Integrated Leak Rate Testing Interval Optimization Risk Impact Assessment Considerations

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NEI & EPRI

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Agenda

- Background
- Current Status
- Project Direction
  - Risk Impact Assessment and Expert Panel Function
  - Expert Panel Composition, Deliverables, and Schedule
  - Project schedule
- Discussion, conclusions, action items

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ATTACHMENT 2

Background

- Last July, NEI/EPRI met with NRC and discussed plans to revise NEI 94-01 to provide for Type A ILRT to be performed at least once per twenty years based on acceptable performance history.
- The revision to NEI 94-01 was to be based on a revised EPRI risk impact assessment and updated industry ILRT experience.
- After the July meeting, the following were added to the project:
  - A methodology responsive to RG 1.174
  - Promulgation of interim (standard) guidance for performing plant specific risk impact assessments in support of one-time ILRT interval extensions

Current Status

- NEI survey of ILRT failures and containment degradation events since 1995 is complete. 58 plants (91 units) responded.
- A draft database of ILRT failures and significant containment degradation events has been developed.
- "Interim Guidance for Performing (plant-specific) Risk Impact Assessments in Support of One-Time Extensions for Containment Integrated Leakage Rate Test Intervals" was promulgated in November 2001.
- A revision to the EPRI risk impact assessment (EPRI TR-104285) is being developed to generically assess the risk impact of optimized ILRT intervals.

Direction

- The risk impact assessment will use population dose risk metrics as well as those referred to in RG 1.174 (LERF, defense in depth).
- The risk impact assessment will utilize the basic methodology as contained in the interim guidance.
  - A bounding approach was previously taken in respect to assessing risk increase as a function of ILRT interval.
    - Conservatisms introduced regarding ILRT "failure" frequency and consequences (ΔLERF) result in some impacts in the "small" range of RG 1.174.
  - It is appropriate to reduce the level of conservatism or bounding in the methodology.

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Direction, continued

- Draft EPRI/DS&S Paper "ILRT Type A Test Interval Optimization Methodology Problem Statement" describes the situation in detail, and suggests that the expert elicitation process be used to develop a more informed basis for the determination of the frequency and size of a significant containment leakage path.
  - *Examination of ILRT "failure" and containment degradation data indicates that there are very few events not identifiable by other means (e.g., local testing, inspection), and that the leakage is small, ~<2La.*

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Expert Panel Function

- The goal of the expert elicitation process is to obtain frequency and magnitude estimates for significant containment degradation and leakage events that would not be detected by inspections, tests, or alternative means to conducting ILRTs.
- The expert panel would be asked to:
  - Provide an estimate of the probability of a significant containment leakage event as a function of the magnitude of the leak for 3 points.
- This information would then be used in the existing methodology determination of LERF and population dose.

Expert Panel Function, continued

- In estimating the frequency and magnitude of significant containment leakage or degradation events, the expert panel should consider all of the following:
  - ILRT "failure" and significant containment degradation data
  - Containment failure and/or degradation modes
  - Impact of inspections
  - Impact of low pressure monitoring
  - Impact of aging effects

Expert Panel

- The process is described in draft EPRI/DS&S paper "ILRT Type A Test Interval Optimization Methodology Expert Elicitation Process".
- The process will be consistent with appropriate regulatory guidance (NUREG/CR 6372, Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts; and NUREG-1563, Branch Technical Position on the Use of Expert Elicitation in the High Level Radioactive Waste Program)

Expert Panel, continued

- The paper describes five functional requirements for the expert elicitation process:
  1. Identification of the expert judgment process
  2. Identification and selection of experts
  3. Determination of need for expert judgment
  4. Utilization of the Technical Integrator or Technical Facilitator/Integrator
  5. Responsibility for the expert judgment

Expert Panel, continued

- The process selected is a Degree of Importance II and a Level of Complexity C.
- Expert panelists will have expertise in one or more of the following: Performing ILRTs and/or interpreting/ characterizing ILRT test results; Statistics / Probability Theory / Probabilistic Risk Assessment; Failure mechanics
- The technical integrator facilitates the expert panel meeting.
- The panelists provide individual judgments consistent with the problem statement. The judgments are integrated into a community distribution for panel consensus. The final community distribution becomes a statement of the panel results.

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Schedule

- Following is a milestone schedule for this project:

Item	Date
Conduct Expert Panel Meeting	June (EPRI Charlotte)
Complete draft revised Risk Impact Assessment (dRIA)	July
Share dRIA with NRC	August
Convene NEI Task Force to revise NEI 94-01	September
Complete draft revised NEI 94-01	October
Discuss NEI 94-01-01 with NRC	November

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Discussion, Conclusions, and Action Items

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NEIILRT5/08.13

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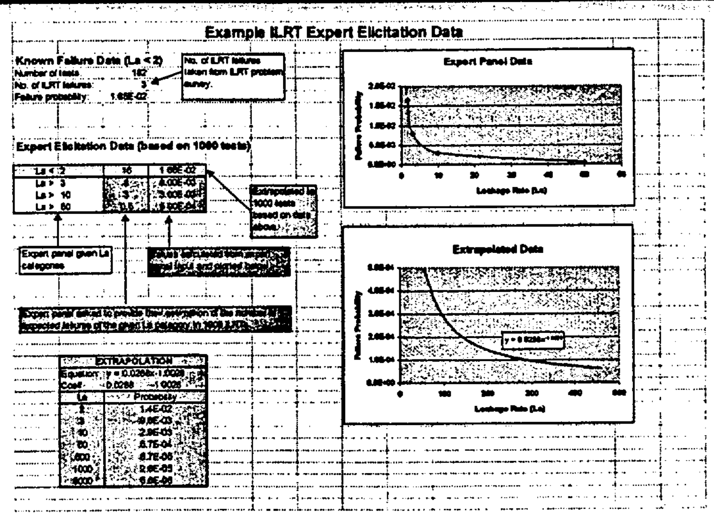
Example



NEIILRT5/08.14

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Example

Example ILRT Expert Elicitation Data

Known Failure Data (La < 2)

Number of tests:	182
No. of ILRT failures:	3
Failure probability:	1.65E-02

No. of ILRT failures taken from ILRT problem survey.

Expert Elicitation Data (based on 1000 tests)

La < 2	16	1.65E-02
La > 3	8	8.00E-03
La > 10	3	3.00E-03
La > 50	0.5	5.00E-04

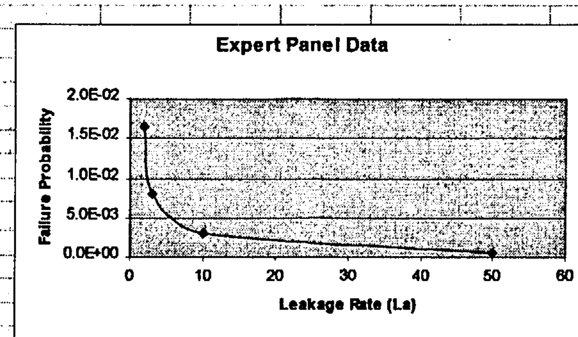
Extrapolated to 1000 tests based on data above.

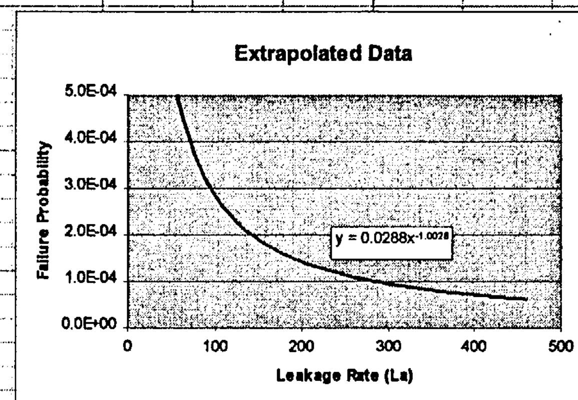
Expert panel given La categories

Values calculated from expert panel input and plotted below

Expert panel asked to provide their estimation of the number of expected failures of the given La category in 1000 ILRTs

EXTRAPOLATION	
Equation:	y = 0.0288x-1.0028
Coeff.	0.0288 -1.0028
La	**Probability**
2	1.4E-02
3	9.6E-03
10	2.9E-03
50	5.7E-04
500	5.7E-05
1000	2.8E-05
5000	5.6E-06





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DRAFT

ILRT Type A Test Interval Optimization Methodology Problem Statement

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1.0 INTRODUCTION

NEI has initiated a project to revise the industry guidance and associated requirements for containment integrated leakage rate testing (ILRT). Based on performance history, risk insights, and other containment testing and inspections, it is believed that the required ILRT Type A testing interval, presently minimum of one test in ten years, can be optimized to one test in up to twenty years.

This project builds on the previous work performed in EPRI TR-104285, Risk Impact Assessment of Revised Containment Leak Rate Testing Intervals [1] and NUREG-1493, Performance-Based Leakage Test Program [2]. In fact, NUREG-1493 states, *"Reducing the frequency of Type A tests (ILRTs) from the current three per 10 years to one per 20 years was found to lead to imperceptible increase in risk"*. Since the publication of NUREG-1493 additional containment inspections are now performed at all nuclear power plants (i.e., IWE and IWL) and historical ILRT performance has been good. Using new methods and the additional more recent data, this project will demonstrate that this conclusion remains valid.

ATTACHMENT 3

2.0 BACKGROUND

A revision to the NEI Guidance (NEI 94-01) permitting an optimized ILRT Type A testing interval of up to once per twenty years is planned. The revision will be based on a risk impact assessment that will be documented in a revision to EPRI TR-104285, Risk Impact Assessment of Revised Containment Leak Rate Testing Intervals [1]. The risk impact assessment will generically assess the risk impact of the up to once per twenty-year testing interval and consider industry experience and appropriate regulatory guidance (RG 1.174) [4].

This document focuses on a "problem statement" that illustrates the need for, and the role of, the expert elicitation in process of developing the risk impact assessment of the revised containment leak rate testing intervals. Additional details on the expert elicitation process are contained in the "ILRT Type A Test Interval Optimization Methodology - Expert Elicitation Process".

3.0 FRAMEWORK

Risk is defined as the product of probability and consequence, where probability is the periodic occurrence of an undesired event and the consequence is defined as the magnitude of the undesired event.

RISK = PROBABILITY x CONSEQUENCE

In the case of the risk associated with the revised ILRT testing interval, the probability is defined as the probability of a significant containment leakage event that would not be detected by alternative means such as a local leak rate test or other inspection. Note that containment leakage or degradation detectable by alternative means does not impact the risk associated with revising the ILRT interval.

The consequence is defined as the increase, or delta, large early release frequency (LERF). The large early release frequency figure of merit is one traditional figure of merit in risk informed applications [4]. In the case of the risk impact assessment of the revised ILRT testing interval, the delta LERF is determined by multiplying the core damage frequency (CDF) by the change in the probability of a significant containment leakage event that would not be detected by means other than an ILRT.

An additional figure of merit, the increase, or delta, population dose is also developed. The delta population dose is calculated by multiplying the base population dose by the change in the probability of a significant containment leakage event for the affected core damage frequency endstates.

RISK	=	Probability	x	Consequence
Δ LERF	=	Δ ILRT Failure [1] Probability	x	CDF
Δ Population Dose	=	Δ ILRT Failure [1] Probability	x	Population Dose

In the previous "one time" ILRT extension submittals [3] [6], and as a matter of course in most risk informed applications, a bounding approach was taken. This

1 The term "ILRT failure" is used in this report. The reader is reminded that "ILRT failure" is not a failure of the ILRT test to measure the containment leakage. Rather, the term "ILRT failure" is used to describe those ILRT tests in which containment leakage was identified above the acceptance criteria that would not be detected by a local leak rate test, containment inspections, or other alternate means.

bounding approach utilized very conservative assumptions with respect to assessing the risk increase as a function of a revised ILRT testing interval. These assumptions include conservatisms associated with the determination of the ILRT failure probability as well as conservatisms associated with the determination of the consequences (delta population dose and delta LERF):

- **Data Applicability.** Data used to estimate the initial probability of ILRT failure is conservatively classified. Containment leakage events, that would not significantly affect population dose and/or LERF calculations are included in the estimation of the ILRT failure probability. For example, events such as steam generator manway leakage are included in the estimation of ILRT failure probability. Steam generator manway leakage would be discovered during reactor startup or during normal operation.

- **No Alternate Means of Detection.** The probability of alternate means of detection such as local leak rate tests, inspections or other means is not always considered.

- **Estimation of Population Dose.** Low containment leakage rates (i.e., low La values) with higher probabilities of occurrence are used to represent a large early release.

Despite the very conservative assumptions above, the submittals to date have been able to demonstrate that the revised ILRT testing interval has little impact on risk. That is, the risk or the delta population dose and delta LERF are small.

In the case of delta LERF, Regulatory Guide 1.174 describes changes to the licensing basis with a delta LERF impact below 1E-7 as "very small." Such changes are generally acceptable. Proposed delta LERF impacts between 1E-6 and 1E-7 per year are described as "small" changes, and are acceptable, but result in increased NRC management and technical attention, including consideration of the plant's baseline LERF.

When applying the existing methods to the all plants, particularly those with higher CDF values, it is possible that a fraction of the calculated delta LERF values will fall into the "small" change region and therefore result in increased NRC management and technical attention. The increased NRC management and technical attention, when based on a conservative conclusion, is not an optimum use of either the NRC's or utility resources. By considering and reducing the conservatisms in the current methods most, if not all, calculated delta LERF values will be in the "very small" change region thereby optimizing resources associated with the ILRT testing as well as NRC and utility management and technical resources.

4.0 EXPERT ELICITION INPUT

In order to obtain more realistic values for delta LERF, the conservatisms in the current methodology and presented in Section 3 must be addressed. The report-sub-sections consider the conservative assumptions individually.

4.1 Data Applicability

Based on NEI utility surveys [8][9], data has been collected for 182 ILRT Type A tests that have been performed in the nuclear industry. Based on this data, the number of significant containment leakage events, found during the performance of these tests is very small. In fact, no large failures that would produce a large early release (LERF) have been found. As such, the testing data alone does not, without expert opinion, support the development of realistic values for the probability of a significant containment leakage event.

Consider the significant containment leakage or degradation event data contained in Attachment 1. This attachment is a compilation of data from two NEI utility surveys, NUREG-1493, and other events discovered in reviewing other industry data (LER's, reportable events, etc.). The first survey was performed in early 1994 [8] and represented the NEI (known as NUMARC at that time) input used in NUREG-1493. In this survey, the data from 144 ILRT Type A tests was collected. The second survey was performed in the fall of 2001 [9]. In the second survey, data was collected from 58 plants (91 units), reporting 38 ILRT Type A tests performed. The combined surveys do not represent all ILRTs performed. In the initial survey, utilities were chosen that represented a broad spectrum of reactor designs and was considered a representative sample of industry ILRTs performed. The response to the most recent survey was significant (91 nuclear units responded) and the data is considered a representative set of ILRT Type A test experience. Lastly, the data collected by the surveys is supplemented by additional literature searches including LERs and reportable events.

The data was then sorted by those events that resulted in excessive leakage when compared with the established acceptance criteria. This includes all causes that resulted in ILRT tests exceeding the acceptance criteria including those that are a result of local leak rate test penalties. A total of 70 significant leakage or degraded liner events are included in Attachment 1. The details associated with these 70 events are provided in the attachment.

From a review of the data in Attachment 1 and knowledge of the number of tests performed, a failure rate can be determined. In order to determine a failure rate, the number of failed events are divided by the number of demands, or in this case the number of ILRTs performed. Some previous submittals have conservatively assumed (based on reference 1) that three (3) failures have occurred (based on the 1994 NUMARC survey). However, based on a more comprehensive review of the data, no significant containment leakage events (where an increase in the ILRT surveillance interval would have increased the time the leak pathway was not detected) have been discovered. (Events that were initially counted as significant leakage events were due to steam generator manway leakage or other leakage events for which an alternate means of detection exists.) Therefore, there are zero (0) significant containment leakage events. Based on the data obtained by NUMARC and NEI surveys [8] [9] only, 182 ILRTs have been performed.

With zero (0) failed events a variety of statistical methods are available to estimate a failure rate. Each method assumes a number of failed events to obtain a failure rate. The number of assumed failed events varies by the statistical method as illustrated in the table below. The comments section of the table provides the basis for the use of the statistical method.

Statistical Method	Assumed No. of failures	No. of Demands	ILRT "Failure" Probability	Comments
Chebychev	1	182	5.5E-3	Upper bound estimate
Jeffery's Non-Informative Prior	0.5	182	2.7E-3	Based on no physical or engineering information available
Typical range	0.3	182	1.6E-3	Typical range of values for a non-informative basis
	0.1	182	5.0E-4	

As can be seen from the table above the resulting ILRT failure probabilities vary widely depending on the statistical method employed. The statistical method is in turn dependent on the uses of the final information (i.e. upper bound estimate) or assumptions concerning the amount of physical or engineering information concerning failure rates or failure modes and causes. Choosing the statistical method and resulting significant containment leakage event probability is therefore a matter for expert elicitation.

4.2 No Alternate Means of Detection

Various alternative methods of detecting a significant leakage pathway ("ILRT failure") in containment exist. These methods include local leak rate tests (LLRT), reactor startup, normal operation and other containment and piping inspections. Since the publication of NUREG-1493, additional containment inspections are now performed at all nuclear plants (i.e., IWE and IWL). In addition, during normal reactor startup and during normal power operation is it fairly routine, for most containment designs, to either vent the overpressure that has built up or to provide nitrogen makeup (for inerted containment designs). Significant changes in the venting or makeup rate during normal operation may provide an indication of the existence of a leakage pathway. These factors, as well as others, provide additional means of detection of significant containment leakage pathways. Expert opinion will assist in the determination of the appropriate alternative means ILRT failure detection as well as the probability of detection over an increased ILRT interval.

4.3 Estimation of Population Dose

ILRT extension submittals have used an estimated leakage rate as a result of an assumed large ILRT failure of 35 La. The leakage value of 35 La is then assumed to represent the leakage rate associated with a large early release as calculated in the Level 2 probabilistic risk assessment (PRA). However, the definition of LERF is generally given as the exchange of a single containment volume before the effective implementation of the offsite emergency response and public protective actions [7]. In turn, public protective actions, are generally assumed to be taken approximately 2 to 4 hours following a core damage event. The exchange of a single containment volume within a 4 hour period corresponds to a leakage rate of 600% per day or 600 – 6000 times La assuming that the ILRT acceptance criteria for the plant in question is between 1% and 0.1% per day.

From an examination of the events in Attachment 1, one event (No. 35) discovered during performance of an ILRT, with a stated leak rate, was greater than 2 La (15.3La). There were several events reported with leakage rates greater 2 La, with a maximum of ~21 La. However, with the single exception, all these events were identified by local leak rate tests. In any event, it does not appear that extension of the ILRT interval would increase the time that a leak path was not detected, as the single exception should have been identified by local leak rate testing[2] and has not repeated. Two ILRTs have been conducted at the plant since the event. With no increase in the non-detection time, there would be no increase in risk attributable to ILRT extension.

Three events were identified which could have been detected only by conducting an ILRT (Nos. 1, 45, and 57). However, these events had leakage rates less than 2 La or did not have state leakage rates. One involved two holes drilled in a liner (no stated leakage rate), one was a construction deficiency where pipes were not capped (0.9 La), and the third involved the ejection of a radiation monitor during an ILRT (1.3 La). None of the three events have repeated and the maximum measured leakage rate was less than 1.3 La.

In summary, from a detailed review of the available data, there have been no events that could have resulted in a large early release as currently defined.

[2] Section 9.1.1 of NEI 94-01 discusses the performance criteria for establishing Type A test intervals and states that if leakage cannot be determined by local leak rate testing, the performance criteria are not met. I.e., if an ILRT fails due to excessive local penetration leakage after a local test of the penetration, then the performance criteria for extending the ILRT intervals have not been met.

4.4 Expert Elicitation Example

As stated in Section 3, the generic application of the existing statistical treatment of ILRT events (e.g., Jeffery's Non Informative Prior) can result in some plants having a delta LERF in the "small" increase versus the "very small" increase region of Regulatory Guide 1.174 when calculating the risk impact of revised ILRT intervals. Given the minimal number of significant leakage events in the ILRT testing experience, the expert elicitation process will be used to develop a more informed basis for the determination of the probability of a significant containment leakage event.

The expert elicitation process is used to determine the probability of a significant containment leakage event. The expert elicitation would be based on the expert elicitation methods outlined in reference [11] and [12] as well as experts whose areas of expertise include one or more of the following:

- Available ILRT off-normal events
- Knowledge of containment systems
- Knowledge of ILRT
- Knowledge of containment inspections (IWE/IWL, maintenance)
- Knowledge of containment failure modes and causes
- Typical range of failures for non-informative priors

The expert panel would be asked to provide an estimate of the probability of a significant containment leakage event as a function of the magnitude of the failure. That is, the expert panel would be asked to estimate the probability of a significant containment leakage event for various La. The magnitudes, or La, would be provided for at least three points. The expert panel would also be asked to determine the shape of the probability distribution for a significant containment leakage event as a function of the magnitude (La) of the leakage.

The expert panel estimates would be based on the existing data and knowledge of the panel.

Following the solicitation of the estimates from the expert panel, the curve of probability of a significant containment leakage event versus magnitude of the leakage would be extrapolated for larger magnitudes (La). A bounding La that represents LERF would be chosen. Using the extrapolated curve and the bounding value of LERF chosen, a probability of a significant containment leakage event will be determined at the bounding LERF leakage value. The base population dose and LERF would be determined using the guidance in reference 10. Continuing to assume that the ILRT failure probability is linear with time, the ILRT failure probability and magnitude will be used to estimate the risk in terms of population dose for the revised ILRT test interval. The methods for estimating the delta population dose and the delta LERF would be also be based on the interim guidance contained in reference 10.

5.0 REFERENCES

1. Electric Power Research Institute, "Risk Impact Assessment of Revised Containment Leak Rate Test Intervals", EPRI TR-104285, August 1994.

2. Nuclear Regulatory Commission, "Performance-Based Containment Leak-Testing Programs", NUREG-1493, September 1995.

3. Entergy Nuclear Northeast, Indian Point 3 Nuclear Power Plant Letter of January 18, 2001, "Supplemental Information Regarding Proposed Change to Section 6.14 of the Administrative Section of Technical Specifications".

4. Nuclear Regulatory Commission, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis", Regulatory Guide 1.174, July 1998.

5. Nuclear Regulatory Commission, "Indian Point Nuclear Generating Station Unit No. 3 – Issuance of Amendment Re: Frequency of Performance-Based Leakage Rate Testing", April 17, 2001.

6. Florida Power – Progress Energy, Crystal River Nuclear Plant Letter of June 20, 2001, "Supplemental Risk Informed Information in Support of License Amendment Request No. 267".

7. Electric Power Research Institute, "PSA Applications Guide", EPRI TR-105396, August 1995.

8. NUMARC, "ILRT Survey Data", February 18, 1994.

9. NEI ILRT Survey, 2001

10. Nuclear Energy Institute, "Interim Guidance for Performing Risk Impact Assessments in Support of One-Time Extensions for Containment Leakage Rate Test Surveillance Intervals", Developed for NEI by EPRI and DS&S, November 2001.

11. Nuclear Regulatory Commission, "Branch Technical Position on the Use of Expert Elicitation in the High-Level Radioactive Waste Program", NUREG-1563, 1996.

12. Nuclear Regulatory Commission, "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts", NUREG/CR-6372, April 1997.

ATTACHMENT 1:
SIGNIFICANT CONTAINMENT LEAKAGE OR DEGRADED LINER EVENTS

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
1	Mar-77	NUMARC Note	NUMARC Letter 2/18/94 to NRC	Unknown	ILRT	Holes inadvertently drilled in liner			Yes
2	Apr-77	NUMARC 24		1+	ILRT	SG manway gasket leak	Excessive leakage identified by ILRT	Manway gasket leakage is detectable during startup and operation, releases through SG would be late and scrubbed.	No
3	Mar-78	NUMARC 4		Unknown	ILRT	SG manway gasket leak	Excessive leakage identified by ILRT	Manway gasket leakage is detectable during startup and operation, releases through SG would be late and scrubbed.	No
4	Jun-80	NUMARC 25		Unknown	LLRT Penalty		Excessive local leakage identified by LLRT		No
5	Feb-81	NUMARC 21		N/A	Verification Test		ILRT exceeded due to instrument verification test discrepancy		No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
6	Jun-82	NUMARC 4		0.77	ILRT	Lineup Error	Excessive local leakage identified by ILRT		No
7	Aug-83	NUMARC 19		Unknown	LLRT		Excessive local leakage identified by LLRT		No
8	Apr-84	NUMARC 25		Unknown	LLRT Penalty		Excessive local leakage identified by LLRT		No
9	Aug-84	NUMARC 28		14.91	LLRT Penalty		Excessive local leakage identified by LLRT		No
10	Jun-85	NUMARC 26		21.73	LLRT Penalty		Excessive local leakage identified by LLRT		No
11	Nov-85	NUMARC 3		1.89	LLRT Penalty		Excessive local leakage identified by LLRT		No
12	Apr-86	NUMARC 28		<9.55	LLRT Penalty		Excessive local leakage identified by LLRT		No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
13	May-86	NUMARC 23		0.99	LLRT Penalty		Excessive local leakage identified by LLRT		No
14	Jun-86	Susquehanna 2	NUREG-1493	2.6	ILRT		ILRT without prior LLRT		No
15	Nov-86	Quad Cities-2	NUREG-1493	0.88	ILRT	Faulty drywell head gasket	Excessive local leakage identified by ILRT and not identified by LLRT	Drywell head gasket would have probably been replaced at each refueling	No
16	Nov-86	TMI-1	NUREG-1493	1	ILRT		ILRT without prior LLRT		No
17	Nov-86	NUMARC 24		1	ILRT	SG manway gasket leak	Excessive leakage identified by ILRT	Manway gasket leakage is detectable during startup and operation, releases through SG would be late and scrubbed.	No
18	Aug-87	NUMARC 27		2.46	LLRT Penalty		Excessive local leakage identified by LLRT		No
19	Sep-87	Quad Cities-1	NUREG-1493	unk	ILRT		ILRT without prior LLRT		No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
20	Sep-87	NUMARC 28		Unknown	LLRT Penalty		Excessive local leakage identified by LLRT		No
21	Sep-88	NUMARC 30		Unknown	LLRT Penalty		Excessive local leakage identified by LLRT		No
22	Oct-89	Harris-1	NUREG-1493	Unknown	ILRT		ILRT without prior LLRT		No
23	Nov-89	Hatch-2	NUREG-1493	0.86	LLRT Penalty		Excessive local leakage identified by LLRT		No
24	Nov-89	Fermi-2	NUREG-1493	1.9	LLRT Penalty		Excessive local leakage identified by LLRT		No
25	Dec-89	Beaver Valley-1	NUREG-1493	Unknown	ILRT	Two penetration leaks discovered during ILRT	Excessive local leakage identified by ILRT and not identified by LLRT	If leakage cannot be identified by local testing, Type A test does not meet NEI 94-01 performance criteria for ILRT interval extension	No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
26	Feb-90	Dresden 3	NUREG-1493	0.78	LLRT Penalty		Excessive local leakage identified by LLRT		No
27	Feb-90	Brunswick-2	NUREG-1493	0.94	LLRT Penalty		Excessive local leakage identified by LLRT		No
28	May-90	Sequoyah-1	NUREG-1493	2.8	LLRT Penalty		Excessive local leakage identified by LLRT		No
29	May-90	Sequoyah-2	NUREG-1493	<La	ILRT		Excessive local leakage identified by ILRT and not identified by LLRT		No
30	Jun-90	LaSalle-2	NUREG-1493	>La	?				No
31	Jun-90	Trojan	NUREG-1493	?	ILRT	Instrumentation Problems			No
32	Sep-90	NUMARC 31		Unknown	LLRT Penalty		Excessive local leakage identified by LLRT		No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
33	Oct-90	Callaway	NUREG-1493	>La	ILRT	Penetration Leakage	Excessive local leakage identified by ILRT and not identified by LLRT	If leakage cannot be identified by local testing, Type A test does not meet NEI 94-01 performance criteria for ILRT interval extension	No
34	Oct-90	NUMARC 20		1.7	ILRT		Excessive local leakage identified by ILRT and not identified by LLRT	If leakage cannot be identified by local testing, Type A test does not meet NEI 94-01 performance criteria for ILRT interval extension	No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
35	Dec-90	Dresden 2	NUREG-1493	15.3	ILRT	Vacuum breaker leakage discovered during ILRT	Excessive local leakage identified by ILRT and not identified by LLRT	If leakage cannot be identified by local testing, Type A test does not meet NEI 94-01 performance criteria for ILRT interval extension	No
36	Feb-91	Braidwood 1	NUREG-1493	0.56	ILRT	Type B failure found during ILRT, Airlock hatch shaft seal	Excessive local leakage identified by ILRT and not identified by LLRT	If leakage cannot be identified by local testing, Type A test does not meet NEI 94-01 performance criteria for ILRT interval extension	No
37	Feb-91	Brunswick 1	NUREG-1493	0.99	LLRT Penalty		Excessive local leakage identified by LLRT		No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
38	Apr-91	NUMARC 2		0.84	ILRT		Excessive local leakage identified by ILRT and not identified by LLRT	If leakage cannot be identified by local testing, Type A test does not meet NEI 94-01 performance criteria for ILRT interval extension	No
39	Jun-91	Millstone-1	NUREG-1493	>.75La	LLRT Penalty		Excessive local leakage identified by LLRT		No
40	Jun-91	NUMARC 27		Unknown	LLRT Penalty		Excessive local leakage identified by LLRT		No
41	Jul-91	Pilgrim	NUREG-1493, LER 91-023-00	1.2	ILRT	Drywell head bolts loose, improper spherical washer material	Failure of spherical washers led to loosening of 11 of 76 bolts, drywell head contribution .74%/day	Had this not been identified in an ILRT, loose bolts and washer failures would probably have been identified in the next refueling outage.	No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
42	Sep-91	Braidwood 2	NUREG-1493	0.55	ILRT	Several local leaks found during ILRT	Excessive local leakage identified by ILRT and not identified by LLRT	If leakage cannot be identified by local testing, Type A test does not meet NEI 94-01 performance criteria for ILRT interval extension	No
43	Dec-91	Brunswick 2	NUREG-1493	0.79	LLRT Penalty		Excessive local leakage identified by LLRT		No
44	Dec-91	PVNGS-2	NUREG-1493	0.83	LLRT Penalty		Excessive local leakage identified by LLRT		No
45	Dec-91	Cooper	NUREG-1493, LER 91-020-00	1.3	ILRT	Structural failure of radiation monitor	Radiation monitor breached its shield chamber during ILRT pressurization at 51 psig		Yes
46	Mar-92	Dresden-3	NUREG-1493	>La	LLRT Penalty		Excessive local leakage identified by LLRT		No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
47	Mar-92	LaSalle-2	NUREG-1493	0.56	LLRT Penalty		Excessive local leakage identified by LLRT		No
48	Apr-92	Vogtle-2	NUREG-1493, NUMARC 1	>.75	LLRT Penalty		Excessive local leakage identified by LLRT	ILRT La exceeded due to B&C leakage penalty identified by LLRT	No
49	May-92	ANO-1	NUREG-1493	>La	LLRT Penalty		Excessive local leakage identified by LLRT	ILRT La exceeded due to B&C leakage penalty identified by LLRT	No
50	Aug-92	River Bend	NUREG-1493	>La	LLRT Penalty		Excessive local leakage identified by LLRT		No
51	Sep-92	NUMARC 21		Unknown	ILRT	SG manway gasket leak	Excessive leakage identified by ILRT	Manway gasket leakage is detectable during startup and operation, releases through SG would be late and scrubbed.	No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
52	Oct-92	Fermi-2	NUREG-1493	<2La	LLRT Penalty		Excessive local leakage identified by LLRT		No
53	Nov-92	Hatch-2	NUREG-1493	1.11	LLRT Penalty		Excessive local leakage identified by LLRT		No
54	Nov-93	3 NUMARC		1.34	ILRT	Lineup Error	Excessive local leakage identified by ILRT		No
55	Feb-94	Ginna	LER 94-003-00	Unknown	I&C Observation	Instrument plug not installed	Instrument Plug not installed following I&C work. Procedures enhanced to insure installation in future	Leakage pathway from containment to atmosphere would exist only when the equipment hatch inner door was open	No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
56	Feb-94	Surry 1	LER 94-003-00	>1	Piping Inspection	Failure of coal tar epoxy coating followed by corrosion	Hole in piping for recirculation spray water heat exchanger	A leak in this pathway would be scrubbed. Radiation monitors and isolation valves are also provided. Fluid leakage would be detected by subsequent piping inspections.	No
57	Mar-94	Braidwood 1	LER 94-003	~0.9	ILRT	Construction deficiency not previously identified	Concrete vent pipes associated with emergency hatch not capped		Yes
58	Apr-94	Sequoyah	LER 94-005-00	.75-1	Inability to maintain PRT P	Circumferential crack in RV bellows	This bellows failure was detected during normal operation		No
59	Dec-94	Pilgrim	LER 94-007-00	>1	I&C inspection	Instrument plug not installed	Plug for torus-atmosphere dp transmitter not installed; corrective action includes verification surveillance	This pathway would probably have been identified in the next instrument calibration cycle	No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
60	Apr-95	Vermont Yankee	NEI Survey	2	ILRT	Excessive local leakage	Valves contaminated with construction debris after passing LLRT	If leakage cannot be identified by local testing, Type A test does not meet NEI 94-01 performance criteria for ILRT interval extension	No
61	Sep-95	Indian Point 3	LER 95-019-00	N/A	Inspection/ Radiograph	Excessive local leakage	Through wall cracks on pipe caps on spare penetration due to contaminated stagnant water	Containment integrity was not an issue as the penetration was pressurized and monitored.	No
62	Feb-96	Surry 2	LER 96001	Unknown	Observation at power		Leaking weld on return pipe from refueling cavity to RWST	A leak in this pathway would be scrubbed, and leakage from piping would be observed.	No
63	Oct-96	Oyster Creek	LER 96-011-0	2	Low Pressure monitoring	Vacuum breaker valve cover leaking	Misalignment of valve cover during assembly, shifting during heatup	This pathway would probably have also been identified in the next local leak rate test.	No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
64	Sep-99	North Anna 2	NEI Survey, LER 1999-002-00	0.07	Liner coating inspection	1/4" defect hole	Wooden timber in concrete in back of liner		No
65	Nov-99	PVNGS 1	LER 2000-004		ILRT	Inadequate procedure for LLRT of Purge valves, valve seat adjustment	Excessive local leakage identified by ILRT	Revised procedure	No
66	Nov-99	Cook 2	NEI Survey		Liner, Coatings Inspection	3/16" hole in liner	Leak rate within limits	Cook 1 had identified pitting in 1998, but no thru wall penetration	No
67	99	Brunswick 2	NEI Survey	<1	IWE Inspection	Three thru wall defects in liner	Pitting corrosion and debris in concrete		No
68	Aug-01	PVNGS-3	Non-emergency event report 8/17/01	?	Operations monitoring containment sump	Quick opening closure device not properly closed, or loosening of device in service.	Fuel transfer tube quick operating closure device leak path.	Leak path should be detected during LLRT.	No

No.	Date	Unit	Reference LER, report	Leakage, fraction of La	How Detected	Cause	Description	Comments	Preliminary Assessment Effect Non Detection Time?
69	Oct-01	Vermont Yankee	Non-emergency event report 10/30/2001	>1	Operator observation and isolation		Tube broke on discharge of H2O2 monitor sample pump.	Engineering evaluation determined that under accident conditions leakage would have exceeded allowable leakage limits	No
70	?	Vermont Yankee	NUREG-1493	1	ILRT	Drywell manway penetration leakage		Leak path should be detected during LLRT.	No

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ILRT Type A Test Interval Optimization Methodology
Expert Elicitation Process

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1.0 INTRODUCTION

This report section provides an overview of the expert elicitation process [11] [12] and its application to the solicitation of expert opinion for the ILRT Type A Testing Interval Optimization Project. The process is based on the "Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and Use of Experts" (NUREG/CR-6372) and "Branch Technical Position on the Use of Expert Elicitation in the High-Level Radioactive Waste Program" (NUREG-1563).

The goal of the expert elicitation process is to obtain frequency and magnitude estimates for significant containment leakage that would not be detected by other inspections, tests, or alternative means.

There are five functional requirements of the expert elicitation process. These five requirements are:

- Requirement 1: Identification of the expert judgment process
- Requirement 2: Identification and selection of experts
- Requirement 3: Determination of the need for outside expert judgment
- Requirement 4: Utilization of either the TI or TFI process
- Requirement 5: Responsibility for the expert judgment

The five functional requirements of the expert judgment process identify the issue, identify the experts, outline the process used in the solicitation of their opinion and specify the use of their judgment in the ILRT Type A Testing Interval Optimization process. Each of the five functional requirements is discussed in detail in the following report Sections 3 through 6.

2.0 EXPERT ELICITATION SUMMARY

The goal of the expert elicitation process is to determine of the probability and magnitude of significant containment leakage events. The probability and magnitude of significant containment leakage events will be used in the determination of the risk impact associated with the ILRT Type A Testing Interval Optimization.

The expert elicitation process inputs are derived from an ILRT events database, consisting of information collected via NEI surveys, LER's, and NRC reports (NUREG-1493). The expert elicitation process uses a facilitated expert meeting which considers data, containment design, maintenance, and testing. The process was consistent with the approach described in the references 11 and 12.

Using the process outlined in references 11 and 12, the ILRT Type A Testing Interval Optimization has been assigned a Degree of Importance of Degree II and a Level of Complexity of C. These assignments indicate that a Technical Integrator (TI) process is sufficient for the expert panel process. In the case of a Level of Complexity of Level C, a facilitated expert panel meeting(s) are required to solicit the opinions of the technical community. Through a nomination process, experts are selected. Each of the experts has significant expertise in areas related to containment structures and/or containment testing.

The technical integrator facilitates the expert panel meeting in which the problem statement is provided. The problem statement includes an ILRT events database and potential approaches (in addition to expert elicitation) and their results. The expert panel then provides their individual judgments. The technical integrator integrates the individual results to obtain the community distribution. The community distribution is provided to the expert panel to ensure agreement with the final community distribution. The results are then used in the risk impact assessment.

3.0 REQUIREMENT 1: IDENTIFICATION OF THE EXPERT JUDGMENT PROCESS

There are several forms the expert elicitation process can take depending on the complexity of the issue, the resources available to address the issue and other factors. This requirement provides the outline of the expert judgment process based on these factors. Three topics are discussed in the following report sub-sections that assist in the determination of the details of the expert elicitation process. These topics are:

- Defining the specific issue
- Determining the degree of importance and degree of complexity of the issue
- Deciding whether to use a Technical Integrator (TI) or Technical Facilitator / Integrator (TFI)

3.1 Defining the Specific Issue

The technical issue for which expert judgment is to be applied needs to be defined clearly and narrowly enough that it is possible to identify the relevant expertise and to use it correctly. Defining the technical issue requires:

- Clearly identify the issue such that one or more technical experts can be selected
- Define how the issue fits into the PRA
- Allow the experts to redefine the issue that allows the experts to provide input

The issue associated with the optimization of ILRT Type A Testing interval has been clearly defined in the ILRT Problem Statement. Therefore, this requirement is assumed satisfied.

3.2 Determining the Degree of Importance and Level of Complexity

In the following report sub-sections, the process used to determine the degree of importance and level of complexity of the ILRT testing optimization are discussed.

3.2.1 Determining the Degree of Importance

To assist the experts in the expert elicitation process as well as to define the form of the process, it is necessary to classify the technical issue into on of three degrees. These three degrees are defined as Degree I, Degree II and Degree III are intended for use in the determination of the expert elicitation process to use. The determination of the degree of importance is based on technical criteria only. The degree characterizations are as follows:

Degree I: Non-controversial issue, and/or not significant to the overall results of the analysis.

Degree II: Issue has significant uncertainty or diversity of opinion; controversial; moderately significant to the overall result of the analysis; and/or moderately complex.

Degree III: Highly contentious issue; very significant to the overall result of the analysis; and/or highly complex.

In assigning the degree of importance of an issue, there is some judgment necessary since the degree categories represent a course partition of the range of potential degrees.

In the case of the optimization of the ILRT testing intervals, Degree II is selected. Degree I is not chosen since the results of the expert elicitation process are indeed significant to the results of the analysis. In fact, a case could be made that the results of the expert elicitation process are very significant to the results of the analysis necessitating an assignment of a Degree III. However, the sensitivity of the results of the analysis to the expert elicitation process are mitigated by the availability of significant amounts of data. This data, although not complete enough to perform the analysis, does provides information upon which the experts can base their judgments. In addition, experts will be chosen for the knowledge of the mechanisms that can result in significant containment leakage events and therefore provide additional assurance that their judgment is only moderately significant to the overall result. Lastly, the issue of testing extension and specifically ILRT Type A test optimization is not considered highly complex or is the issue considered highly contentious. Therefore, the assignment of Degree of Importance of Degree II is appropriate.

3.2.2 Determining the Level of Complexity

Once the degree of the issue has been selected, it is necessary to select the Level of Complexity. There are four levels of complexity defined as Level A, B, C or D. A key input to the assignment of the level of complexity is the degree of importance. The degree of importance captures how complex the issue is and how controversial the issue is, but alone is not sufficient for the choice of the level of complexity.

In summary, levels of complexity of A, B or C are characterized by the Technical Integrator (TI) approach. In the technical integrator approach, the technical integrator plays the role of "evaluator". Input to the technical integrator varies depending of the level of complexity assigned to the issue from basing judgments on his/her own experience and literature to obtaining input through the communication with other experts.

With an issue of a level of complexity of A, the technical integrator's role is to evaluate and weight models based on literature review and experience. With a level of complexity of A, the technical integrator would estimate the community distribution.

With an issue assigned a level of complexity of B, the technical integrator's role is to conduct a literature review and contact those individuals who have developed interpretations or who have particular relevant experience and develop the community distribution.

With an issue assigned a level of complexity of C, the technical integrator's role is to gain additional insight by bringing together experts and focusing their interactions. In the sessions with the technical experts, the experts are given an opportunity to explain their hypotheses, data and basis. Proponents or advocates of particular technical positions are asked to describe and defend their positions to the other experts. As with levels A and B, the technical integrator develops the community distribution.

Levels of complexity of D are characterized by the Technical Facilitator / Integrator (TFI) approach. In level D, a group of expert "evaluators" are identified and their judgments elicited. The technical facilitator / integrator is responsible for identifying the roles of the proponents and evaluators and for ensuring their interactions provide an opportunity for focused discussion challenge. In the level D analysis, resources permit and the situation dictates multiple evaluators and hence a technical facilitator integrator takes responsibility for the aggregated product. The TFI organizes and manages interactions among the proponents and evaluators, identifies and mitigates problems that potentially develop during the course of the study (e.g., an expert who is unwilling or unable to play the evaluator role), and ensures that the evaluators' judgments are properly represented and documented.

Regardless of the level of the study, the goal in the various approaches is the same: to provide the community distribution, which is defined as a representation of the informed technical community's view of the important components and issues and, finally, the result. Also, regardless of the level of the study a peer review is performed to review the process and substance of the study.

The level of complexity of the ILRT Type A Testing Optimization is chosen as Level C. The factors affecting this assignment include but are not limited to regulatory issues, public and technical community perception and resource constraints.

A level of complexity of D is not chosen since empirical data is available that provides an indication of the range of the result of the final analysis. In addition, the phenomena related to significant containment leakage events are generally understood. In addition, the conceptual models that are involved in the optimization of the ILRT testing interval and potential significant containment leakage events are relatively limited. Given the required resources and the above discussion a complexity level of D is not chosen.

Assignment of a level of complexity of A is rejected since it does not significantly involve the technical community in the development of the analysis. Given the regulatory nature of the analysis, it is important to involve the technical community is the development of the analysis.

While a level of complexity of B does involve the technical community, it does not provide a forum for the exchange of alternate conceptual models. Therefore, a level of complexity of B is also not chosen.

A level of complexity of C provides the optimum use of resources since it allows for the technical community to participate in the development of the analysis results and the proposal of alternate conceptual models while limiting the resources associated with the solicitation of the expert judgment.

4.0 REQUIREMENT 2: IDENTIFICATION AND SELECTION OF EXPERTS

One or more evaluators (individuals capable of evaluating the relative credibility of multiple alternative hypotheses to explain the available information) need to be identified. In addition, other experts such as proponents (experts who advocate a particular hypotheses or technical position) as well as resource experts (technical experts with knowledge of a particular area of importance to issue) will also be identified and nominated for participation.

Experts will be nominated to the panel by the ILRT Optimization project manger. Experts should have extensive experience in containment structure testing and/or maintenance and one or more of the following additional areas:

- Performing ILRTs or interpreting/characterizing ILRT test results
- Statistics / Probability Theory / Probabilistic Risk Assessment
- Failure mechanics

5.0 REQUIREMENT 3: DETERMINATION OF THE NEED FOR OUTSIDE EXPERT JUDGMENT

In the case of the ILRT Type A Testing Optimization, the decision to seek outside (i.e., expert elicitation process) expert judgment has already been made as opposed to using members of the ILRT Optimization Project Team. As previously mentioned, the regulatory nature of the analysis requires that technical community be involved in the development of the analysis. The selection of the participant will be in accordance with Section 3 of this report.

6.0 REQUIREMENT 4: UTILIZE THE TI OR TFI PROCESS

This requirement is used to determine whether the TI process or the TFI process will be used and to specify the requirements of the process chosen. Since a Level C analysis has been chosen, and there is no other basis to decide differently, then the Technical Integrator (TI) process is to be used. As described earlier, the TFI process is applied to only Level D analysis. The TI process includes the following significant elements:

- Identifying available information and analysis and information retrieval methods;
- Accumulating information relevant to the issue;
- Performing the analysis and the data diagnostics;
- Developing the community distribution

6.1 Identifying available information and analysis and information retrieval methods

The TI is responsible for assembling all relevant technical databases and other information important to the analysis problem at hand, including any data that have been gathered specifically for the analysis. The TI also identifies technical researchers and proponents that he/she intends to contact during the course of the study to gain insight into their positions and interpretations (in a Level C analysis, this means identifying those individuals that he/she intends to assemble for discussion and interactions). In addition, the TI defines the procedures and methods that will be followed in conducting the analysis.

6.2 Accumulating information relevant to the issue, performing the analysis and developing the community distribution

The TI is responsible for understanding the entire spectrum of technical information that is brought to bear on the issue, including written literature, recent works by other experts, and other technical resources. (In advanced technical work, it is always the responsibility of the investigator to learn about the most recent advances in the field, often by direct contact with other experts through personal correspondence, personal meetings, telephone conversations, and so on.) In a level C study, members of the technical community are brought together and the TI orchestrates interactions and possibly, workshops to focus the discussions on the technical issues of most significance to the analysis, and to be sure that he/she is aware of the diversity in interpretations for these key issues. The TI uses all this information to develop a community distribution of the range of uncertainty for the particular issue being addressed.

6.3 Performing the Peer Review

The TI needs to use the peer review team as a sounding board to learn whether the full range of technical views have been identified and assimilated into the project. The ILRT Optimization Project Team will serve as the peer reviewers for the expert panel. In addition, the expert panel will be free to consult other resources as they see necessary.

7.0 REQUIREMENT 5: RESPONSIBILITY FOR THE EXPERT JUDGMENT

A basic principle is that it is an absolute requirement that there must be a clear definition of the ownership of expert judgments, opinions, and/or interpretations, both as expressed by the individual experts and as integrated together.

In the case of the ILRT Type A Testing Optimization, the owner of the process and the results is the technical integrator. The individual expert will own their individual judgments and interpretations.

Degrees of Issues and Levels of Study

Issue Degree	Decision Factors	Study Level
Degree I Non controversial; and/or insignificant to the result		Level A TI evaluates/weights models based on literature review and experience; estimates community distribution
Degree II Significant uncertainty and diversity; controversial; and complex	Regulatory concern	Level B TI interacts with proponents and resource experts to identify issues and interpretations; estimates the community distribution
Degree III Highly contentious; significant to result and highly complex	Resources available	Level C TI brings together proponents and resource experts for debate and interaction; TI focus debate and evaluates alternative interpretations; estimate community distribution
	Public perception	Level D TFI organizes panel of experts to interpret and evaluate; focus discussions; avoids inappropriate behavior on the part of the evaluators; draws picture of evaluators' estimate of the community's composite distribution; has ultimate responsibility for project