October 12, 1982

Docket No. 50-213
LS05-82- 10-041

Mr. W. G. Counsil, Vice President
Nuclear Engineering and Operations
Connecticut Yankee Atomic Power Co.
Post Office Box 270
Hartford, Connecticut 06101

Dear Mr. Counsil:

SUBJECT: SEP TOPIC III-5.A, EFFECTS OF PIPE BREAK ON STRUCTURES, SYSTEMS AND COMPONENTS INSIDE CONTAINMENT
HADDAM NECK PLANT

By letter dated September 17, 1982, you provided a safety assessment of this topic. The staff has reviewed your assessment and concludes that the methodology and acceptance criteria being used in your continuing evaluations are appropriate to resolve the ten issues identified in the enclosed safety evaluation report.

The need and schedule to resolve each of these issues will be addressed in the integrated assessment. This 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,

Original signed by:

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

Enclosure:
As stated

cc w/enclosure:
See next page

SEOA
DSU USE EX(02)
Add: Gary Staley

SEPB *
RHermann
10/4/82

AD:SA:DL
EMiraglia
10/ /82

*See previous concurrence

OFFICE	SEPB *	SEPB *	SEPB *	SEPB	SEPB	ORB#5	ORB#5
SURNAME	EMcKenna:bl	PYChen	SBrown	CGrimes	WRussell	JLyons	DCrutchfield
DATE	9/30/82	9/30/82	10/1/82	10/6/82	10/7/82	10/8/82	10/12/82

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Dear Mr. Counsil:

SUBJECT: SEP TOPIC III-5.A, EFFECTS OF PIPE BREAK ON STRUCTURES, SYSTEMS AND COMPONENTS INSIDE CONTAINMENT
HADDAM NECK PLANT

By letter dated September 17, 1982, yourprovided a safety assessment of this topic. The staff has reviewed your assessment and based on this review, it is the staff's position that yourshould resolve the ten issues identified in the summary of the enclosed safety evaluation report.

The need to implement any changes to resolve these issues will be addressed in the integrated assessment. This 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,

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

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NRC FORM 318 (10-80) NRCM 0240 OFFICIAL RECORD COPY USGPO: 1981—335-960

Mr. W. G. Counsil

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SYSTEMATIC EVALUATION REPORT

TOPIC III-5.A

HADDAM NECK PLANT

TOPIC: III-5.A, Effects of Pipe Break on Structures, Systems and Components Inside Containment

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 as described in Section II above. The review relied upon information submitted by the licensee, Connecticut Yankee Atomic Power Company (CYAPCo), in Reference 1.

V. EVALUATION

A. Criteria and Assumptions

The licensee submitted its safety assessment report on the effects of high energy line break inside containment in the Attachment to Reference 1. The staff has made a preliminary review of this assessment and our comments to date are discussed below:

1. The licensee has classified high energy fluid systems as those that are maintained under conditions where either or both the maximum operating temperature and pressure exceed 200°F and 275 psig during normal operation. This is consistent with current MEB criteria.

2. The licensee has utilized the Mechanistic Approach and the Simplified Mechanistic Approach in postulating high energy pipe break points inside containment. Based on the information submitted in Reference 1, we have concluded that the criteria used to define the break locations and the break types are in accordance with currently accepted standards.

3. The licensee has used the following assumptions in its pipe whip and jet impingement analysis.

   a. Pipe whip was assumed to occur as a result of a circumferential rupture in a high energy system provided there was a significant reservoir of energy.

   b. For circumferential breaks, the free end of a moving pipe will be assumed to move in only one direction parallel to its reaction force. This type of pipe break event will not cause dynamic instability (large amplitude oscillations) since the critical length required for this phenomena is substantially greater than any major pipes in the containment.

   c. Impacted active equipment (e.g., valves and instruments) will be considered unable to perform its intended function unless it has been specifically designed to operate following such impact.

   d. Impacted passive equipment (e.g., pipes, restraints, or structures) will be considered capable of continuing to perform their intended functions provided that the resulting strain levels due to the impact do not exceed defined allowables.

   e. Valves which are not signaled to change state shall be assumed to fail in the position in which they were prior to impact.

   f. Plastic hinge formation due to pipe rupture was assumed to occur at system anchors or at other intermediate locations as dictated by the complexity of the particular system configuration. The hinges can form in either bending or torsional modes depending on the configuration.

   g. Longitudinal breaks were assumed to cause a jet in the form if a cone with a twenty degree angle of divergence. A steam or water jet was assumed to have sufficient energy to cause damage to the following:

      i. Electric cable trays and conduit.
      ii. Electric motor operators.
      iii. Instrumentation and instrument tubing.

   h. A whipping pipe was considered to have sufficient energy to cause damage to the following:

      i. Pipes of smaller nominal size and lighter wall thickness.
      ii. Electric motor operators.
      iii. Electric conduit and cable trays.

      A whipping pipe will be considered sufficient to cause a leakage crack in an impacted pipe of equal or larger nominal size and lighter wall thickness.

4. Based on a review of the above information, we have determined that the licensee's pipe whip and jet impingement analysis are, in general, consistent with the currently accepted standards except as follows:

   a. In considering the pipe whip damage, it is acceptable to use the conservative assumption that the particular safety system becomes inoperative, irrespective of the actual energy which would be involved in the collision or the strength of the impacted piping system. Nevertheless, the staff's position is that it is necessary to consider all the possible sequences of cascading failures, i.e., the damaged target may damage another piping system and so forth, and to evaluate the overall effects of cascading failure such as the effect on multiple blowdown transients and to provide a shutdown/cooldown scenario for the cascading failures. The licensee is requested to supply this information or to confirm that such was the case in its evaluation.

   b. With respect to jet impingement analysis, the licensee has utilized assumption 3g of Section V.A. Assumption 3g specifically refers to "longitudinal breaks" when considering the jet expansion model. It is the staff's position that jet impingement effects should be considered as a result of both circumferential breaks and longitudinal breaks. Furthermore, in the case of circumferential breaks, jets in conjunction with pipe whip should be considered to sweep the arc traveled during the whip. The licensee should expand its evaluation to address the criteria used for jet impingement from circumferential breaks.

   c. In addition, assumption 3g only addresses the jet impingement effects on electric cable trays and conduit, electric motor operators and instrumentation and instrument tubing. Based on the information submitted in Reference 1, it is not clear how the licensee has assessed the jet impingement effects on the impinged target piping system (See B.2 below).

   d. Assumption 3d states that impacted passive equipment (e.g., pipes, restraints, or structures) will be considered capable of continuing to perform their intended functions provided that the resulting strain levels due to the impact do not exceed defined allowables. The licensee is requested to provide clarification concerning the allowable strain level utilized in its study.

B. EFFECTS ON SYSTEMS, STRUCTURES AND COMPONENTS

1. With respect to pipe break effects on the containment liner, the licensee stated that since the containment liner is flush with the concrete containment shell and has a minimum thickness of 1/4", it is not considered credible that a whipping pipe or water or steam jet impinging on the steel liner could fail the material or degrade in any manner the liner's function as an environmental barrier. Based on the information submitted in Reference 1, we have determined that the licensee has not provided adequate information to justify its conclusion. Additional justification concerning the containment integrity is required.

2. The licensee has performed an interaction matrix to study the consequences of postulated pipe breaks on safety-related systems, structures and components. The matrices are prepared on a system basis showing the potential interaction between the source, for each postulated break point, and the selected target. It is noted that for many interaction evaluations the licensee simply concludes that the potential damage to target piping is not considered credible based on size consideration. Based on the information in Reference 1, it is not clear now the licensee has utilized the size differential criteria in the jet impingement effects evaluation. In accordance with staff positions transmitted on January 4, 1980 (Reference 2), the effects of jet impingement should be considered and evaluated regardless of the ratio of impinged and postulated broken pipe sizes. The licensee is requested to assess its evaluation given the staff position.

3. As identified in Section 6.0 of Reference 1, the licensee has not completed its evaluation for the effects of postulated breaks on the necessary instrumentation for plant safe shutdown. The licensee has committed to perform further evaluation with respect to possible pipe whip and jet impingement effects on the instrumentation.

4. For the main reactor coolant system loop, the licensee has evaluated jet impingement effects from small slot piping failures. The basis for not postulating larger breaks stems from the evaluations conducted under Unresolved Safety Issue A-2. This approach is acceptable to the staff; however, the licensee should verify that the seismic loads assumed in the A-2 analyses are compatible with the seismic loads being addressed in SEP. This aspect should be coordinated with the seismic reevaluation under SEP Topic III-6. Furthermore, since this approach relies upon RCPB leakage detection systems, the type and number of the systems provided should be commensurate with the guidelines of Regulatory Guide 1.45. This aspect should be coorinated with SEP Topic V-5, "RCPB Leakage Detection."

5. Three methods of plant shutdown are discussed in the licensee's submittal. The third method is feeding of cool water directly to the RCS through the emergency core cooling system. The licensee is requested to identify under what circumstances this method is intended to be used, i.e., following a loss of coolant accident or with an intact reactor coolant pressure boundary. The procedure describes how water is provided to the primary system but not how energy is removed.

6. The interaction matrices for some main steam line breaks show interactions, with possible damage ("D" in the matrix), with feedwater lines. For example, for line 24-SHP-601-2, (main steam from #2 generator) interactions are shown for WFPD-601-7 (feed for #1 generator) and WFPD-601-8 (feed for #2 generator).

   The discussion in Section VII.A of Reference 4, indicates that interactions between steam and feed lines from breaks in main steam lines from steam generators 2 and 3 are not credible.

   The licensee is requested to:

   a. Clarify the apparent inconsistency.
   b. Identify any situations in which a break in piping for one generator affects piping to another generator.

   The licensee has considered the consequences of a main steam line break damaging the feedwater line to the same generator. The staff concurs with the licensee's argument that the consequences are acceptable.

7. For a pipe break in the core deluge piping between the vessel head and the isolation valves, a LOCA will result. A single failure of the other LPSI train was postulated, resulting in two trains of HPSI as the available mitigating systems. The licensee should verify that other postulated failures, such as in the emergency power system, would not be more limiting and that the available mitigating systems are adequate to provide core cooling.

VI. SUMMARY

In summary, the licensee should address the concerns discussed above in Sections:

A.4.a Cascading Effects
A.4.b Jet Impingement from Circumferential Breaks
A.4.d Strain Levels
B.1 Containment Integrity
B.2 Jet Impingement Effects on Target Piping
B.3 Effects on Instrumentation
B.4 Main Coolant Loop Breaks
B.5 Plant Shutdown Method 3
B.6 Main Steam/Main Feedwater Interactions
B.7 Core Deluge Piping Breaks

VII. REFERENCES

1. Letter, W.G. Counsil (CYAPCo) to D.M. Crutchfield (NRC), dated September 17, 1982.

2. Letter, D. Ziemann (NRC) to W.G. Counsil (CYAPCo), dated January 4, 1980.