ATTACHMENT 2

# TECHNICAL EVALUATION REPORT

# CONTAINMENT LEAKAGE RATE TESTING

## WISCONSIN PUBLIC SERVICE CORPORATION
## KEWAUNEE NUCLEAR GENERATING PLANT

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# FOREWORD

This Technical Evaluaticn Report was prepared by Franklin Research Center. under a contract with the U.S.-Nuclear Regulatory Commission (Office of Nuolear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor lioensing 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 August 5, 1975 [1], the NRC requested Wisoonsin Public Service Corp. (WPS) to review the containment leakage testing program at the Kewaunee Nuclear Generating Plant (Kewaunee) and to provide a plan for achieving full compliance with 10CFR50, Appendix J, Containment Leakage Testing, including appropriate design modifications, changes to technical specifications, or requests for exemption from the requirements pursuant to 10CFR50.12, where necessary.

On September 5, 1975 [2], WPS responded to the NRC's request, stating that two variances concerning Type C testing of isolation valves existed between Appendix J and the Kewaunee testing program. These variances were:

1. For systems which cannot be fully drained of water, the isolation valves would be tested hydraulically instead of pneumatically, and a water-to-air leakage ratio would be applied to obtain the air leakage rate.

2. The time interval between Type C tests did not have the 2-year limitation required by Appendix J.

On January 4, 1977 [3], WPS submitted proposed Amendment No. 23 to the Technical Specifications and Operating License for the Kewaunee plant. This letter also requested the following exemptions from Appendix J:

1. For safeguard systems designed to operate post-loss of coolant accident (LOCA), valves which will remain open post-accident would be exempt from Type C testing. However, those systems would be inspected at pressures exceeding peak containment pressure and at least equivalent post-accident conditions.

2. Containment vacuum breakers with their O-ring seals would be tested with pressure applied in the opposite direction to the direction of post-LOCA pressure.

3. Type A testing would be done after Type B and C tests. The Type A pre-repair leakage rate would be determined from the post-repair integrated leakage rate and the pre- and post-repair local leakage rates.

In Table TS 4.4-1 of Reference 3, WPS listed all penetrations and test methods for the Kewaunee containment. For those penetrations for which test methods differed from the Appendix J requirements, exemptions were requested.

An exemption was also requested to permit personnel airlocks to be tested by either pressurization between the airlock doors or pressurization between the double-gasketed door seals. On August 17, 1981 [4], WPS provided additional information relative to certain exemption requests of Amendment No. 23 in response to NRC questions of April 21, 1981.

The purpose of this report is to provide technical evaluations of Licensee submittals regarding the implementation of 10CFR50, Appendix J, at the Kewaunee plant. Consequently, technical evaluations of requests for exemption from Appendix J requirements submitted in References 2 and 3 are provided.

## 2. EVALUATION CRITERIA

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

#### 3.1.1 Water Testing of Isolation Valves

In Reference 2, WPS states:

> The Kewaunee Plant was constructed prior to adoption of Appendix J and certain valving systems cannot be drained for testing with air or nitrogen. It is our intent to test these valves with water leakage and apply a water-air leakage ratio. A similar technique was employed during the initial local leak rate testing of the preoperational test program and was considered acceptable by the AEC. We assume that this manner of testing will continue to be adequate and acceptable for future tests.

EVALUATION

Appendix J requires local leakage rate testing of isolation valves to be performed with air or nitrogen as a test medium. This is because the post-accident containment atmosphere is closely simulated by air or nitrogen. The acceptance criteria are based upon air or nitrogen leakage rates. There is no provision for hydraulic testing because the measurement of liquid leakage is not the objective of Appendix J.

Where certain system designs, however, make it impractical (if not impossible) to perform pneumatic testing, hydraulic testing may be substituted provided the objectives of Appendix J are met. Two instances in which hydraulic testing satisfies the objectives of Appendix J are described below.

First, hydraulic testing may be employed where the test demonstrates that the containment isolation valve or valves will remain water covered throughout the post-accident period. If a valve remains water covered throughout the post-accident period, it cannot become a leakage path for containment air and therefore the measurement of an air leak rate is not required. The leakage contribution of this valve to the total gaseous leakage rates from the Type B and C penetrations (to determine acceptance under the maximum limit of 0.6 La) is zero. Use of a hydraulic test in this case is similar to the exclusion from Type C testing requirements provided in Section III.C.3 of Appendix J for valves which are sealed by a fluid from a seal system for 30 days following a LOCA.

In order to use this hydraulic testing technique, the system or portion of the system pressurized for the test must be designed to remain intact after an accident (e.g., designed to ESF system criteria). Reliance on non-safety-related boundaries is unacceptable since a rupture or other failure of the piping system voids the concept of the hydraulic test. Acceptance criteria for this type of test must be established to ensure that the inventory of water available at the start of an accident is sufficient to maintain the valve or valves water sealed throughout the post-accident period.

Second, hydraulic testing may be employed where the measured isolation valve liquid leakage rate can be conservatively converted to equivalent gaseous leakage rate for inclusion in the total leak rate of the Type B and C penetrations. Because of the generally low leakage rates and the unpredictable flow path characteristics involved, no licensee has been successful in proposing a correlation acceptable to the NRC.

WPS has provided no indication of the proposed water-air leakage ratio for use in converting measured liquid to equivalent air leakage nor has a basis for such a ratio been provided.

CONCLUSION

The WPS proposal to continue hydraulic testing in lieu of pneumatic testing is technical adequate only where the liquid leakage measurements are used to demonstrate a water seal at the valves throughout the post-accident period.

### 3.1.2 Time Interval for Type C Testing

In Reference 2, WPS states that the time interval for testing has been discussed with the ACRS and with the AEC many times. WPS further states:

> Consequently, our Technical Specifications were developed on the basis of the acknowledged superior dual containment system we had constructed, and we would not be required to meet the full thrust of the testing time intervals of Appendix J. Our Technical Specifications are consistent with the time interval requirements on Type A testing and consistent with the "each refueling" interval specification of the Type B and C tests. Our Technical Specifications do not address the "no greater than 2 years" part of Appendix J in regards to Type "C" tests. It is our understanding

from the records of the assorted meetings and the subsequently isssued technical specifications that an exception has been granted to the Kewaunee Plant in regards to the two year Type "C" test interval.

EVALUATION

Appendix J, Section III.D.3, states that Type C tests shall be performed during each reactor shutdown for refueling but in no case at intervals greater than 2 years. The purpose of the Type C tests is to determine the degradation rate on the sealing capability of the isolation valves. Present experience indicates that 2 years is the maximum time interval that should be allowed before retesting the sealing capability of individual valves.

In its submittal, WPS stated that the Technical Specifications are consistent with the time interval requirements for Type A testing and consistent with the "each refueling" interval specification for the Type B and C teste. Since present refuelings generally occur more frequently than every 2 years, the "no greater than two years" requirement will usually have been complied with in practice. An exception to this requirement would mean that occasionally, when the time between refuelings happens to exceed 2 years, the interval between Type C tests will also exceed 2 years. This, however, would risk excessive degradation of the sealing capability of one or more valves. Type A testing is not a satisfactory substitute for Type C testing because an individual valve, which contributes only a part of the total leakage, may have deteriorated at a rate high enough that the total leakage will become excessive soon after the Type A test has been passed. It is only by testing of individual valves that a high rate of deterioration of any one valve can be detected or ruled out. The availability of a secondary containment does not alleviate the need for non-leaking isolation valves.

CONCLUSION

The Kewaunee Technical Specifications should be changed to conform to the "no greater than two years" requirement of 10CFR50, Appendix J, with respect to Type B and Type C tests.

### 3.1.3 Safeguard System Pressure Test in Lieu of Type C Test of Valves

In Reference 3, WPS states:

> Safeguard systems which are designed to be operated post accident to maintain a safe condition should be subject to an integrated test which is consistent with the functional conditions of such system post accident. The present requirement of 10 CFR 50 Appendix J necessitates the performance of Type C test on safeguard system valves nearest the penetration when those valves will remain open post accident. Such testing is not meaningful and clearly does not provide for the protection of the public. Each of the safeguard systems which are designed to remain intact post accident and provide cooling to either the containment vessel or the reactor are extensions of the containment themselves and are designed for pressures well in excess (at least a factor of 3 and in certain cases a factor of 60) of the peak containment pressure. We propose that these systems be inspected at pressure at least equivalent to the conditions which would exist post accident in lieu of performance of Type C tests on valves which will not be closed post accident. The penetrations associated with these safeguard systems are noted on Table TS 4.4-1 and the inspection conditions are specified in proposed Specification 4.4.c.

WPS then described current testing for various safety systems (see Sections 3.1.3.1 through 3.1.3.6).

#### 3.1.3.1 Residual Heat Removal and Low Head Safety Injection (Penetration Nos. 9, 10, 30E, 30W, and 48)

In Section 4.4.c.1.A, WPS states:

> Those portions of the Residual Heat Removal System external to the isolation valves at the Reactor Coolant System shall be hydrostatically tested in excess of 350 psig at each major refueling outage, or they shall be tested during their use in normal operation at least once between successive major refueling outages.

EVALUATION

Section III.A.1 (d) of Appendix J states that containment isolation valves in systems which are normally filled with water and operating in a post-accident condition need not be vented and drained for a Type A test but that these valves should subsequently be Type C tested. Section II.B, however, defines containment isolation valves as those valves relied upon to perform a containment isolation function. Combining this definition with the definition of "leakage rate" in Section II.D, containment isolation valves can be further described as those valves relied upon to prevent the escape of containment air to the cutside atmosphere. The question of whether Type C testing of isolation valves in penetration Nos. 10 and 48 is required by Appendix J, therefore, turns on whether these valves are relied upon to prevent the escape of containment air to the outside atmosphere at some time during the post-accident period.

Under normal circumstances, the isolation valves in question are not relied upon to prevent the escape of containment air to outside atmosphere thrcughout the post-accident period. This is because the residual heat removal (RHR) pumps will be providing water to the reactor coolant system through these penetrations (except for penetration No. 9, which is sealed by RHR water pressure). The water pressure is higher than peak calculated post-accident containment pressure, and in the recirculation mode this cooling flow will be continuously supplied throughout the long-term post-accident cooling period.

At the same time, it should be noted that the two RHR injection loops are essentially independent loops. While there is crossover piping between the loops, there are normally shut, manual valves in the crossover piping which may be inaccessible during accident conditions. Consequently, should one of the two pumps fail to start or become inoperative following the start of an accident, the appropriate isolation valves then become potential barriers to leakage of containment air. In this case, the reliability of the isolation valves to prevent the escape of containment air to the outside atmosphere is contigent upon the ability of the piping system beyond the penetration to contain potential leakage.

A portion of the piping system exterior to the containment will be continuously water filled because of the pressure head of the containment recirculation sumps which supply the suction side of the system. The ability of the remainder of the exterior system to remain water filled is a function of the leak-tightness of the system. WPS proposes to verify this leak-tightness by means of periodic hydrostatic testing. Provided that these hydrostatic tests verify that the remainder of the system will be water filled throughout the post-accident period, the possibility of escape of containment air through the penetrations in question is precluded and, therefore, even with the imposition of a single active failure to the system (i.e., failure of one pump), the isolation valves are not relied upon to prevent the escape of containment air.

CONCLUSION

The combination of the design features of the RHR system and the proposed periodic hydrostatic testing is sufficient to assure that the isolation valves of penetration Nos. 9, 10, and 48 are not relied upon to prevent the escape of containment air to atmosphere where the hydraulic test is used to demonstrate system leak-tightness. In this case, substitution of a hydrostatic test for the required pneumatic test is a justifiable exemption to the requirements of Appendix J.

In the case of penetraticn Nos. 30E and 30W, no exemption is required since the liquid level of the Containment Sump B provides a continuous water seal at these penetrations throughout the post-accident period.

3.1.3.2 Safety Injection System (High Head) (Penetration Nos. 28N, 28E, and 35)

In Section 4.4.c.2.A, WPS states:

Those portions of the Safety Injection System in service post-accident shall be hydrostatically tested by closure of the motor operated valves nearest the Reactor Coolant System and operation of the pumps on the minimum flow test line to the refueling water storage tank. This test shall be performed during each major refueling outage.

EVALUATION

Section III.A.1.(d) of Appendix J states that containment isolation valves in systems which are normally water filled and operating in a post-accident condition need not be vented and drained for a Type A test, but that these valves should be subsequently Type C tested. Section II.B, however, defines containment isolation valves as those valves relied upon to perform a containment isolation function. Combining this definition with the definition of "leakage rate" in Section II.d, containment isolation valves can be further described as those valves relied upon to prevent the escape of containment air to the outside atmosphere. The question of whether Type C testing of isolation valves in penetration No. 35 is required by Appendix J, therefore, turns on whether these valves are relied upon to prevent the escape of containment air to the outside atmosphere at some time during the post-accident period.

Penetration No. 35 provides the containment penetration for the safety injection accumulator test return line to the refueling water storage tank. In the initial phase of an accident causing containment pressurization, there is no possibility for the escape of containment air to the outside atmosphere because high pressure coolant injection water will pressurize the inside containment portion of this line through normally looked-open valves SI-203A-1 and SI-203B-1.

Penetration Nos. 28N and 28E provide the main injection paths for high-pressure safety injection water. These lines will normally be water filled and operating, after an accident, to inject high-pressure water. In case of a failure of one of the high-pressure injection pumps, the affected penetration may continue to be water sealed by the RHR system pressure-head by opening motor-operated valves RHR-300A and -300B. Similarly, when high-pressure injection is no longer required following an accident and the pumps are secured, the RHR water seal of penetration Nos. 28N, 28E, and 35 is still available.

CONCLUSION

The combination of the design features of the safety injection and RHR systems and the proposed periodic hydrostatic testing is sufficient to assure that the isolation valves of penetration Nos. 28N, 28E, and 35 are not relied upon to prevent the escape of containment air to the atmosphere where the hydrostatic test is used to demonstrate leak-tightness. In this case, substitution of a hydrostatic test for the required pneumatic test is a justifiable exemption to the requirements of Appendix J. The Licensee should ensure that emergency procedures are established to require pressurization of portions of the system for air-leakage prevention, when needed.

3.1.3.3 Internal Containment Spray System (Penetration Nos. 29N and 29E)

In Section 4.4.C.3.A, WPS states:

> Those portions of the Internal Containment Spray System in service post accident shall be hydrostatically tested by closure of the manual isolation valves nearest the spray ring assembly and operation of the pumps on the 2" test line to the refueling water storage tank. This test shall be performed during each major refueling outage.

In Reference 4, WPS also provided the following additional information:

> The portions of the system under pressure during hydrostatic testing include all piping from the discharge of the pumps to the manual isolation valves ICS7A and ICS7B. Recirculation through the 2" test line to the Refueling Water Storage Tank would dissipate pump heat and be subject to a lower pressure than elsewhere. Visual inspection would pinpoint leakage areas which then would be volumetrically measured on a timed basis. To date, no significant leakage has been identified on this system.

EVALUATION

Section III.A.1.(d) of Appendix J states that containment isolation valves in systems which are normally filled with water and operating in a post-accident condition need not be vented and drained for a Type A test, but that these valves should be subsequently Type C tested. Section II.B, however, defines containment isolation valves as those valves relied upon to perform a containment isolation function. Combining this definition with the definition of "leakage rate" in Section II.D, containment isolation valves can be further described as those valves relied upon to prevent the escape of containment to the outside atmosphere. The question of whether Type C testing of isolation valves in penetration Nos. 29N and 29E is required by Appendix J, therefore, turns on whether these valves are relied upon to prevent the escape of containment air to the outside atmosphere at some time during the post-accident period.

Under normal circumstances, the isolation valves in question are not relied upon to prevent the escape of containment air to the outside atmosphere throughout the post-accident period because each containment spray pump will be providing water to the containment through its two penetrations. The water pressure is higher than peak calculated post-accident containment pressure and, in the recirculation mode, this flow will generally be supplied as long as containment pressure exceeds atmospheric pressure.

The redundant containment spray loops are independent of each other. Therefore, should one pump fail to start on signal, the isolation check valve in the affected loop would become a potential barrier to the leakage of containment air. In this case, the hydrostatic test proposed by WPS is used to demonstrate leak-tightness of the piping system such that air leakage is prevented. The test, however, is needed only to demonstrate that air leakage will be prevented during the injection phase of an accident because the spray system is essentially liquid sealed during the recirculation phase.

The containment spray system is supplied with water by the refueling water storage tank during the injection phase. In recirculation, however, water is supplied by the RHR system at the pressure-head of the RHR pumps. Consequently, once the plant is in the recirculation mode, potential leakage of containment air through the spray system is prevented by a water seal, at pressures above accident pressure, provided by the RHR system.

CONCLUSION

The combination of the design features of the containment spray system and the proposed hydrostatic testing is sufficient to assure that the isolation valves for penetration Nos. 29N and 29E are not relied upon to prevent the escape of containment air to the atmosphere. Substitution of the hydrostatic test for the required pneumatic test is a justifiable exemption to the requirements of Appendix J.

3.1.3.4 Chemical and Volume Control System (Penetration No. 12)

In Section 4.4.c.4.A, WPS states:

The Chemical and Volume Control Charging System piping from the charging pump discharge to the Reactor Coolant System shall be inspected for leakage during the startup following each major refueling outage when the charging system is in service and the Reactor Coolant System is at normal temperature and pressure.

EVALUATION

The chemical and volume control system (CVCS) is not an engineered safety feature system designed to perform a post-accident mitigation function. It will not normally be in continuous operation throughout the post-accident period following a design basis LOCA. Penetration No. 12 (the CVCS charging line) has been designed with appropriate test fittings (CVC-33 and CVC-32) to permit testing of its containment isolation valves.

There is no guarantee that post-accident containment air will not enter the idle CVCS system following a design basis LOCA nor does the proposed inspection by WPS provide any confidence that the containment air will not leak to the outside atmosphere through any of a number of potential leakage paths from this system.

CONCLUSION

The proposed operational inspection of the charging portion of the CVCS system is not a technically adequate substitute for the pneumatic leakage test of the isolation valves of penetration No. 12 required by Appendix J. These valves should be Type C tested in accordance with Appendix J. Test connections are installed for this purpose.

3.1.3.5 Component Cooling System (Penetration Nos. 32N, 32E, 33N, 33E, 39, and 40)

In Section 4.4.c.5.A, WPS states:

The Component Cooling System piping shall be inspected for leakage at each major refueling outage.

EVALUATION

The component cooling system inside containment consists of three separate closed loops which are designed to remain intact after an accident. WPS has stated that this piping is, in effect, an extension of the containment boundary.

Appendix J, Section III.A.1(d) does not require Type C testing of isolation valves in systems which are closed to the containment atmosphere, do not communicate with the reactor coolant pressure boundary, and do not rupture as a result of a LOCA because the isolation valves in these "closed systems" are not relied upon to prevent the escape cf containment air to outside atmosphere (Sections II.B and II.D).

CONCLUSION

Type C testing of component cooling system isolation valves (penetration Nos. 32N, 32E, 33N, 33E, 39, and 40) is not required. No exemption is necessary because Appendix J does not require this testing.

3.1.3.6 Fan Coil Cooling Service Water Lines (Penetration Nos. 37NW, 37NE, 37ES, 37EN, 38NW, 38NE, 38ES, and 38EN)

In Section 4.4.c.6.A, WPS states:

> The Service Water System piping for the fan coil coolers which are located within containment shall be inspected for leakage during each major refueling outage. The inspections shall be performed by closure of the fan coil cooler outlet isolation valve during normal operation of the service water supply system and visually inspecting the piping within containment.

EVALUATION

With regard to the requirements of Appendix J, service water to the fan coil units is comparable to the component cooling lines inside containment discussed in Section 3.1.3.5.

CONCLUSION

Type C testing of service water isolation valves to the fan coil units (penetration Nos. 37NW, 37NE, 37ES, 37EN, 38NW, 38NE, 38ES, and 38EN) is not required. No exemption is necessary because Appendix J does not require testing.

3.1.4 Containment Vacuum Breaker O-Ring Seals (Penetration Nos. 41E and 41 S/S)

Table TS 4.4-1 indicates that the containment vacuum breakers with their O-ring seals are tested with pressure applied in the direction opposite that which would exist after a LOCA. All other penetrations subject to Type B or C tests have pressure applied in the same direction as that which would exist after a LOCA.

In Reference 4, the Licensee further stated:

> The containment vacuum breaker valves are tested in the reverse direction to that of the pressure which would exist post-LOCA. They are tested in this manner because it verifies leakage rates of both the vacuum breaker valves and the check valves downstream.
>
> The vacuum breaker valves are 18" butterfly valves with air to close, spring to open operators. The valve discs are center pivot and rotate when closing to an EPT base material seat. When closed, the disc is positioned fully on the seat regardless of flow or pressure direction.
>
> Therefore, the results of the testing in the reverse direction will produce results equivalent to testing in the direction of the safety function.

EVALUATION

Section III.C of Appendix J states:

> The pressure shall be applied in the same direction as that when the valve would be required to perform its safety function, unless it can be determined that the results from the test for a pressure applied in a different direction will provide equivalent or more conservative results.

In Reference 4, the Licensee has indicated that the results of testing the vacuum breaker O-ring seals in the reverse direction is equivalent to the results of testing in the direction of accident pressure. The Licensee has also presented a technical basis for this conclusion.

CONCLUSION

Testing of vacuum breaker O-ring seals in the direction opposite that of accident pressure is technically adequate, and no exemption is required because this testing is in accordance with Appendix J.

3.1.5 Sequence of Leakage Rate Testing

In Section 4.4.b.1.B of Reference 3, WPS states:

> Type B and C tests may be performed prior to performance of Type A periodic tests. Leak rate measurements prior to and following any repair work on penetrations accomplished in preparation for a Type A test shall be employed in the evaluation of total measured leakage from containments, $L_{tm}$, conformance to the allowed maximum leakage limits of Specification 4.4.a.5. The leakage reduction due to repairs to the penetrations, $L_{\Delta t}$, shall be added to the measured leakage at $P_t$ to determine $L_{tm}$ for the purpose of evaluating conformance to 10CFR50 Appendix J Section III.4.b. Where:
>
> $L_{\Delta t} = L_{\Delta BC} \ (P_t/P_a)$
>
> $L_{\Delta BC}$ = Leakage prior to any repairs to penetrations - leakage following repairs (both leakages are measured at a pressure in excess of $P_a$).

The following additional justification was also provided by WPS in Reference 3:

> The integrated leak rate test requires a number of days to perform the pressurization, stabilization and leak rate measurement. Appendix J requires that a Type "A" test be performed prior to any repairs or Type "B" or "C" tests. Then if the Type "A" leakage is excessive, repairs are required and possibly a rerun of the Type "A" test may be necessary. We believe the objective is to assure that the leak rate is within the limits of 10 CFR 50 Appendix J and the accident analysis and that leak paths requiring repair are identified and repaired. Our proposed specification 4.4.b.1.B would accomplish these objectives plus it would provide assurance that the Type "A" test would not have to be performed twice during the same refueling outage. The pre-repair leak rate is determinable by the relationship provided in the proposed specification

4.4.b.1.B and would be employed to evaluate conformance to Appendix J in regards to $L_{tm}$ limits. This proposed order of performing Appendix J tests would minimize cost to the public and provide the necessary information desired by Appendix J.

EVALUATION

It is agreed that adding the difference between pre- and post-repaired local leakage rates to the measured containment integrated leakage rate, when repairs have been accomplished prior to a Type A test, provides the necessary information desired by Appendix J. It is also agreed that it is desirable to preclude the disruption of a refueling outage caused by the performance of two Type A tests during the same outage. Nevertheless, in using the proposed testing sequence, the Licensee must ensure that conservative data are obtained.

First, when conducting local leakage measurements prior to repair work, any measured leakage must be conservatively assumed to be in a direction out of the containment. Second, when conducting local leakage measurements after repair, measured leakage should be assumed to be recirculation leakage within the containment (e.g., a packing leak through a valve within containment), unless the geometry of the test is such that there is no possible path for recirculation leakage (e.g., when testing an outside containment isolation valve in the reverse direction). By this method, the most conservative value of $L_{\Delta BC}$ is obtained. This procedure results in the addition of essentially all the pre-repaired leakage when determining $L_{tm}$, which, in the normal case where post-repair leakage is reduced to a very small value, is both conservative and very close to actual conditions.

Second, where Type B or C tests are performed prior to the Type A test, the Licensee must be particularly aware of the Appendix J requirement to shut these values for testing by the normal mode with no preliminary exercising or adjustment. This requirement has implications for the conduct of both the Type C test and the Type A test. First, the isolation valves should be shut by normal operation with no preliminary exercising or adjustment prior to performance of the Type C test, both pre- and post-repair, when applicable.

Then, prior to conducting the Type A test, all systems should be returned to their normal configuration before closing all isolation valves by normal operation. This step is necessary in order to place the plant, as nearly as possible, in the position it would have been in had the Type A test been performed immediately following the shutdown for refueling.

Finally, the correlation proposed by the Licensee, $L_{\Delta t} = L_{\Delta BC}$ (Pt/Pa), is not the most conservative correlation which could be applied in this situation. For example, where the repaired leakage path is essentially orifice-like in nature, the correlation $L_{\Delta t} = L_{\Delta BC} (Pt/Pa)^{1/2}$ is more representative of the actual relationship and also provides more conservative results. The need to use either of these correlations, however, is eliminated by using the following procedure:

1. Where the Type A test is performed at full pressure (Pa), there is no need for a correlation since $L_{\Delta BC}$ is measured at Pa (in accordance with Section III.C.2 of Appendix J for Type C tests) and therefore it is added directly to Lam for determining acceptability (<.75 La).

2. Where the Type A test is performed at reduced pressure (Pt), the results of the Type A test (Ltm) should first be converted to equivalent full pressure leakage (Lamc*) by using the formula of Section III.A.4.(a)(1) (iii):

   Lamc = Ltm (K) for K > 1.4

   or $Lamc = Ltm (Pa/Pt)^{1/2}$ for K < 1.4

   Where K = the ratio of Lam to Ltm as derived from the preoperational test.

   Having converted Ltm to Lamc, $L_{\Delta BC}$ is added directly to Lamc to determine acceptability (<.75 La). (Again $L_{\Delta BC}$ is measured at a pressure of Pa.)

CONCLUSION

The proposal to perform Type C testing prior to the Type A test is technically adequate where a conservative determination of the pre- and

Lamc* = Lam (calculated).

post-repair differential leakage is added to the Type A leakage measurement and where due regard is given to the shutting of isolation valves by normal operation, without preliminary exercising or adjustment.

### 3.1.6 Airlock Testing

In Section 4.4.b.1.c of Reference 3, WPS states:

Testing of the personnel airlocks may be accomplished by either:

i. pressurization between the airlock docrs, or
ii. pressurization between double seals.

EVALUATION

Reference 3 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 whenever the airlock is 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, or at a reduced pressure, and, in addition, may be conducted by pressurizing between double seals.

3. Airlock door seal testing may not be substituted for the 6-month test of the entire airlock at Pa.

Since 1969, there have been approximately 70 reported instances in which airlock testing results have exceeded allowable leakage limits. Of these events, 25% were the result of leakage other than that resulting from improper seating of airlock docr seals. These failures were generally caused by leakage past docr operating mechanism handwheel packing, door operating cylinder shaft seals, equalizer valves, or test lines. These penetrations are similar to other Type B or Type C containment penetrations except that they may be operated more frequently. Since airlocks are tested at a pressure of Pa every 6 months, these penetrations are tested, at a minimum, four times more frequently than typical Type B or C penetrations. The 6-month test is therefore considered to be both justified and adequate for the prompt identification of this leakage.

Improper seating of the airlock door seals, however, is not only the most frequent cause of airlock failures (the remaining 75%), but also represents the largest potential leakage path. While testing at a pressure of Pa after each opening will identify seal leakage, seal leakage can also be identified by alternative methods such as pressurizing between double-gasketed door seals (for airlocks designed with this type of seal) or pressurizing the airlock to pressures other than Pa. Furthermore, experience gained in testing airlocks since the issuance of Appendix J indicates that the use of one of these alternative methods may be preferable to the full-pressure test of the entire airlock.

Airlocks in plants designed prior to the issuance of Appendix J often do not have the capability to be tested at Pa without the installation of strongbacks or the performance of mechanical adjustments to the operating mechanisms of the inner doors because the inner doors are designed to seat with accident pressure on the containment side of the door and therefore the operating mechanisms were not designed to withstand accident pressure in the opposite direction. When the airlock is pressurized for a local airlock test (i.e., pressurized between the doors), pressure is exerted on the airlock side of the inner door causing the door to unseat and preventing the conduct of a meaningful test. The strongbacks or mechanical adjustments prevent the unseating of the inner door, allowing the test to proceed. The installation of strongbacks or performance of mechanical adjustments is time consuming (often taking several hours), may result in additional radiation exposure to operating personnel, and may also cause degradation to the operating mechanisms of the inner door with consequent loss of reliability of the airlock. In addition, when conditions require frequent openings over a short period of time, testing at Pa after each opening both becomes impractical (tests often take from 8 hours to several days) and accelerates the rate of exposure to personnel and degradation of mechanical equipment.

If a satisfactory test of the airlock door seals is performed within 72 hours of opening or every 72 hours during periods of frequent openings whenever containment integrity is required, the intent of Appendix J is satisfied and the undesirable effects of testing after each opening are reduced. The test of the airlock door seals may by performed by pressurizing the space between the double-gasketed seals (if so equipped) or by pressurizing the entire airlock to a pressure less than Pa that does not require the installation of strongbacks or performance of other mechanical adjustments. If the reduced pressure airlock test is employed, the results of this test must be conservatively extrapolated to the results of the Pa air test.

Section III.B.3 of Appendix J requires that the total of all Type B and Type C tests (local leakage rate tests) be less than 0.6 La (maximum allowable containment integrated leakage). Therefore, Appendix J requires that the airlock leakage at Pa, when combined with leakage from local testing of penetrations and isolation valves in accordance with Appendix J, does not exceed 0.6 La. Since this leakage rate is in terms of Pa, the results of testing at Pt must be conservatively extrapolated to Pa.

In the absence of knowledge of the leakage path geometry, it is possible that the leakage path consists of the space between two very closely spaced surfaces. Since air is compressible, the mass flow rate measured at Pt should be multiplied by:

$$\frac{[(Pa + Patm)^2 - (Patm)^2] \quad (\mu t)}{[(Pt + Patm)^2 - (Patm)^2] \quad (\mu a)}$$

where Pa and Pt are in psig. Patm is the discharge pressure for leakage path in psia, μa is the viscosity of air at the temperature at which a test at Pa would be performed, and μt is the viscosity of air at the temperature of the test. As an example, if Pa = 60 psig, Pt = 10 psig, Patm = 14.7 psia, and μt = μa, then the extrapolation factor is 13.6. This is a more conservative result than would be obtained from other assumptions concerning the leakage path geometry.

CONCLUSION

In view of the above discussion, the measures set forth in Section 4.4.b.1.C are not sufficient to ensure all the requirements of the revised Section III.D.2 of Appendix J are achieved. The airlock testing program should be revised to conform to Appendix J.

3.2 PROPOSED TECHNICAL SPECIFICATION CHANGES

In Reference 3, WPS submitted Proposed Amendment No. 23 to the Technical Specifications for the Kewaunee plant. Proposed Amendment No. 23 added the specific parameters of leakage rate testing (Pa, Pt, La, etc.) to the Technical Specifications, required testing in accordance with Appendix J except as modified by Section 4.4.b, and added Table 4.4-1, which provides for the type of test and test method for each Kewaunee penetration.

EVALUATION

The specific parameters included in Section 4.4.a are in accordance with Appendix J. No further discussion of these items is required.

The variations from Appendix J described in Section 4.4.b have been evaluated in Section 3.1 of this report. Subject to the conclusions of Section 3.1, these items are either technically adequate or require modification. No further discussion of these items is included.

With regard to Table 4.4-1, deviations from the requirements of Appendix J have also been evaluated in Section 3.1 of this report with the exception of penetration Nos. 6E and 6W (main steam isolation valves), 7E and 7W (feedwater isolation valves), and 8S and 8N (steam generator blowdown isolation valves).

These valves are located in the secondary side of the steam generators and therefore are generally excluded from testing in accordance with Appendix J because the secondary side of a steam generator forms a closed loop inside containment which does not rupture as result of a LOCA. For this reason, Section II.H of Appendix J, which specifically requires testing of main steam and feedwater isolation valves in BWRs, makes no mention of these valves in PWRs.

At the same time, to preclude potential atmospheric leakage through these lines, the Licensee's emergency procedures should require that sufficient water level is maintained above the steam generator tubes following an accident. Also, the vent paths used to vent the steam generators for the Type A test must be effectively secured.

In Reference 4, the Licensee provided the following information regarding the testing of penetrations 6, 7, and 8:

> The penetrations listed in this section should have included the expansion bellows type B testing only. The associated isolation valves should have been exempted under 10CFR50 Appendix J, Section III A.I.d. Specifically, they are neither part of the reactor coolant boundary nor are they open directly to the containment atmosphere under post-accident conditions and these valves do not become an extension of the containment. Neither are portions of closed systems inside containment that penetrate containment and rupture as a result of a loss of coclant accident. Therefore, these valves are excluded from this submittal.
>
> Table TS 4.4-1 shall be revised to reflect these as follows:

| Penetration No. | Penetration | Penetration Category | Type of Test Required | Test Method |
|---|---|---|---|---|
| 6E & 6W | Main Steam Expansion Bellows | Annulus | B | Pneumatic |
| 7E & 7W | Feedwater Expansion Bellows | Annulus | B | Pneumatic |
| 8S & 8N | Steam Generator Blowdown Expansion Bellows | Annulus | B | Pneumatic |

In view of this change to Table TS 4.4-1, there are no other deviations in Table TS 4.4-1 that have not been addressed in this report.

CONCLUSION

Subject to the technical evaluations of the exemption requests in Section 3.1 of this report and the above modification of Table 4.4-1, revised Technical Specification Sections 4.4.a and 4.4.b and Table TS 4.4-1 are in accordance with the requirements or objectives of Appendix J.

## 4. CONCLUSIONS

Technical evaluations of all outstanding issues regarding the implementation of 10CFR50, Appendix J at the Kewaunee plant (requests for exemption from the requirements and proposed technical specification changes) were conducted. The conclusions of these evaluations are summarized below:

- The proposal to continue hydraulic testing in lieu of pneumatic testing of certain isolation valves is technically adequate only where the liquid leakage measurements are used to demonstrate a water seal at the valves throughout the post-accident period.

- The Technical Specifications should be revised to conform to the "no greater than 2 years" requirements with respect to Type B and Type C testing.

- The combination of the design features of the RHR system and the proposed periodic hydrostatic testing is sufficient to ensure that the isolation valves of penetration Nos. 9, 10, and 48 are not relied upon to prevent the escape of containment air to the atmosphere where the hydraulic test is used to demonstrate system leak-tightness. In this case, substitution of a hydrostatic test for the required pneumatic test is a justifiable exemption to the requirements of Appendix J. In the case of penetration Nos. 30E and 30W, no exemption is required since the liquid level of Containment Sump B provides a continuous water seal at these penetrations throughout the post-accident period.

- The combination of the design features of the safety injection and RHR systems and the proposed periodic hydrostatic testing is sufficient to ensure that the isolation valves of penetration Nos. 28N, 28E, and 35 are not relied upon to prevent the escape of containment air to atmosphere where the hydrostatic test is used to demonstrate system leak-tightness. In this case, substitution of a hydrostatic test for the required pneumatic test is a justifiable exemption to the requirements of Appendix J.

- The combination of the design features of the conteinment spray system and the proposed hydrostatic testing is sufficient to ensure that the isolation valves for penetration Nos. 29N and 29E are not relied upon to prevent the escape of containment air to the atmosphere. Substitution of the hydrostatic test for the required pneumatic test is a justifiable exemption to the requirements of Appendix J.

- The proposed operational inspection of the charging portion of the CVCS system is not a technically adequate substitute for the pneumatic leakage test of the isolation valves of penetration No. 12 required by Appendix J. These valves should be Type C tested in accordance with Appendix J. Test connections are installed for this purpose.

- Type C testing of component cooling system isolation valves (penetration Nos. 32N, 32E, 33N, 33E, 39, and 40) is not required. No exemption is necessary because Appendix J does not require their testing.

- Type C testing of service water isolation valves to the fan coil units (penetration Nos. 37NW, 37NE, 37ES, 37EN, 38NW, 38NE, 38ES, and 38EN) is not required. No exemption is necessary because Appendix J does not require testing.

- Testing of vacuum breaker O-ring seals in the direction opposite that in which the safety function is performed is technically adequate and no exemption is required because the test results will be equivalent to or more conservative than testing in the direction of accident pressure.

- The proposal to perform Type C tests prior to the Type A test is a justifiable exemption provided a conservative measure of pre- and post-repair differential leakage is added to the Type A results and other similar conservative procedures are followed.

- Section 4.4.b.1.C of Technical Specification 4.4 is not sufficient to ensure that all the requirements of the revised Section III.D.2 of Appendix J are achieved. The airlock testing program should be revised to conform to Appendix J.

- Subject to the technical evaluations of Section 3.1 of this report, revised Technical Specification Sections 4.4.a and 4.4.b and Table 4.4-1 are in accordance with the requirements or objectives of Appendix J.

## 5. REFERENCES

1. K. R. Goller (NRC)
Letter to E. W. James (WPS)
August 5, 1975

2. E. W. James (WPS)
Letter to K. R. Goller (NRC)
September 5, 1975

3. E. W. James (WPS)
Letter to A. Schwencer (NRC)
January 4, 1977

4. E. R. Mathews (WPS)
Letter to S. A Varga (NRC)
August 17, 1981