August 20, 1982

Docket No. 50-029
LS05-82-08-043

Mr. James A. Kay
Senior Engineer - Licensing
Yankee Atomic Electric Company
1671 Worcester Road
Framingham, Massachusetts 01701

Dear Mr. Kay:

SUBJECT: SEP TOPIC III-5.A, EFFECTS OF PIPE BREAK ON STRUCTURES, SYSTEMS AND COMPONENTS INSIDE CONTAINMENT - YANKEE NUCLEAR POWER STATION

In your letter dated March 18, 1982, you submitted a safety assessment report on the above topic. We have completed our evaluation, which is enclosed. We conclude that the plant is adequately protected from the dynamic effects of pipe break inside containment subject to resolution of the following in the Integrated Plant Safety Assessment:

A. Clarification of assumptions used in the jet impingement and pipe whip evaluations.

B. Evaluation of thrust forces on steam generator due to main steam or feedwater line breaks.

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C. Evaluation of effects of jet impingement on blister 12E.

D. Evaluation of pipe whip interactions on loop compartment walls from postulated breaks in large RCS piping.

The need to actually implement changes as a result of these items will be determined during the integrated safety assessment. This safety evaluation may be revised in the future if your facility design is changed or if NRC criteria relating to this topic are modified before the integrated assessment is completed.

Sincerely,

SEPB:DL
RHermann
8/18/82

Ralph Caruso, Project Manager
Operating Reactors Branch No. 5
Division of Licensing

OFFICE	ORB#5:PM	ORB#5:BC	AD:SA:DL		SEPB:DL	SEPB:DL	SEPB:DL	SEPB:DL
SURNAME	RCaruso	DCrutchfield	GLainas		EMcKenna:dk	MBoyle	CGrimes	WRussell
	8/19/82	8/20/82	8/19/82		8/03/82	8/11/82	8/16/82	8/19/82

SEPB:DL
PYChen
8/3/82

Enclosure: As stated

cc w/enclosure: See next page

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cc
Mr. James E. Tribble, President
Yankee Atomic Electric Company
25 Research Drive
Westborough, Massachusetts 01581

Chairman
Board of Selectmen
Town of Rowe
Rowe, Massachusetts 01367

Energy Facilities Siting Council
14th Floor
One Ashburton Place
Boston, Massachusetts 02108

U. S. Environmental Protection
Agency
Region I Office
ATTN: Regional Radiation Representative
JFK Federal Building
Boston, Massachusetts 02203

Resident Inspector
Yankee Rowe Nuclear Power Station
c/o U.S. NRC
Post Office Box 28
Monroe Bridge, Massachusetts 01350

Ronald C. Haynes, Regional Administrator
Nuclear Regulatory Commission, Region I
631 Park Avenue
King of Prussia, Pennsylvania 19406

SEP EVALUATION

OF

EFFECTS OF PIPE BREAK ON STRUCTURES, SYSTEMS AND COMPONENTS INSIDE CONTAINMENT

TOPIC III-5.A

FOR

THE YANKEE NUCLEAR POWER PLANT

TABLE OF CONTENTS

I. INTRODUCTION

The safety objective of Systematic Evaluation Program (SEP) Topic III-5.A, "Effects of Pipe Break on Structures, Systems and Components Inside 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 shutdown 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 shutdown 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.

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 USI A-24, "Environmental Qualification of Safety-Related Eequipment."

3. The effects of potential missiles generated by fluid system ruptures and rotating machinery are evaluated under SEP Topic III-4.C, "Internally Generated Missiles."

4. The effects of compartment pressurization are under SEP Topic VI-2.D, "Mass and Energy Release for Possible Pipe Break Inside Containment," and VI-3, "Containment Pressure and Heat Removal Capability."

5. The original plant design criteria in the areas of seismic input, analysis design criteria are evaluated under SEP Topic III-6, "Seismic Design Consideration."

6. The effects of steam line breaks on core reactivity and primary cooldown are addressed under SEP Topic XV-2, "Spectrum of Steam System Piping Failures Inside and Outside Containment (PWR)."

7. The effects of feedwater line breaks on the main coolant system and secondary system pressurization, and core integrity are addressed under SEP Topic XV-6, "Feedwater System Pipe Breaks Inside and Outside Containment."

8. The effects of primary system breaks on the reactor core are addressed under SEP Topic XV-19, "Loss of Coolant Accidents Resulting from Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary."

IV. REVIEW GUIDELINES

The current criteria for review of pipe breaks inside containment are contained in 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).

The licensee's break location criteria and methods of analysis for evaluating postulated breaks in high energy piping systems inside containment have been compared with the currently accepted review criteria. The review relied upon information submitted by the licensee, Yankee Atomic Electric Company (YAEC), in Reference 1. 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 consequence of postulated pipe break and to assure that pipe break would not cause the loss of required function of "safety-related" systems, structures and components and to assure that the plant can be safely shutdown in the event of such break.

V. EVALUATION

A. BACKGROUND

On July 20, 1978, the SEP Branch sent a letter (Reference 2) to KMC, Inc. requesting an analysis of the effects of postulated pipe breaks on structures, systems and components inside containment. In that letter, the staff included a position that stated three approache were appropriate for postulating breaks in high energy piping systems either P>275 psig or T>200°F. The approaches are:

1. Mechanistic
2. Simplified Mechanistic
3. Effects Oriented

The staff further stated that combinations of the three approaches could be utilized if justified.

In response to our letter, the licensee submitted Reference 1 which summarized and documented YAEC's evaluation of the effects of high energy pipe break inside containment.

B. APPROACH AND CRITERIA

The licensee has utilized the effects-oriented approach in its high energy line break (HELB) study (Reference 1).

The following assumptions were made by the licensee:

1. High energy fluid systems are systems with operating temperature >200°F or operating pressure >275 psig. In accordance with Branch Technical Position (BTP) MEB 3-1, breaks are not postulated in piping of systems that qualify as high energy systems for only short operational periods (i.e., less than 2% of the time the system operates as a moderate energy system or less than 1% of the time that the plant operates). The boundary of the high energy line is taken as the first normally closed valve, check valve, relief/safety valve or first valve capable of remote or automatic closure.

2. The worst, unrelated, single active failure occurs simultaneously with the pipe break. Unrelated passive failures are not considered in the short-term.

3. A simultaneous, unrelated, pipe failure is not postulated with the high energy pipe break.

4. The effects of pipe whip or jet impingement will not damage equal diameter or larger piping which has equal or greater wall thickness.

5. Effects of pipe whip and jet impingement from rupture of piping 1" nominal pipe size and smaller are not required to be analyzed.

6. The effects of pipe whip or impingement from low energy pipe systems are not required.

Our review of the licensee's assumptions as described above indicates that assumption 4 requires clarification. The staff concurs that the effects of pipe whip will not damage equal diameter or larger piping with equal or greater wall thickness. However, in accordance with staff positions transmitted on January 4, 1980 (Reference 3), the effects of jet impingement should be considered and evaluated regardless of the ratio of impinged and postulated broken pipe sizes. The staff assessed the consequences for those identified interactions in which the licensee did not assume damage due to jet impingement because of Assumption 4. For the cases discussed below, the staff determined that the consequences of damage to the target would be acceptable.

For instance, for the feedwater line break, the licensee stated that they did not believe that the feedwater line would damage the steam line. Even if damage did occur, this event is then similar to the main steam line break which was assumed to damage the feedline, which is discussed below.

The steam generator blowdown lines run in close proximity to each other in the loop compartments. A break in any one line was assumed not to damage the others since they are the same size and pipe schedule. If damage did occur the results would still be acceptable since the additional break area is bounded by the design basis steam line break, the blowdown piping is not needed to mitigate the event and, for each case, at least one steam generator remains intact.

However, the licensee should perform additional evaluation of the effects of jet impingement on any other piping systems which were excluded from previous evaluations by the licensee's assumption. In addition, based on the information currently available, we have determined that the licensee has not adequately addressed the assumptions used in its jet impingement and pipe whip evaluation. Specifically, the licensee is requested to provide information concerning the jet expansion model and direction of pipe whip motions.

C. SAFETY-RELATED EQUIPMENT

Safety-related equipment includes systems needed to mitigate the effects of the line breaks and to bring the reactor to safe shutdown. These systems and equipment perform the following functions:

1. Insert negative reactivity into the reactor core.
2. Maintain reactor coolant system (RCS) and/or secondary side water inventory.
3. Control RCS overpressure.
4. Remove decay heat and control cooldown of the RCS.

The licensee has identified the following safety-related equipment:

1. Main Steam Safety Valves (MSSV) and main steam piping inside containment.
2. Atmospheric Dump Valves (ADVs).
3. Emergency Feed Pumps (EFPs) and feedwater piping inside containment.
4. Demineralized Water Storage Tank (DWST) and Primary Water Storage Tank (PWST).
5. Shutdown Cooling System (SCS) and piping inside containment.
6. Component Cooling System (CCS).
7. Service Water System (WSW).
8. Emergency Power System.
9. 125 V DC Power System.

10. Chemical and Volume Control System (CVCS) and piping inside containment.
11. Pressure Control and Relief System.
12. Instrumentation for Shutdown and Cooldown.

D. INTERACTION STUDIES

Using the criteria as described in Section B.1 of this Safety Evaluation Report, the applicant has identified the high energy fluid systems inside containment as follows:

1. Main Steam
2. Feedwater
3. Steam Generator Blowdown (SGBD)
4. Charging and Volume Control System (CVCS)
5. Steam Generator Instrumentation
6. Reactor Coolant System (RCS) - including interconnected system up to first normally closed valve, check valve, safety valve, relief valve, and remote or automatic isolation valve. These are:

    a. RCS Vents and Drains
    b. Shutdown Cooling System (SCS)
    c. Safety Injection System (SIS)
    d. Normal Charging and Letdown of the CVCS
    e. Pressure Control and Relief

Using the effects-oriented approach, the licensee evaluated the effects of the postulated pipe breaks on a system-by-system basis. Each system has been analyzed for the effect that postulated pipe breaks would have on the ability to safely shut the plant down or to stay shutdown. The licensee has concluded that the vast majority of breaks do not prevent the plant from achieving and maintaining a safe shutdown condition. However, the licensee has identified the following two interactions which require further analysis.

1. The resulting thrust forces on the steam generator due to main steam line and feedwater line breaks must be analyzed.

2. The effects of main steam jet impingement on the containment electrical penetrations in blister 12E (main steam line break with simultaneous loss of power to all four reactor coolant pumps).

In addition, the licensee has identified that the potential pipe whip on the loop compartment divider walls from postulated pipe breaks in the large RCS piping are unacceptable. The licensee is presently evaluating possible alternatives to develop an acceptable solution to these break locations.

The licensee has provided an evaluation of the effects of a main steam line break from the #3 steam generator, which is considered to be the limiting secondary system break.

The following adverse effects on systems, structures and components could occur:

- jet impingement on instrument cable routed to or near penetration blister 5E, which includes steam generator level indications, pressurizer level indications and RCS pressure indications.

- damage to the vapor container due to pipe whip or jet impingement resulting in violation of containment integrity.

- impact on the main feedwater line for the affected steam generator.

A shutdown scenario with unaffected equipment was provided assuming loss of offsite power and a single active failure. The unaffected steam generators and equipment and instrumentation located outside containment would be relied upon to mitigate the break and reach safe shutdown.

The instrumentation lost by the jet impingement forces would normally be used by the operator to monitor plant response. Since all channels of important parameters could be lost, the staff considers that changes should be made to reduce the instrumentation that could be affected by a break. Several plant modifications are already planned as a result of equipment environmental qualification.

- The existing electrical penetrations in the blisters will be replaced.

- A new set of steam generator wide-range level indication channels will be added.

- Routing of the existing cables and the new instrument cable will be changed to split the instruments between blisters 5E and 7E.

The proposed modifications, which are presently scheduled for the next refueling outage, will improve plant capability to respond to such pipe breaks.

Damage to the feedwater line to the generator with the broken steam line is acceptable since the other three generators could be used for decay heat removal.

As discussed above, a main steam line break could result in loss of containment integrity. The staff has concluded that the activity released to the environment would not result in exposures in excess of 10 CFR Part 100 limits for the reasons discussed below.

No fuel failure is predicted for this event. The activity available for release is the airborne activity, steam from the break, with any primary coolant that has leaked to the secondary side, and reactor coolant system leakage. The Yankee technical specifications include limits on maximum primary coolant activity, primary-to-secondary leakage and reactor coolant leakage.

Therefore, it is considered acceptable that some degradation of containment integrity might result from the postulated double-ended main steam line break.

Other secondary system breaks would affect less equipment and are, therefore, bounded by the above event.

VI. CONCLUSION

Based on the information submitted by the licensee, we have reviewed the criteria pertaining to the locations, types and effect of postulated pipe breaks in high energy piping systems inside containment. We have concluded that the criteria used to define the break locations, and types are in accordance with currently accepted standards. We have also determined that it is acceptable under current SEP criteria to use the interaction study to evaluate the effects of postulated pipe breaks and to determine the acceptability of plant response to pipe breaks.

The following items should be addressed in the integrated assessment:

A. Clarification of assumptions used in the jet impingement and pipe whip evaluations, (Section V.B).

B. Evaluation of thrust forces on the steam generator due to main steam or feedwater line breaks, (Section V.D.1).

C. Evaluation of effect of jet impingement on blister 12E, (Section V.D.2).

D. Evaluation of pipe whip interactions on loop compartment walls from postulated breaks in large RCS piping, (Section V.D).

VII. REFERENCES

1. Report, "SEP TOPIC III-5.A EFFECTS OF HIGH ENERGY PIPING SYSTEM BREAKS INSIDE THE VAPOR CONTAINER AT YANKEE ATOMIC POWER STATION", Yankee Atomic Electric Company, dated March 18, 1982.

2. Letter, D. Davis (NRC) to J. McEwen (KMc, Inc.), "ASSESSMENT OF POSTULATED PIPE BREAKS INSIDE CONTAINMENT FOR SEP PLANTS", dated July 20, 1978.

3. Letter, D. Ziemann (NRC) to R. Groce (YAEC), "EVALUATION OF PIPE WHIP IMPACT AND JET IMPINGEMENT EFFECTS OF POSTULATED PIPE BREAKS FOR SEP TOPICS III-5.A AND III-5.B", dated January 4, 1980.