Clinton Power Station Unit 1

Determination of an Acceptable Bypass Leakage of Secondary Containment used in the Design Basis Analysis of the Radiological Consequences of a Loss-of-Coolant Accident

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PURPOSE

The purpose of this report is to demonstrate the acceptability of a Technical Specification limit of 11 percent unfiltered bypass leakage from the Clinton Unit 1 containment. This acceptability is based on meeting the regulatory requirements for the analysis of the radiological consequences of a Loss-of-coolant accident, and is demonstrated using the conservative dose conversion factors as used by the NRC.

SUMMARY OF DISCUSSION TOPICS

The following topics will be presented in the DISCUSSION section of this report:

1. Radiation safety benefits of 11 percent (vice 4%) bypass leakage limit.
2. Conservatisms in the bypass leakage calculations.
3. Conservatisms in the MSIV leakage calculations.
4. Conservatisms in the dose conversion factor calculations.
5. Appropriate limit for offsite dose calculations.
6. Appropriate operating power level assumption.
7. Re-estimate of 0-2 hour thyroid dose based on 11% bypass leakage.

BACKGROUND

The Clinton FSAR has proposed a maximum allowable containment leakage rate of 0.65% per 24 hours and a 12 percent unfiltered bypass. The FSAR also presents a computed time of 194 seconds between isolation of the normal secondary containment ventilation system and the establishment of 1/4 inch WG subatmospheric pressure within the secondary containment by the SGTS.

In the Clinton SER, the NRC staff states that under provisions of the SRP, all containment leakage during the 0-194 sec time period is considered as bypassing the SGTS, and because of this, "... the doses computed for the applicant's proposed Technical Specifications exceed the staff guidelines." The NRC then stated that a bypass leakage limit of 4 percent would be required for the CPS Technical Specifications.

Illinois Power believes that the NRC position is more restrictive than NRC's own regulations and in fact detracts from optimum plant nuclear safety. Specifically a 4 percent bypass leakage limit will contribute to a real increase in plant personnel exposure, whereas it is not required for meeting the off site dose limits resulting from a low probability loss-of-coolant accident.

DISCUSSION

1. Radiation safety benefits of 11 percent (vice 4%) bypass leakage limit

The valves and penetrations in the designated bypass paths have a design leakage of about 1/3 of the NRC proposed 4% bypass leakage limit. However, after several years of plant operation, it is likely that the leakage rate in these valves will approach the 4% limit. Therefore a very rigorous surveillance and maintenance program will be required which would tend to increase the radiation exposure of plant personnel.

The Clinton plant has committed (a) to comply with nuclear regulations that plant personnel doses be kept as low as reasonably achievable (ALARA) as well as (b) to meet regulations concerning calculated offsite doses.

An 11 percent bypass leakage limit would permit a more reasonable level of valve leakage surveillance and maintenance; this would therefore minimize unnecessary radiation exposure of plant personnel.

2. Conservatisms in the bypass leakage assumptions

Bypass leakage can hypothetically occur via process lines or penetrations which are routed between the primary containment atmosphere and the atmosphere outside secondary containment. In order for the bypass leakage to occur, piping or penetration failure must occur outside of secondary con-

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tainment. Often the failure must also occur inside the primary containment. The calculations do not take credit for the low probability of coincident failure of all bypass leakage paths.

In the Clinton SER, the NRC staff states that all containment leakage during the 0-194 second time period is considered as bypassing the SGTS. (The 194 seconds is the computed time for establishment of 1/4 inch WG subatmospheric pressure within secondary containment). Such a requirement is ultra-conservative:

a. Little, if any, transfer of radioactivity from the reactor to the primary containment, or from the primary to secondary containment would occur during the first 194 seconds.

b. For the relatively small amount of radioactivity transferred to the secondary containment during the first 194 seconds, very little would be released to the atmosphere during the first 194 seconds.

Illinois Power Co. believes that the acceptability of an 11 percent bypass leakage limit can be demonstrated, even without taking credit for these bypass leakage conservatisms.

3. Conservatisms in the MSIV leakage calculations

The NRC staff has not allowed credit for the transport

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delay related to the MSIV Leakage Control System (LCS) in calculating the off-site doses. Illinois Power Co. believes that such credit is appropriate and supported by RG 1.96, Revision 1 (Section C). In fact, RG 1.96 states that "Staff analyses of the contribution of main steam isolation valve leakage to total calculated offsite doses in postulated design-basis accidents made with conservative allowances for transport delay effects show that the 2-hour site boundary dose is not affected by the subject leakage." Allowing such credit would reduce the calculated total off-site dose, and would permit a higher bypass leakage.

4. Conservatisms in the dose conversion factor calculations

NRC staff has indicated in discussions with GE and IP, that dose conversion factors (DCF) (Rem/CI) from the Task Group Lung Model (TGLM) (Ref. NUREG-CR-0150) are preferred but that DCF's from TID-14844 are also acceptable. GE's calculation uses DCF's from NUREG-0172 (RG 1.109). The DCF's from TID-14844 are derived from ICRP #2 whereas the DCF's from NUREG-0172 are derived from ICRP #10. The factors in ICRP #2 and ICRP #10 are identical except that ICRP #10 takes into account the different half lives of the various iodine isotopes. NRC will accept TID-14844 (ICRP #2) because its DCF's

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are similar to the TGLM. The NRC prefers the TGLM because it conservatively assumes all iodine to be in the particulate form. In absence of data to the contrary, NRC staff does not allow credit for precipitation of some particulates prior to reaching exclusion area boundary. Also in absence of data to the contrary, NRC requires that the most restrictive particulate sizes to be assumed.

For comparison purposes, the DCF's from TID-14844 and Reg Guide 1.109 are summarized below:

	DCF's (Rem/Curie)	
Isotope	TID-14844	RG 1.109
I-131	$1.5x10^6$	$1.5x10^6$
I-132	$5.4x10^4$	$1.4x10^4$
I-133	$4.0x10^5$	$2.7x10^5$
I-134	$2.5x10^4$	$3.7x10^3$
I-135	$1.2x10^5$	$5.6x10^4$

5. Appropriate limits on offsite dose calculations

Regulatory Guide 1.3, Rev. 2, states that "It should be shown that the offsite dose consequences will be within the guidelines of 10CFR Part 100." The guidelines of 10CFR Part 100 provide the following limits:

a. Exclusion Area boundary 0-2 hr dose
   1. Whole body - 25 Rem
   2. Thyroid from iodine inhalation - 300 Rem

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   b. Low Population Zone boundary dose
      (during entire period of radioactive cloud passage)
      1. Whole body - 25 Rem
      2. Thyroid from iodine inhalation - 300 Rem

6. Appropriate operating power level assumption

The Clinton SER (Table 15-2) assumes an operating power level of 3039 Mwt (105% of Rated). Apparently this is based on SRP 15.65 App A (Rev 1), Paragraph III.1 which requires the reviewer to assume that the core has operated at design power level for about 3 years. The 105% of rated is the instantaneous power level for designing systems but should not be considered the design value for determining fission product inventory due to long term operation.

A more appropriate criteria for the assumed power level is given by SRP 15.6.5 (Rev 2) Paragraph III.4.a which requires a power level of 102% for evaluating ECCS performance. It is logical to conclude that if 102% of rated power is appropriate for ECCS performance analysis, then 105% of rated is excessive for fission product inventory calculations.

In summary, some conservatism in the assumed power level is appropriate. However an assumed power level of 102% of rated should be adequate to account for

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uncertainties in power level measurements, and is supported by SRP 15.6.5, Revision 2, Paragraph III.4.a.

7. Re-estimate of 0-2 hour thyroid dose based on 11% bypass

The Clinton SER tabulates the following NRC calculated radiological doses as a consequence of a design basis loss of coolant accident:

	0-2 hour doses, exclusion area boundary, rems		0-30 day doses, low population zone, rems	
Loss of Coolant Accident	thyroid	whole body	thyroid	whole body
Bypass	131	1	71	0.2
SGTS	28	10	27	3.4
LCS	16	6	16	2.0
Total	176	17	114	5.6

The above values are based on an assumed bypass leakage of 112 scfh. For assumed increases in bypass leakage, the 0.2 hr exclusion area boundary thyroid dose is clearly limiting.

Based on NRC's very conservative assumptions, the 0-2 hr thyroid dose is re-estimated for an 11 percent bypass leakage. First, estimate the portion of the 131 Rem

a. due to the 100% bypass during 0-194 sec and

b. due to the 4% bypass during 194 sec-2 hour

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$$(a) = \frac{100\% \times 194 \text{ sec}}{100\% \times 194 \text{ sec} + 4\% \times (7200-194) \text{ sec}} \times 131 \text{ Rem}$$

$$(a) = 53.6 \text{ Rem}$$

$$(b) = 131 - 53.6$$

$$(b) = 77.4 \text{ Rem}$$

Next, estimate the dose for a bypass leakage of 11%:

Bypass Leakage Dose (194 sec - 2 hr) $= \frac{11}{4} \times 77.4 = 212.9$ Rem

SGTS Dose $= 28 \text{ Rem} \times \frac{(1-0.11)}{(1-0.04)} = 26$ Rem

Next, adjust the doses for an assumed operating power level of 2952 Mwt (102% of rated)

100% Bypass Dose (0-194 sec) $= \frac{2952}{3039} \times 53.6 = 52.1$

11% Bypass Dose (0-2 hr) $= \frac{2952}{3039} \times 212.9 = 206.8$

SGTS $= \frac{2952}{3039} \times 26 = 25.3$

MSIV $= \frac{2952}{3039} \times 16 = 15.5$

Next, adjust the doses for no dose contribution from MSIV LCS.

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The re-estimates of the 2 hr thyroid dose are summarized below:

	NRC Calculated Dose	Re-estimates of NRC Dose		
	4% Bypass 3039 Mwt LCS Dose	11% Bypass 3039 Mwt LCS Dose	11% Bypass 2952 Mwt LCS Dose	11% Bypass 2952 Mwt No LCS Dos
Bypass	131	265.6	258.9	260.3
0-194 sec	(53.6)	(52.7)	(52.1)	
194sec-2hr	(77.4)	(212.9)	(206.8)	
SGTS	28	26	25.3	25.3
MSIV LCS	16	16	15.5	0
Total	176 Rem	307.6 Rem	299.7 Rem	285.6Re

In summary, a 2 hour exclusion area boundary thyroid dose of 285.6 Rem is estimated, using the following adjustments to NRC's very conservative assumptions:

(1) Increase bypass leakage from 4 percent to 11 percent

(2) Reduce the assumed reactor operating power level from 105% to 102% of rated.

(3) Eliminate the dose contribution from MSIV leakage by taking credit for fission product transport delay provided by the Leakage Control System.

The 285.6 Rem is less than the 300 Rem limit and therefore should be acceptable.

CONCLUSION

Based on the previous discussion, it is concluded that the Clinton Power Station Unit 1 can be operated safely with Technical Specification Limits of

a. 0.65%/24 hr containment integrated leak rate and

b. 11% unfiltered bypass leakage

We would hope that NRC will find our position acceptable and that such a finding will be included in a supplement to the Clinton SER.