SCIE-NRC-217-93

KEWAUNEE
INDIVIDUAL PLANT EXAMINATION
BACK-END
TECHNICAL EVALUATION REPORT

W. H. Amarasooriya

Prepared for the U.S. Nuclear Regulatory Commission
Under Contract NRC-05-91-068-17
July 25, 1995

SCIENTECH, Inc.
11140 Rockville Pike
Rockville, Maryland 20852

TABLE OF CONTENTS

1. INTRODUCTION

This technical evaluation report (TER) documents the results of the SCIENTECH submittal-only, back-end review of the Kewaunee individual plant examination (IPE) report submitted by Wisconsin Public Services Corporation (WPSC) [1,2] and WPSC's Responses to Requests for Additional Information (RRAI)[3,4]. This technical evaluation report complies with the requirements of the U.S. Nuclear Regulatory Commission contractor task order for the submittal-only reviews, and adopts the NRC submittal-only review objectives, which include the following:

- To determine if the IPE submittal provides the level of detail requested in the "Submittal Guidance Document," NUREG-1335

- To assess the strengths and the weaknesses of the IPE submittal

- To pose a preliminary list of questions about the IPE submittal, based on this limited submittal-only review

- To complete the IPE Evaluation Data Summary Sheet.

In Section 2 of the TER, we summarize our findings and briefly describe the Kewaunee IPE submittal as it pertains to the work requirements outlined in the contractor task order. Each portion of Section 2.1 corresponds to a specific work requirement. In Section 2.2, we set out our assessment of the Kewaunee submittal strengths and weaknesses. In Section 3, we present our evaluation of the Kewaunee IPE, based on the submittal-only review. Appended to this report is an evaluation summary sheet completed on the Kewaunee IPE.

2. CONTRACTOR REVIEW FINDINGS

2.1 Review and Identification of IPE Insights

This section is structured in accordance with Task Order Subtask 1.

2.1.1 General Review of IPE Back-End Analytical Process

2.1.1.1 Completeness

Although there is a large body of information provided in the back-end portion of the Kewaunee IPE submittal, key portions of this information are provided in "phenomenological evaluation studies" [3], the review of which is outside the scope of this TER. Therefore, although the submittal appears complete in these areas, a detailed review was not conducted. The NRC staff is conducting a separate review of the phenomenological evaluation studies. In the other areas, however, the submittal is essentially complete with respect to the level of detail requested in NUREG-1335.

The IPE submittal appears to meet the NRC sequence selection screening criteria described in Generic Letter 88-20.

2.1.1.2 Description, Justification, and Consistency

The IPE methodology used is described clearly. The approach taken appears to us consistent with the basic tenets of Generic Letter GL 88-20, Appendix 1.

2.1.1.3 Process Used for IPE

Section 1.3, pages 5-6 of the submittal, describes the process used for the IPE. The Westinghouse software WLINK was used to perform the core melt quantification and the plant damage states (PDSs) quantification. After grouping Level 1 results into containment event tree (CET) end states, representative sequences from each end state were analyzed with MAAP. Release categories were then assigned to CET end states.

The Kewaunee IPE was not an examination of an as-built, as-operated plant: As noted in Table 1.4-1, page 10, plant and procedure modifications not yet incorporated into the hardware and operations were assumed during the course of the IPE. This summer, Kewaunee has scheduled to modify the "emergency operating procedure ECA 1.2 to improve guidance to the operators in identifying and mitigating an interfacing systems LOCA."

2.1.1.4 Peer Review of IPE

Section 5.0 of the submittal describes the utility participation and both the internal and external review teams. Kewaunee contracted Westinghouse Electric Corporation for Level 1 PRA support and Fauske and Associates, Incorporated, (FAI) to perform the Level 2 containment analysis.

A group of nine Kewaunee plant personnel conducted an internal peer review (Table 5.2-1, page 531). The submittal identifies these individuals by job title, but does not indicate which areas of the IPE they reviewed, nor whether they had sufficient familiarity with back-end issues to perform the review function adequately.

The Kewaunee "PRA External Independent Review Team" is described in Table 5.2-2, page 532 of the submittal. This team has "Level 2" areas of expertise, but the submittal does not indicate what, if any, contribution this team made to the final IPE product.

2.1.2 Containment Analysis/Characterization

2.1.2.1 Front-end Back-end Dependencies

The Kewaunee IPE handled front-end back-end interfaces using 122 PDSs. Each PDS consisted of accident sequences grouped on the basis of their similarities with respect to the following (Section 3.1.5, page 150):

- Initiating event type (large LOCA, small LOCA, transient, and containment bypass)
- Injection phase faults (core damage occurs early) or later recirculation phase faults (core damage occurs late)
- Containment safeguard operability (low-pressure containment recirculation, containment spray, containment fan coolers, and containment isolation).

The Westinghouse software WLINK was used to perform PDS quantification. The front-end back-end dependencies appear to have been treated adequately and presented clearly. However, those who conducted the Kewaunee IPE did not group the PDSs into Key PDSs, even though further binning into KPDSs is often helpful in performing and evaluating IPEs.

Some of the front-end recovery assumptions had an important impact on the back-end results. For example, for the sequence analyzed for the highest CET end state (SBO-18, 2.6E-5, see page 502), the assumption was that AC power would be restored after 24 hours.

2.1.2.2 Sequence with Significant Probability

In conducting the Level 2 analysis, the Kewaunee IPE team made use of the top 100, Level 1 systemic sequences listed in Table 4.3-2, pages 498-501 of the submittal. These sequences appear to have been taken directly from the "List of Plant Damage States,"

Table 3.1.5-1, pages 156-163. The NUREG-1335 screening criteria, addressed in Section 4.3.3.1, page 473, appear to have been met.

2.1.2.3 Failure Modes and Timing

The Kewaunee IPE team characterized the containment failure using modeling and bounding calculations, based on experimental data, phenomenological uncertainties, and some MAAP calculations (Section 4.2-5, pages 455-456). The following failure mechanisms were considered unlikely to occur during the Level 2 mission time of 48 hours: hydrogen detonations and deflagrations, direct containment heating, steam explosions, molten core-concrete attack, thermal attack of containment penetrations, and vessel thrust forces.

Failure modes more likely to occur were late overpressurization, bypass, and isolation failures. Table 4.2-1, pages 466-468, summarizes the results of the containment failure mode evaluations. The conclusion was that, within the 48-hour mission time, no containment failure would be caused by severe accident phenomenology; only isolation failures and bypasses of the containment possibly would occur. (Beyond 48 hours, some accident sequences could lead to slow overpressurization failures of the containment, if containment heat removal were not restored.)

The containment's ultimate strength was calculated for the failure of the shell wall, lower head, emergency air lock, and personnel air lock. Figure 4.2-2, page 469, shows results for each failure mode as a variation of failure probability with the containment pressure. The median for total probability was 151 psig, while the 5-percent lower bound and the 95-percent upper bound were 122 psig and 177 psig, respectively. The containment was assumed to fail catastrophically.

Source term analysis was based on the assumption that the containment failure occurred at 122 psig due to membrane stress failure of the cylindrical section (mid-height region). As shown in Figure 4.2-2, failure of the ellipsoidal lower head would be more probable. The analysis was based on a failure of the cylindrical section because it is a conservative failure location and because larger uncertainty surrounds an ellipsoidal lower head failure.

The submittal provides no support information or references related to the determination of the failure pressures or failure location.

As noted in Section 1.2, pages 2 and 4 of the submittal, the Kewaunee plant has a power-generating capacity of 1650 MWt with a containment free volume of 1.32E6 cubic feet. The containment is designed for a pressure of 46 psig and a temperature of 268°F. The submittal does not report data on some reactor design features, which would have been helpful for the review, such as the volume of primary system water, mass of fuel, and mass of zirconium. (Table 4.1-1, page 444, lists the locations of these values in the MAAP parameter file, which is not part of the submittal.)

The reactor eavity design has an important bearing on the accident progressions. The submittal states on page 440:

> The Kewaunee containment does not facilitate flooding of the reactor eavity . . . . A potential flow path does exist in the form of two access hatches . . . . These hatches are closed during normal operations, but if they were left open, the cavity could be easily flooded.

When the hatches are closed, the cavity will be dry for all sequences in which residual heat removal (RHR) recirculation is not available. In the sensitivity analysis performed as part of the Kewaunee IPE, the hatches were assumed to be open. In the two cases run, it appeared that little benefit would be gained from flooding the cavity (pages 513-514 of the submittal).

2.1.2.4 Containment Isolation Failure

Section 4.2.5.2, page 457, states that the containment isolation will fail if one or more of the following conditions exist: open fluid line or mechanical penetration, open isolation valves of a fluid line, and open fluid line of a safety system not in operation.

Isolation failure was used as a top event for the CET. The frequency of containment isolation failure was 1.5E-8 per reactor year, or a small fraction (0.00023) of the total core damage frequency.

2.1.2.5 System/Human Response

Operator actions are required to enact the following containment safeguard systems (Section 3.1.5.2, pages 152-4):

- Low Pressure Recirculation System (LPRS). The LPRS provides cooling of debris after vessel failure by delivering water to the reactor upper plenum. This water spills through the vessel break on to the debris in the cavity. Either the automatic safety injection system or the control room operator actuates the LPRS. The operator is to switch over the pumps to recirculation upon activation of the RWST low-low level alarm.

- Internal Containment Spray (ICS) System. Either the automatic containment spray system or the control room operator actuates the ICS. The operator is to switch over the pumps to recirculation upon activation of the RWST low-low level alarm.

- Containment Isolation System (CIS). Either the automatic system or the control room operator actuates the CIS.

The carryover of operator actions to the back-end analysis is summarized on page 449 of the submittal, namely, "Level 2 analysis takes no credit for operations or recoveries not initiated under Level 1." This appears to be inconsistent with the restoration of AC power after 24 hours in some of the Station Blackout sequences (for example, see Sequence 5 (PDS-18), page 476), unless restoration is initiated under Level 1. Also note that, for the Medium LOCA, Sequence 61, page 487, operators successfully cool down and depressurize the primary system to below the RHR shutoff head.

2.1.2.6 Radionuclide Release Characterization

Section 4.3 of the submittal describes the source term quantification for the Kewaunee plant. The IPE team analyzed the top 100, Level 1 sequences using CETs and obtained 14 CET end states. The team performed MAAP calculations for 13 sequences representing the top 100, Level 1 sequences, and yielding 11 CET end states with unique, radioactive release times and magnitudes. (See Table 4.3-3, page 502.) Source terms of these end states bounded the source terms of the remaining three CET end states. The release magnitude was quantified for noble gas, volatiles, and non-volatiles.

Initially, the Kewaunee IPE team defined 19 release categories, as given in Table 4.3-4, pages 503-504 of the submittal. Only four of these release categories were used and assigned to the 14 CET end states. They were S, A, G, and T — the four release categories representing the source term for the Kewaunee plant. Table 1 shows the definitions and important parameters of these four release categories.

The Kewaunee source term quantification appears to be consistent with the recommendations of GL 88-20.

2.1.3 Quantitative Core Damage Estimate

2.1.3.1 Severe Accident Progression

The Kewaunce IPE addressed the phenomenological uncertainties of severe accident progression using (1) plant-specific phenomenological evaluations, (2) MAAP sensitivity analyses, and (3) experimental studies by key phenomena (page 447 of the submittal). Section 4.2.5.3, which describes the Kewaunee phenomenological evaluation summaries, identified the following as phenomena that would not lead to containment failure within the Level 2 mission time of 48 hours:

- Hydrogen detonations and deflagrations
- Direct containment heating
- Liner melt-through
- Steam explosions
- Molten core-concrete attack
- Thermal attack of containment penetrations
- Vessel thrust forces.

Direct containment heating was found not to lead to containment failure, mainly because of special cavity geometry that enhances de-entraining debris. However, the original submittal [1] does not describe the analysis that led to this conclusion. That analysis, as well as that of all other "phenomenological" issues, is contained in the response to NRC's RAI [3]. For completeness here, the following summary from Ref [3] is included. As noted in Section

2.1.1.1, this analysis was outside the scope of this TER. Nevertheless, the analysis does appear to cover the phenomenological areas of concern.

PHENOMENOLOGICAL EVALUATIONS

Kewaunee-specific phenomenological evaluation summaries are the principal means of addressing the impact of phenomenological uncertainties on plant response. These summaries address a wide range of phenomenological issues and provide an in-depth review of plant-specific features which influence the uncertainty, or act to mitigate, the consequences of such phenomena. The phenomenological evaluation summaries investigate both the likelihood of occurrence and the probable consequences of key severe accident phenomena. The phenomenological evaluation summaries are supported by available experimental information from open literature as well as information which has been developed using the FAI experimental information from open literature as well as information which has been developed using the FAI experimental facilities in direct support of the IPE. A combination of these evaluations and MAAP sensitivity analyses is used to assess the importance of the phenomenological issues and the significance of uncertainty. This approach to dealing with phenomena provide a technical basis for maintaining containment systems and functional events in the Kewaunee containment event trees (CETs).

This section of the Kewaunee Level II source term notebook contains the following phenomenological evaluation summaries:

- Direct Containment Heating
- Steam Explosions
- Hydrogen Detonations and Deflagrations
- Molten Core-Concrete Interaction (MCCI)
- Vessel Thrust Forces
- Thermal Loading of Containment Penetrations
- Containment Overpressurization
- Liner Melt-through
- Direct Containment Bypass
- Containment Isolation Failure

The following were identified as events that would lead to containment failure within the Level 2 mission time of 48 hours:

- Containment overpressurization
- Containment isolation failure
- Containment bypass.

The submittal claims that phenomenological evaluation summaries are supported by available experimental information and information developed using the Fauske and Associates, Incorporated, experimental facilities (page 447).

Section 4.4 describes the MAAP sensitivity analyses performed for the following issues:

- Hydrogen burn completeness
- In-vessel hydrogen production and core relocation
- Reactor vessel failure mode
- Hot leg creep rupture failure for a high-pressure sequence
- Containment failure pressure and area
- Volatile fission product release and retention in the primary system
- Ex-vessel debris coolability.

Table 4.4-1, pages 516-521, lists MAAP sensitivity analyses performed to address uncertainties in accident progression. Table 4.2-1, pages 466-468, summarizes containment failure modes along with phenomena, issues/failure mechanisms, major areas of uncertainty, and impact on the reactor pressure vessel, containment, or radioactivity release.

The "hot leg creep rupture failure for a high pressure sequence" sensitivity study indicated that RCS depressurization due to induced hot leg failure (and subsequent low-pressure vessel failure) would cause a greater containment pressure loading than vessel failure at high pressure. This would be due to the non-coolable debris located in the reactor cavity and the subsequent concrete ablation, characteristics of a low-pressure vessel failure.

2.1.3.2 Dominant Contributors Consistency with IPE Insights

Table 1 on the next page (which was extracted from Figure 1.4-2, page 11 of the submittal) shows the dominant contributors in terms of release categories. Basically, over the 48-hour mission time, the containment had a success probability of 92 percent (no failures); the 8 percent of failures were attributed to containment bypass. Beyond the 48-hour mission time, accident management actions (not credited in the IPE) would be needed to prevent gradual overpressurization failure of the containment about 49 percent of the time.

Table 1. Kewaunee Release Categories*

Release Category	Definition	No. of CET End States	No. of Level 1 Sequences	Frequency (per year)	Conditional Probability
S	No containment failure (leakage only, successful maintenance of containment integrity; containment not bypassed; isolation successful)	7	56	2.87E-5	0.45
T	Containment bypassed with noble gases and more than 10% of the volatiles released	3	33	5.32E-6	0.08
G	Containment failure prior to vessel failure with noble gases and up to 10% of the volatiles released (containment isolation impaired)	3	6	1.48E-8	2.30E-4
A	No containment failure within 48-hour mission time, but failure could occur eventually without accident management action; noble gases and less than 0.015 volatiles released	1	6	3.03E-5	0.47
	Total	14	100	6.4E-5	1.00

*These values reflect the changes reported in reference [2].

Table 2. Containment Failure As a Percentage of Total CDF for Internal Initiators: Kewaunee Comparison with Surry NUREG-1150 PRA, and with The Results of IPEs at Zion, Diahlo Canyon, Maine Yankee, and Palo Verde

Containment Failure	Surry/ NUREG-1150	Zion IPE	Diablo Canyon-IPE[1]	Maine Yankee IPE[2]	Palo Verde IPE	Kewaunee	
						within 48-hr mission time	beyond 48-hr mission time[1]
CDF (per reactor year)	4.1E-5	4.0E-6	8.8E-5	7.4E-5	9.0E-5	6.6E-5	
Early	1	0	4.6	8	10	0	0
Late	6	5	66.6	48	14[3]	0	47
Bypass	12	30	1.8	2.1	4	8	8
Isolation	*	2	7	**	0[4]	0.023[5]	0.023[5]
Intact	81	63	20	43	72	92	45

* Included in early failure
** Bypass and isolation combined
1 Reflects the IPE results without taking credit for recovery of containment heat removal 48 hours after event initiation
2 Values do not add to "100"
3 43 percent of the late failures are due to basemat melt-through
4 Probability is less than 0.001, conditional on core melt
5 IPE submittal gives isolation failure in early-failure time frame

In Table 2, we compare dominant contributors to Kewaunee containment failure with those contributors identified during individual plant examinations performed at the Zion, Diablo Canyon, Maine Yankee, and Palo Verde plants, and with the NUREG/CR-1150 results obtained at the Surry plant. As shown in Table 2, the probability of early failure is zero for Kewaunee and Zion, compared to relatively large values for the other "IPE" plants.

In the conclusions of many IPE and PRA studies, bypass of the containment was a relatively high contributor. This is all the more important because of the high radionuclide releases that usually accompany a bypass failure.

Section 2.4.2, pages 21-22 of the submittal, notes that the Kewaunee IPE team reviewed 13 IPE submittals (Surry, Turkey Point, Diablo Canyon, DC Cook, Seabrook, Millstone 3, Zion, Farley, V.C. Summer, Vogtle, Pt. Beach, Ginna and Wolf Creek) and four PRA studies (WASH-1400; NUREG-4550 for Zion, Sequoyah, and Surry; NSAC-60 for Oconee Unit 3; and NUREG-4458, Decay Heat Removal study for Pt. Beach). However, we could not locate a reference in the submittal to any insights gained by comparing the Kewaunee results with those of other IPEs and PRA studies.

2.1.3.3 Characterization of Containment Performance

The Kewaunee IPE team characterized containment performance using containment event trees (CETs) consisting of the following top events:

- Occurrence of containment isolation-intact
- Occurrence of high-pressure melt ejection
- Occurrence of late or no containment failure
- Operation of RHR pumps and heat exchangers
- Operation of containment sprays with RHR heat exchangers
- Operation of fan coil units
- Operation of RHR pumps and heat exchangers in the recirculation mode after vessel breach.

The CETs are displayed in Figures 4.3-1a, -1b, and -1c, pages 494-496 of the submittal. Only five top events exist, if the "transfer" top events are not counted. Except for the top event "late or no containment failure," the CETs appear to be nothing more than a re-representation of the PDSs, already grouped according to whether they are high- or low-pressure sequences and whether safety systems (LP recirculation, fan coolers, sprays and containment isolation) are available. With the exception of "late or no containment failure," all the top events address system availability questions, as contrasted with phenomenological questions, and all of these system availability questions were addressed in the front-end IPE. Thus, no purpose appears to be served by these CETs. (It shall be noted that WPSC did provide a description of the role of the containment safeguards tree and the linking of that tree with the Level 1 trees. They included a containment safeguards tree which was omitted from the original submittal, in their RRAI [4].)

The split fractions for all of the top events are either "1" or "0." Note from Figure 4.3-1 that the top event "late or no containment failure" is always suceessful, that is, there are no early failures. This is the only phenomenological question. The only basis for this "success" conclusion, namely that the conditional probability of early containment failure (not including containment bypass and failure to isolate) is zero, appears to be contained in the phenomenological evaluation summaries discussed on page 447 of the submittal and in the MAAP sensitivity studies. As noted in Sections 2.1.1.1 and 2.1.3.1, the review of the phenomenological evaluation summaries was determined to be outside the scope of work of this TER. However, all the key phenomenological issues, important for containment failure, are addressed in these summaries.

Section 4.2.1, page 448 of the submittal notes that the Kewaunee IPE did not treat in the CET top events the phenomenological uncertainties of early containment failure resulting from steam explosions, direct containment heating, vessel thrust forces, and direct contact of shell with fuel debris, but instead considered them in phenomenological evaluation summaries (PESs) and MAAP sensitivity studies. However, not even this appears to be the case. Table 4.4-1, pages 516 through 518, notes that the IPE addressed the above phenomena only in PESs, but not in MAAP sensitivity studies. Thus the PESs constitute the whole basis for concluding that no early failures would result from the above phenomena. (The PESs are described briefly and qualitatively in Section 4.2.5.3, pages 458 through 460.)

Figures 4.3-1a through 4.3-1c present the results of CET quantification. These results are not described in the submittal, which refers the reader to Section 8.2 of the Kewaunee PRA study for details (see page 455 of the submittal [1]). However, we could not locate in the submittal a citation reference to the PRA study itself.

To obtain containment loading, the Kewaunee IPE team used MAAP with a plant-specific parameter file. The team used a slightly modified version of MAAP PWR 3.0B Revision 18.

2.1.3.4 Impact on Equipment Behavior

We could not locate in the submittal a discussion of equipment survivability within severe accident environments. However, certain assumptions made in the analysis are relevant. Note (page 449) that all systems associated with the PDSs considered successful under Level I (front-end) were also assumed functional at Level 2 (back-end). This means that no impact was assumed on fan coolers, sprays, and RHR resulting from the temperature, pressure, aerosols, debris, and radiation associated with severe accidents.

2.1.4 Reducing Probability of Core Damage or Fission Product Release

2.1.4.1 Definition of Vulnerability

Section 3.4.3, page 395 of the submittal notes that "WPSC defines a vulnerability as a feature in plant design, procedures, training, etc., which results in a contribution to core melt risk greater than what is expected." We could not locate in the submittal a definition for "what is expected."

Section 6.4, page 537, of the submittal notes the following:

> The bypass frequency of 5.28E-6 is dominated by steam generator tube ruptures. These cases are consistent with industry experience and easily remedied with procedural enhancements to refill the RWST and maintain water to the secondary of the ruptured steam generator. These types of enhancements will be considered in the Kewaunee severe accident management program. Kewaunee, it is concluded, does not exhibit any Level 2 vulnerabilities.

2.1.4.2 Plant Improvements

As noted in Section 2.1.4.1 of this report, Kewaunee will consider under its severe accident management program plant enhancements to mitigate containment bypasses caused by steam generator tube ruptures. The plant also will consider containment cooling restoration improvements.

2.1.5 Responses to CPI Program Recommendations

One recommendation of the CPI program pertaining to PWRs with large, dry containments is that utilities evaluate containment and equipment vulnerabilities to hydrogen combustion (local and global) as a part of IPE analysis and identify needs for improvements in procedures and equipment.

We could not locate in the original submittal [1] any section responding to the above recommendation. However, as noted in the submittal, analyses showed that "not enough hydrogen would accumulate to produce a deflagration that could challenge the containment ultimate pressure capacity." (Section 4.2.5.3, page 458). The phenomenological evaluation studies [3] included a "hydrogen detonations and deflagratives" section that supports the WPSC position that there are no containment vulnerabilities due to hydrogen generation.

2.2 IPE Strengths and Weaknesses

2.2.1 IPE Strengths

1. The IPE submittal contains a thorough discussion of the Kewaunee source term.

2. Wisconsin Public Service Corporation has performed sensitivity analyses to address the following:

   - Some in- and ex-vessel phenomena important for containment performance
   - Uncertainties of above phenomena
   - Uncertainties of MAAP modeling assumptions.

3. The IPE submittal is well written and well organized.

2.2.2 IPE Weaknesses

1. It is difficult for us to understand how the authors justify the quantitative results of the back-end portion of the IPE. The key issues that drive the important quantitative results are not addressed in the CETs. (For example, Section 4.3.1, page 448 of the submittal, notes that the Kewaunee IPE did not treat in the CET top events the phenomenological uncertainties of early containment failure resulting from steam explosions, direct containment heating, vessel thrust forces, and direct contact of shell with fuel debris.)

It is not imperative that all the issues be addressed in the context of the CETs. However, the CETs (in PRAs and other IPEs) do provide a traceable and understandable map of the quantification process and product. Absent this, the relationship between the quantitative results in the CETs and the deterministic analysis that supports the results should be delineated and understood.

This relationship is absent in the original IPE submittal [1]. For example, with regard to the phenomenological uncertainties mentioned above, no deterministic analysis is evident in the IPE original submittal; only abstracts of "phenomenological evaluation summaries." However, the relationship is presented in the responses to the RAI [3] (phenomenological evaluation studies). While the studies appear complete, no detailed review was performed.

2. The submittal does not show an understanding of the relationship between PDSs and the containment performance.

3. The Kewaunee definition of vulnerability is vague (Section 3.4.3, page 395): "WPSC defines a vulnerability as a feature in plant design, procedures, training, etc., which results in a contribution to core melt risk greater than what is expected."

3. OVERALL EVALUATION

As discussed in Section 2, this IPE submittal contains a large amount of back-end information, which contributes to the resolution of severe accident vulnerability issues at Kewaunee.

The fundamental conclusion stated in this IPE submittal is that the Kewaunee containment will not fail from severe accident loadings (pressure, temperature) during the first 48 hours after a severe accident occurs. (There is an 8-percent probability of a containment bypass and a very small "containment isolation" failure probability.) Although this conclusion may be valid, the information provided in the original submittal [1] is not sufficient to support this result. The subsequent response to the staff's RAI [3], does address the key phenomenological issues and thereby does support this result (note Section 2.1.1.1 of this TER).

4. REFERENCES

1. Wisconsin Public Services Corporation, "Kewaunee Individual Plant Examination Report," December 1992.

2. Wisconsin Public Services Corporation, Response Generic Letter 88-20, Individual Plant Examination, November 11, 1993.

3. Wisconsin Public Services Corporation, Response Generic Letter 88-20, Individual Plant Examination, June 3, 1994.

4. Wisconsin Public Services Corporation, Response Generic Letter 88-20, Individual Plant Examination, September 21, 1994.

APPENDIX

IPE EVALUATION AND DATA SUMMARY SHEET

PWR Back-end Facts

Plant Name

Kewaunee

Containment Type

PWR, large, dry

Unique Containment Features

Four containment fan cooling units and two internal containment spray trains, each equipped with heat exchangers; large, free-volume, with openings between compartments; cavity and instrument tunnel that de-entrain debris following a high-pressure melt ejection. The ultimate containment pressure is 2.7 times the design pressure (with 95-percent confidence), and the containment penetrations are capable of withstanding high-temperature conditions.

Unique Vessel Features

None found

Number of Plant Damage States

122

Ultimate Containment Failure Pressure

151 psig

Additional Radionuclide Transport And Retention Structures

Reference to auxiliary building structures (see page 470 of the submittal)

Conditional Probability That The Containment Is Not Isolated

0.00023

APPENDIX (continued)

IPE EVALUATION AND DATA SUMMARY SHEET

Important Insights, Including Unique Safety Features

Listed above under Unique Containment Features

Implemented Plant Improvements

None

C-Matrix

The information in the IPE submittal does not appear sufficient to generate a C-matrix.

APPENDIX C

KEWAUNEE NUCLEAR POWER PLANT INDIVIDUAL PLANT EXAMINATION

TECHNICAL EVALUATION REPORT

(HUMAN RELIABILITY ANALYSIS)