TECHNICAL EVALUATION REPORT

CONTAINMENT LEAKAGE RATE TESTING

YANKEE ATOMIC ELECTRIC COMPANY

YANKEE ROWE NUCLEAR GENERATING PLANT

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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

Mr. T. J. DelGaizo contributed to the technical preparation of this report through a subcontract with WESTEC Services, Inc.

1. BACKGROUND

On May 20, 1975, the Nuclear Regulatory Commission (NRC) requested [1] the Yankee Atomic Electric Company (YAEC) to review the containment leakage testing program at Yankee Rowe Nuclear Generating Plant (Yankee Rowe) and to provide a plan for achieving full compliance with 10CFR50, Appendix J, including appropriate design modifications, changes to technical specifications, or requests for exemption from the requirements pursuant to 10CFR50.12, where necessary.

YAEC submitted responses to this request on June 4, 1975 [2], September 2, 1975 [3], September 30, 1975 [4], and October 10, 1975 [5]. In Reference 5, YAEC requested specific exemptions from the requirements of Appendix J regarding containment airlocks, certain containment penetrations, and testing of certain containment isolation valves. Following receipt of correspondence from the NRC relative to these requests [6, 7], YAEC submitted additional information to the NRC in letters dated February 7, 1977 [8] and April 27, 1981 [9].

The purpose of this report is to provide technical evaluations of outstanding issues regarding the implementation of 10CFR50, Appendix J, at the Yankee Rowe plant, including requests for exemption from the requirements of the regulation, submitted in Reference 5 and amplified in References 8 and 9. In Reference 9, YAEC indicated that Proposed Technical Specification Change No. 149 [10], which was prepared on the basis of the exemption requested of Reference 8, would be revised and resubmitted following NRC's disposition of the current exemption requests. Therefore, YAEC's proposed technical specification changes of Reference 10 are not addressed in this report.

2. EVALUATION CRITERIA

Code of Federal Regulations, Title 10, Part 50 (10CRF50), Appendix J, Containment Leakage Testing, provided the criteria for the technical evaluations. Where applied to the following evaluations, the criteria are either referenced or briefly stated, where necessary, in support of the evaluations. Furthermore, in recognition of the plant-specific conditions that could lead to requests for exemption not explicitly covered by the regulations, the NRC directed that the technical reviews constantly emphasize the basic intent of Appendix J, that potential containment atmospheric leakage paths be identified, monitored, and maintained below established limits.

3. TECHNICAL EVALUATION

3.1 REQUESTS FOR EXEMPTION FROM THE REQUIREMENTS OF 10CFR50, APPENDIX J

In Reference 5, YAEC submitted requests for exemption from certain requirements of 10CFR50, Appendix J for the Yankee Rowe plant. References 8 and 9 provided additional information relating to these requests. Each request for exemption is discussed separately below.

3.1.1 Testing of Containment Airlocks

In Reference 5, YAEC proposed to test containment airlocks using a continuous containment leakage rate monitoring system. In Reference 6, however, the NRC stated that the continuous leakage rate monitoring system was not sufficiently sensitive to detect the relatively small changes in leakage rate that would indicate that the airlock door seals were improperly sealed.

Subsequently, YAEC submitted the following airlock exemption request in Reference 8:

> "The containment airlock is equipped with single door seals which preclude testing of individual seals. The airlock is designed, however, to permit pressurization to containment design pressure for leakage measurement. Testing is arduous, due to the lack of proper test facilities. Yankee will install the necessary piping, valves, and test equipment prior to the post refueling startup scheduled for the summer of 1977 to permit airlock testing by a method in compliance with Appendix J. Yankee requests an exemption from the testing frequency specified in Appendix J after each door opening and proposes the following:
>
> > Should the airlock be opened during the interval between the six month tests, the airlock door seals shall be leak tested within 72 hours of the first of a series of openings.
>
> The 6 month test requirement of Appendix J will also be observed."

Evaluation

Reference 8 was prepared in 1977. In October 1980, the NRC revised Section III.D.2 of Appendix J regarding airlock testing. Basically, the revised rule requires:

1. Testing of the entire airlock assembly at accident pressure (Pa) every 6 months or after the airlock has been opened during a period when containment integrity is not required.

2. Airlock testing within 72 hours of opening (or every 72 hours during periods of frequent opening) whenever containment integrity is required. This testing may be at Pa, at a reduced pressure, or may be conducted by pressurizing between double seals.

3. Airlock door seal testing may not be substituted for the 6 months test at not less than Pa.

In view of this revision to Appendix J, YAEC's exemption request is no longer required because the proposed testing of airlocks within 72 hours of use is in accordance with Appendix J.

Conclusion

YAEC's proposed airlock testing is technically adequate and no exemption from the requirements of Appendix J is needed because of the revision to Section III.D.2 of Appendix J, effective October 1980. YAEC should ensure that its airlock testing program satisfies all requirements of the revised Section III.D.2.

3.1.2 Expansion Joints and Hatches

In Reference 5, YAEC requested an exemption from Type B testing requirements of Appendix J for the equipment hatch, emergency hatch, containment leg expansion joint, and the fuel chute expansion joint. In Reference 8, YAEC stated:

> Certain Type B penetrations, to wit ~~the equipment hatch, the emergency~~ hatch, the containment leg expansion joints and the fuel chute expansion joint, do not incorporate in their design provisions for local testing. Experience has shown these penetrations are not subject to short term deteriorations and leakage has never been detected in any of these

penetrations. The continuous leakage monitoring system is capable of detecting leakage. During the Type A test, while the containment is pressurized, these penetrations are examined closely for indications of leakage. Based upon the foregoing, Yankee requests a specific exemption from the testing requirements of Appendix J, paragraph III.D.2, Type B Periodic Retest Schedule for these aforementioned Type B penetrations.

Evaluation

These joints and hatches are passive leakage barriers that are not exposed to severe operational transients. Testing experience indicates that these barriers are not subject to short-term deterioration. Any increase in leakage can be determined from the continuous leakage monitor or during the Type A test. Further, the emergency hatch is a bolted and gasketed manhole cover which is not opened unless the reactor coolant system has been depressurized.

Conclusion

Exemptions from Type B testing requirements for the equipment and emergency hatches, containment leg expansion joints, and the fuel chute expansion joint are justifiable because testing experience has shown that periodic Type A testing provides sufficient leakage monitoring of these penetrations.

3.1.3 Non-Metallic Containment Penetration Seals

In Reference 5, YAEC requested an exemption from the Type B testing time interval specified in Section III.D.2 of Appendix J with regard to testing of electrical penetrations which do not include provisions for ease of testing. In Reference 8, YAEC further stated:

"The electrical penetrations were not designed for ease of testing. Each of the penetrations requires one test for the seal rings and one test for the cartridge holding the electrical conductors. Testing of energized electrical penetrations must be performed with extreme care and has proven to be very time consuming. Again, the containment continuous leakage monitoring system is capable of detecting leakage through electrical penetrations. Yankee requests an extension of the time interval specified in paragraph III.D.2 of Appendix J for local leak testing requirements and proposes the following:

Yankee will locally leak test at least 25% of the electrical penetrations annually with the following conditions:

1) During testing of the electrical penetrations, any penetration which fails the leak test will be included in the subsequent annual tests until two acceptable consecutive leak tests have been demonstrated.

2) These penetrations will be additional to the 25% selected for testing during the subsequent annual test periods."

Evaluation

The Yankee Rowe design has 163 electrical penetrations. The design of these penetrations did not include provisions for ease of testing. Although the penetrations are testable, each penetration requires two tests. One test is for the double O-ring seals, and another is needed for the cylinder holding the electrical conductors. These tests require that considerable time be allocated for each electrical penetration, and extreme care must be taken when testing the penetrations and exposed terminal boards, which are electrically energized.

The penetrations are passive leakage barriers that are not exposed to severe operational transients. The continuous containment leakage monitoring system will provide an additional means of determining an increase in leakage in the interval between Type A tests. In view of the leakage monitoring system at the Yankee Rowe plant , testing each penetration at the frequency required by Section III.D.2 of Appendix J (every 2 years) would serve only to identify the need for corrective action at a particular penetration. Furthermore, when the penetrations themselves are continuously monitored, Section III.D.2 permits extension of the penetration testing interval to 3 years.

YAEC's proposed plan would test each penetration once every 4 years. Annual testing of those penetrations which fail tests (until two successive satisfactory tests are performed) also helps to determine the non-leakage reliability of the penetrations. In view of the design of the Yankee Rowe plant, this testing is considered to be a reasonable approach to achieving the objective of Appendix J.

Conclusion

YAEC's proposal to test 25% of the electrical penetrations at the Yankee Rowe plant annually with provisions for retest of failures is technically adequate considering the design of the penetrations, the type of penetration, and the existence of the continuous containment leakage monitoring system. An exception from the Type B testing requirements of Appendix J should be granted.

3.1.4 Testing of Containment Isolation Valves

In Reference 8, YAEC requested exemptions from the Type C testing requirements of certain containment isolation valves. The requests were in reference to the various sections of Table 3.6-1 of the Technical Specifications for Yankee Rowe which had been issued in a new format by Amendment No. 27 (dated July 14, 1976).

The following evaluations are categorized by the sections of Table 3.6-1.

3.1.4.1 Section A of Table 3.6-1

In Reference 8, YAEC stated:

> "Section A of Table 3.6-1 lists those lines containing automatic isolation valves. Plant modifications are planned, which shall be completed prior to the post refueling startup scheduled for the summer of 1977, to permit testing with air those valves in Section A currently tested with liquid. Those valves in Section A listed as "Not subject to Type C tests" are located in the secondary steam system of a pressurized water reactor, whereas Appendix J specifically addressed only those valves in direct cycle boiling water reactors. In addition, these valves are system isolation valves and are not intended as containment isolation valves. We feel the valves should be removed from Section A of Table 3.6-1. Yankee sees no need for an exemption from the testing requirements of Appendix J for any other valves in Section A of Table 3.6-1."

Evaluation

Generally, the isolation valves of systems on the secondary side of a steam generator are not relied upon to prevent the escape of containment air to outside atmosphere. This is because the systems are either closed systems

inside containment which do not rupture as result of a LOCA or remain liquid-filled after an accident because of the water level in the steam generator. For this reason, Appendix J specifically requires Type C testing of the main steam and feedwater systems of BWRs while making no mention of these systems in PWRs. Furthermore, by definition, a containment isolation valve, for purposes of Appendix J, must be relied upon to prevent the escape of containment air to outside atmosphere.

Conclusion

Appendix J does not require Type C testing of isolation valves in the secondary side of a steam generator. These valves should be removed from Section A of Table 3.6-1. However, the Licensee should have a post-accident procedure in effect to require the steam generators to be filled above the level of the tubes and presurrized to greater than Pa to ensure no possibility of leakage from these lines.

3.1.4.2 Section B of Table 3.6-1

In Reference 8, YAEC stated:

"Section B of Table 3.6-1 lists incoming lines containing check valves. All lines, with the exception of the one containing HC-V-1199, steam supply to containment heaters, are liquid filled, are at a pressure in excess of the calculated peak containment pressure, and have available a 30 day supply of water. HC-V-1199 is in a 15 psig steam line forming a closed loop both inside and outside the containment. A direct leakage path does not exist under postulated accident conditions. Based upon the fact that leakage from the containment will not occur under postulated accident conditions, a radiological assessment of leakage is not necessary and Yankee requests a specific exemption from the Type C testing requirements for those check valves listed in Section B of Table 3.6-1 of the new formed Technical Specifications."

In Reference 9, YAEC indicated that it was withdrawing its exemption request for HC-V-1199, the component cooling lines, and service water lines to containment. YAEC had decided to modify these penetrations to permit Type C testing. YAEC also stated the following regarding the remaining valves:

"For those lines containing check valves acting as isolation valves (SI V-14, CS-V-621, and CH-V-611), an exemption from testing is requested on the basis that these lines will be water filled for 30 days following an accident. These lines are safety related and are required for emergency core cooling; thereby providing a continuous water seal in these penetrations. In addition, we have reviewed these lines and conclude that no single active failures would cause a loss of the 30-day water supply."

"Valve	Function	Exemption Basis
SI-V-14 CS-V-621	HP Safety Injection LP Safety Injection	Both of these emergency core cooling lines are classified Safety Class 2. These lines are both assured a 30-day water supply by a multiple pump system with multiple water sources (i.e. Safety Injection Tank, Demineralized Water Storage Tank, Boric Acid Mix Tank, and the Vapor Container Sump). The integrity of these lines is assured by the system function.
CH-V-611 CH-MOV-522	Charging Line to Loop #4 Charging for Isolated Loop	These Safety Class 2 lines supply charging water to the main coolant system via the positive displacement charging pumps. A 30-day water supply is assured from the Low Pressure Surge Tank and the sources described above. Backflow of water through the three-stage reciprocating charging pumps is not possible. In any event, the operation of one of three pumps will assure that pressure in these lines is maintained in excess of containment atmosphere."

Evaluation

The only valves in Section B of Table 3.6-1 for which YAEC continues to request exemption are SI-V-14, CS-V-621, and CH-V-611. YAEC has plainly indicated that these are the isolation valves in safety-related lines which are (1) required for emergency core cooling, (2) liquid-filled and pressurized

in excess of post-accident containment pressure, and (3) assured of at least 30 days' supply of water considering possible single active failures. It is clear that these valves are not relied upon to prevent the escape of containment air to outside atmosphere during the post-accident period.

Section II.B of Appendix J defines a containment isolation valve as one relied upon to perform a containment isolation function. Combined with other definitions in Appendix J, this means containment isolation valves are those relied upon to prevent the escape of containment air to outside atmosphere during a post-accident period. Valves which do not meet this definition of containment isolation valve do not require Type C testing in accordance with Appendix J.

Conclusion

In view of YAEC's withdrawal of exemption requests for valve HC-V-1199 and for the component cooling [illegible] netrations and service water penetrations, the remaining check valves of Section B of Table 3.6-1 (valves SI-V-14, CS-V-621, and CH-V-611) do not require Type C testing, and no exemption from the requirements of Appendix J is needed because Appendix J does not require the testing of these valves.

3.1.4.3 Section C of Table 3.6-1

In Reference 8, YAEC requested exemptions from the Type C testing requirements of Appendix J for several manual valves in lines penetrating the containment. Reference 8 also provided justifications for the exemption requests. YAEC stated:

> "SC-MOV-551, 552, 553 & 554 - Shutdown Cooling - In and Out - These lines form a closed loop outside the containment and connect directly to the reactor coolant system. The inboard valves on each line are under constant test by holding leak tight against system pressure of 2000 psig.
>
> CH-MOV-522 - MC Feed to Loop Fill Header - This line feeds directly to the reactor coolant system and is under constant test when closed by holding against system pressure of 2000 psig.

CA-V-746 - Containment Air Charge - This valve is closed and leak tight against a service air system pressure of 100 psig. Leakage would be detected by the continuous leakage monitoring system.

HV-V-5 & 6 - Containment H_2 Vent System - Procurement of Valves and fittings is in progress. Installation during 1977 refuelling outage will permit testing of these valves.

VD-V-752 & 754 - Neutron Shield Tank Leakage Monitor Lines - These are 1/2 inch sample lines which are valved closed and are capped.

BF-CV-1000, 1100, 1200 & 1300 Steam Generator Feedwater Regulator Valves - These are feedwater valves in a pressurized water reactor and do not present a credible leakage path. Appendix J addresses these valves only in direct cycle boiling water reactors."

In Reference 9, YAEC withdrew its exemption request for the containment air charge line, stating that this penetration had been modified and was being Type C tested. YAEC also stated:

"For those manual valves in lines penetrating containment (CH-MOV-522, SC-MOV-551, 552, 553, and 554), an exemption from testing is requested on the basis that these lines remain water filled after system operation. These lines are safety grade and cannot become potential atmospheric leakage paths in that a water seal is present and can be maintained for the 30-day post-accident period."

"Valve	Function	Exemption Basis
CH-V-611 CH-MOV-522	Charging Line to Loop 4 Charging for Isolated Loop	These Safety Class 2 lines supply charging water to the main coolant system via the positive displacement charging pumps. A 30-day water supply is assured from the Low Pressure Surge Tank and the sources described above. Backflow of water through the three-stage reciprocating charging pumps is not possible. In any event, the operation of one of the three pumps will assure that pressure in these lines is maintained in excess of containment atmosphere.
SC-MOV-551 SC-MOV-552 SC-MOV-553 SC-MOV-554	Shutdown Cooling (OUTBD)TC Shutdown Cooling (OUTBD)TH Shutdown Cooling (INBD)TC Shutdown Cooling (INBD)TH	These Safety Class 1 valves are normally closed during operation and each pair of valves held leak tight against main coolant system

"Valve	Function	Exemption Basis
		pressure of 2000 psi. The shutdown cooling loop remains water filled after system operation. In lieu of running the pumps, the capability exists to pressurize this line by maintaining a sufficient over pressure in the Low Pressure Surge Tank (LPST). The LPST is assured a 30-day water supply via the multiple water sources described above."

Evaluation

As discussion in Section 3.1.4.2 of this report, isolation valves do not require Type C testing unless they are relied upon to prevent the escape of containment air to outside atmosphere during the post-accident period. YAEC has demonstrated that valves CH-MOV-522, SC-MOV-551, -552, -553, and -554 are not relied upon to prevent this leakage. In the case of SC-MOV-551 through -554, however, the Licensee should ensure that emergency procedures are in effect to ensure that the operators maintain over-pressure in these lines under post-accident conditions.

As discussed in Section 3.1.4.1 of this report, Type C testing of secondary side steam generator lines is not required. However, there is no apparent justification for exempting the 0.5-in sample line from Type C testing in accordance with Appendix J.

Conclusion

Valves SC-MOV-551 through -554, CH-MOV-522, and BF-CV-1000, -1100, -1200, and -1300 do not require Type C testing. No exemption is necessary because Appendix J does not require that these valves be tested. Valves VO-V-752 and -754 should be Type C tested in accordance with Appendix J.

(It should be further noted that where YAEC requested temporary exemptions from the Type C testing requirements of certain isolation valves while installing the test fittings necessary to perform these tests, these temporary exemptions are justifiable since no estimated completion date for these modifications is later than the 1982 refuelling outage at the Yankee Rowe plant.)

4. CONCLUSIONS

Technical evaluations were conducted of outstanding issues regarding the implementation of 10CFR50, Appendix J, at the Yankee Rowe plant. The following is a summary of the conclusions of these evaluations.

- YAEC's proposed airlock testing is technically adequate, and no exemption from the requirements of Appendix J is needed because of the revision to Section III.D.2 of Appendix J, effective October 1980. YAEC should ensure that its airlock testing program satisfies all requirements of the revised Section III.D.2.

- An exemption from the Type B testing requirements for the equipment and emergency hatches, containment leg expansion joints, and the fuel chute expansion joint is justifiable because testing experience has shown that periodic Type A testing provides sufficient leakage monitoring of these penetrations.

- YAEC's proposal to test 25% of the electrical penetrations at the Yankee Rowe plant annually with provisions for the retest of failures is technically adequate, considering the design of the penetrations, the type of penetration, and the continuous containment leakage monitoring system. An exemption from Type B testing should be granted.

- The isolation valves listed in Section A of Table 3.6-1 of the Technical Specifications, which are in lines associated with the secondary side of the steam generators, should be removed from the table because Appendix J does not require the testing of these valves.

- Valves SI-V-14, CS-V-621, and CH-V-611 do not require Type C testing and no exemption is necessary because Appendix J does not require this testing.

- Valves SC-MOV-551 through -554, CH-MOV-522, and BF-CV-1000, -1100, -1200, and -1300 do not require Type C testing, and no exemption is necessary because Appendix J does not require testing. Valves VD-V-752 and -754 should be Type C tested in accordance with Appendix J.

- YAEC's request for temporary exemptions from the Type C testing requirements while modifying the penetrations to permit testing is justifiable since all planned modifications will be completed by the 1982 refuelling outage.

5. REFERENCES

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