure effect analysis as described in SR-6 has been considered.

With respect to the heating steam system, a discussion of pipe break effects was provided in attachment I of Reference 5. The licensee has concluded that the energy contained within this system is insufficient to produce unacceptable consequences. Based on a review of the information submitted, we have determined that the licensee has provided a valid basis for their conclusion.

2. In SR-6, the licensee did not evaluate the effect of postulated breaks in the auxiliary feedwater system because of low usage of the system. However, SRP 3.6.2 specifically notes that this piping system is a high energy system. As addressed in Reference 5, significant modifications are being made to the system in the licensee's response to NUREG-0737, items II.E.1.1. A high-energy line break (HELB) analysis of this system will be included as part of the design and analysis effort associated with these modifications.

3. In SR-6, the licensee's pipe whip and jet impingement analyses were based on Bechtel Topical Report, BN-TOP-2 Revision 1, dated September 1973. However, it should be noted that the jet expansion model for calculating the impingement forces as described in BN-TOP-2 Revision 1 is only applicable to steam or water-steam blowdown. For water or sub-cooled water blowdown, the current acceptable criteria for jet expansion model is a half angle not exceeding 10 degrees. This difference of jet expansion model may result in a non-conservative calculation of the jet impingement force from water or sub-cooled water blowdown on a nearby target. The licensee is requested to provide more information to justify that the use of the BN-TOP-2 Revision 1 jet expansion model in analyses of pipe breaks outside containment will not result in any non-conservative calculation of the jet impingement force as described above.
4. Current criteria also require that through-wall leakage cracks be postulated in moderate-energy line piping ( $<200^{\circ}\text{F}$  and  $<275$  psig). The licensee has not addressed this subject in this SEP topic assessment. The effects of failure in non-Category I moderate energy lines (MEL) were reviewed by the staff under Multiplant Issue B-11 in Reference 10. Therefore, as part of Topic III-5.B, only cracks in Seismic Category I MEL's remain to be addressed.

In order for the staff to complete this topic evaluation, the licensee should provide the following:

- A. Identification of Seismic Category I moderate energy piping systems outside containment.
- B. Evaluation of the effects on safety-related equipment of leakage cracks in these systems in accordance with the review criteria. There are several approaches that can be taken, as specified in Section B.2 of BTP MEB 3-1.
- C. Information on plant features such as physical separation, isolation capability, sump level indication, moisture detectors, water-tight doors that would ensure that safety-related equipment is adequately protected.

In summary, based on the information submitted in References 4 and 5, we have determined that except for the subjects of reactor coolant letdown piping breaks evaluation, the jet expansion model and evaluation of the effects of cracks in Category I MEL's, addressed in Sections B.1, B.3 and B.4 above, the criteria used in the licensee's SEP reevaluation are in accordance with currently accepted standards.

C. THE EFFECT OF 1979-1981 PIPING REANALYSIS ON POSTULATED BREAK EVALUATION

Subsequent to completion of SR-6, large bore safety piping at Palisades was re-analyzed based on "as built" data collected in 1978 and 1980. As a result of this reanalysis performed in the 1979-1981 period, some points of highest combined stresses changed from those points considered by SR-6. The high stress point relocations have been reviewed by the licensee on a sample basis and found not to be significant, i.e., the reanalyses do not invalidate SR-6 results. Our comparison of the recalculated stress values as listed in Tables 1, 2 and 3 of Reference 5 with those of SR-6, indicates significant differences in four points of high stress in the feedwater piping system, i.e., node points 35, 40, 56 and 47 (Table 2 of Reference 5). These four node points, which were not considered as break locations by SR-6, would now be considered as postulated break locations. However, it is noted that all of the four locations are in the turbine building, which is of sufficient size to dissipate any energy release without significant pressurization or other adverse environmental effects. In addition, there are no critical structures or components in the proximity of these locations and, consequently, no further analysis is required. In summary, based on the information submitted, we have determined that the effect of piping reanalyses on postulated break evaluations is not significant and the reanalyses do not invalidate SR-6 results.

VI. CONCLUSION

In References 7 and 8, the staff previously approved the information submitted in References 1, 2 and 3. As part of the topic evaluation, we have reviewed Reference 5 in which the licensee compares the criteria in the above references with current criteria. In addition, we have reviewed the effects of postulated pipe breaks in two systems, i.e., reactor coolant letdown and heating steam systems which were excluded from high energy system consideration by the licensee's criteria used in SR-6. We have also reviewed the effect of piping reanalyses on postulated break evaluations.

We have concluded that the licensee's criteria for postulating pipe breaks and its method for evaluating postulated breaks in high energy piping outside containment are, in general, in accordance with currently accepted standards. However, we have found that the subjects of reactor coolant letdown piping break evaluation, the jet expansion model and evaluation of



the effects of cracks in seismic Category I moderate-energy lines, as identified in Sections B.1, B.3 and B.4 respectively, have not been addressed adequately in the licensee's evaluation. The licensee is requested to provide additional information on these subjects. Moreover, it should be noted that the licensee has not addressed the effect of postulated breaks in the auxiliary feedwater system in its SEP evaluation. A high energy line break analysis of this system will be included in the licensee's response to NUREG-0737, item II.E.1.1, "Auxiliary Feedwater System Evaluation".

#### REFERENCES

1. Special Report-6, "ANALYSIS OF POSTULATED HIGH ENERGY LINE BREAK OUTSIDE CONTAINMENT", Consumer Power Company, dated May 1, 1973.
2. Revision 1 to Report above, July 13, 1973.
3. Revision 2 to Report above, July 27, 1973.
4. Revision 3 to Report above, June 30, 1975.
5. Report, "PALISADES PLANT SEP TOPIC III-5.B HIGH ENERGY LINE BREAK OUTSIDE CONTAINMENT", Consumer Power Company, dated August 25, 1981.
6. Letter, A. Giambusso (NRC) to CPCo, "GENERAL INFORMATION REQUIRED OF THE EFFECTS OF A PIPING SYSTEM BREAK OUTSIDE CONTAINMENT", dated December 15, 1972.
7. Letter, D. Skovholt (NRC) to R. Youngdahl (CPCo) on Review of CPCo Special Report-6, dated August 7, 1973.
8. Letter, D. Skovholt (NRC) to R. Haueter (CPCo) on Augmented Inservice Inspection Program for High Energy Lines Outside of Containment, dated October 9, 1973.
9. NRC IE Bulletin 79-14, "SEISMIC ANALYSES FOR AS-BUILT SAFETY-RELATED PIPING SYSTEMS", July 2, 1979.
10. Letter, D.M. Crutchfield (NRC) to D.P. Hoffman (CPCo), dated April 30, 1981.