UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

APPENDIX J REVIEW

QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2

DOCKET NOS. 50-254 AND 50-265

1.0 Introduction

On August 5, 1975 (Reference 1), the NRC requested Commonwealth Edison Company (licensee) to review its containment leakage testing program for Quad Cities Nuclear Power Station, Units 1 and 2 (Quad Cities 1 and 2) and the associated Technical Specifications, for compliance with the requirements of Appendix J to 10 CFR Part 50.

Appendix J to 10 CFR Part 50 was published on February 14, 1973. Since by this date there were already many operating nuclear plants and a number more in advanced stages of design or construction, the NRC decided to have these plants reevaluated against the requirements of this new regulation. Therefore, beginning in August 1975, requests for review of the extent of compliance with the requirements of Appendix J were made of each licensee. Following the initial responses to these requests, NRC staff positions were developed which would assure that the objectives of the testing requirements of the above cited regulation were satisfied. Subsequently, Section III.D.2 of Appendix J was revised, effective October 22, 1980 and conformance is considered in our evaluation. These staff positions have since been applied in our review of the submittals filed by the licensee for Quad Cities 1 and 2. The results of our evaluation are provided below.

2.0 Evaluation

Our consultant, the Franklin Research Center (FRC), has reviewed the licensee's submittals (References 2, 3, 5 and 6) and prepared the enclosed Technical Evaluation Report (TER-C5257, 45/46), Containment Leak Testing for Quad Cities 1 and 2. We have reviewed FRC's evaluation and concur in its bases and findings except in the following respects.

The licensee's request concerning the integrated leak rate duration has already been addressed in an action taken by issuance of our letter dated November 2, 1982.

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Additionally, the licensee's request for an exemption pertaining to the frequency of Type B tests of the containment airlock is further evaluated below.

Section III.D.2 of Appendix J, effective October 22, 1980, requires testing of the airlock as follows:

1. Every six months at a pressure of not less than accident pressure (Pa) and after periods when the airlock is opened and containment integrity is not required.

2. Within three days of opening (or every three days during periods of frequent opening) when containment integrity is required, at a pressure of Pa or at a reduced pressure as stated in the Technical Specifications.

By letter dated September 26, 1975, the licensee requested an exemption from the frequency requirements of Section III.D.2 in order to permit testing on a frequency consistent with the plant operating cycle (i.e., each refueling outage). FRC's evaluation of the licensee's submittals in support of the exemption request which is contained in the enclosed TER concluded that the licensee's program related to the test frequency and pressure should conform to the requirements of Section III.D.2 of Appendix J.

However, subsequent discussions with the licensee regarding test methodology and additional evaluation by the staff of airlock degradation causal factors and operating history have resulted in a reevaluation of our position. Test performance requires shutting down the reactor and opening the equipment hatch in order to install a strongback on the inner airlock door to prevent unseating the airlock door, and subsequent door and hatch openings to remove the strongback. This would result in an outage of several days for the licensee, the cost of replacement power to the public, and could subject operating personnel to additional radiation exposure. In addition, the additional openings of the equipment hatch and airlock provide additional opportunities for inadvertent seal degradation.

Based on these considerations, we have developed the following modified position which we believe meets the objectives of Appendix J requirements for Type B tests of containment airlocks.

We will still require containment airlocks to be tested every six months at a pressure of not less than Pa in accordance with Appendix J, except that the test interval may be extended to the next refueling outage (up to a maximum interval between Pa tests of 24 months) provided that there have been no airlock openings since the last successful test at Pa and a Pa test is performed following the next airlock opening. The intent of the Appendix J requirement is to assure that the airlock door seal integrity is maintained and no degradation has occurred as a result of opening of the airlock doors between testing intervals at Pa. Since there is no adequate basis to conclude that airlock seal degradation integrity is maintained if the airlock doors have not been opened between extended testing intervals at Pa, we believe that reduced pressure testing should be performed to assure that the airlock door seal integrity is maintained between the extended testing intervals at Pa. We believe this position satisfies the objectives of the requirements. The licensee will be requested to propose modifications to the Technical Specifications as appropriate.

Therefore, the exemption from the airlock testing frequency requirements of Appendix J requested by the licensee should be granted provided the licensee complies with the staff's revised position on airlock testing.

3.0 Summary

Based on our review of the enclosed Technical Evaluation Report and our additional review of the containment airlock testing requirements, our conclusions regarding all exemption requests are summarized below:

1. The licensee's request (Reference 3) for exemption from the required sequence of conducting Type A and C tests is acceptable provided that:

    a. When performing Type C tests, the conservative assumption that all measured leakage is in a direction out of the containment is applied unless the test is performed by pressurizing between the isolation valves; and

    b. When performing Type C tests by pressurizing between the isolation valves, the conservative assumption that the two valves leak equally (and therefore one half of the measured leakage is in a direction out of the containment) is applied, where the isolation valves are shut by normal operation without preliminary exercising or adjustment.

2. The licensee's request (References 2 and 5) for exemption from Type C testing requirements for instrument line isolation valves is acceptable provided that the affected instrument lines are not isolated from the containment atmosphere during the performance of a Type A test.

3. The licensee's request (Reference 2) for exemption from the required containment airlock test frequency is acceptable provided the licensee adheres to the provisions of the staff's revised position on containment airlock testing.

Periodic testing of the airlock at a test pressure of Pa will be required in order to demonstrate airlock integrity at accident pressures.

4. The licensee's request (Reference 2) for exemption from Type C testing requirements for main steam isolation valves is acceptable due to the unique design of these valves.

5. The licensee's proposal (References 3 and 5) to perform Type C testing of the traversing incore probe system valves by disconnecting the tubes at fittings just inside the drywell is acceptable and no exemption is required since the licensee has developed an acceptable methodology for performing the Type C tests.

6. The licensee's proposal (Reference 6) to shut check valves using a hydraulic differential pressure of 50 psig prior to draining the lines for Type C testing is acceptable and does not require an exemption from the requirements of Appendix J since the procedure is in compliance with Section III.C.1 regarding closing the valves by normal operation.

Principal Contributors: J. Huang, R. Bevan

Enclosure: Technical Evaluation Report

Dated: June 12, 1984

<u>References</u>

1. K. R. Goller (NRC) Generic Letter to CWE on Containment Leakage Testing, dated August 5, 1975.
2. G. J. Pliml (CECo) letter to K. R. Goller (NRC), dated September 26, 1975.
3. G. J. Pliml (CECo) letter to K. R. Goller (NRC), dated September 9, 1976.
4. D. L. Ziemann (NRC) letter to R. L. Bolger (CECo), dated February 2, 1977.
5. M. S. Turbak (CECo) letter to D. L. Ziemann (NRC), dated April 5, 1977.
6. C. Reed (CECo) letter to E. G. Case (NRC), dated March 21, 1978.

TECHNICAL EVALUATION REPORT

CONTAINMENT LEAKAGE RATE TESTING

COMMONWEALTH EDISON COMPANY
QUAD CITIES UNITS 1 AND 2

NRC DOCKET NO. 50-254, 50-265

FRC PROJECT C5257

NRC TAC NO. 08666, 08667

FRC ASSIGNMENT 1

NRC CONTRACT NO. NRC-03-79-118

FRC TASKS 45, 46

Prepared by

Franklin Research Center
The Parkway at Twentieth Street
Philadelphia, PA 19103

Author: P. Noell

FRC Group Leader: T. J. DelGaizo

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: Y. S. Huang

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Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

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1. BACKGROUND

On August 5, 1975 [1],* the NRC requested Commonwealth Edision Company (CWE) to review the containment leakage testing program for Quad Cities Units 1 and 2 (Quad Cities 1 and 2) and to provide a plan for achieving full compliance, where necessary, including appropriate design modifications, changes to technical specifications, or requests for exemption from the requirements of 10CFR50, Appendix J.

CWE responded to the NRC's requests in a letter dated September 26, 1975 [2], in which five requests for exemption from the requirements of Appendix J were listed for Quad Cities 1 and 2. On September 9, 1976 [3], CWE submitted two additional requests for exemption. The NRC responsed in a letter dated February 2, 1977 [4], asking several questions regarding these submittals.

On April 5, 1977 [5], CWE replied to the NRC's questions. In this letter, CWE provided additional information relative to the requests for exemption from the requirements of Appendix J for Quad Cities 1 and 2 and also requested another exemption for a proposed feedwater check valve testing procedure. Subsequently, on March 21, 1978 [6], CWE submitted a proposed technical specification change related to reducing the minimum time requirement for conducting the integrated primary containment leak rate test.

The purpose of this report is to provide a technical evaluation of the outstanding submittals regarding the implementation of the requirements of 10CFR50, Appendix J, at Quad Cities 1 and 2. Consequently, technical evaluations of the exemption requests provided in References 2, 3, and 5 are provided. In addition, a technical evaluation of the proposed technical specification change submitted in Reference 6 is included.

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*Numbers in brackets refer to citations in the list of references, Section 5.

2. REVIEW 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 technical evaluations. The criteria are either referenced or briefly stated, where necessary, to support the results of the evaluations. Furthermore, in recognition of the plant-specific conditions not explicitly covered by the regulations, the NRC directed that the technical review constantly emphasize the basic intent of 10CFR50, 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

In Reference 2, CWE requested approval of the following exemptions:

1. Exemption from the required sequence of conducting Type A and Type C tests.
2. Exemption from Type C testing requirements for instrument line isolation valves.
3. Exemption from the required frequency of testing containment airlocks.
4. Exemption from the required pressure for testing containment airlocks.
5. Exemption from Type C testing requirements for main steam isolation valves.

In Reference 3, CWE requested an additional exemption from Type C testing requirements for the transversing incore probe system valves. In Reference 5, CWE requested an exemption from Type C testing requirements for the feedwater check valves.

Technical evaluations of these requests for exemption are provided in Sections 3.1.1 through 3.1.6.

3.1.1 Exemption from the Required Sequence of Conducting Type A and Type C Tests

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

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

> 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

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end of the outage. The results of the integrated leak rate test are then corrected back to determine the conditions that existed at the beginning of the outage using local leak rate test results.

In Reference 4, the NRC indicated to CWE that this procedure would be acceptable, provided that, in back-correcting the results of the integrated test, the conservative assumption that all measured local leakage is in a direction out of the containment is applied. In Reference 5, however, CWE asserted that this assumption is not representative of the actual containment outleakage when the combined leakage of two isolation valves is measured in a single test by pressurizing between the valves. CWE maintained that, in this case, a conservative assumption would be that one-half the total measured local leakage from these valves was outleakage. CWE stated:

> In those cases where the combined leakage of two isolation valves is measured in a single test by pressurizing between the valves, the above assumption cannot apply since under accident conditions, the leakage out of the containment via such a penetration would have to pass through smaller leak rate of the two valves since it effectively throttles the flow through the penetration. In these cases, we intend to make the most conservative assumption possible--the valves leak equally.

CWE further stated that a multiple, single-failure criterion imposed upon all valves measured by local leak rate procedures was unnecessarily conservative and that the CWE-proposed procedure provided integrated leak rate test results that were more nearly "as is," while the NRC's conservative assumption represented a "worst possible case."

FRC EVALUATION

During the conduct of a local leak rate test of an isolation valve located inside containment in the direction in which the valve performs its safety function, several potential leakage paths that do not result in containment outleakage (packing leaks, body-to-bonnet leaks, gasket seal leaks, etc.) may be available. Since these potential leakage paths cannot be easily separated from valve seat leakage, which does result in outleakage, the NRC's conservative assumption that all measured leakage is outleakage must be applied. However, when conducting a normal Type A test, where test pressure is applied through two shut isolation valves in series, the actual leakage to the outside atmosphere will be no greater than the lower of the leakage rates of the two valves taken individually. Therefore, when testing by pressurizing between the isolation valves during a local leak rate test (assuming that the reverse-direction testing of the inboard valve is at least equivalent to or more conservative than testing in the direction of accident pressure), the assumption that the two valves leak equally is a conservative assumption for the purpose of back-correcting the results of the Type A test. In fact, where one of the two valves is leaktight while the other has significant leakage, the effect of back-correcting with the assumption that both valves leak equally will yield quite conservative results for the Type A test, while normal Type A testing would have resulted in zero leakage through the penetration.

The Type A testing procedures of Appendix J account for the possibility of active failures in determining the "as is" condition of the containment by requiring that the isolation valves be shut by normal means without any adjustments, exercising, or other special precautions. Consequently, if both valves are shut by normal means prior to the Type A test, the test pressure is applied to the penetration, with isolation provided by two shut valves in series. If one valve fails to shut, the "as is" test is performed with the single valve isolation. Since CWE proposes to adhere to the requirements of Appendix J in shutting the valves prior to conducting the local leak rate test, the requirement that the total leakage be considered outleakage imposes an unreasonable conservatism in back-correcting to determine the "as is" condition when pressurizing between the valves. However, should one valve fail to shut prior to the local leak rate test, after the other valve has been repaired and shut, the total measured local leakage rate (pressurizing between the valves) must then be attributed to the single shut valve. Therefore, the assumption that the total measured leakage rate is in the direction out of containment must be applied for this penetration. In this way, the condition that would have existed if the Type A test had been performed prior to the local leak rate test will be conservatively achieved.

The possibility that a single active failure could occur in a subsequent accident situation is accounted for in Appendix J by the requirement to perform local leak rate tests on these same isolation valves with the criterion that the total leakage from all tested penetrations and isolation valves be less than 0.6 La (Section III.C.3). During Type C testing, the leakage rates of all designated isolation valves are accounted for individually, so that in the event of a single active failure the total penetration leakage rate will still remain within allowable limits. Consequently, when including local leak rate test results in the 0.6-La total, the total measured leakage rate, even when pressurizing between the valves, must be considered to be outleakage in order to include the leakage contribution of each isolation valve in the total.

FRC concludes that CWE's proposal to conduct local leak rate tests prior to the integrated primary containment leak rate test is acceptable. FRC further concludes that, when local leak rate tests are performed by pressurizing between isolation valves, the assumption that the valves leak equally is acceptable when back-correcting the results of the integrated containment leak rate (Type A) test, provided that the closure of the valves has been accomplished by normal operation and without any preliminary exercising or adjustment, in accordance with Section III.A.1.(b) of Appendix J. However, if the valve closure is accomplished by other than normal means or if local leak rate test results are included in the total leakage of all Type B and Type C tests to meet the 0.6-La requirement of Section III.C.3, all determined local leakage must be considered containment outleakage.

3.1.2 Exemption from Type C Testing Requirements for Instrument Line Isolation Valves

In Reference 2, CWE requested an exemption from the requirements of paragraph II.H.1 of Appendix J, relating to the Type C testing of instrument line manual isolation valves. The Licensee's view is stated as follows:

> Paragraph II.H.1 specifies the leakage tests be conducted on isolation valves of instrument lines penetrating the primary containment. These manually operated valves have not been routinely tested in the past because they are not normally closed in the event of a primary containment isolation, nor should they be. These lines provide channels for the transfer of information about conditions inside the containment. They are equipped with check valves which automatically limit excess flow through the line, should high flow conditions develop. These check

valves are routinely tested. Since these intrument line manual isolation valves are not relied upon to limit the consequences of an accident, there is no basis for them to be tested periodically.

In Reference 5, CWE provided an additional technical discussion in support of the request for exemption from Type C testing requirements for 96 instrument lines (per unit) penetrating the drywell. In addition to a discussion of the radiological consequences of the failure of one of these lines, CWE indicated that the instrument lines of both units were in accordance with the provisions of Regulatory Guide 1.11 (Instrument Lines Penetrating Primary Reactor Containment) and its supplements.

FRC EVALUATION

Section II.H.1 of Appendix J requires Type C testing of containment isolation valves that provide a direct connection between inside and outside atmospheres of the primary reactor containment under normal operation, such as purge and ventilation, vacumm relief, and instrument valves. The instrument valves for which CWE has requested exemption are not those that provide a direct connection between the inside and outside atmospheres of the containment under normal operation, since these valves are open under both normal operation and post-accident conditions. These particular valves, in fact, provide a path for leakage of primary containment atmosphere only upon a rupture or other failure of the associated instrument line. Regulatory Guide 1.11 provides guidances on prevention of unacceptable releases of radioactivity in case of a failure or rupture of instrument lines.

Consequently, since Type C testing of these valves is not required by Section II.H.1 of Appendix J and also since the penetrations conform to the requirements of Regulatory Guide 1.11, there is no need to perform Type C testing of these valves, and no exemption is required.

3.1.3 Airlock Testing

In Reference 2, CWE requested exemptions from the Type B testing requirements for containment airlocks for both the frequency of testing and the pressure of the test. These requests are evaluated in Sections 3.1.3.1 and 3.1.3.2.

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3.1.3.1 Exemption from the Required Frequency of Testing Containment Airlocks

CWE requested an exemption from the Type B testing frequency requirements for containment airlocks to permit testing of airlocks during each refueling outage. CWE stated that experience indicated that testing at each refueling outage would satisfactorily ensure that the integrity of the locks would be maintained. The NRC's reply in Reference 4 stated that more frequent testing was required because airlocks represent a potentially large leakage path that is more subject to human error than other isolation barriers. The NRC provided CWE with additional guidance to assist the Licensee in preparing an acceptable program for the testing of airlocks.

In response, CWE submitted additional information in Reference 5 supporting the contention that airlocks should be tested during each refueling outage. CWE stated that the electrical and mechanical penetrations of the airlocks, including airlock cylinders, hinge assemblies, welded connections, and other leakage paths, formed parts of rigid boundaries that are not subjected to mechanical cycling, the mating of seating surfaces, or human error and should, therefore, be tested at the same once-per-cycle interval as other containment penetrations. CWE further proposed to conduct a detailed visual examination of the door seals following each series of entries to ensure timely identification of developing problems.

FRC EVALUATION

Appendix J, Section III.D.2, requires that airlocks be tested at 6-month intervals and that airlocks which are opened during the 6-month interim be tested after each use. Airlocks represent potentially large leakage paths that are more subject to human error than other isolation barriers; therefore, they are tested more often than other isolation barriers. The requirement to test airlocks after each use was added to ensure that the sealing mechanisms were not damaged during an airlock entry and to ensure that this large potential leakage path was correctly secured after use.

For certain types of reactors, frequent use of airlocks has occurred. Testing airlocks after each opening may represent a situation in which a more rapid degradation of the critical isolation barriers being tested occurs.

Moreover, experience since 1969 indicates that only a very few airlock tests have resulted in greater-than-allowable leakage rates. This infrequent failure of airlock tests plus the possibility that excessive testing could lead to a loss of reliability due to equipment degradation leads to the judgement that testing after each opening may be undersirable. As a compromise between these competing interests, the requirement to test after each opening has been defined as within 3 days of the first of a series of openings. By this definition, the intent of Appendix J (that airlock integrity be verified within a reasonable period of time after use) is achieved, without the excessive testing that would otherwise be required when a series of openings occurs within a short period of time.

CWE proposes to test airlocks once per cycle with a detailed visual examination of the door seals following a series of entries. This testing program is not acceptable. CWE's proposal does not make adequate allowance for the detection of potential deterioration of the airlocks through normal use, for potential damage to the airlocks due to moving equipment in and out of containment, or for possible fouling of the door seals during closure. The detailed visual inspection following each series of openings might reveal some of these potential problems, but cannot be considered an adequate substitute for an actual airlock test. In view of the potential consequences of failure to detect these deficiencies, use of a visual inspection in lieu of an actual test cannot be accepted.

FRC finds that the minimum acceptable airlock testing program which complies with the requirements of Appendix J requires that the entire airlock be tested at 6-month intervals and that intermediate tests be performed within 72 hours of the first of a series of openings during the period between 6-month tests. CWE's request for exemption from the requirements of Section III.D.2 is not acceptable.

3.1.3.2 Exemption from the Required Pressure for Testing Containment Airlocks

CWE has requested an exemption from the Type B testing pressure requirements to permit airlock testing at 2 psig instead of at the peak calculated accident pressure (Pa) of 62 psig. As a basis for this request, CWE stated:

> The airlock is designed to seal the door against a pressure of 2 psig and against 62 psig pressure of the containment vessel existing in the vessel or vessel and lock. Were the airlock to be tested at Pa, the inner door and door mechanism would be subjected to a force of approximately 172,000 lbs. in excess of design. Even with the normal mechanism augmented by the use of strongbacks, such a test is inconsistent with good engineering practice and presents an unacceptable safety hazard. In addition, the use of special restraint is contrary to the premise that meaningful data requires containment boundaries be set without employing extraordinary means.

Additionally, CWE objected to performing the intermediate tests at a reduced pressure, saying that even at 1 psig the nearly 2 tons of force exerted against the inner door would cause serious threat of equipment damage, that there is no practical means for personnel to enter the drywell to inspect the inner door, and that the test would not necessarily be a meaningful representation of the door's ability to perform its safety function. CWE concluded that, in view of the fact that there had been no airlock door seal failures at Quad Cities, a proposed detailed visual examination following each series of entries in place of the reduced pressure test would provide comparable reliability and timely identification of developing problems.

FRC EVALUATION

Appendix J, Section III.B.2, requires that airlocks be tested at a pressure of not less than Pa. For plants designed prior to the issuance of Appendix J and for airlocks not designed to withstand this pressure in the reverse direction against the inner door, meeting this criterion requires the installation of strongbacks or other locking devices to support the normal door operating mechanism in order to allow performance of the test.

Due to the necessity of proving the integrity of this potentially large leakage source at 6-month intervals, as discussed in Section 3.1.2.1, the test must be undertaken at least every 6 months.

Since 1969, there have been approximately 70 instances in which leak tests have resulted in greater-than-allowable leakage rates. Of these failures, 75% were caused by failures of door seals. Testing seals at a reduced pressure will suffice to verify the seals following an entry, particularly in view of the fact that a full pressure containment airlock test is performed every 6 months. Consequently, for the purpose of verification of airlock door seals following airlock openings between the 6-month tests, a reduced-pressure test which does not require the use of strongbacks or other locking devices may be used, provided that the results of the reduced-pressure tests can be extrapolated to conservatively predict the results from a full pressure test.

FRC does not concur with CWE's contention that testing of airlocks at Pa is inconsistent with good engineering practice and presents an unacceptable safety hazard. The door is designed to withstand the force resulting from peak calculated accident pressure when the pressure is on the containment side of the door. The typical problem with pressurizing an airlock from the inside is that the reverse pressure causes the inner door to unseat and leak to the point that test results become invalid. Strongbacks help to maintain the seat of the inner door seal so that a valid test can be performed. In fact, since the 172,000 lb of force in an actual accident condition would tend to seat the inner door, testing the airlock from within, even with strongbacks in place, provides a conservative estimate of the capability of the airlock to seal against atmospheric leakage.

FRC also does not concur with CWE's contention that reduced pressure testing is not a meaningful representation of the ability of the airlock to perform its safety function. Since the test is a pressure drop test, it may be performed without inspecting the inner door. The purpose of these intermediate tests is to ensure that the airlock has not been damaged and has not deteriorated since the last biannual test. Satisfactory performance of a pressure drop test, with the results conservatively extrapolated to the results of the Pa test, provides reasonable indication that such degradation has not occurred. Furthermore, CWE alleges that exposing an airlock door to a pressure of 1 psig when the door is designed to seal against a pressure of 2 psig and against a pressure of 62 psig from the containment side causes a serious threat of equipment damage. This position has not been taken by any other licensee and there appears to be no technical basis for it. Nevertheless, should a threat of equipment damage exist, modifications or other precautions should be taken so that testing which satisfies the intent of Appendix J may proceed.

FRC finds that CWE's proposal to test airlocks at 2 psig is unacceptable. The airlock test conducted every 6 months must be at a pressure of Pa. Intermediate tests performed in compliance with the "after each use" requirement of Appendix J may be performed at a reduced pressure not requiring the application of strongbacks provided that the test results can be conservatively extrapolated to yield Pa test results within the acceptance criteria limits.

3.1.4 Exemption from Type C Testing Requirements for Main Steam Isolation Valves

In Reference 2, CWE requested an exemption from the Type C testing requirements for the main steam isolation valves (MSIVs) to permit testing at 25 psig rather than at the peak calculated accident pressure (Pa), 62 psig. CWE's basis for this request is that, although the design of these valves requires that they be tested by pressurizing between two valves, using a pressure of Pa will cause the inboard valve to lift off its seat (this valve being tested in the reverse direction), resulting in erroneously high leakage rates.

FRC EVALUATION

The design of main steam systems in most operating BWR plants necessitates leak testing of the MSIVs by pressurizing between the valves. The MSIVs are angled in the main steam lines to afford better sealing in the direction of accident leakage. A test pressure of Pa acting on the inboard disc lifts the disc off its seat, resulting in excessive leakage into the reactor vessel. Consideration was given to this feature when the original test pressure of 25 psig was established for the MSIVs at the design stage of the BWR plants.

Testing of the MSIVs at reduced pressure results in a conservative determination of the leakage rate through the valves; therefore, FRC finds that the proposed exemption is acceptable.

3.1.5 Exemption from Type C Testing Requirements for Traversing Incore Probe System Valves

In Reference 3, CWE requested an exemption from the Type C testing requirements of Appendix J for the traversing incore probe (TIP) system valves, saying that the valves were untestable. Reference 5 indicated, however, that TIP system and purge line valves were successfully tested by disconnecting the TIP tubes at the fittings just inside the drywell. By this technique, CWE was able to test the TIP system valves without performing any piping modifications. CWE stated that testing of the TIP system valves would be performed by this method, beginning during the Spring 1977 refueling outage at Quad Cities Unit 1.

FRC EVALUATION

Since these valve will be tested as required by Appendix J, no exemption is necessary.

3.1.6 Local Leak Rate Test Methods for the Feedwater Check Valves

In Reference 6, CWE submitted a request for exemption concerning a modified local leak rate testing method for the feedwater check valves. This method would consist of using a hydraulic differential pressure across the check valves to shut the valves, then draining the lines of fluid and conducting a local leak rate test in accordance with normal Type C testing procedures. This procedure was developed because CWE discovered that, unless the valves were initially seated using a fluid medium, they were not adequately seated and caused unsatisfactory test results; however, if the valves were hydraulically seated, they would perform satsifactorily. CWE's basis for this procedure is that the revised test method simulates as closely as possible the normal closing operation of these valves during accident conditions. Since there would still be water on the valves at the time of closing, due to their position in the low point of the line, the valves would initially be shut by a differential pressure acting on a column of water. After the water has leaked out or flashed to steam, the valves would be

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required to seal against potential leakage of containment atmosphere. CWE maintains that this procedure fulfills as closely as possible the requirements of Section III.C.1 of Appendix J (that the valves to be tested be closed by normal operation without preliminary exercising or adjustment).

FRC EVALUATION

Section III.C.1 of Appendix J requires that the testing of valves be performed after closing by normal operation without preliminary exercising or adjustments. FRC concurs that the method proposed by CWE approximates as closely as possible the actual conditions which will shut these valves in an accident situation. Since the procedure is in compliance with the requirements of Section III.C.1 with regard to closing the valves by normal operation, this method is acceptable. No exemption from the requirements of Appendix J is required.

3.2 PROPOSED TECHNICAL SPECIFICATION CHANGES

3.2.1 Minimum Duration of the Integrated Primary Containment Leak Rate Test

In Reference 6, CWE proposed to amend the Technical Specification for Quad Cites 1 and 2 concerning the minimum duration of the integrated primary containment leak rate test (IPCLRT). The proposed change would reduce the minimum duration of the IPCLRT from 24 to 12 hours. The requirement that the test continue beyond this minimum time, if necessary to demonstrate compliance with the Technical Specification limits for allowable leakage, would remain unchanged.

CWE's basis for this request is that the availability of improved instrumentation and data acquisition equipment and the direct data reduction capability of the station process computer yield an acceptable calculated leak rate and a rapid convergence of the 95 percent confidence limits long before 24 hours have elapsed. CWE's system can automatically scan the containment conditions and provide a weighted, average, statistically determined leakage rate as often as every 10 minutes during the test.

CWE stated that reports of two recent IPCLRTs using the new equipment and methods indicate that an acceptable statistical leak rate and associated upper 95 percent confidence level can be verified in as little as 8 to 10 hours of testing. Thus, CWE believes that an acceptable leak rate can be established by the end of a 12-hour-minimum test. The minimum stabilization period of 4 hours at 48 psig required by ANSI N45.4-1972 would not be affected by the proposed change and would precede the 12-hour-minimum test.

FRC EVALUATION

Section III.A.3 of Appendix J requires that the IPCLRT be conducted in accordance with ANSI N45.4-1972, Leakage-Rate Testing of Containment Structures for Nuclear Reactors. Section 7.6 of ANSI N45.4-1972 states:

> 7.6 Period of Test. The leakage-rate test period, for any method, shall extend to 24 h of retained internal pressure. If it can be demonstrated to the satisfaction of those responsible for the acceptance of the containment structure that the leakage rate can be accurately determined during a shorter test period, the agreed-upon shorter period may be used. Leakage-rate tests should not be started until essential temperature equilibrium has been attained. Completion of the test should preferably be scheduled to coincide with atmospheric temperatures and pressures close to those at the start of the test, as far as possible. Check tests or repetition of tests shall be a matter of agreement between those responsible for the containment structure and those in charge of the leakage-rate testing.

Clearly, the regulatory requirements permit authorization of a test period shorter than 24 hours, provided the licensee can demonstrate that the results of the shorter test will be equivalent to or more conservative than the results provided by the 24-hour test. After review of this matter, FRC finds that such is not the case and that the 24-hour test duration should be retained for the following reasons:

1. The shorter test introduces the possibly non-conservative assumption that the actual leakage rate of the containment is either a constant or some known function of time, such as monotonically decreasing (and not increasing).

2. During the shorter test, the actual leakage rate may be masked by changes bought about by diurnal effects, resulting in an artifically low leakage rate due to the inability to accurately determine actual containment parameters (such as average containment temperature).

3. The 24-hour period is not only the shortest time period over which diurnal effects may be averaged, but is also a time period of significance with regard to plant operations; therefore, the leakage rate should actually be measured over 24 hours, unless the test can be done in a shorter period without imposing any non-conservative assumptions.

In CWE's detailed discussion of the bases for the request to employ an IPCLRT of shorter duration than the required 24-hour minimum, the Licensee stated: "The functional integrity of the primary containment can be demonstrated independent of the test period, so long as equilibrium has been attained in the variables measured during the test." In other words, it can be demonstrated that the ability to measure the leakage rate is independent of a specific duration of the test, such as 24 hours, provided that, following the 4-hour stabilization period, the integrated containment leakage rate is either a constant value or some other known function of time, such as monotonically decreasing (and not increasing). FRC agrees with this premise, but believes that it cannot be shown that the leakage rate is a constant or that equilibrium has been attained in the variables measured during the test. Variables, such as valves that are water covered at the start of the test but after some period of leakage are no longer water covered and begin to leak air, will affect the leakage rate. Resilient seals exposed to the test pressure may also experience accelerated leakage with increasing exposure to the pressure. Check valves that are non-leakers at higher pressures may begin to leak as the containment pressure decreases throughout the test period due to either temperature changes or the effect of the overall leakage rate.

Diurnal effects have also been known to mask the actual containment leakage rate for several hours. Diurnal effects combined with the inability to accurately measure change in certain key containment parameters (such as temperature) have periodically caused significantly erroneous results which would not have been obvious without the full 24 hours of data. In some cases, near-zero and even positive leakage rates (theoretical in-leakage) have been measured for several hours before the diurnal effects settled out and the actual leakage rate became apparent. These diurnal effects are very difficult to estimate from one test to the next; for this reason, ANSI N45.4-1972 requires that the atmospheric temperature and pressure at the start of the test correspond as closely as possible to those at the completion of the test. A 24-hour test is the most consistent method of obtaining that goal, particularly considering that the test may be performed at any season of the year.

Finally, the 24-hour period is not an arbitrary time period selected to ensure that an otherwise constant leakage rate may be accurately measured, but a time which has significance with regard to plant design and operation. For example, the containment spray system and the containment heat removal system are designed to reduce peak calculated containment accident pressure to one-half its original value within 24 hours. Also, the time periods for which off-site dose calculations are performed during the design of the plant are zero to 2 hours, 2 to 8 hours, 8 to 24 hours, and beyond 24 hours. Therefore, due to the significance of the first 24 hours following a design basis accident, the accurate measurement of the leakage rate during this period should not be contingent upon the validity of any additional assumptions (such as equilibrium of variables), unless these assumptions can be clearly proven. This is particularly true since the alternative (actually measuring leakage over 24 hours) is not an unreasonable requirement.

In view of the above considerations, FRC finds that the proposal to reduce the minimum duration of the IPCLRT from 24 hours to 12 hours is not acceptable because there is no adequate assurance that the accuracy of the results of the 12-hour test will be equivalent to or more conservative than the results of the 24-hour test. The minimum 24-hour test duration of ANSI N.45-4-1972 should be retained.

4. CONCLUSIONS

This report contains technical evaluations of requests for exemption from the requirements of 10CFR50, Appendix J, Containment Leakage Testing, and also technical evaluations of proposed technical specification changes related to the containment leakage testing program at Quad Cities 1 and 2. The following is a summary of the conclusions of these evaluations:

- CWE's request to perform local valve leak 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 using the results of Type C tests is acceptable provided that:

  1. when performing Type C testing, the conservative assumption that all measured leakage is in a direction out of containment is applied, unless the test is performed by pressurizing between the isolation valves

  2. when performing Type C testing by pressurizing between the isolation valves, the conservative assumption that the two valves leak equally is applied, provided the valves are shut by normal operation without preliminary exercising or adjustment.

- CWE's request for exemption from Type C testing for instrument line manual isolation valves which meet the requirements of Regulatory Guide 1.11, Instrument Lines Penetrating Primary Reactor Containment, is acceptable and no exemption from Appendix J is required.

- CWE's proposal to test containment airlocks at 2 psig in lieu of 62 psig and to test once per cycle instead of every 6 months and after each opening is unacceptable. The minimum acceptable program should require testing of airlocks at 62 psig once each 6 months and at a reduced pressure within 72 hours of the first of a series of openings during the interim.

- CWE's proposal to test main steam isolation valves (MSIVs) at 25 psig by pressurizing between the valves is an acceptable exemption to the requirements of Appendix J due to the unique design of these valves.

- CWE's proposal to perform Type C testing of the traversing incore probe system valves by disconnecting the tubes at the fittings just inside the drywell is acceptable, and no exemption from the requirements of Appendix J is required.

- CWE's proposal to shut feedwater check valves using a hydraulic differential pressure of 50 psig prior to draining the lines for Type

C testing by normal means is acceptable and does not require an exemption from the requirements of Appendix J.

- CWE's proposal to perform a minimum 12-hour integrated primary containment leak rate test in lieu of the minimum 24-hour test required by ANSI N45.4-1972 is unacceptable, and the 24-hour test should continue to be conducted.

Franklin Research Center
A Division of The Franklin Institute

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