LACROSSE BOILING WATER REACTOR
DOCKET NO. 50-409
SAFETY EVALUATION REPORT
IPSAR SECTION 4.11
EFFECTS OF PIPE BREAKS ON STRUCTURES, SYSTEMS AND COMPONENTS INSIDE CONTAINMENT

I. INTRODUCTION

In Section 4.11 of the LaCrosse Boiling Water Reactor Integrated Plant Safety Assessment Report (IPSAR NUREG-0827, Reference 1), the staff identified six open items concerning the effects of pipe breaks inside containment which required further evaluation. By letters dated December 29, 1983, June 29, 1984, and July 26, 1985, the licensee provided information for five of the six open items. The sixth item concerning the implementation of relocating a valve has been confirmed. The resolutions of these open items are discussed below.

II. DISCUSSION

A. IPSAR Section 4.11, Item (1)

Issue:

Clarification concerning the effects of jet impingement and pipe whip motion on mitigation systems.

Response:

In 1975 and 1976, a comprehensive review of the LACBWR ECCS systems was performed to evaluate potential failure modes which might impair their capabilities to perform their design function. Among the failure modes considered were high energy line breaks and their effects. A location was identified where a postulated break in the high-energy portion of the alternate core spray (ACS) line could conceivably disable the high pressure core spray (HPCS) system by means of pipe whip damage to the HPCS suction line. To remedy this situation, the licensee installed two pipe whip restraints designed and located by its consultant, Nuclear Energy Services (NES).

In their analysis, NES postulated breaks in the ACS line where it ran in close proximity to the HPCS suction line. Breaks were postulated at areas of potential stress raisers (elbows, attachments, valves, etc.). Circumferential, double-ended breaks were assumed, and pipe-whip directions were determined based upon direction of thrust (axial at break location), pipe geometry, and location of plastic

hinge formation (for each break location). Analytical methods and results are included in a document dated June 24, 1976. Jet impingement effects were not evaluated at that time, therefore, the staff requested that the licensee assess jet effects from bre. , in these lines.

By letter dated July 26, 1985 (Reference 4), the licensee provided their review of jet impingement on the HPCS suction line. A postulated break in the ACS line, in the vicinity of the HPCS line was analyzed. The jet impingement load on the HPCS suction line was calculated and the resulting stress was found to be less than the allowable of 1.5 Sm. During this review, the licensee also identified two branch lines off the HPCS suction line that may be damaged by a break in main steam line to the shutdown condenser. Damage to branch lines could divert flow from the HPCS, which is a system needed to mitigate the postulated break. Therefore, these two lines will be rerouted.

Evaluation:

The licensee has proposed to reroute two branch lines off the HPCS suction line (the 2-inch line that supplies emergency makeup to the seal injection and the 2-inch line that provides for rejecting primary water from the purification system to the overhead storage tank). These changes will prevent damage to mitigating systems from this high energy line break. With these modifications, the staff concurs that the most limiting jet impingement scenario is the postulated break in the ACS line near the HPCS suction line, and that the consequences of such a break satisfy staff criteria. Therefore, the proposed modifications are sufficient to resolve this issue.

B. IPSAR Section 4.11, Item (2)

Issue:

Confirmation that the portion of the steel vessel not protected by the 9-inch concrete would not be damaged by any postulated high energy line breaks.

Response:

In Reference 2, the licensee stated:

"The unprotected areas comprise the hemispherical diameter of the containment vessel, and an area approximately 11 feet high and 22 feet wide adjacent to the electrical penetration room. However, the lack of concrete shielding over these parts of the Containment vessel wall is not a concern, since there is no high energy lines in proximity to either area."

Evaluation:

Since the licensee has confirmed that there is no high energy line in proximity to the areas of concern, the staff considers this response to be acceptable.

C. IPSAR Section 4.11, Item (3)

Issue:

Installation of a valve on the decay heat cooling system blowdown line to the main condenser and administrative controls to maintain it in a closed position during power operation.

Response:

The licensee confirmed that the relocation of the valve, 56-24-009, and the establishment of procedures to close this valve in the event of a loss-of-coolant accident has been completed by DPC Facility Change No. 56-83-2, dated December 1983.

Evaluation:

As discussed in NRC Inspection Report 84-09 (Reference 5), the staff has verified completion of this change and thus this issue is resolved.

D. IPSAR Section 4.11, Item (4)

Issue:

Acceptability of damage to control rod drive mechanisms from postulated high energy line breaks.

Response:

The details of the licensee's response are described in Reference 2 and 3. The licensee stated that the most severe threat to the integrity of the LACBWR Control Rod Drive (CRD) is the jet impingement force originating from a postulated rupture of the 10-inch main steam line. A portion of this line is adjacent to the upper control rod drive mechanisms (CRDM) where the main steam line from the reactor drops to the elevation of its containment penetration. Calculations have been performed to determine the characteristics of a jet issuing from a break in the main steam line at its nearest approach to the CRD's and to determine its effects, i.e., force and resulting stress

on these components. Results of these calculations indicated that the combined stress in the outermost CRDM due to jet impingement load, dead load, pressure stress, and seismic loading is below the allowable for Service Level D loading condition. Stresses on the CRDM farther from the postulated break drop rapidly due to jet expansion and shielding effects of intervening CRDMs.

Other high energy systems which have been identified as having the potential to interact with the Control Rod Drive Mechanisms are the Seal Injection System, Heating Steam System, and Control Rod Drive Effluent piping. However, Heating Steam is at insufficient pressure (125 psig) to generate significant whipping force or jet thrust. Also, the seal injection and CRD effluent lines, while nominally high pressure-high energy systems, are coupled to energy reservoirs through high resistance flow paths which limit available break energy to low levels.

Evaluation:

Based on a review of the information in References 2 and 3, the staff has determined the the licensee's evaluation of potential damage to control rod drive mechanisms from postulated energy breaks is somewhat conservative and the results show that stresses on the CRDM are all below ASME code allowables. The staff considers this item resolved.

E. IPSAR Section 4.11, Item (5)

Issue:

Resolution of postulated breaks in boron injection system piping damaging the containment ventilation exhaust damper operators.

Response:

The licensee, in a submittal dated December 29, 1983 (Reference 2), stated that dynamic effects associated with postulated high energy line breaks in the boron inject line in the vicinity of the containment ventilation dampers had been analyzed in accordance with criteria set forth in the Standard Review Plan. The evaluation demonstrates that:

1. The valve operators are not subject to damage from whipping segments of the boron inject line.

2. The operators may be subject to jet impingement. However, the jet impingement force on the valve operators for postulated circumferential boron inject line breaks is shown to be insufficient to preclude required valve operation (closure).

The anchor bolts which hold the operator assembly to the damper were addressed in this analysis. The calculations did not address the bolts which hold each cylindrical operator to the operator assembly.

The NRC staff questioned whether the bolts analyzed were the most limiting case. A closer look at the calculations proved this not to be the case. The bolts which hold the longer cylindrical operator assembly are the most limiting case. A review of the calculations shows these bolts to be adequate to withstand the boron inject line jet impingement forces. The details for these bolt stress calculations are presented in Reference 3.

Evaluation:

Based on the review of the licensee's original response dated December 29, 1983 (Reference 2), and the licensee's response (Reference 3) to the staff's additional concerns, the staff finds the analysis methods, criteria, and results to be acceptable to resolve the issue of postulated breaks in boron injection system piping damaging the containment exhaust damper operators.

F. IPSAR Section 4.11, Item (6)

Issue:

Justification of the design adequacy of anchor bolts for the existing pipe whip restraints in the alternate core spray lines.

Response:

In Reference 2, the licensee stated that staff questions on the design adequacy of the LaCrosse Boiling Water Reactor Alternate Core Spray (ACS) pipe whip restraint had been reviewed and the pipe whip restraint found to be adequate.

Details on the original structural design and analysis of the ACS line pipe whip restraints are in Attachment No. 4 of Reference 2. Additional design calculations and clarification of the NRC's concerns raised under this topic are contained in Attachment No. 3 of Reference 2.

As described in Attachment No. 3 of Reference 2, the ACS pipe whip restraint anchor bolt pull out and shear loading is within the capability of the Wej-it anchor bolts. As shown in Table 1 of Attachment No. 3, the anchor bolt margin of safety for the West Restraint is 2.37 for pull-out and 5.68 for shear. The margin of safety for the East Restraint is 3.79 for pull-out and 3.70 for shear. These safety margins were calculated using conservative restraint loading assumptions described in Attachment No. 3 of Reference 2.

Also addressed in Attachment 3 is the question of the ACS pipe whip restraint base plate flexibility. The base plate is a one-inch thick steel plate reinforced with gusset plates; thus the rigid base plate assumption is justified in this case.

The alternate core spray (ACS) pipe whip restraint analysis submitted as part of Reference 2 used the steady state thrust loading instead of the initial thrust loading for calculating the restraint reaction loading. The NRC questioned the basis for using the steady state thrust loading.

The SRP section 3.6.2 subsection III.2.c(4) was used to establish the original basis for using the steady state thrust load. Following several conversations between the NRC, the licensee, and the licensee's contractor, it was decided that the initial thrust load would be used in the ACS pipe whip restraint analysis.

The revised ACS pipe whip restraint calculations were performed as described in Reference 3. The as-installed ACS pipe whip restraints are adequate to withstand the revised restraint loading.

Evaluation:

In References 2 and 3, the licensee provided results of a detailed assessment to verify the design adequacy of alternate core spray pipe whip restraint anchor bolts. The energy balance analysis model was used in the analysis of the dynamic effects of pipe whip and pipe whip restraint system response. As discussed above, the pipe rupture load was conservatively taken as equal to that for the initial thrust load rather than the calculated time-dependent jet thrust loads. The results of the licensee's conservative analysis showed that the alternate core spray whip restraint anchor bolt design met the ACI 349-76, "Code Requirements for Nuclear Safety Related Concrete Structures", and had sufficient margin when compared to manufacturer's test data for the maximum pull out and shear strength values of the expansion anchor bolts.

Based on a review of the information in References 2 and 3, the staff has determined that the licensee's analysis provide reasonable assurance that the existing design of the alternate core spray pipe whip restraint anchor bolts is adequate to withstand the dynamic loads associated with the postulated pipe break of the alternate core spray line and therefore, is acceptable. This item is fully resolved.

III. CONCLUSION

Based on the above discussion, the staff concludes that the six open items identified in Section 4.11 of the LaCrosse IPSAR (NUREG-0827) will be satisfactorily resolved upon completion of the proposed rerouting of the two lines connected to the HPCS suction line.

REFERENCES

1. NUREG-0827, Integrated Plant Safety Assessment - LaCrosse Boiling Water Reactor", dated June 1983.

2. Letter with attachments (LAC-9514) from F. Linder to D. Crutchfield, dated December 29, 1983.

3. Letter with attachments (LAC-10011) from F. Linder to D. Crutchfield, dated June 29, 1984.

4. Letter (LAC-11053) from F. Linder to J. Zwolinski, dated July 26, 1985.

5. NRC Inspection Report 50-409/84-09, dated October 5, 1984.