TECHNICAL EVALUATION REPORT

CONTAINMENT LEAKAGE RATE TESTING

COMMONWEALTH EDISON COMPANY
ZION STATION UNITS 1 AND 2

NRC DOCKET NO. 50-295/304

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1. BACKGROUND

On August 5, 1975 [1], the NRC requested Commonwealth Edison Company (CWE) to review the containment leakage testing program for Zion Station Units 1 and 2 (Zion 1 and 2) 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.

CWE responded to the NRC's request in a letter dated September 26, 1975 [2], in which two requests for exemption from the requirements of Appendix J were listed for Zion 1 and 2. The NRC, in a letter dated November 23, 1976 [3], asked CWE several questions regarding this submittal.

In a letter dated January 31, 1977 [4], CWE replied to the questions in Reference 3 and also provided a proposed method of monitoring for airlock seal leakage using the penetration pressurization system.

On May 11, 1977 [5], CWE requested additional exemptions that would omit six valves from the Type C testing requirements of Appendix J, and on July 7, 1980 [6], CWE forwarded additional information in support of previously submitted requests.

The purpose of this report is to provide technical evaluations of the outstanding submittals regarding the implementation of the requirements of 10CFR50, Appendix J at Zion 1 and 2. Consequently, technical evaluations of the exemption requests submitted in References 2 and 5 are provided.

2. EVALUATION CRITERIA

Code of Federal Regulations, Title 10, Part 50 (10CFR50), Appendix J, Containment Leakage Testing, was specified by the NRC as containing the criteria for the evaluations. Where applied to the evaluations in this report, the criteria are either referenced or briefly stated, where necessary, in support of the determinations. Furthermore, in recognition of plant-specific conditions that could lead to requests for exemption not explicitly covered by the regulations, the NRC directed that the technical review constantly emphasize the 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 APPENDIX J

3.1.1 Exemption From the Required Sequence of Conducting Type A and Type C Test

Section III.A.1(a) of Appendix J requires that the Type A test be performed as close to the "as is" condition as practical. When excessive leakage paths are identified during the Type A test, Appendix J requires the test to be terminated and leakage through such paths to be measured by local leakage rate procedures. After repairs or adjustments are made, a subsequent Type A test is performed. The corrective action taken, change in leak rate determined from the tests, and the overall integrated leakage determined from the local and Type A tests are reported to the NRC.

In Reference 2, CWE stated its view concerning this requirement as follows:

> Our plan has been to conduct local leak rate tests during the first part of an outage. We then conduct an integrated leak rate test close to the end of the outage. The results of the integrated leak rate test are then corrected back to determine conditions that existed at the beginning of the outage using local leak rate test results.

In Reference 3, the NRC indicated to CWE that this procedure would be acceptable provided that in back-correcting the results of the integrated test, a conservative assumption is applied that the measured, local leakage rate is in a direction out of the containment. In Reference 4, CWE agreed that all local leak rate tests would be conducted using the conservative assumption that the total measured local leakage rate is in a direction out of the containment.

Evaluation

The intent of Section III.A.1(a) is to ensure that the containment is tested as close to an "as is" condition as possible. The "as is" condition is significant in determining the required frequency of future Type A testing. Where excessive leakage is detected and corrected by local testing procedures prior to performing the Type A test, the "as is" condition is lost, and the subsequent Type A testing frequency may be inadvisably extended based upon unjustified confidence in past containment performance. However, with the conservative assumption that all local leakage is in a direction out of the containment when back-correcting the results of a Type A test, the back-corrected results will actually be conservative relative to measured leakage from a Type A test performed prior to the local testing. This is because a large amount of measured local leakage may not be actual out-leakage. Consequently, there is no possibility of an inappropriate extension of Type A testing frequency where this conservative procedure is used.

In view of the above discussion, CWE's proposal to conduct local leakage rate tests prior to the Type A test and to back-correct the results using the conservative assumption that all measured local leakage is in a direction out of the containment is an acceptable exemption to the requirements of Section III.A.1(a).

3.1.2 <u>Exemption From the Required Pressure for Testing Containment Airlocks</u>

In Reference 2, CWE requested an exemption from Type B testing requirements of Appendix J to permit airlock door seal testing at reduced pressure (3 psig) using the penetration pressurization system in lieu of testing at peak calculated containment pressure (Pa) for airlocks which are opened during the 6-month interval between required tests. CWE stated that the airlock door seals are continuously pressurized to 3 psig and monitored for leakage through the penetration pressurization system. CWE further indicated that the existing high flow alarm was not sensitive enough to provide indication of door seal failure before exceeding the technical specification limit on allowable leakage. CWE stated that a modification would be completed to install a flowmeter with a high flow alarm which would be sufficiently sensitive to detect a high leakage condition on the seals well before reaching the technical specification limit. In Reference 6, this modification was reported to have been completed.

In Reference 4, CWE described its method of extrapolating seal testing at reduced pressure to full pressure test results. CWE proposed to use the formula provided in the paper "Conversion of Leak Flow-Rates for Various Fluids and Different Pressure Conditions," by J. Amesz [7]:

$$\frac{L_1}{L_2} = \frac{P_1^2 - 1}{P_2^2 - 1}$$

where

L_1 = leakage rate at pressure P_1 (SCFH)
L_2 = leakage rate at pressure P_2 (SCFH)
P_1 = pressure in areas where leakage rate is L_1 (atmospheres)
P_2 = pressure in areas where leakage rate is L_2 (atmospheres).

Evaluation

The requirements for periodic testing of containment airlocks are set forth in Sections III.B.2 and III.D.2 of Appendix J. Section III.D.2 was recently revised by the NRC, effective October 22, 1980. Subparagraph [b][iii] of the revised Section III.D.2 reads as follows:

> Airlocks opened during periods when containment integrity is required by plant's Technical Specifications shall be tested within 3 days after being opened. For airlock doors opened more frequently than once every 3 days, the airlock shall be tested at least once every 3 days during the period of frequent openings. For airlock doors having testable seals, testing the seals fulfills the 3-day test requirements. In the event that the testing for this 3-day interval cannot be at Pa, the test pressure shall be as stated in the Technical Specifications. Airlock door seal testing shall not be substituted for the 6-month test of the entire airlock at not less than Pa.

Since this revision provides for reduced pressure testing of airlock door seals, CWE's request for exemption from the requirements of Appendix J is no longer necessary. CWE should ensure that its airlock testing program is in accordance with all the requirements of the revised Appendix J.

FRC has also reviewed CWE's method of extrapolating the results of airlock testing at 3 psig to Pa (47 psig) provided in Reference 4. This extrapolation provides a conservative correlation between leakage rate at low pressure and full pressure leakage rate and is therefore acceptable.

3.1.3 Exemption From Type C Testing Requirements for the Component Cooling Water Return Valve

In Reference 5, CWE requested an exemption from the Type C testing requirements of Appendix J for the component cooling water return line valve (AOV-CC9437) from the excess letdown heat exchanger. CWE's basis for this request is that this valve is a normally closed valve located in a closed system inside containment which does not communicate directly with the reactor coolant system pressure boundary or the containment atmosphere. In Reference 6, CWE stated:

> This containment isolation valve on the component cooling water return line from the excess letdown heat exchanger isolates a closed system within the containment. The closed system does not communicate directly with the reactor coolant system (RCS) pressure boundary or the containment atmosphere. A portion of the system piping and equipment is inside the missile barrier and a portion is outside the missile barrier. The outside portion is missile protected by the barrier and the inside portion is also shielded from missiles because of its enclosure within concrete walls as can be seen on the attached drawings, M-128 and M-137. As indicated in Reference (c), the component cooling water system pressure of 100 psig is well above the containment post accident peak pressure of 47 psig, and thus any leakage past valve AOV-CC9437 and a ruptured component cooling line would be into the containment and not out. Therefore, no safety implications are involved. Since the valve is normally in the closed position, no provisions for leak testing are provided, nor required for the above reasons.

Evaluation

Section II.H of Appendix J requires Type C testing of a normally shut valve such as AOV-CC9437 when it can provide a direct connection between inside and outside containment atmosphere. Section III.A.1.(d) of Appendix J requires Type C testing of this valve if the component cooling water system communicates directly with the reactor coolant system or if the component cooling water system ruptures as a result of a loss-of-coolant accident (LOCA).

The component cooling water system inside containment is a closed system inside containment which does not communicate directly with either the reactor coolant system or the containment atmosphere. The heat exchanger is a Seismic

Category I component. The closed system is protected from internally generated LOCA missiles by either the missile barrier or other concrete walls. Consequently, this system is not liable to rupture as a result of a LOCA.

The component cooling piping inside containment services no essential post-accident loads; therefore, this piping is automatically isolated from the system at the start of the accident. Even if this piping were to rupture during the post-accident period (e.g., due to an intervening seismic event), the containment penetration would be water sealed by the component cooling system outside containment, which is designed to continue servicing vital loads outside containment. The water seal is sufficient to remain effective throughout the post-accident period since there are ample safeguards to ensure that the system's water inventory is maintained throughout the entire period. This is provided by two surge tanks (each of 2000 gallons), which are each capable of being refilled, if necessary, from two independent sources - the primary water system and the demineralized water system.

Consequently, valve AOV-CC9437 need not be Type C tested because it isolates a closed system that is not likely to rupture after an accident, and even in the event of a rupture, it is not relied upon to prevent atmospheric leakage because of a water seal by the operating cooling system. No exemption from the requirements of Appendix J is necessary because testing of this valve is not required by Appendix J.

3.1.4 Exemption From Type C Testing Requirements for the Nitrogen Line Valves to the Pressurizer Relief Tank (PRT)

In Reference 5, CWE requested exemption from the Type C testing requirements of Appendix J for valve AOV-RC8033, the nitrogen supply line isolation valve to the pressurizer relief tank. CWE's basis for this request is that the valve isolates a closed system within containment. CWE stated that the system does not communicate directly with the RCS pressure boundary, since the pressurizer safety and relief valves constitute the RCS pressure boundary as demonstrated by the system design classification change downstream of these valves, nor does it communicate directly with the containment atmosphere. The system piping and equipment are located outside the missile barrier and are therefore missile protected. The nitrogen system pressure of 100 psig on the line to the PRT is well above the post-accident containment peak pressure of 47 psig; thus, any leakage past valve ACV-RC8033 would be into the containment and not out. Therefore, CWE stated that no safety implications are involved, and since the valve is normally closed, no provisions for leak testing are provided or required.

Evaluation

Section II.H of Appendix J requires Type C testing of a normally shut valve such as ACV-RC8803 when it can provide a direct connection between inside and outside containment atmospheres. Section III.A.1(d) of Appendix J requires Type C testing of this valve if the nitrogen system communicates directly with the reactor coolant pressure boundary or the containment atmosphere or ruptures as a result of a LOCA.

CWE's basis for the exemption request is that the nitrogen line to the pressurizer relief tank (PRT) does not communicate directly with the reactor coolant system or the containment atmosphere, does not rupture as a result of LOCA, and therefore does not provide a direct connection between inside and outside containment atmospheres. CWE also maintains that any leakage through this penetration will be into containment because of the 100-psig nitrogen source outside of the containment.

The 100-psig nitrogen source cannot be relied upon to perform a post-accident sealing function, however, since it is not safety-related or designed to other higher reliability standards. In a post-accident condition, this source must be considered unavailable. Also, this line cannot be considered to be a closed system inside containment since it is connected to the pressurizer relief tank. Operation of either the pressurizer relief/safety valves or the tank rupture disc connect this line directly to the reactor coolant system or the containment atmosphere, respectively. While for certain accident scenarios this line will be part of a closed system, it does not follow that it will always be a closed system under accident conditions.

Finally, with regard to the contention that the system does not rupture after an accident, FRC concurs that the line is not likely to rupture since it is protected from LOCA missiles. It should be noted, however, that ANSI N271-1976 requires a closed system inside containment to be designed to Seismic Category I standards in order to take credit for the piping system as an isolation boundary. While ANSI N271-1976 addresses containment isolation provisions, the concept is similar. The nitrogen line to the PRT is not a Seismic Category I line and therefore its integrity throughout the post-accident period is not guaranteed.

Taken altogether (non-safety-related nitrogen source, direct connection to the PRT, and non-seismic design), there is insufficient justification for concluding that this line will not be a source of potential containment atmospheric leakage throughout the post-accident period. Consequently, an exemption in this case is inappropriate and valve ACV-RC8803 should be tested in accordance with Section III.A.1.(d) of Appendix J.

3.1.5 Exemption From Type C Testing Requirements for the Nitrogen Line Valve to the Safety Injection Accumulators

In Reference 5, CWE requested an exemption from the Type C testing requirements of Appendix J for Valve ACV-SI8880, the isolation valve in the nitrogen line to the safety injection accumulators. CWE's basis for this request is that the valve isolates a closed system inside containment. The closed system does not communicate directly with the RCS pressure boundary, since the accumulator discharge line check valves constitute the RCS pressure boundary as demonstrated by the system design classification change downstream of these valves, nor does it communicate directly with the containment atmosphere. The system piping and equipment are located outside the missile barrier and are therefore missile protected. The nitrogen system pressure of 600 psig in the line to the accumulators is well above the post-accident containment pressure of 47 psig, and thus, any leakage past valve ACV-SI8880 would be into the containment and not out. CWE stated that no safety implications are involved, and since the valve is normally closed, no provisions for leak testing are provided or required.

Evaluation

Section II.H of Appendix J requires Type C testing of a normally shut valve such as AOV-RC8880 when it can provide a direct connection between inside and outside containment atmospheres. Section III.A.1(d) of Appendix J requires Type C testing of this valve if the nitrogen system communicates directly with the reactor coolant pressure boundary or the containment atmosphere or ruptures as a result of a LOCA.

CWE's basis for the exemption request is that the nitrogen line to the safety injection accumulators does not communicate directly with the reactor coolant system or the containment atmosphere, does not rupture as a result of LOCA, and therefore does not provide a direct connection between inside and outside containment atmospheres. CWE also maintains that any leakage through this penetration will be into the containment because of the nitrogen source outside of the containment.

The nitrogen source cannot be relied upon to perform a post-accident sealing function, however, since it is not safety-related or designed to other higher reliability standards. In a post-accident condition, this source must be considered unavailable. Also, this line cannot be considered to be a closed system inside containment since it is directly connected to the safety injection accumlators which are directly connected to the reactor coolant piping. The fact that there are two check valves in each line from the accumulators to the reactor coolant piping (which are not periodically pneumatically leak tested) is not a sufficient basis for establishing the nitrogen system as a closed system inside containment.

Finally, with regard to the contention that the system does not rupture after an accident, FRC concurs that the line is not likely to rupture since it is protected from LOCA missiles. It should be noted, however, that ANSI

N271-1976 requires a closed system inside containment to be designed to Seismic Category I standards in order to take credit for the piping system as an isolation boundary. While ANSI N271-1976 addresses containment isolation provisions, the concept is similar. The nitrogen line to the PRT is not a Seismic Category I line and therefore its integrity throughout the post-accident period is not guaranteed.

Taken altogether (non-safety-related nitrogen source, direct connection to the reactor coolant system, and non-seismic design), there is insufficient justification for concluding that this line will not be a source of potential containment atmospheric leakage throughout the post-accident period. Consequently, an exemption in this case is inappropriate and valve AOV-RC8803 should be tested in accordance with Section III.A.1.(d) of Appendix J.

3.1.6 Exemption From Type C Testing Requirements for the Fire Protection Header Isolation Valves

In Reference 5, CWE requested exemption from the Type C testing requirements of Appendix J for valve FCV-FP08, the isolation valve in the fire protection supply header. CWE's basis for this request is that this valve isolates a closed system inside containment which does not communicate directly with the reactor coolant system pressure boundary or the containment atmosphere. The system piping and equipment is located outside the missile barrier and, therefore, is missile protected. This valve is in a closed position, and any leakage past valve FCV-FP08 would be into the containment and not out since the fire protection header pressure of 100 psig is well above the containment post-accident peak pressure. CWE stated that no safety implications are involved, and since the valve is normally closed, no provisions for leak testing are provided or required.

Evaluation

Section II.H of Appendix J requires Type C testing of a normally shut valve such as FCV-FP08 when it can provide a direct connection between inside and outside containment atmospheres. Section III.A.1.(d) of Appendix J requires testing of this valve if the fire protection system communicates directly with the reactor coolant system or if the fire protection system ruptures as a result of a LOCA.

The fire protection does not communicate in any way with the reactor coolant system or the containment atmosphere. Further, since the system is entirely located outside the missile barrier, it is unlikely to rupture as a result of LOCA. If the piping were to rupture (e.g., because of an intervening seismic event), the penetration is effectively sealed by 100-psig water pressure from the fire protection system. While this water pressure source is not safety-related, as a fire protection system it is designed to meet certain reliability standards and is capable of providing this water pressure for the entire post-accident period.

The reliability of this system is provided by two Seismic Category I pumps rated at 2000 gpm, one motor-driven and one diesel-driven, each taking a suction directly from the crib house forebay. The motor-driven pump, which receives electrical power from the essential bus, starts automatically if fire protection header pressure falls to 110 psig. If header pressure falls to 100 psig, the diesel-driven pump starts automatically. The diesel-driven pump is battery started and requires no external electrical power for operation. With Lake Michigan as a water supply, the system can provide a water seal at the containment penetration throughout the post-accident period. With regard to valve FCV-FP08, therefore, the fire protection system effectively serves as a seal-water system in accordance with Section III.C.3 of Appendix J.

Consequently, valve FCV-FP08 does not require type C testing because the fire protection system is a closed system inside containment which is unlikely to rupture after an accident and should it rupture, the penetration is water sealed. Since a water seal can be maintained at 1.1 Pa for at least 30 days, no exemption is required because the requirements of Section III.C.3 will be met.

3.1.7 Exemption From Type C Testing Requirements for the Residual Heat Removal System (RHR) Suction Line Valves

In Reference 5, CWE requested exemption from the Type C testing requirements of Appendix J for valve MOV-RH8701 and MOV-RH8702, the outboard and inboard RHR pump suction line isolation valves. CWE's basis for this request is that these suction line isolation valves would normally be closed and filled with water under post-accident conditions. Any leakage past these valves would be returned to the RHR pump suction and would remain within the closed RHR system.

Evaluation

Section III.A.1.(d) of Appendix J requires Type C testing of containment isolation valves in systems that connect directly to the reactor coolant system pressure boundary. Section II.B of Appendix J defines containment isolation valves as those valves relied upon to perform a containment isolation function. Since any leakage past MOV-RH8701 and MOV-RH8702 is returned to the suction side of the RHR pumps, there is no possibility for leakage of containment atmosphere through this path since the suction side of the RHR pumps in a post-accident condition is continuously water covered by the pressure head of the containment sump. Consequently, these valves are not relied upon to perform a containment isolation function, and therefore, Appendix J does not require that they be tested. No exemption from Appendix J is necessary.

4. CONCLUSIONS

Technical evaluations of requests for exemption from the requirements of Appendix J were conducted. The conclusions of these evaluations are summarized below.

- o CWE's request for exemption to perform local valve leakage rate tests (Type C tests) prior to the integrated primary containment leakage rate test (Type A test) and to back-correct the results of the Type A test with the results of the Type C test, using the conservative assumption that all measured local leakage is in a direction out of the containment, is acceptable.

- o CWE's proposal to test containment airlock door seals at 3 psig, using the penetration pressurization system for the after-each-opening requirement of Appendix J, is no longer required because of the revision to Section III.D.2 of Appendix J effective October 22, 1980. CWE should ensure that its airlock testing program complies with the revised requirements of Appendix J.

- o CWE's request to exclude component cooling water valve AOV-CC9437 from Type C testing is acceptable. No exemption from Appendix J is required.

- o CWE's request to exclude nitrogen line isolation valve AOV-RC8033 from Type C testing is not acceptable. The valve should be tested in accordance with Appendix J.

- o CWE's request to exclude nitrogen line isolation valve AOV-SI8880 from Type C testing is not acceptable. The valves should be tested in accordance with Appendix J.

- o CWE's request to exclude fire protection header isolation valve FCV-FP08 from Type C testing is acceptable. No exemption from Appendix J is required.

- o CWE's request to exclude RHR isolation valves MOV-RH8701 and MOV-RH8702 from Type C testing is acceptable. No exemption from Appendix J is required.