REQUEST FOR ADDITIONAL INFORMATION (RAI)

DRESDEN UNITS 2 AND 3

ASSESSMENT OF IMPACT ON ILRT RISK RESULTS DUE TO DEGRADED BELLOWS CONTAINMENT PENETRATION ASSEMBLIES

Prepared by: [signature] Date: 6/14/2004

Reviewed by: Lawrence Lee Date: 6/15/2004

Approved by: [signature] Date: 6/16/2004

Revisions:

Rev.	Description	Preparer/Date	Reviewer/Date	Approver/Date

TABLE OF CONTENTS

Request for Additional Information (RAI)

In response to the submission of the Dresden Risk Assessment to Support ILRT Interval Extension Request, the NRC requested additional information as follows:

1. *It is our understanding that many of the two-ply containment penetration bellows have been replaced at Dresden because of degradation, but that several potentially-degraded bellows remain in service. Leakage through these bellows was not considered in the risk assessment submitted in support of the license amendment request. In this regard, please provide the following information related to potential leakage through the bellows:*

    a. *The estimated probability of a leak to the environment via a degraded bellows, and the basis for this estimate. This should consider the number of degraded bellows that has been identified out of the total population of bellows (classified in terms of type and general location, if appropriate), the number of potentially degraded bellows that are still in service in each Unit, and the frequency and results of periodic local leak rate testing performed on the bellows.*

    b. *A characterization of the potential leak rate from the containment airspace to the environment for a degraded bellow (SIC), and the conditional probability that the leak would be classified as small versus large. This should consider the range of leak rates observed for degraded bellows and whether the leakage represents leakage through one or both plies of the bellows.*

    c. *An assessment of (or sensitivity case exploring) the impact on risk results if the potential for leakage via degraded bellows was included in the risk model.*

Response

1.0 PURPOSE

The NRC has submitted Requests for Additional Information (RAI) to support their review of the Exelon request for a one-time Dresden ILRT interval extension from 10 years to 15 years.

This assessment provides the response to NRC RAI #1a, 1b, and 1c of the Dresden ILRT submittal.

This assessment provides a sensitivity case exploring the quantitative impact on risk results of the Dresden ILRT interval extension risk assessment if degraded containment bellows and their potential leakage is more explicitly included in the risk analysis.

2.0 BACKGROUND

Quad Cities and Dresden Stations utilize two-ply stainless steel bellows for containment penetrations.

On November 19, 1990, during the Quad Cities, Unit 1, Cycle 11 Refueling Outage, a local leak rate test (LLRT) was performed on the Drywell Ventilation Penetration X-25 bellows. This was done using the normal methodology of pressurizing the small space between the two plies of the bellows assembly by using a test tap made for that purpose. The measured leakage rate was 4.3 standard cubic feet per hour (scfh). After the LLRT was performed, a significant amount of maintenance and new construction work was performed in the area surrounding the bellows assembly. After the completion of this maintenance and construction, a new LLRT was performed on the X-25 bellows, with a measured leakage rate of 6 scfh.

Approximately two days later, the primary containment integrated leak rate test (ILRT) was performed. While the containment was at pressure, application of a soap solution to the surface of the X-25 bellows indicated three cracks ranging in length from 0.187 inch to 1.7 inch, and a large number of small pin-hole cracks. The ILRT was successfully completed with the leaking bellows in its as-found condition. Following the ILRT, an additional LLRT was performed on the bellows, and the results matched the previous LLRT leakage rate. A soap solution was applied to the bellows assembly during this LLRT and showed only a few small leaks.

In order to evaluate the validity of the original LLRT, a "special" LLRT was performed. A steel plate was welded to the vent line inlet which is located inside the drywell. The bellows were pressurized through a threaded hole in the plate and a leak rate test was performed on the entire penetration. The soap solution indicated a large leak with many small leaks similar to that encountered during the ILRT. A leakage rate of 137 scfh was measured.

Based on these test experiences and further investigation, Exelon identified to the NRC that the two-ply bellows penetrations at Dresden and Quad Cities were determined to be effectively non-testable[1] to meet Type B testing requirements of Appendix J. The NRC granted an exemption from certain Type B testing requirements of 10 CFR 50, Appendix J, for the two-ply containment penetration expansion bellows at Dresden and Quad Cities. The exemption specified an alternative program of bellows testing and replacement that involves testing with air at a reduced leakage limit, testing any leaking bellows with helium (i.e., sniffer testing), replacing bellows that are unacceptable, and performing a Type A test each refueling outage until all of the bellows have been replaced with testable bellows. This testing program is intended to assure that at least one ply of a two-ply bellows is intact and that overall containment leakage is within its allowable limit as shown by Type A testing. (See NRC letter from B.A. Boyer to T.J. Kovach dated Feb. 6, 1992).

In 1995, as part of the movement to a 10 year ILRT frequency under 10CFR 50, Appendix J, Option B, Exelon identified alternative methods to provide Type B testing of the bellows if required because both plies indicated leakage. The NRC approved the proposed alternate testing methodology noting that the underlying purpose of the regulation will be met in that the proposed testing program will detect bellows assemblies with significant flaws and result in replacement of flawed assemblies within one operating cycle, or be tested with a Type B test to ensure license limits are met during which period there is reasonable assurance that the bellows assemblies will not suffer excessive degradation. (See letter from R.M. Pulsifer (NRC) to D.L. Farrar (ComEd) dated February 9, 1995.) Exelon indicated that the degradation failure modes appear to be transgranular stress corrosion cracking and that the new approved test procedure provides more than adequate indication of when these degradation mechanisms could result in containment leakage sufficient to be of interest.

[1] The forming process can bring the plies into contact, thereby limiting the flow of the local leak rate test medium (inert gas or air) between the inner and outer plies.

3.0 BELLOWS TEST DATA

There are 23 primary containment penetration bellows for each Dresden Unit (DR 2 and DR 3). Since the discovery of the two-ply bellows testing issue at Quad Cities in 1990, 15 bellows have been replaced at Dresden due to leakage degradation. Table 1 presents a chronology of bellows leakage identification and replacement for each Dresden Unit. It is noted that the majority of leaking bellows were identified in the first outage for each unit immediately following the discovery of the testability issue and the implementation of the helium sniff test. Most of these leaking bellows assemblies were replaced in either that first outage, or in the subsequent outage as allowed by the NRC exemption. Four bellows on Unit 2 (i.e., X-108A, X-116A, X-116B, and X-126) remained in use for additional outage cycles because the leakage was determined to be limited to one-ply.

It is specifically noted that since the initial identification of leaking bellows following the discovery of the testability issue in 1990, only two "new" leaking bellows have been identified for Dresden (i.e., Unit 2 X-124 in 1995, and Unit 3 X-107A in 2000). These two leaking bellows are judged to characterize the frequency of expected "new" bellows leakage in the future. The time period from D3R13 in 1994 to the present is judged to characterize the data pool for opportunities to detect "new" failures following the discovery of the testability issue.

Table 2 lists those Dresden bellows assemblies that are currently Non-Type-B-Testable and utilize the NRC approved alternate testing methodology, i.e., 14 on Unit 2 and 17 on Unit 3.

Table 3 lists those Dresden bellows which are currently Type-B-Testable (i.e., can utilize the standard type B test methodology) and are not considered part of the population to be examined for this RAI, i.e., nine (9) on Unit 2 and six (6) on Unit 3.

At this time, only one degraded bellows (Unit 3 X-107A) currently remains installed (as allowed) since the helium sniff test has shown that only one of the two plies exhibits leakage.

The test history of the recent bellows degradations are presented in Tables 4 and 5. Tables 4 and 5 summarize the characteristic pattern of degradation on the subject stainless steel bellows, i.e., progressive slow increase in leakage rate first through only one-ply and then eventually through both plies.

4.0 CALCULATIONAL APPROACH

The risk assessment provided as part of the Dresden license amendment request (RS-04-004 dated January 15, 2004) included an assessment of the probability that there may be a pre-existing failure in the containment. Leakage through the containment penetration Non-Type-B-Testable bellows assemblies has been found to be below the containment Technical Specification allowable leakage of 540 scfh[(1)]. The maximum observed case was 137 scfh from a Quad Cities modified test. Therefore, the previously submitted ILRT risk evaluation is considered to encompass the potential that a bellows assembly may degrade and leak.

The NRC approved local leak rate test method is considered adequate to identify incipient leaking bellows assemblies so that they will be replaced before the leakage becomes significant. Nevertheless, a sensitivity calculation is provided that ties the bellows assembly integrity to the ILRT frequency. This sensitivity case is developed to conservatively bound the bellows failure effects if it were also assumed that the ILRT frequency directly impacts the ability to identify leaking bellows assemblies for replacement.

The following steps outline the calculational approach taken:

Step 1

- Using data from these Dresden LLRTs following the NRC approved change to the LLRT procedure for non-Type-B-Testable bellows, characterize the frequency of degraded non-Type-B-testable bellows assemblies and the leakage rate. For sensitivity purposes, this assessed probability can be modified using the historical Dresden information on non-Type-B-Testable bellows assemblies to evaluate the impact on the risk metrics used in the risk assessment.

(1) For the currently authorized 1.6%/day Technical Specification leakage.

Step 2

- Compare the leak rate with the leakage and failure sizes used in the ILRT risk assessment and conservatively characterize the change to the appropriate pre-existing failure probabilities.

Step 3

- Recalculate all of the risk metrics assuming this conditional bellows failure probability applies to Dresden despite the latest approved LLRT.

5.0 CALCULATIONS

Step 1

Subsequent to the implementation of an adequate bellows test procedure, a number of non-Type-B-Testable assemblies were found in need of replacement. The current as-built, as-operated plant is best characterized by the data obtained after the initial residual leaking assemblies were identified and replaced.

Therefore, from the bellows data presented in Table 1, the following U2 and U3 refuelings represent the applicable data relevant to current and future bellows degradations, i.e., following initial identification of the bellows LLRT issue:

Unit	No. Refuelings Since Initial Leakages Identified	Number of Bellows Ass'y of Non-Type B Testable Construction	Total No. of Tests
U2	5 (D2R14-D2R18)	14	70
U3	5 (D3R13-D3R17)	17	85
Total No. Tests			**155**

During this time period considered characteristic of future plant operation, two "new" degradations were identified (i.e., Unit 2 X-124, Unit 3 X-107A). Although X-107A is currently only leaking through one-ply, it is conservatively regarded as a leakage failure for this sensitivity calculation. Based upon these two failures, the probability of a new bellows degradation in the future may be estimated as:

$$\frac{\text{2 failures}}{\text{155 LLRTs}} = \text{1.3E-2 failures/LLRT-Ass'y}$$

Given this data, the probability that a bellows assembly would leak given that a severe accident occurs can be estimated for each unit based on this probability and the number of Non-Type-B-Testable assemblies in each unit.

The following table represents the answer to RAI 1a.

Unit	Number of Bellows Ass'y of Non-Type B Testable Construction	Bellows Leakage Conditional Probability Given a Severe Accident
U2	14	0.18[1]
U3	17	0.22[1]

[1] Probability = (No. of Ass'y) * (1.3E-2/Ass'y)

Unit 3 is the most limiting (largest number of non-Type-B-Testable bellows assemblies) and is used for the assessment of risk impacts.

<u>Step 2</u>

The following provides the answer to RAI 1b.

Three allowed containment leakage rates (i.e., allowed Technical Specification leakage, La) are relevant to the Dresden ILRT risk assessment previously performed, as follows:

- La=1.6% was the Dresden approved Technical Specification leakage at the time of the ILRT risk assessment
- La=3.0% was the pending new Dresden Technical Specification leakage at the time of the IRLT risk assessment for Alternate Source Term.
- La=0.5% was the Technical Specification leakage utilized in the SAMA analysis which formed the basis for the Level 3 results used in the actual ILRT risk assessment base case.

The ILRT risk assessment included a sensitivity to demonstrate the minimal impact on ILRT risk of increasing La over the range from 0.5% to 3.0%.

The containment failure leakage characterization (i.e., intact, small and large) as utilized in the ILRT risk assessment is based on the NEI methodology and the allowed Technical Specification leakage. The following represents Technical Specification leakage as it would be applied to ILRT and LLRT results:

Category	NEI EPRI Category Description	Leakage Rate[1] scfh
1	Containment Intact (1.0 La) (No Containment Failure)	540
3a	Small Pre-Existing Failure (10 La)	5400
3b	Large Pre-Existing Failure (35 La)	18,900

[1] (La = 1.6% Cont. Air by wt/day)

In relationship to the ILRT allowed test leakage (540 scfh) and the small pre-existing failure size (5400 scfh) and large pre-existing failure size (18,900 scfh) used in the ILRT risk assessment, a realistic spectrum of hypothetical bellows "failures" represent the following fraction of each category:

Hypothetical Bellows Leakage[1] (scfh)	Fraction of Bellows Leakage "X"		
	"X" = ILRT Allowed	"X" = Small Leak	"X" = Large Leak
0.5	9E-4	9E-5	2.6E-5
50	.09	.009	.0026
150	.28	.028	.0079

[1] Although the observed bellows degradation leakage is typically quantified in the range of 0.5 to 5 scfh, it is recognized that "actual" leakage, as might be quantified by a "special" LLRT, could well be an order of magnitude greater or more as was experienced at Quad Cities where the original LLRT measured 6 scfh and the "special" LLRT measured 137 scfh. This recognition is factored into the assessment of the leakage rate for "leaking" assemblies by conservatively assigning these leakage failures to the Category 3a defined by EPRI. The lower threshold for Category 3a is greater than the observed leakage of 137 scfh. Thus, this classification is judged very conservative.

This comparison demonstrates that the leakage associated with a degraded bellows is small compared to that utilized in the ILRT risk assessment.

Based on industry data, the NEI methodology utilizes a "small" pre-existing failure probability of 2.7E-2. For the purpose of conducting a sensitivity case, it is judged conservative to count bellows degradation cases as small pre-existing leaks. For the sensitivity case, the bellows degradation probability calculated in Step 1 is considered characteristic of an ILRT test interval of 3 years and is added to the failure probability of the small pre-existing failure as follows.

<u>3 Year ILRT Interval</u>

Conditional Probability of Category 3a for 3-year ILRT interval:

2.7E-2 + 0.22 = 0.25

<u>10 Year ILRT Interval</u>

The 3 year ILRT interval Conditional Probability for Category 3a is modified depending on the ILRT interval. Consistent with the NEI methodology, this probability increases by a factor of 3.33 for the 10 year ILRT interval to be 0.833.

<u>15 Year ILRT Interval</u>

For the 15 year ILRT interval, the conditional probability would exceed 1.0 following the NEI guidance (i.e., increasing the 3 year probability by a factor of five). It is not considered physically meaningful and therefore a maximum conditional probability of 1.0 is used.

<u>Step 3</u>

This Step provides the answer to RAI 1c.

The sensitivity calculation of the Population Dose Rate can be performed using the same approach as used in the ILRT interval extension risk assessment with the following changes:

- The Category 3a conditional probability of occurrence for the 3 per 10 year ILRT case is modified from 2.7E-2 to 0.25 based on the conservative assumed impact of leaking bellows assemblies as derived in Step 2.

- This conditional probability is then increased as a function of increasing ILRT interval just as in the risk assessment submittal. However, the increase in conditional probability cannot exceed 1.0, therefore, for the 15 year interval the conditional probability of Category 3a is set to the maximum of 1.0.
- The large failure of containment is not impacted by the leakage failure modes and it is retained as in the base case calculations as shown in Step 2.

Three EPRI categories are affected by the proposed sensitivities and in turn affect the risk metric results:

EPRI Category	Assigned Max. Leak Rate (scfh)(2)	Conditional Probability		
		3 per 10 year ILRT	1 per 10 year ILRT	1 per 15 year ILRT
1	540	(1)	(1)	(1)
3a	5,400	0.25	0.833	1.0
3b	18,900	2.7E-3	9.0E-3	0.0135

(1) Assessed based on the residual frequency, recognizing that the sum of accident frequencies of 1, 3a, and 3b are constant and the determination of release mode only re-allocates the failure path among these three EPRI categories.

(2) For reference only to the case of allowed T.S. leakage of 1.6%/day.

From Section 3.1 of the "Risk Impact Assessment of Extending the Dresden ILRT Interval", the following calculations are performed:

<u>Frequency of EPRI Category 1</u>

This group consists of all core damage accident sequences in which the containment is initially isolated and remains intact throughout the accident (i.e., containment leakage at or below maximum allowable Technical Specification leakage). The ILRT methodology artificially divides this category among the Technical Specification leakage case (Category 1) and two other categories that are used to simulate possible changes due to reduced ILRT frequencies (i.e., Categories 3a and 3b; see below for their definition). Per NEI Interim Guidance, the frequency per year for this category is calculated by subtracting the frequencies of EPRI Categories 3a and 3b (see below) from the sum of all severe accident sequence frequencies in which the containment is initially isolated and remains intact (i.e., accident sequences classified as "OK" in the Dresden Level 2 PSA).

As discussed previously in Section 2.4, the frequency of the Dresden Level 2 PSA "OK" or "No Release" accident bin is 1.12E-6/yr.

Frequency of EPRI Category 3a

This group consists of all core damage accident sequences in which the containment is failed due to a pre-existing "small" leak in the containment structure that would be identifiable only from an ILRT (and thus affected by ILRT testing frequency). Consistent with NEI Interim Guidance [21], the frequency per year for this category is calculated as:

Frequency 3a = (3a conditional failure probability) x (CDF – CDF with independent LERF – CDF that cannot cause LERF)

The 3a conditional failure probability (0.25) value[(1)] is the conditional probability of having a pre-existing "small" containment leak that is detectable only by ILRTs. This value is also assumed reflective of ILRT testing frequencies of 3 tests in 10 years.

The pre-existing leakage probability is multiplied by the residual core damage frequency (CDF) determined as the total CDF minus the CDF for those individual sequences that either may already (independently) cause a LERF or could never cause a LERF due to the delay time of the release (i.e., non-early). The Dresden total core damage frequency is 1.89E-6/yr. Of this total CDF, the following core damage accidents involve either LERF directly (containment bypass) or will never result in LERF:

- Long Term Station Blackout (SBO) scenarios (Class IBL) = 1.08E-7/yr [18]
- Loss of Containment Heat Removal accidents (Class II): 8.15E-8/yr [18]
- Containment Bypass accidents (Class V): 1.74E-9/yr [18]

Therefore, for the 3-per-10-year ILRT sensitivity case including the bellows assemblies in Category 3a, the frequency of EPRI Category 3a is calculated as (0.25) x (1.89E-6/yr – 1.08E-7/yr – 8.15E-8/yr – 1.74E-9/yr) = 4.25E-7/yr.

(1) Modified for the sensitivity case to include conservative assumptions regarding the bellows assemblies.

Frequency of EPRI Category 3b

This group consists of all core damage accident sequences in which the containment is failed due to a pre-existing "large" leak in the containment structure that would be identifiable only from an ILRT. Because the bellows leakage is classified as a "small" pre-existing containment failure (a conservative assignment), which is a non-LERF contributor, there is no impact to the calculated change in LERF in this sensitivity analysis.

The results of the bellows sensitivity case for an assumed 0.5%/day T.S. leakage rate are presented in Table 6 (which may be compared with Table 4-1 of the Dresden ILRT risk assessment).

Table 7 repeats these calculations for as assumed 3.0%/day T.S. leakage rate.

A summary of comparative impacts is presented in Section 6.

6.0 SUMMARY

In summary, the sensitivity cases demonstrate a negligible impact on the ILRT risk results.

6.1 <u>Containment Technical Specification Leakage of 0.5%/day</u>

6.1.1 Reference Base Case Results

Table 8 provides the Base Case results for the 0.5% allowable Technical Specification leakage situation already submitted as part of the license amendment. The result is a 4.7E-3 person-rem/yr increase as the ILRT interval increases from 3 years to 15 years. This compares with a total of 10.3 person-rem/yr calculated dose rate. When this is compared with the total population dose rate of 10.3 person-rem/yr, it represents a negligible increase of 0.05%.

6.1.2 Sensitivity Case to Include Bellows Assemblies

Table 9 provides the sensitivity case impact on the dose rate when the bellows failures are assumed to be additive as considered equivalent to "small" leakages. The result shows that in going from a 3 year to a 15 year ILRT interval, the dose rate increase goes from 4.74E-3 person-rem/yr in the base case to 2.51E-2 when assuming failed bellows assemblies make an additive contribution to Category 3a. Again when this is compared with the total population dose rate of 10.3 person-rem/yr, it is judged negligible (0.2% change).

6.1.3 Comparison of Base Case and Sensitivity Case

The assessed change in population dose rate due to the addition of the assumed bellows assembly failures as leakage controlled failures (Category 3a) for an assumed 15 year ILRT interval increases from 4.77E-3 person-rem/yr for the base case (Table 8) to 3.53E-2 person-rem/yr for the sensitivity case (Table 9) assuming the bellows penetration failures are classified as “small” leaks. This changes the total population dose rate from all sources from 10.3 person-rem/yr to 10.4 person-rem/yr. This change is considered negligible (0.3% increase).

6.2 Containment Technical Specification Leakage of 3.0%/day

6.2.1 Reference Base Case Results

Table 10 provides the Base Case results for the 3.0% allowable Technical Specification leakage situation. The result is a 2.84E-2 person-rem/yr increase as the ILRT interval increases from 3 years to 15 years. This compares with a total of 10.4 person-rem/yr calculated dose rate. This change is considered negligible (0.27% increase).

6.2.2 Sensitivity Case to Include Bellows Assemblies

Table 11 provides the sensitivity case impact on the dose rate when the bellows failures are considered to be equivalent to “small” leakages. The result shows that in going from a 3 year to a 15 year ILRT interval, the dose rate increase goes from 2.84E-2 person-rem/yr in the base case to 0.149 person-rem/yr when assuming bellows assembly failures make an additive contribution to Category 3a. Again when this is compared with the total population dose rate of 10.4 person-rem/yr it is judged negligible (1.2% increase).

6.2.3 Comparison of Base Case and Sensitivity Case

The assessed change in population dose rate due to the addition of the assumed bellows assembly failures as leakage controlled failures (Category 3a) for an assumed 15 year ILRT interval increases from 2.86E-2 person-rem/yr for the base case (Table 10) to 0.211 person-rem/yr for the sensitivity case (Table 11) assuming the bellows penetration failures are classified as “small” leaks. This changes the total population dose rate from all sources from 10.4 person-rem/yr to 10.6 person-rem/yr. This change is considered negligible (1.8% increase).

7.0 CONCLUSION

Three risk measures are evaluated in the ILRT risk assessment:

- Change in Large Early Release Frequency (LERF) based on EPRI Category 3b ("large" pre-existing containment failure)
- Change in Conditional Containment Failure Probability (CCFP) based on EPRI Category 1 (containment intact with Technical Specification leakage) and EPRI Category 3a ("small" pre-existing containment failure)
- Change in Population dose rate

<u>LERF Impact</u>

Because the bellows leakage is classified as a "small" pre-existing containment failure (a conservative assignment) that is a non-LERF contributor, there is no impact to the calculated change in LERF in this sensitivity analysis. It is estimated that all bellows assemblies would need to be failed to produce sufficient leakage to be even close to the LERF threshold. The simultaneous failure probability of all Non-Type-B-Testable bellows assemblies is estimated at less than 1E-5.

<u>CCFP Impact</u>

Using the NEI calculational methodology, there is no change associated with the CCFP. Per the NEI methodology the frequency of EPRI Category 1 is defined as the PRA determined containment intact frequency minus the frequency of Categories 3a and 3b. The increase in the sensitivity case Category 3a frequency due to the increased probability of a small pre-existing bellows leakage failure requires a corresponding decrease in the Category 1 frequency to maintain the PRA containment intact frequency constant. Based on the NEI defined CCFP calculational approach, the 3a frequency increase is effectively canceled out by the corresponding Category 1 decrease such that there is no change to the CCFP.

Total Population Dose Rate Impact

The total dose rate changes are found to be negligible compared to the ILRT total dose rate of 10.3 person-rem/yr over the range of Technical Specification allowable leakages from 0.5% to 3.0%.

The sensitivity cases demonstrate that the potential adverse impact associated with continued operation with non-Type-B-Testable bellows assemblies at Dresden Station is negligible in the determination of risk associated with a one time extension of the ILRT interval to 15 years.

Table 1

DRESDEN BELLOWS LEAKAGE AND REPLACEMENT CHRONOLOGY[1]

Year	Outage	Unit 2 Bellows		Unit 3 Bellows	
		Leakage Identified[2]	Replacement	Leakage Identified[2]	Replacement
1992 (3)	D3R12	N/A	N/A	X-105A X-107B X-111A X-125 X-138 X-149B	X-105A X-107B
1993 (3)	D2R13	X-113 X-125 X-149A X-149B X-108A X-116A X-116B X-126	X-113 X-125 X-149A X-149B	N/A	N/A
1994	D3R13	N/A	N/A	(X-111A) (X-125) (X-138) (X-149B)	X-111A X-125 X-138 X-149B
1995	D2R14	(X-108A) (X-116A) (X-126) (X-116B) X-124	X-108A X-116A X-126	N/A	N/A
1997	D3R14	N/A	N/A	None	None
1998	D2R15	(X-116B) (X-124)	None	N/A	N/A
1999	D3R15 D2R16	(X-116B) (X-124)	None	None	None
2000	D3R16	N/A	N/A	X-107A	None
2001	D2R17	(X-116B) (X-124)	X-116B X-124	N/A	N/A
2002	D3R17	N/A	N/A	(X-107A)	None
2003	D2R18	None	None	N/A	N/A
Total		9	9	7	6

Notes to Table 1:

(1) Only "non-type-B-testable" bellows are included, beginning with the first refueling outage after identification of the bellows testing issue by ComEd, i.e., 1990.

(2) Leakage identified refers to exceeding the quantitative leakage criteria and failure of at least one-ply determined by the helium sniff test. If only one-ply is determined leaking, the bellows are acceptable for continued use. Failure of both plies requires replacement at the next refueling outage. Bellows in parentheses indicates leakage through one or both plies was initially identified in a previous outage.

(3) The shaded years of 1992 and 1993 represent the cumulative state of the bellows assemblies for DR 2 and 3 having operated with less than effective testing on bellows penetration assemblies for many years. These shaded rows provide a list of leaking assemblies which are characteristic of the out of date plant testing program which has been subsequently improved and is approved by the NRC.

Table 2

NON-TYPE-B-TESTABLE
PRIMARY CONTAINMENT PENETRATION EXPANSION BELLOWS
FOR UNITS 2 AND 3

System	Penetration No.	
	Unit 2	Unit 3
Main Steam Line	X-105A	N/A
Main Steam Line	X-105B	X-105B
Main Steam Line	X-105C	X-105C
Main Steam Line	X-150D	X-150D
Main Steam Line	X-106	X-106
Feedwater	X-107A	X-107A
Feedwater	X-107B	N/A
Isolation Condenser Steam Supply	N/A	X-108A
Isolation Condenser Cond Return	X-109B	X-109A
Shutdown Cooling	X-111A	N/A
Shutdown Cooling	X-111B	X-111B
Cleanup	N/A	X-113
HPCI Steam Supply	X-115A	X-128
LPCI Injection	N/A	X-116A
LPCI Injection	N/A	X-116B
RBCCW Inlet	X-123	X-123
RBCCW Outlet	N/A	X-124
Vent to Drywell	N/A	X-126
Standby Liquid Control	X-130	N/A
CRD Return	Bellows (X-144) sealed during D2R13	Bellows (X-144) sealed during RPR outage
Reactor Head Spray	X-147	X-147
Core Spray	N/A	X-149A
Total Non-Type-B-Testable Bellows Assemblies	14	17

Table 3

TYPE-B-TESTABLE
PRIMARY CONTAINMENT PENETRATION EXPANSION BELLOWS
FOR UNITS 2 AND 3

System	Penetration No.	
	Unit 2	Unit 3
Main Steam Line	N/A	X-105A
Feedwater	N/A	X-107B
Isolation Condenser Steam Supply	X-108A	N/A
Shutdown Cooling	N/A	X-111A
Cleanup	X-113	N/A
LPCI Injection	X-116A	N/A
LPCI Injection	X-116B	N/A
RBWCC Outlet	X-124	N/A
Vent from Drywell	X-125	X-125
Vent to Drywell	X-126	N/A
Standby Liquid Control	N/A	X-138
Core Spray	X-149A	N/A
Core Spray	X-149B	X-149B
Total Type-B-Testable Bellows Assemblies	9	6

Table 4

UNIT 2 RECENT DEGRADED BELLOWS LEAKAGE

Bellows Pen.	Outage	Year	As Found Leakage (scfh)	Acceptance Criteria (scfh)
2-X-124	D2R10	1986/87	0	N/A[1]
2-X-124	D2R11	1988/89	0.3	N/A[1]
2-X-124	D2R12	1990	0.4	N/A[1]
2-X-124	D2R13	1993	0.39	0.5
2-X-124	D2R14	1995	1.62[3]	0.5
2-X-124	D2R15	1998	1.61[3]	0.5
2-X-124	D2R16	1999	1.97[4]	0.5
2-X-124	D2R17	2001	1.97 / .004[2]	0.5 / 5[2]
2-X-124	D2R18	2003	0.01[2]	5[2]

(1) Prior to recognition of testability issue.

(2) During D2R17 bellows X-124 was removed and replaced with testable bellows. Acceptance criteria for testable bellows is 5 scfh.

(3) Helium detected through one-ply only. Acceptable for continued use.

(4) Helium detected through both plies. Replacement required next cycle.

Table 5

UNIT 3 RECENT DEGRADED BELLOWS LEAKAGE

Bellows Pen.	Outage	Year	As Found Leakage (scfh)	Acceptance Criteria (scfh)
3-X-107A	D3R14	1997	0.0	0.5
3-X-107A	D3R15	1999	0.054	0.5
3-X-107A	D3R16	2000	2.10[1]	0.5
3-X-107A	D3R17	2002	1.78[1]	0.5

(1) Helium detected through one-ply only. Acceptable for continued use.

Table 6

QUANTITATIVE RESULTS AS A FUNCTION OF ILRT INTERVAL – BELLOWS SENSITIVITY
(0.5%/day T.S. Leak Rate)

EPRI Category	Dose (Person-Rem Within 50 miles)	Quantitative Results as a Function of ILRT Frequency					
		Baseline (3-per-10 year ILRT)		Current (1-per-10 year ILRT)		Proposed (1-per-15 year ILRT)	
		Accident Frequency (per year)	Population Dose Rate (Person-Rem/Year Within 50 miles)	Accident Frequency (per year)	Population Dose Rate (Person-Rem/Year Within 50 miles)	Accident Frequency (per year)	Population Dose Rate (Person-Rem/Year Within 50 miles)
1	2.08E+3	6.90E-7	1.44E-3	-3.15E-7(4)	-6.55E-4(4)	-6.02E-7(4)	-1.25E-3(4)
2	2.22E+7	4.67E-9	1.04E-1	4.67E-9	1.04E-1	4.67E-9	1.04E-1
3a	2.08E+4	4.25E-7	8.84E-3	1.42E-6	2.95E-2	1.70E-6(5)	3.53E-2
3b	7.28E+4	4.59E-9	3.34E-4	1.53E-8	1.11E-3	2.29E-8	1.67E-3
4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	1.33E+7	7.65E-7	1.02E+1	7.65E-7	1.02E+1	7.65E-7	1.02E+1
8	2.79E+7	1.74E-9	4.85E-2	1.74E-9	4.85E-2	1.74E-9	4.85E-2
TOTALS:		1.89E-6	10.36	1.89E-6(4)	10.38	1.89E-6(4)	10.39
Increase in Dose Rate (1)					0.02		0.01
Increase in LERF (2)				1.07E-8		7.65E-9	
Increase in CCFP (%) (3)				0.6%		0.4%	

Notes to Table 6:

(1) The increase in dose rate (person-rem/year) is with respect to the results for the preceding ILRT interval, as presented in the table. For example, the increase in dose rate for the proposed 15-year ILRT is calculated as: total dose rate for 15-year ILRT, minus total dose rate for 10-year ILRT. For each case, the dose rate increase is insignificant.

(2) The increase in Large Early Release Frequency (LERF) is with respect to the results for the preceding ILRT interval, as presented in the table. As discussed in Section 3.4.4 of the report, the change in LERF is determined by the change in the accident frequency of EPRI Category 3b.

(3) The conditional containment failure probability (CCFP) is calculated as:

$$CCFP = [1 - ((\text{Category \#1 Frequency} + \text{Category \#3a Frequency}) / CDF)] \times 100\%$$

(4) The total core damage frequency (CDF) does not change as a result of the ILRT interval change. Therefore, the sum of accident frequencies of Categories 1, 3a, and 3b are constant per the NEI methodology. Category 3b is not impacted by this sensitivity. The Category 1 frequency and population dose takes on negative values for very high Category 3a assumed probabilities based on the NEI methodology. This represents an artifice of the NEI methodology which is acceptable because:

- the total CDF is preserved
- the total release severity increases by transferring releases to the more severe Category of 3a

(See the discussion under Section 5, Step 3 for Category 1 calculational method.)

(5) The accident sequence frequency for Category 3a is limited to the use of a conditional probability for 3a of 1.0 when the conditional probability calculated using the NEI formalism would increase above 1.0.

Table 7

QUANTITATIVE RESULTS AS A FUNCTION OF ILRT INTERVAL – BELLOWS SENSITIVITY
(3.0%/day T.S. Leak Rate)

EPRI Category	Dose (Person-Rem Within 50 miles)	Quantitative Results as a Function of ILRT Frequency					
		Baseline (3-per-10 year ILRT)		Current (1-per-10 year ILRT)		Proposed (1-per-15 year ILRT)	
		Accident Frequency (per year)	Population Dose Rate (Person-Rem/Year Within 50 miles)	Accident Frequency (per year)	Population Dose Rate (Person-Rem/Year Within 50 miles)	Accident Frequency (per year)	Population Dose Rate (Person-Rem/Year Within 50 miles)
1	1.24E+4(5)	6.90E-7	8.55E-3	-3.15E-7(4)	-3.91E-3	-6.02E-7(4)	-7.46E-3
2	2.22E+7	4.67E-9	1.04E-1	4.67E-9	1.04E-1	4.67E-9	1.04E-1
3a	1.24E+5(5)	4.25E-7	5.27E-2	1.42E-6	1.76E-1	1.70E-6(6)	2.11E-1
3b	4.37E+5(5)	4.59E-9	2.00E-3	1.53E-8	6.69E-3	2.29E-8	1.00E-2
4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	1.33E+7	7.65E-7	1.02E+1	7.65E-7	1.02E+1	7.65E-7	1.02E+1
8	2.79E+7	1.74E-9	4.85E-2	1.74E-9	4.85E-2	1.74E-9	4.85E-2
TOTALS:		1.89E-6	10.42	1.89E-6(4)	10.53	1.89E-6(4)	10.57
Increase in Dose Rate (1)					0.11		0.04
Increase in LERF (2)				1.07E-8		7.65E-9	
Increase in CCFP (%) (3)				0.6%		0.4%	

Notes to Table 7:

(1) The increase in dose rate (person-rem/year) is with respect to the results for the preceding ILRT interval, as presented in the table. For example, the increase in dose rate for the proposed 15-year ILRT is calculated as: total dose rate for 15-year ILRT, minus total dose rate for 10-year ILRT. For each case, the dose rate increase is insignificant.

(2) The increase in Large Early Release Frequency (LERF) is with respect to the results for the preceding ILRT interval, as presented in the table. As discussed in Section 3.4.4 of the report, the change in LERF is determined by the change in the accident frequency of EPRI Category 3b.

(3) The conditional containment failure probability (CCFP) is calculated as:

CCFP = [1 – ((Category #1 Frequency + Category #3a Frequency) / CDF)] x 100%

(4) The total core damage frequency (CDF) does not change as a result of the ILRT interval change. Therefore, the sum of accident frequencies of Categories 1, 3a, and 3b are constant per the NEI methodology. Category 3b is not impacted by this sensitivity. The Category 1 frequency and population dose takes on negative values for very high Category 3a assumed probabilities based on the NEI methodology. This represents an artifice of the NEI methodology which is acceptable because:

- the total CDF is preserved
- the total release severity increases by transferring releases to the more severe Category of 3a

(See the discussion under Section 5, Step 3 for Category 1 calculational method.)

(5) Dose values increased by a factor of six (6) to account for increase of allowed Technical Specification leakage from 0.5% to 3.0%.

(6) The accident sequence frequency for Category 3a is limited to the use of a conditional probability for 3a of 1.0 when the conditional probability calculated using the NEI formalism would increase above 1.0.

Table 8

BASE CASE
POPULATION DOSE RATE FOR 0.5%/DAY T.S. LEAKAGE RATE

Category	Base Case ILRT Interval		
	15 year (Person-rem/yr)	3 year (Person-rem/yr)	Δ (Person-rem/yr)
1	1.80E-3	2.22E-3	-4.20E-4[1]
3a	4.77E-3	9.54E-4	3.82E-3
3b	1.67E-3	3.34E-4	1.34E-3
Total Change			4.74E-3

(1) As explained in Footnote (4) of Tables 6 and 7, this represents an artifice of the NEI methodology which is acceptable because:

- the total CDF is preserved
- the total release severity increases by transferring releases to the more severe Category of 3a

(See the discussion under Section 5, Step 3 for Category 1 calculational method.)

Table 9

BELLOWS ASSEMBLY SENSITIVITY CASE
POPULATION DOSE RATE FOR 0.5%/DAY T.S. LEAKAGE RATE

Category	Bellows Case ILRT Interval 15 year (Person-rem/yr)	3 year (Person-rem/yr)	Δ (Person-rem/yr)
1	-1.25E-3[1]	1.44E-3	-2.69E-3[1]
3a	3.53E-2	8.84E-3	2.64E-2
3b	1.67E-3	3.34E-4	1.34E-3
Total Change			2.51E-2

[1] As explained in Footnote (4) of Tables 6 and 7, this represents an artifice of the NEI methodology which is acceptable because:

- the total CDF is preserved
- the total release severity increases by transferring releases to the more severe Category of 3a

(See the discussion under Section 5, Step 3 for Category 1 calculational method.)

Table 10

BASE CASE
POPULATION DOSE RATE FOR 3.0%/DAY T.S. LEAKAGE RATE

Category	Base Case ILRT Interval		
	15 year (Person-rem/yr)	3 year (Person-rem/yr)	Δ (Person-rem/yr)
1	1.08E-2	1.33E-2	-2.5E-3[(1)]
3a	2.86E-2	5.69E-3	2.29E-2
3b	1.00E-2	2.00E-3	8.00E-3
Total Change			2.84E-2

[(1)] As explained in Footnote (4) of Tables 6 and 7, this represents an artifice of the NEI methodology which is acceptable because:

- the total CDF is preserved
- the total release severity increases by transferring releases to the more severe Category of 3a

(See the discussion under Section 5, Step 3 for Category 1 calculational method.)

Table 11

SENSITIVITY CASE FOR BELLOWS ASSEMBLIES
POPULATION DOSE RATE FOR 3.0%/DAY T.S. LEAKAGE RATE

Category	Bellows Case ILRT Interval 15 year (Person-rem/yr)	3 year (Person-rem/yr)	Δ (Person-rem/yr)
1	-7.46E-3[1]	8.55E-3	-1.60E-2[1]
3a	0.211	5.27E-2	0.158
3b	1.00E-2	2.00E-3	8.00E-3
Total Change			0.149

[1] As explained in Footnote (4) of Tables 6 and 7, this represents an artifice of the NEI methodology which is acceptable because:

- the total CDF is preserved
- the total release severity increases by transferring releases to the more severe Category of 3a

(See the discussion under Section 5, Step 3 for Category 1 calculational method.)