Entergy

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December 30, 2003
BVY 03-119

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Subject: **Vermont Yankee Nuclear Power Station**
License No. DPR-28 (Docket No. 50-271)
Technical Specification Proposed Change No. 262
Alternative Source Term
Second Response to Request for Additional Information

This letter provides a response to NRC's request of December 1, 2003[1], for additional information (RAI) regarding Vermont Yankee's[2] (VY) license amendment request to incorporate an Alternative Source Term (AST) methodology into the Vermont Yankee Nuclear Power Station (VYNPS) licensing basis. VY originally proposed to amend Facility Operating License DPR-28 to support the full-scope application of the AST at VYNPS by letter dated July 31, 2003[3]. VY provided a partial response to the RAI by letter dated December 11, 2003[4]. The responses provided herewith address the remaining questions in the RAI.

Attachment 1 to this letter provides a response to the remaining three RAI questions (6, 8 and 9). The sensitivity evaluation information provided in response to RAI question 6 is not intended to expand the scope or change the conclusions of the analyses of the original application for license amendment. Our response to RAI No. 9 provides revised Safety Assessment Tables 2-3, 2-5, 2-6, 2-14, 3-1 and 3-4 (pages 36 – 41). These revised tables replace the aforementioned tables of the original safety assessment provided in the letter dated July 31, 2003[3].

The information and changes provided herewith do not change the determination of no significant hazards consideration.

[1] U.S. Nuclear Regulatory Commission letter to Entergy Nuclear Operations, Inc., "Vermont Yankee Nuclear Power Station – Alternative Source Term Request for Additional Information (TAC No. MC0253)," NVY 03-94, December 1, 2003.

[2] Entergy Nuclear Vermont Yankee, LLC and Entergy Nuclear Operations, Inc. are the licensees of the Vermont Yankee Nuclear Power Station.

[3] Vermont Yankee letter to U.S. Nuclear Regulatory Commission, "Proposed Change No. 262, Alternative Source Term," BVY 03-70, July 31, 2003.

[4] Vermont Yankee letter to U.S. Nuclear Regulatory Commission, "Proposed Change No. 262, Alternative Source Term, Response to Request for Additional Information," BVY 03-117, December 11, 2003.

A001

If you have any questions in this regard, please contact Mr. James DeVincentis at (802) 258-4236.

Sincerely,

Jay K. Thayer
Site Vice President

STATE OF VERMONT)
)ss
WINDHAM COUNTY)

Then personally appeared before me, Jay K. Thayer, who, being duly sworn, did state that he is Site Vice President of the Vermont Yankee Nuclear Power Station, that he is duly authorized to execute and file the foregoing document, and that the statements therein are true to the best of his knowledge and belief.

Mary J. Dower, Notary Public
My Commission Expires February 10, 2007

Attachment

cc:

- USNRC Region 1 Administrator
- USNRC Resident Inspector – VYNPS
- USNRC Project Manager – VYNPS
- Vermont Department of Public Service

Docket No. 50-271
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Attachment 1

Vermont Yankee Nuclear Power Station

Proposed Technical Specification Change No. 262

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RAI No. 6

In the Safety Assessment (Attachment 5) for this amendment request, on page 8 it states that an assumed post-isolation unfiltered inleakage rate equal to the pre-isolation unfiltered intake rate (3700 cubic feet per minute (cfm)) into the control room is used for the analyses. No credit was taken for manually placing the control room ventilation system into recirculation mode after the accident. Control room isolation is only achieved through manual initiation. In effect, these assumptions imply no credit for control room isolation after a design basis accident (DBA).

a. *Have you performed control room envelope inleakage testing? If so, what was the result, and how does that compare to the assumption of 3700 cfm of unfiltered inleakage?*

b. *Have you determined how the dose results of each of the postulated DBAs would be affected by assuming manual control room isolation occurs with a lesser unfiltered inleakage rate than currently assumed? A greater unfiltered inleakage rate?*

Response to RAI No. 6 a.

Vermont Yankee performed tracer gas testing of the Control Room envelope in 1982 which resulted in an in-leakage volumetric flow rate of 21.5 cfm. The assumption of 3700 cfm bounds the 1982 in-leakage measurement.

Response to RAI No. 6 b.

Each of the four DBA analyses (Loss of Coolant Accident (LOCA), Control Rod Drop Accident (CRDA), Fuel Handling Accident (FHA), and Main Steam Line Break (MSLB)) has been evaluated considering this RAI.

Summary of Sensitivity Evaluation Results

The FHA and MSLB Control Room dose analyses currently assume an infinite unfiltered exchange rate between the Control Room and the environment. LOCA and CRDA assume a value greater than the design allows. Therefore, greater unfiltered in-leakage values do not need to be considered.

With respect to isolation, the following results (in the third column of the following table) are for Control Room isolation assumed at t = 10 minutes and de-isolation at t = 25 minutes. It is possible that isolation occurring immediately following a large release could trap activity in the Control Room. However, prolonged isolation is not expected, because for the limiting events, outside air activity concentration rapidly falls below that of the isolated Control Room (when analyzed conservatively). The Control Room I-131 concentration (as an example) may be ~2,000 to ~10,000 times the Derived Air Concentration (DAC) at the time of isolation for the cases studied in this sensitivity evaluation. Fifteen minutes later, the outside air concentration would be a minimum of a factor of five less than the Control Room value.

Other conservatisms in the analyses compensate for not considering isolation in the original analyses. Any isolation would be a temporary condition and these sensitivity analyses demonstrate that isolation is unnecessary to protect the Control Room operators under DBA conditions.

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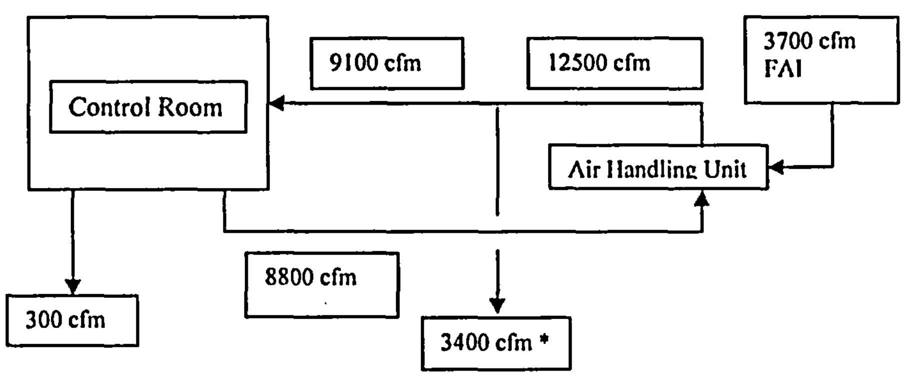
Event	Original Control Room Dose (3700 cfm continuous Control Room Ventilation)	Control Room Dose with Control Room Isolation and Other Analysis Enhancements
LOCA, SGTS failure	3.4 rem TEDE	4.2 rem TEDE (1)
LOCA, SGTS failure	3.4 rem TEDE	1.9 rem TEDE (2)
MSLB, "puff" χ/Q, 4.0 µCi/gm coolant activity	2.0 rem TEDE	2.3 rem TEDE

1. Control Room ventilation modeling enhancements only
2. Control Room ventilation modeling enhancements plus bypass hold-up (36 volumes per day Reactor Building (RB) exchange with environment after loss of normal ventilation until RB pressure negative at t = 10 minutes)

Background

The design of the Vermont Yankee Control Room ventilation system does not have High Efficiency Particulate Air (HEPA) or charcoal filtration. During normal operation, the ventilation system has a fresh air intake of 3700 cfm. However, the ventilation system is designed to supply the Control Room with about 2700 cfm of fresh air (i.e., (9100/12500)×3700) and the remaining fresh air is supplied to other building locations. This configuration is depicted on the following sketch.



* to Cable Vault

A "recirculation" ventilation mode exists where fresh air intake (FAI) is eliminated. However, placing the Heating Ventilation and Air Conditioning (HVAC) system in recirculation mode requires manual operator action that is controlled by procedure. The Control Room ventilation system is placed in recirculation mode for some conditions including high radiation.

Evaluation Methodology

The original analyses assumed either an infinite exchange rate of air between the Control Room and the environment (in which the operators were effectively assumed to breathe outside air - FHA and MSLB) or assumed no Control Room isolation (i.e., continued supply of outside air at 3700 cfm – LOCA and CRDA). The objective was to show that no isolation of the Control Room is needed (given AST) to provide adequate protection to Control Room operators.

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In terms of supplying air at rates greater than 3700 cfm, the FHA and MSLB already assume an infinite rate and the LOCA and CRDA assume maximum design rate. However, 3700 cfm is more than can actually be supplied.

With a Control Room volume of approximately 41,500 ft^3 and an exchange rate of 3700 cfm, it would require less than 34 minutes to provide three air changes in the Control Room. Even considering the fact that 27% of this fresh air is diverted to the Cable Vault (i.e., 3400/12500 cfm of total intake plus recirculation flows) the occupied space is still purged at a rate of about 2700 cfm (i.e. $(1-0.27) \times 3700$ cfm), providing three air changes in about 46 minutes. Therefore, should contamination levels within the Control Room become excessive because of normal ventilation during periods of high activity release (and atmospheric concentration) followed by isolation during periods of low activity release (and atmospheric concentration), the concentration of activity in the Control Room can be rapidly reduced to atmospheric levels and the original analyses have shown that such levels are acceptable. In other words, de-isolation can be implemented without a concern that the operator doses may exceed the Control Room dose limits of RG 1.183.

Presently, Control Room isolation is governed by Off-Normal Procedure ON-3153. According to this procedure, the decision to isolate is guided by (1) air samples taken in the Turbine Building being above 0.3 DAC values of 10CFR20 Appendix B, Table 1, Column 3 or (2) the existence of a "source of the abnormally high radiation levels [that] cannot be readily determined or contained ...". Both conditions call for the placement of the Control Room HVAC Recirc Mode Select switch in the "EMER" position. However, it is also noted in ON-3153 that "Steps [in the procedure] may be performed in any order ..." as directed by senior Operations personnel.

Certain Design Basis events (or specific variations of Design Basis events) provide the most significant challenge to Control Room habitability. These are the DBA-LOCA with failure of a Standby Gas Treatment System (SGTS) train (leading to a positive pressure period for the Reactor Building), and MSLB. These events lead to an assumed early and rapid ground level release of activity (unlike the CRDA and FHA events, for example) and these were re-evaluated in support of responding to the RAI with the following assumptions.

<u>Assumptions</u>

Assumption 1: The sensitivity evaluation assumed initial isolation of the Control Room would be within ten minutes (t = 10 minutes) for the DBAs listed above.

Justification: Within that time, for the DBAs listed above, it would be clear that a "source of ... abnormally high radiation levels [that] cannot be readily determined or contained ..." exists.

Assumption 2: If excessive activity concentration levels exist within the post-DBA Control Room, the sensitivity evaluation assumed action would be within twenty-five minutes (t = 25) minutes to de-isolate the Control Room if ambient atmospheric levels are much lower.

Justification: "Excessive" (as defined for the purposes of this assumption) is > ~83 times the DAC, since such a level would result in Control Room operator doses > 5 rem TEDE within ~24 hours. Since Control Room isolation, itself, is tied to Turbine Building airborne activity levels that might adversely impact the Control Room (established at a level of 0.3 times

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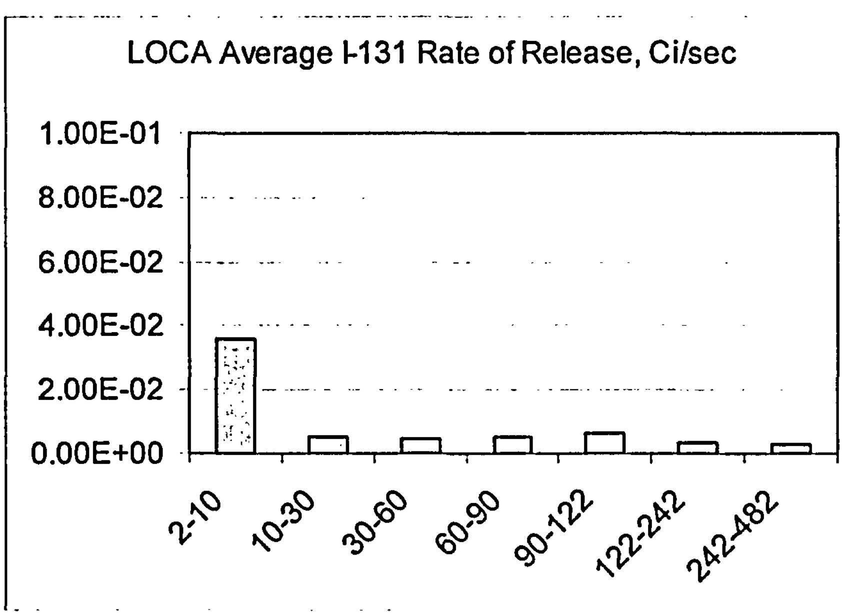
the DAC), it is reasonable to assume that a level 275 times greater within the Control Room would call for de-isolation as long as ambient atmosphere levels were lower.

Since (1) I-131 is the dominant dose contributor for all of the DBAs listed above, (2) the DAC for I-131 is 2E-8 μCi/cc (or Ci/m^3), and (3) the VY Control Room volume is approximately 41,500 ft^3 (or 1176 m^3), the activity in the Control Room may be considered "excessive" (for the purposes of this assumption) when the I-131 activity in the Control Room exceeds approximately 2E-3 Ci (i.e. 2E-08 × 1176 × 83).

As analyzed in the original analyses, the I-131 activity in the Control Room at ten minutes after the start of the LOCA and MSLB events is as follows:

Event	LOCA, SGTS failure, no Reactor Building hold-up for first 10 minutes	MSLB, conservative Polestar "puff" χ/Q, 4.0 μCi/gm coolant activity
Activity	7.1E-2 Ci	4.6E-2 Ci

As can be seen, the I-131 activity in the Control Room within 10 minutes into the event is considerably in excess of 2E-3 Ci. This is precisely the result of making analysis assumptions that skew the activity release to the beginning of the event. What this means is that the activity release will be decreasing substantially with time. This is evidenced by the following charts, based on the original analyses that show the release rate in Ci/sec as a function of time (minutes):



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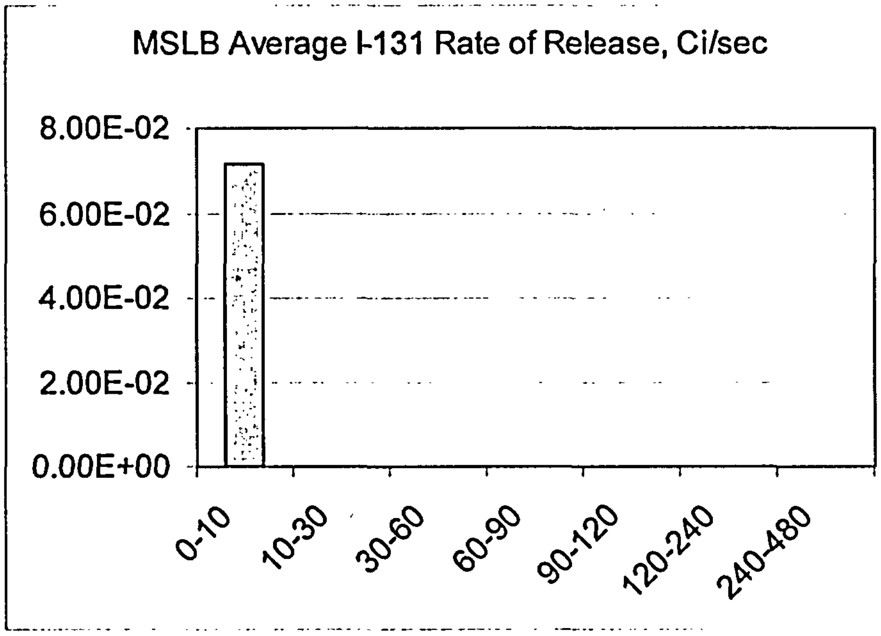

If, for each of the events, one considers the I-131 activity concentration in the Control Room at the end of ten minutes and compares it to "outside air" concentration based on the average I-131 release rate and the Control Room χ/Q between 10 and 30 minutes after the start of the event, the following comparison may be made:

Event	LOCA, SGTS failure, no Reactor Building hold-up for first 10 minutes	MSLB, conservative Polestar "puff" χ/Q, 4.0 µCi/gm coolant activity
CR I-131 Concentration at 10 min	6.1E-05 Ci/m^3 (3050 x DAC)	3.9E-05 Ci/m^3 (1950 x DAC)
Outside Air I-131 Concentration, 10 to 30 min	1.2E-05 Ci/m^3*	0.0E+00 Ci/m^3

*Based on reactor building N-2 line bypass pathway χ/Q

The minimum reduction is a factor of five lower concentration for the outside air (for the LOCA) beyond ten minutes. It is on the basis of (1) decreasing activity release with time and (2) the dramatically reduced outside air concentration that one can assume that isolation of the Control Room would not continue beyond 25 minutes after the start of the event for any of the limiting events being considered.

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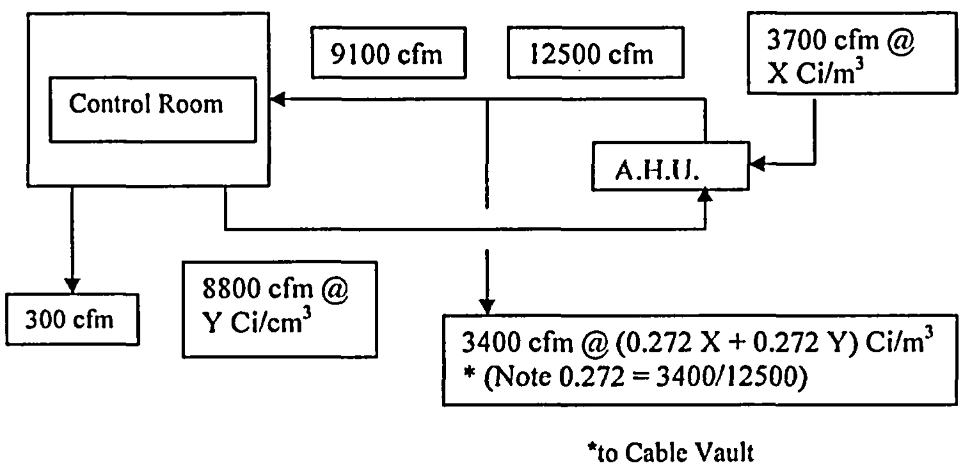
Design Inputs

Modeling in this evaluation will make use of the original analysis STARDOSE models for DBA-LOCA with SGTS failure. No STARDOSE model existed for MSLB, so one was developed for this evaluation.

Evaluation

LOCA

The Control Room ventilation model has been changed to reflect the actual configuration. In normal mode, 8800 cfm is recirculated and 3700 cfm of outside air is added to the mixing plenum. Of the total return flow of 12,500 cfm, 3400 cfm is delivered to the Cable Vault area, leaving 9100 cfm returning to the Control Room. Therefore, the 3400 cfm flow to the Cable Vault area acts like a 27.2% efficient filter for all activity (including noble gas), and this removal efficiency applies to both the 8800 cfm recirculation flow and the 3700 cfm intake flow. The normal Control Room exhaust is 300 cfm. In the emergency mode, Control Room leakage is assumed to be 22 cfm based on testing conducted in 1982. A graphical depiction of the normal operational mode (illustrating the 27.2% efficiency) is as follows:



The assumed Control Room isolation is at t = 10 minutes and the drywell sprays are assumed to be actuated five minutes later, at t = 15 minutes. The Reactor Building drawdown will have been completed by t = 10 minutes, as well, even with the loss of one train of SGTS. Therefore, with the elimination of activity being released at ground level from the Reactor Building and with the drywell sprays operating five minutes after the establishment of the secondary containment function, one would expect a decreasing atmospheric activity concentration. Indeed, that is what has been observed (Assumption 2).

The original LOCA analysis contains the conservatism of the Control Room ventilation system simplification. In addition to that conservatism, there are several others: (1) the fact that during the 10 minute drawdown period, the Reactor Building is actually at a positive pressure for only six minutes and (2) the fact that nitrogen supply system secondary containment bypass pathway will exhibit aerosol retention characteristics similar to those of the steam lines (72% aerosol removal efficiency). However, there is another major conservatism as follows:

- The normal Reactor Building ventilation system provides for about 1.5 volume changes per hour (36 volume changes per day) and an elevated release. If it were assumed that forced ventilation ceases immediately at the start of the accident, that the reactor building pressure immediately becomes positive, and that the reactor building leaks at ground level at a rate equal to that of the forced ventilation exchange (36 volume changes per day), the containment leakage now assumed to be instantaneously released to the environment would experience a hold-up equivalent to about 2.5E-2 volumes per minute. The containment leakage could be assumed to experience this degree of hold-up for the first 10 minutes during the time that the remaining SGTS train is drawing down the reactor building. The release is still a bypass release with no credit for filtration or the stack (as an elevated release point).

MSLB

In order to study the impact of Control Room isolation for the MSLB, it was necessary to develop a STARDOSE model similar to those that already existed for the LOCA. What is unique about MSLB is the ground level "puff" release rather than a continuous release. To model a puff, the simplest approach is to create a control volume with the same volume as the puff, introduce the coolant activity into that volume, and then draw activity into the Control Room using the appropriate makeup or in-leakage rate and the appropriate transit time for the puff.

The original analysis steam puff volume is 3.64E+4 m^3 (1.272E6 ft^3). For the simple Polestar hemispherical puff passing by the intake at the puff's maximum diameter, the time is 51.7 seconds (0.0144 hours) at an assumed wind speed of 1.0 m/sec (see original analysis). This yields a normalized time-integrated concentration of 51.7 sec/3.6E4 m^3 = 1.44E-3 sec/m^3.

The original analysis included a calculation using the NRC model for puff release given in RG-1.194. The NRC model considers a three-dimensional Gaussian distribution of the activity within the puff. When integrated from -3σ to $+3\sigma$ (the NRC default integration), the result (as in the original analysis) is about 1.16E-3 sec/m^3. However, this would imply a distance from the point of the release to the Control Room air intake of about 50 m (since σ, according to NRC model for a 3.6E4 m^3 puff, would be about 16.6 m). It's not likely that the distance would actually be more than about 33 m (i.e., about 2σ) which means that about 2.5% of the 3σ integration is not actually appropriate. This would bring the integral down to about 1.13E-3 sec/m^3, about 22% less than the value obtained using the assumed hemispherical puff with a uniform activity distribution within (i.e. 1.44E-3 sec/m^3). The 1.13E-3 sec/m^3 was used in this evaluation after benchmarking the model using the 1.44E-3 sec/m^3 value.

Sensitivity Case Results

The Control Room dose results for the original LOCA, and MSLB cases, respectively, compared to the results of this sensitivity evaluation (considering both Control Room isolation and the removal of some conservatisms) are as follows:

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Event	Original Control Room Dose (3700 cfm continuous Control Room Ventilation)	Control Room Dose with Control Room Isolation and Other Analysis Enhancements
LOCA, SGTS failure	3.4 rem TEDE	4.2 rem TEDE (1)
LOCA, SGTS failure	3.4 rem TEDE	1.9 rem TEDE (2)
MSLB, "puff" X/Q, 4.0 μCi/gm coolant activity	2.0 rem TEDE	2.3 rem TEDE

1. Control Room ventilation analytical model enhancements only
2. Control Room ventilation analytical model enhancements plus bypass hold-up (36 volumes per day RB exchange with environment after loss of normal ventilation until RB pressure negative at t = 10 minutes)

Conclusions

The FHA and MSLB Control Room dose analyses currently assume an infinite unfiltered exchange rate between the Control Room and the environment. LOCA and CRDA assume a value greater than the design allows. Therefore, greater unfiltered in-leakage values do not need to be considered. It has been shown in the original analyses that an isolated Control Room is not necessary to limit Control Room operator doses to the dose limits of RG 1.183.

Two limiting events (and specific variations of those events) have been identified that involve a rapid ground level release of activity to the environment at the onset of the event. This rapid and early release at the ground level permits significant levels of activity (~2,000 to ~10,000 DAC for I-131, for example) to be brought into the Control Room prior to isolation. The CRDA and FHA are not one of those events.

There was no assessment performed for the FHA since the activity released was assumed to be instantaneous at an elevated level (stack) resulting in a relatively low atmospheric concentration at the Control Room fresh air intake. This is evidenced in the calculated Control Room dose of 0.15 rem TEDE.

For the CRDA, no assessment was performed. This is because the activity release occurs uniformly (one percent condenser volume per day and 1.6 %/day for the coolant activity); and therefore, the kind of behavior exhibited by the limiting events in which a large ground level release occurs early followed by a much reduced release immediately following is not a factor.

Prolonged isolation is not expected because, for the limiting events, outside air activity concentration rapidly falls below that of the isolated Control Room (when analyzed conservatively). As noted, the Control Room I-131 concentration (as an example) may be ~2,000 to ~10,000 times the DAC at the time of isolation for the cases studied in this calculation. Fifteen minutes later, the outside air concentration would be a minimum of a factor of five less than the Control Room value.

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With respect to Control Room isolation, the justifications for Assumptions 1 and 2 support the conservatism of assuming isolation at t = 10 minutes and de-isolation at t = 25 minutes for the purposes of this study. The effect of isolation (which does tend to increase the Control Room dose if effected when atmospheric activity concentrations are very high) is largely compensated for by other conservatisms in the calculation.

In all of the original calculations, the Control Room ventilation was modeled as a continuous 3700 cfm exchange with the environment. In fact, the effective value is approximately 2700 cfm. This is one of the conservatisms removed in this study.

Additional conservatisms removed are as follows:

For the LOCA, minimal hold-up in the Reactor Building was assumed during the first 10 minutes when (for roughly six minutes out of the 10) the Reactor Building might be above atmospheric pressure. During this 10 minutes, a ground-level release was assumed at a rate equal to the normal ventilation exhaust rate, even though the normal ventilation exhaust rate is sufficient to maintain the building at a negative pressure. With the normal ventilation off (the condition that leads to the transient positive pressure for the case of one SGTS train having failed), the natural exchange would have to be less than this value given that the building was at a negative pressure with respect to all sides when the normal ventilation was on. The Control Room dose for this case is 1.9 rem TEDE even with isolation; less than the original analysis value of 3.4 rem TEDE.

For the MSLB, no additional conservatisms were removed. The Control Room dose for this case is 2.3 rem TEDE even with isolation; only 15% greater than the original analysis value of 2.0 rem TEDE. However, this result is for a coolant activity of 4.0 μCi/gm Dose Equivalent (DE) I-131, 3.64 times greater than the Technical Specification value of 1.1 μCi/gm. Using 1.1 μCi/gm would reduce the Control Room dose to 0.6 rem TEDE even with isolation.

Overall, it has been shown that not considering isolation is compensated for by other conservatisms in the analysis. Isolation would be a temporary condition, and it has been shown to be unnecessary to protect the Control Room operators under DBA conditions.

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RAI No. 8

With respect to Attachment 5, please provide a detailed description of all inputs and assumptions for all relative concentration (χ/Q) values not previously approved by the U.S. Nuclear Regulatory Commission (NRC). This appears to include the exclusion area boundary ground level reactor building (RB) bypass and siding, and stack 2-8 and 8-24 hour χ/Q values; the low population zone (LPZ) ground level main steam isolation valve (MSIV) and ground level RB bypass and siding χ/Q values; and the control room χ/Q values for the loss-of-coolant accident (LOCA), main steam line break (MSLB), and fuel handling accidents. Note 3 of Table 2-6 states that control rod drop accident ground level release LPZ χ/Q values are documented in the UFSAR. Were these values previously approved by the NRC? If so, please provide a reference citation.

Response to RAI No.8

The (χ/Q) tabulations and associated design inputs are presented in Tables 1-21, in the following sequence:

Table 1*	LOCA - MSIV Leakage (Turbine Building Releases) to EAB
Table 2	LOCA - RB Bypass and RB Siding Releases to EAB
Table 3*	LOCA - Stack Releases to EAB
Table 4	LOCA - MSIV Leakage, RB Bypass and RB Siding Releases to LPZ
Table 5*	LOCA - Stack Releases to LPZ
Table 6	LOCA - RB Bypass Releases to CR and TSC
Table 7	LOCA - RB Siding Releases to CR and TSC
Table 8	LOCA - MSIV Leakage (via Turbine Building) to CR and TSC
Table 9	LOCA - Stack Releases to CR and TSC
Table 10*	MSLB - Ground-Level Release to EAB
Table 11	MSLB - Ground-Level Steam Puff Release to CR
Table 12*	Refueling Accident - Ground-Level Releases to EAB
Table 13*	Refueling Accident - Stack Releases to EAB
Table 14	Refueling Accident - Ground-Level Releases to CR
Table 15*	Refueling Accident - Stack Releases to CR
Table 16*	CRDA - Ground-Level Releases to EAB
Table 17*	CRDA - Stack Releases to EAB
Table 18	CRDA - Ground-Level Releases to LPZ
Table 19*	CRDA - Stack Releases to LPZ
Table 20*	CRDA - Ground-Level Releases to CR
Table 21*	CRDA - Stack Releases to CR

The following are noted:

(a) Tables with asterisks (*) above indicate prior NRC review and approval of the (χ/Q)s (TAC No. MB4610. License Amendment 212). In all these cases, the computer code employed was SKIRON-II.

(b) The (χ/Q)s for a given release point and a given receptor may appear in more than one table, for different accidents. For the EAB and ground-level releases, for instance, Tables 1 (LOCA), 10 (MSLB), 12 (RA) and 16 (CRDA) are identical. This was done to provide a complete set of (χ/Q)s for each design-basis accident, independently.

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Table 1
Design Input for Atmospheric Dispersion Factors
LOCA - MSIV Leakage (Turbine Building Releases) to EAB
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 2 hrs	
	1.69E-03	
Design Input	Release height	Ground level
	Building cross-sectional area for building wake effects	954.2 m^2
	Building height (for building wake effects)	21.3 m
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms	0.268 m/sec
	Wind speed adjustment with height	Not considered
	Plume rise	Not applicable
	Average depth of limited mixing layer (for plume reflection)	950 m
	Temperature sensor separation (198' - 33')	50.3 m
	Plume meander	Considered
	Receptor distances (minimum distance from the turbine building to the site area boundary for gaseous effluents within a 45-degree sector centered on the compass direction of interest, per Sec. C.1.2 of Reg. Guide 1.145):	
	Downwind sector: N	439.1 m
	NNE	436.9 m
	NE	436.9 m
	ENE	474.9 m
	E	474.9 m
	ESE	448.1 m
	SE	457.0 m
	SSE	483.9 m
	S	233.0 m
	SSW	188.2 m
	SW	183.7 m
	WSW	183.7 m
	W	192.7 m
	WNW	206.1 m
	NW	268.8 m
	NNW	537.7 m
	Terrain height above release-point grade elevation (all sectors)	0 m
Computer Code & Met Data Base	SKIRON-II (1989 met data)	
Notes	This atmospheric dispersion factor has been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Page 4)	

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Table 2
Design Input for Atmospheric Dispersion Factors
LOCA - RB Bypass and RB Siding Releases to EAB

(χ/Q)s (sec/m^3)	0 - 2 hrs					
	1.476E-03					
Design Input	Upper wind speed in each wind-speed group (11 groups)					0.42 (m/sec) 0.89, 1.56 3.35, 5.59 8.27, 10.95 14.08, 17.21 20.78, 40.23
	Wind speed assigned to calms					0.21 m/sec
	Release height					0 m
	Adjacent building height (above release point grade)					41.5 m
	Adjacent building cross-sectional area					1416 m^2
	Average depth of limited mixing layer (for plume reflection)					950 m
	Temperature sensor separation (198' - 33')					50.3 m
	Distances to site area boundary for gaseous effluents (N through NNW, clockwise)					424 m 415 m 415 m 419 m 445 m 445 m 455 m 506 m 344 m 252 m 242 m 242 m 244 m 284 m 384 m 502 m
	Terrain height at receptor locations with respect to grade elevation at release point (all sectors) [Has no impact since > release height]					2.44 m
	Plume meander					Considered
	Wind speed adjustment with height					Not considered
	Recirculation correction for annual (χ/Q)s					Not considered
Computer Code & Met Data Base	AEOLUS-3 (1995-1999 met data)					
Notes	The RB siding (χ/Q) bounds the RB Bypass. The RB siding release was used for both releases.					

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Table 3
Design Input for Atmospheric Dispersion Factors
LOCA - Stack Releases to EAB
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 0.5 hr	0.5 - 1 hr	1 - 2 hrs	2 - 8 hrs	8 - 24 hrs	
	2.03E-04	1.54E-04	9.17E-05	4.04E-05	5.26E-06	
Design Input [0 - 0. 5 hr, Fumigation Conditions	Stack height					93.9 m
	Terrain height at receptor of interest					2.4 m
	Critical receptor distances from stack (shortest distance from the stack to a receptor on the Site Area Boundary for Gaseous Effluents within a 45-degree sector centered on the compass direction of interest, per Sec. C.1.2 of Reg. Guide 1.145)					253 m (WSW)
	Plume standard deviations at 253 m: sigma-y sigma-z					10.7 m 4.8 m
	Wind speed					2 m/sec
Design Input [0. 5 - 24 hrs, Normal Conditions]	Release height (stack height)					93.9 m
	Building cross-sectional area and height for building wake effects, and plume meander					Not applicable
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (295'-33')					79.9 m
	Plume rise					Not credited
	Average depth of limited mixing layer (for plume reflection)					950 m
	Critical receptor distances from stack (where the terrain height first exceeds the stack height)					2100 m
	Terrain height at critical receptor (W sector)					106.1 m
Computer Code & Met Data Base	Hand calculated value for the fumigation condition (based on Reg. Guide 1.145). SKIRON-II (1985 met data) for the normal atmospheric conditions.					
Notes	The (χ/Q)s for 0-0.5, 0.5-1 and 1-2 hrs have been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Table 1)					

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Table 4
Design Input for Atmospheric Dispersion Factors
LOCA - MSIV Leakage, RB Bypass and RB Siding Releases to LPZ

(χ/Q)s (sec/m^3)	0 - 2 hrs	2 - 8 hrs	8 - 24 hrs	1 - 4 days	4 - 30 days	
	5.25E-05	2.23E-05	1.47E-05	5.95E-06	1.63E-06	
Design Input	Upper wind speed in each wind-speed group (11 groups)					0.42 (m/sec) 0.89, 1.56 3.35, 5.59 8.27, 10.95 14.08, 17.21 20.78, 40.23
	Wind speed assigned to calms					0.21 m/sec
	Release height					0 m
	Adjacent building height (above release point grade)					41.5 m
	Adjacent building cross-sectional area					1416 m^2
	Average depth of limited mixing layer (for plume reflection)					950 m
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (198' - 33')					50.3 m
	Distances to receptors of interest at the LPZ (same for all sectors)					8050 m
	Terrain heights at receptor locations with respect to grade elevation at release point (N through NNW, clockwise) [Provided as input but have no impact on the (χ/Q)s since the release height is 0.]					234.1 m 319.4 313.3 265.8 203.6 275.5 100.0 154.8 302.7 282.9 267.6 340.8 325.5 252.4 181.1 179.2
	Plume meander					Considered
	Recirculation correction for annual (χ/Q)s					Not considered
Computer Code & Met Data Base	AEOLUS-3 (1995-1999 met data)					
Notes	In view of the LPZ 5-mile distance, the MSIV, RB Bypass and RB Siding (χ/Q)s are the same.					

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Table 5
Design Input for Atmospheric Dispersion Factors
LOCA - Stack Releases to LPZ
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 1 hr	1 - 2 hrs	2 - 8 hrs	8 - 24 hrs	1 - 4 days	4 - 30 days
	2.55E-05	1.87E-05	1.01E-05	1.09E-06	6.90E-07	4.61E-07
Design Input	Release height (stack height)					93.9 m
	Building cross-sectional area and height for building wake effects, and plume meander					Not applicable
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (295'-33')					79.9 m
	Plume rise					Not credited
	Average depth of limited mixing layer (for plume reflection)					950 m
	Receptor distance from stack (all sectors)					5 miles (8047 m)
	Terrain height at receptors (arbitrarily set higher than the release height of 93.9 m; i.e., plume centerline is at ground level)					100 m
Computer Code & Met Data Base	SKIRON-II (1985 met data)					
Notes	These (χ/Q)s have been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Table 1)					

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Table 6
Design Input for Atmospheric Dispersion Factors

LOCA - RB Bypass Releases to CR and TSC

(χ/Q)s (sec/m^3)	0 - 2 hrs	2 - 8 hrs	8 - 24 hrs	1 - 4 days	4 - 30 days	
	2.25E-03	8.18E-04	3.53E-04	2.77E-04	2.23E-04	
Design Input	Height of lower wind instrument					10.7 m
	Height of upper wind instrument					90.5 m
	Wind speed units					mph
	Release type					Ground level, point source
	Release height					1.8 m
	Building cross-sectional area					1746 m^2
	Effluent vertical velocity, vent or stack flow, vent stack radius					0
	Direction, intake to source (sector width)					111 deg (90)
	Distance to intake					41 m
	Intake height					10.5
	Terrain elevation difference					0
	Minimum wind speed					0.5 m/sec
	Surface roughness					0.2 m
	Sector averaging constant					4.3
	Initial plume standard deviations (sigma-y and sigma-z)					0 m
Computer Code & Met Data Base	ARCON96 (1995-1999 met data)					

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Table 7
Design Input for Atmospheric Dispersion Factors

LOCA - RB Siding Releases to CR and TSC

(χ/Q)s (sec/m^3)	0 - 0.5 hr					
	2.98E-03					
Design Input	Height of lower wind instrument					10.7 m
	Height of upper wind instrument					90.5 m
	Wind speed units					mph
	Release type					Ground level, diffuse area
	Release height					34.9 m
	Building cross-sectional area					0 m^2
	Effluent vertical velocity, vent or stack flow, vent stack radius					0
	Direction, intake to source (sector width)					75 deg (90)
	Distance to intake					9.8 m
	Intake height					10.5
	Terrain elevation difference					0
	Minimum wind speed					0.5 m/sec
	Surface roughness					0.2 m
	Sector averaging constant					4.3
	Initial plume standard deviations: sigma-y sigma-z					7.3 m 2.1 m
Computer Code & Met Data Base	ARCON96 (1995-1999 met data)					
Notes	Applicable only during RB draw-down time.					

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Table 8
Design Input for Atmospheric Dispersion Factors

LOCA - MSIV Leakage (via Turbine Building) to CR and TSC

(χ/Q)s (sec/m^3)	0 - 2 hrs	2 - 8 hrs	8 - 24 hrs	1 - 4 days	4 - 30 days	
	4.66E-03	3.46E-03	1.45E-03	1.09E-03	9.92E-04	
Design Input	Height of lower wind instrument					10.7 m
	Height of upper wind instrument					90.5 m
	Wind speed units					mph
	Release type					Ground level, point source
	Release height					2.3 m
	Building cross-sectional area					150 m^2
	Effluent vertical velocity, vent or stack flow, vent stack radius					0
	Direction, intake to source (sector width)					296 deg (90)
	Distance to intake					33 m
	Intake height					10.5
	Terrain elevation difference					0
	Minimum wind speed					0.5 m/sec
	Surface roughness					0.2 m
	Sector averaging constant					4.3
	Initial values of sigma-y and sigma-z					0 m
Computer Code & Met Data Base	ARCON96 (1995-1999 met data)					

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Table 9
Design Input for Atmospheric Dispersion Factors

LOCA - Stack Releases to CR and TSC

$(\chi/Q)s$ (sec/m^3)	0 - 2 hrs	2 - 8 hrs	8 - 24 hrs	1 - 4 days	4 - 30 days	
	1.92E-05	8.28E-07	3.36E-07	3.08E-07	1.79E-07	
Design Input (ARCON96)	Height of lower wind instrument					10.7 m
	Height of upper wind instrument					90.5 m
	Wind speed units					mph
	Release type					Elevated
	Release height					93.9 m
	Building cross-sectional area					0.01 m^2
	Effluent vertical velocity, vent or stack flow, vent stack radius					0
	Direction, intake to source (sector width)					337 deg (90)
	Distance to intake					276 m
	Intake height					10.5
	Terrain elevation difference					0
	Minimum wind speed					0.5 m/sec
	Surface roughness					0.2 m
	Sector averaging constant					4.3
	Initial values of sigma-y and sigma-z					0 m

Continued

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Table 9 (Continued)

LOCA - Stack Releases to CR and TSC

Design Input (AEOLUS-3)	Upper wind speed in each wind-speed group (11 groups)	0.42 (m/sec) 0.89, 1.56 3.35, 5.59 8.27, 10.95 14.08, 17.21 20.78, 40.23
	Release height [set equal to the difference between the heights of the stack (93.9) and the CR intake (10.5 m)]	83.4 m
	Building cross-sectional area and height for building wake effects, and plume meander	Not applicable
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms	0.447 and 0.21 m/sec
	Wind speed adjustment with height	Not considered
	Temperature sensor separation (295'-33')	79.9 m
	Plume rise	Not credited
	Average depth of limited mixing layer (for plume reflection)	950 m
	Receptor distances (looking for maximum χ/Qs)	30 distances: 400 - 7500 m
	Terrain elevation (set equal to the effective elevation of the CR intake)	0 m
	Recirculation correction on annual average (χ/Q)	Not considered
Computer Code & Met Data Base	ARCON96 and AEOLUS-3 (1995-1999 met data)	
Notes	a. The ARCON96 and AEOLUS-3 results were combined in accordance with the guidance in Reg. Guide 1.194 b. The AEOLUS-3 (χ/Q)s peak at 3000 m for the 0-2, 2-8 and 8-24 hr intervals, and at 2500 m thereafter.	

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Table 10
Design Input for Atmospheric Dispersion Factors

MSLB - Ground-Level Release to EAB
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 2 hrs					
	1.69E-03					
Design Input	Release height					Ground level
	Building cross-sectional area for building wake effects					954.2 m^2
	Building height (for building wake effects)					21.3 m
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Plume rise					Not applicable
	Average depth of limited mixing layer (for plume reflection)					950 m
	Temperature sensor separation (198' - 33')					50.3 m
	Plume meander					Considered
	Receptor distances (minimum distance from the turbine building to the site area boundary for gaseous effluents within a 45-degree sector centered on the compass direction of interest, per Sec. C.1.2 of Reg. Guide 1.145):					
	Downwind sector: N					439.1 m
	NNE					436.9 m
	NE					436.9 m
	ENE					474.9 m
	E					474.9 m
	ESE					448.1 m
	SE					457.0 m
	SSE					483.9 m
	S					233.0 m
	SSW					188.2 m
	SW					183.7 m
	WSW					183.7 m
	W					192.7 m
	WNW					206.1 m
	NW					268.8 m
	NNW					537.7 m
	Terrain height above release-point grade elevation (all sectors)					0 m
Computer Code & Met Data Base	SKIRON-II (1989 met data)					
Notes	This atmospheric dispersion factor has been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Page 4)					

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Table 11
Design Input for Atmospheric Dispersion Factors

MSLB - Ground-Level Steam Puff Release to CR

(χ/Q)s (sec/m^3)	0 - 2 hrs				
	1.44E-03				
Design Input	Please see Polestar calculation PSAT 3019CF.QA.06 for details.				
Reference					
Computer Code & Met Data Base					

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Table 12
Design Input for Atmospheric Dispersion Factors
Refueling Accident - Ground-Level Releases to EAB
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 2 hrs					
	1.69E-03					
Design Input	Release height					Ground level
	Building cross-sectional area for building wake effects					954.2 m^2
	Building height (for building wake effects)					21.3 m
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Plume rise					Not applicable
	Average depth of limited mixing layer (for plume reflection)					950 m
	Temperature sensor separation (198' - 33')					50.3 m
	Plume meander					Considered
	Receptor distances (minimum distance from the turbine building to the site area boundary for gaseous effluents within a 45-degree sector centered on the compass direction of interest, per Sec. C.1.2 of Reg. Guide 1.145):					
	Downwind sector: N					439.1 m
	NNE					436.9 m
	NE					436.9 m
	ENE					474.9 m
	E					474.9 m
	ESE					448.1 m
	SE					457.0 m
	SSE					483.9 m
	S					233.0 m
	SSW					188.2 m
	SW					183.7 m
	WSW					183.7 m
	W					192.7 m
	WNW					206.1 m
	NW					268.8 m
	NNW					537.7 m
	Terrain height above release-point grade elevation (all sectors)					0 m
Computer Code & Met Data Base	SKIRON-II (1989 met data)					
Notes	Presented here for information only since FHA analysis applied an elevated release.					

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Table 13
Design Input for Atmospheric Dispersion Factors
Refueling Accident - Stack Releases to EAB
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 0.5 hr	0.5 - 1 hr	1 - 2 hrs			
	2.03E-04	1.54E-04	9.17E-05			
Design Input [0 - 0. 5 hr, Fumigation Conditions	Stack height					93.9 m
	Terrain height at receptor of interest					2.4 m
	Critical receptor distances from stack (shortest distance from the stack to a receptor on the Site Area Boundary for Gaseous Effluents within a 45-degree sector centered on the compass direction of interest, per Sec. C.1.2 of Reg. Guide 1.145)					253 m (WSW)
	Plume standard deviations at 253 m: sigma-y sigma-z					10.7 m 4.8 m
	Wind speed					2 m/sec
Design Input [0. 5 - 24 hrs, Normal Conditions]	Release height (stack height)					93.9 m
	Building cross-sectional area and height for building wake effects, and plume meander					Not applicable
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (295'-33')					79.9 m
	Plume rise					Not credited
	Average depth of limited mixing layer (for plume reflection)					950 m
	Critical receptor distances from stack (where the terrain height first exceeds the stack height)					2100 m
	Terrain height at critical receptor (W sector)					106.1 m
Computer Code & Met Data Base	Hand calculated value for the fumigation condition (based on Reg. Guide 1.145). SKIRON-II (1985 met data) for the normal atmospheric conditions.					
Notes	These (χ/Q)s have been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Table 1)					

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Table 14
Design Input for Atmospheric Dispersion Factors
Refueling Accident - Ground-Level Releases to CR

(χ/Q)s (sec/m³)	0 - 2 hr					
	5.89E-03					
Design Input	Height of lower wind instrument					10.7 m
	Height of upper wind instrument					90.5 m
	Wind speed units					mph
	Release type					Ground level, point source
	Release height					34.9 m
	Building cross-sectional area					1337.3 m^2
	Effluent vertical velocity, vent or stack flow, vent stack radius					0
	Direction, intake to source (sector width)					75 deg (90)
	Distance to intake					9.8 m
	Intake height					10.5
	Terrain elevation difference					0
	Minimum wind speed					0.5 m/sec
	Surface roughness					0.2 m
	Sector averaging constant					4.3
	Initial values of sigma-y and sigma-z					0 m
Computer Code & Met Data Base	ARCON96 (1995-1999 met data)					
Notes	Presented here for information only since FHA analysis applied an elevated release.					

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Table 15
Design Input for Atmospheric Dispersion Factors
Refueling Accident - Stack Releases to CR
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 0.5 hr	0.5 - 1 hr	1 - 2 hr			
	2.39E-04	1.05E-06	8.70E-07			

Design Input [0 - 0. 5 hr, Fumigation Conditions]	Stack height	93.9 m
	Distance from stack to CR building	213 m
	Terrain height at receptor of interest	2.4 m
	Plume standard deviations at 213 m: sigma-y sigma-z	9.1 m 4.2 m
	Wind speed	2 m/sec
Design Input [0.5 - 24 hrs, Normal Conditions]	Release height (stack height)	93.9 m
	Building cross-sectional area and height for building wake effects, and plume meander	Not applicable
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms	0.268 m/sec
	Wind speed adjustment with height	Not considered
	Temperature sensor separation (295'-33')	79.9 m
	Plume rise	Not credited
	Average depth of limited mixing layer (for plume reflection)	950 m
	Distance from stack to CR air intake [Note: The concentration at the intake is higher than at the CR building, since, for elevated plumes, the plume spreads closer to the ground as the distance from the release point increases.]	259 m (SSE)
	Terrain height at receptor of interest	2.4 m
Computer Code & Met Data Base	Hand calculated value for the fumigation condition (based on Reg. Guide 1.145). SKIRON-II (1985 met data) for the normal atmospheric conditions	
Notes	These (χ/Q)s, as well as those for the remaining time intervals beyond 2 hrs (see Table 21), have been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Table 1)	

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Table 16
Design Input for Atmospheric Dispersion Factors
CRDA - Ground-Level Releases to EAB
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 2 hrs					
	1.69E-03					
Design Input	Release height					Ground level
	Building cross-sectional area for building wake effects					954.2 m^2
	Building height (for building wake effects)					21.3 m
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Plume rise					Not applicable
	Average depth of limited mixing layer (for plume reflection)					950 m
	Temperature sensor separation (198' - 33')					50.3 m
	Plume meander					Considered
	Receptor distances (minimum distance from the turbine building to the site area boundary for gaseous effluents within a 45-degree sector centered on the compass direction of interest, per Sec. C.1.2 of Reg. Guide 1.145): Downwind sector: N NNE NE ENE E ESE SE SSE S SSW SW WSW W WNW NW NNW					439.1 m 436.9 m 436.9 m 474.9 m 474.9 m 448.1 m 457.0 m 483.9 m 233.0 m 188.2 m 183.7 m 183.7 m 192.7 m 206.1 m 268.8 m 537.7 m
	Terrain height above release-point grade elevation (all sectors)					0 m
Computer Code & Met Data Base	SKIRON-II (1989 met data)					
Notes	This atmospheric dispersion factor has been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Page 4)					

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Table 17
Design Input for Atmospheric Dispersion Factors
CRDA - Stack Releases to EAB
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 0.5 hr	0.5 - 1 hr	1 - 2 hrs			
	2.03E-04	1.54E-04	9.17E-05			
Design Input [0 - 0. 5 hr, Fumigation Conditions	Stack height					93.9 m
	Terrain height at receptor of interest					2.4 m
	Critical receptor distances from stack (shortest distance from the stack to a receptor on the Site Area Boundary for Gaseous Effluents within a 45-degree sector centered on the compass direction of interest, per Sec. C.1.2 of Reg. Guide 1.145)					253 m (WSW)
	Plume standard deviations at 253 m: sigma-y sigma-z					10.7 m 4.8 m
	Wind speed					2 m/sec
Design Input [0. 5 - 24 hrs, Normal Conditions]	Release height (stack height)					93.9 m
	Building cross-sectional area and height for building wake effects, and plume meander					Not applicable
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (295'-33')					79.9 m
	Plume rise					Not credited
	Average depth of limited mixing layer (for plume reflection)					950 m
	Critical receptor distances from stack (where the terrain height first exceeds the stack height)					2100 m
	Terrain height at critical receptor (W sector)					106.1 m
Computer Code & Met Data Base	Hand calculated value for the fumigation condition (based on Reg. Guide 1.145). SKIRON-II (1985 met data) for the normal atmospheric conditions.					
Notes	These (χ/Q)s have been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Table 1)					

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Table 18
Design Input for Atmospheric Dispersion Factors
CRDA - Ground-Level Releases to LPZ

(χ/Q)s (sec/m^3)	0 - 2 hrs	2 - 8 hrs	8 - 24 hrs	1 - 4 days	4 - 30 days	
	5.25E-05	2.23E-05	1.47E-05	5.95E-06	1.63E-06	
Design Input	Upper wind speed in each wind-speed group (11 groups)					0.42 (m/sec) 0.89, 1.56 3.35, 5.59 8.27, 10.95 14.08, 17.21 20.78, 40.23
	Wind speed assigned to calms					0.21 m/sec
	Release height					0 m
	Adjacent building height (above release point grade)					41.5 m
	Adjacent building cross-sectional area					1416 m^2
	Average depth of limited mixing layer (for plume reflection)					950 m
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (198' - 33')					50.3 m
	Distances to receptors of interest at the LPZ (same for all sectors)					8050 m
	Terrain heights at receptor locations with respect to grade elevation at release point (N through NNW, clockwise) [Provided as input but have no impact on the (χ/Q)s since the release height is 0.]					234.1 m 319.4 313.3 265.8 203.6 275.5 100.0 154.8 302.7 282.9 267.6 340.8 325.5 252.4 181.1 179.2
	Plume meander					Considered
	Recirculation correction for annual (χ/Q)s					Not considered
Computer Code & Met Data Base	AEOLUS-3 (1995-1999 met data)					
Notes	In view of the LPZ 5-mile distance, the (χ/Q)s for Reactor Building Releases and Turbine Building releases are the same.					

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Table 19
Design Input for Atmospheric Dispersion Factors
CRDA - Stack Releases to LPZ
(NRC Approved)

(χ/Q)s (sec/m³)	0 - 1 hr	1 - 2 hrs	2 - 8 hrs	8 - 24 hrs	1 - 4 days	4 - 30 days
	2.55E-05	1.87E-05	1.01E-05	1.09E-06	6.90E-07	4.61E-07
Design Input	Release height (stack height)					93.9 m
	Building cross-sectional area and height for building wake effects, and plume meander					Not applicable
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (295'-33')					79.9 m
	Plume rise					Not credited
	Average depth of limited mixing layer (for plume reflection)					950 m
	Receptor distance from stack (all sectors)					5 miles (8047 m)
	Terrain height at receptors (arbitrarily set higher than the release height of 93.9 m; i.e., plume centerline is at ground level)					100 m
Computer Code & Met Data Base	SKIRON-II (1985 met data)					
Notes	These (χ/Q)s have been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Table 1)					

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Table 20
Design Input for Atmospheric Dispersion Factors
CRDA - Ground-Level Releases to CR
(NRC Approved)

(χ/Q)s (sec/m^3)	0 - 1 hr	1 - 2 hrs	2 - 8 hrs	8 - 24 hrs	1 - 4 days	4 - 30 days
	3.67E-03	2.19E-03	7.57E-04	3.93E-04	2.71E-04	2.04E-04
Design Input	Release height					Ground level (0 m)
	Building cross-sectional area for building wake effects (CR-affecting sectors) [Note: In view of the short distance to the CR, plume meander was excluded, and no limit was imposed on the building-wake correction.]					1936 m^2
	Building height (for building wake effects, sector averaging model)					21 m
	Minimum wind speed acceptable as valid observation					0.268 m/sec
	Wind speed assigned to calms					0.134 m/sec
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (198'-33')					50.3 m
	Plume rise and terrain heights					Not applicable
	Average depth of limited mixing layer (for plume reflection)					1000 m
	Downwind sectors which may potentially affect the Control Room [Note: Selected χ/Q was for worst-case individual sector]					NE, ENE, E, ESE and SE
	Receptor distance (release point to CR)					25 m (all sectors)
Computer Code & Met Data Base	SKIRON-II, Murphy/Campe simulation option (1979 met data)					
Notes	These (χ/Q)s have been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Table 1)					

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Table 21
Design Input for Atmospheric Dispersion Factors
CRDA - Stack Releases to CR
(NRC Approved)

(χ/Q)s (sec/m³)	0 - 0.5 hr	0.5 - 1 hr	1 - 2 hr	2 - 8 hrs	8 - 24 hrs	1 - 4 days 4 - 30 days
	2.39E-04	1.05E-06	8.70E-07	4.79E-07	2.34E-07	1.23E-07 6.90E-08
Design Input [0 - 0. 5 hr, Fumigation Conditions]	Stack height					93.9 m
	Distance from stack to CR building					213 m
	Terrain height at receptor of interest					2.4 m
	Plume standard deviations at 213 m: sigma-y sigma-z					9.1 m 4.2 m
	Wind speed					2 m/sec
Design Input [0.5 - 24 hrs, Normal Conditions]	Release height (stack height)					93.9 m
	Building cross-sectional area and height for building wake effects, and plume meander					Not applicable
	Minimum wind speed acceptable as valid observation, and wind speed assigned to calms					0.268 m/sec
	Wind speed adjustment with height					Not considered
	Temperature sensor separation (295'-33')					79.9 m
	Plume rise					Not credited
	Average depth of limited mixing layer (for plume reflection)					950 m
	Distance from stack to CR air intake [Note: The concentration at the intake is higher than at the CR building, since, for elevated plumes, the plume spreads closer to the ground as the distance from the release point increases.]					259 m (SSE)
	Terrain height at receptor of interest					2.4 m
Computer Code & Met Data Base	Hand calculated value for the fumigation condition (based on Reg. Guide 1.145). SKIRON-II (1985 met data) for the normal atmospheric conditions					
Notes	These (χ/Q)s have been previously reviewed and approved by the US NRC (TAC No. MB4610, SER Table 1)					

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RAI No. 9

For the LOCA LPZ estimates, why is there a difference between the ground level MSIV and RB siding and bypass χ/Q values? Is this only because the AEOLUS-3 methodology was used in some of the calculations and the SKIRON-II methodology used when making other estimates? Provide a description of the differences between the AEOLUS-3, SKIRON-II and Regulatory Guide (RG) 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," methodologies and the expected impact of these differences on resultant estimated χ/Q values.

Response to RAI No. 9

The ground-level MSIV to LPZ χ/Q values were calculated in 1986 with SKIRON-II utilizing the latest available meteorological data from 1985. The RB siding and bypass χ/Q values were recently calculated using AEOLUS-3 utilizing meteorological data for the five year period of 1995-1999. The differences between the χ/Q sets is due to the combined effects of using different codes and meteorological data.

The AEOLUS-3 methodology includes a 2σ adjustment factor in the least-square-fit line through the 1-hr χ/Q values per Regulatory Guide 1.145. For the worst-case LPZ sector, this adjustment amounts to 1.2. SKIRON-II uses a sliding window approach applied to hourly χ/Q values; no adjustment is applied since the distributions are more uniform since these are hourly values with their unique meteorological data versus the joint-frequency distributions in AEOLUS-3 (with average wind speeds). This difference would account for a 20% difference between the two codes. If this adjustment factor from AEOLUS-3 is excluded, the AEOLUS-3/SKIRON-II ratios are about 1.12. The combined effect would account for about a 34% (or 1.34) difference between the two codes. Additional difference would be due to differences in the meteorological database.

Vermont Yankee recognizes the ground-level release χ/Q values for the LPZ should be the same considering the proximity of the release points and the five mile distance to the LPZ receptor. The MSIV to LPZ pathway evaluation in the LOCA and CRDA calculations have been updated to use the same χ/Q values as the RB siding and bypass pathways. The updated χ/Q values for the LPZ result in a change to the LOCA LPZ dose results from 0.52 rem TEDE to 0.53 rem TEDE. Safety Assessment Table 3-1 is revised to reflect this update. The CRDA LPZ dose for "Case 1 + Case 3" in Safety Assessment Table 3-4 changes from 0.066 rem TEDE to 0.078 rem TEDE.

The updated LPZ χ/Q input is reflected in revised Safety Assessment Tables 2-3 and 2-6 provided below. The updated LOCA and CRDA results are revised and reflected in Safety Assessment Tables 3-1 and 3-4 respectively. The values that have been updated are in bold type. These tables follow the design input tables.

In addition, two typographical errors were found in Safety Assessment Tables 2-5 and Table 2-14. There is no impact to the analysis results since these were typographical errors limited to the preparation of the Safety Assessment. The stack to EAB 0.5 – 1 hour value in Table 2-5 "χ/Q Values for Radiological Dose Calculations Refueling Accident" should be 1.54E-04 sec/m^3. The revised Table 2-5 is included in this response. The krypton-85 activity in Table 2-5 "Fission Product Inventory (Refueling Accident)" should be 5.05E+02 Ci/MW. The adjusted activity on the table is correct. Also, footnote 1 of the table is revised to reflect the gap fraction adjustment made to krypton-85 and iodine-131 per RG 1.183.

Revised Safety Assessment Tables

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<table>
<tr><th colspan="8">Table 2-3 (Revision 1)
χ/Q Values for Radiological Dose Calculations - LOCA
(sec/m³)</th></tr>
<tr><th rowspan="2">Release Location</th><th colspan="7">Release Timing</th></tr>
<tr><th>0-0.5 hr</th><th>0.5-1 hr</th><th>1-2 hrs</th><th>2-8 hrs</th><th>8-24 hrs</th><th>1-4 days</th><th>4-30 days</th></tr>
<tr><td colspan="8">EAB</td></tr>
<tr><td>Ground [1] MSIV</td><td colspan="3">1.70E-03</td><td>—NA—</td><td>—NA—</td><td>—NA—</td><td>—NA—</td></tr>
<tr><td>Ground RB Bypass [2]</td><td colspan="3">1.476E-03</td><td>—NA—</td><td>—NA—</td><td>—NA—</td><td>—NA—</td></tr>
<tr><td>Ground RB Siding [2]</td><td colspan="3">1.476E-03</td><td>—NA—</td><td>—NA—</td><td>—NA—</td><td>—NA—</td></tr>
<tr><td>Stack Normal [3]</td><td>—</td><td>1.54E-04</td><td>9.17E-05</td><td>4.04E-5</td><td>5.26E-6</td><td>—NA—</td><td>—NA—</td></tr>
<tr><td>Stack Fumig. [3]</td><td>2.03E-4</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—NA—</td><td>—NA—</td></tr>
<tr><td colspan="8">LPZ</td></tr>
<tr><td>Ground MSIV [5]</td><td colspan="3" rowspan="3">5.25E-5</td><td rowspan="3">2.23E-5</td><td rowspan="3">1.47E-5</td><td rowspan="3">5.95E-6</td><td rowspan="3">1.63E-6</td></tr>
<tr><td>Ground RB Bypass [5]</td></tr>
<tr><td>Ground RB Siding [5]</td></tr>
<tr><td>Stack [6]</td><td colspan="2">2.55E-05</td><td>1.87E-05</td><td>1.01E-05</td><td>1.09E-06</td><td>6.90E-07</td><td>4.61E-07</td></tr>
<tr><td colspan="8">CONTROL ROOM and TSC</td></tr>
<tr><td>Ground RB Bypass [7]</td><td colspan="3">2.25E-3</td><td>8.18E-4</td><td>3.53E-4</td><td>2.77E-4</td><td>2.23E-4</td></tr>
<tr><td>Ground RB Siding [8]</td><td>2.98E-3</td><td>—NA—</td><td>—NA—</td><td>—NA—</td><td>—NA—</td><td>—NA—</td><td>—NA—</td></tr>
<tr><td>Ground MSIV [7]</td><td colspan="3">4.66E-3</td><td>3.46E-3</td><td>1.45E-3</td><td>1.09E-3</td><td>9.92E-4</td></tr>
<tr><td>Stack Normal [9]</td><td>—</td><td>1.92E-5</td><td>1.92E-05</td><td>8.28E-7</td><td>3.36E-7</td><td>3.08E-7</td><td>1.79E-07</td></tr>
<tr><td>Stack Fumig. [9]</td><td>1.92E-5</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
</table>

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Table 2-3 (Revision 1)
χ/Q Values for Radiological Dose Calculations - LOCA
(sec/m^3)

NOTES

[1] SKIRON-II. Max. 0-2 hr. Previously calculated and 0-2 hr NRC reviewed (Ref. 9 and 10).
[2] AEOLUS-3 generated. RB Siding χ/Q bounds the RB Bypass. RB Siding release is used for both.
[3] SKIRON-II. Stack release previously calculated. 0-2 hr values NRC reviewed (Ref. 9 and 10).
[4] Not used.
[5] AEOLUS-3. In view of the 5 mile distance, the RB Bypass, Siding & MSIV LPZ χ/Q are the same.
[6] SKIRON-II. Stack to LPZ have been previously reviewed (References 9 and 10).
[7] ARCON96. Based on RG 1.194 point source
[8] ARCON96. Based on RG 1.194 area source. Applicable only during drawdown time.
[9] ARCON96 and AEOLUS. Based on RG 1.194 for habitability assessments.
NA – Not Applicable

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Table 2-5 (Revision 1)
χ/Q Values for Radiological Dose Calculations
Refueling Accident
(sec/m^3)

Release Location	Release Timing		
	0-0.5 hr	0.5 – 1 hr	1 – 2 hrs
EAB			
Ground	1.70E-03 [2]		
Stack	2.03E-04	1.54E-04	9.17E-05
CONTROL ROOM			
Ground [1]	5.89E-03		
Stack	2.39E-04	1.05E-06	8.70E-07
LPZ *			

*LPZ dose not necessary since release is limited to two hours and EAB is more limiting

[1] RB siding facing FAI treated conservatively as point source following RG 1.194.

[2] **Provided for information only since FHA results are based on elevated release.**

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Table 2-6 (Revision 1)
χ/Q Values for Radiological Dose Calculations - CRDA
(sec/m^3)

Release Location	Release Timing						
	0-0.5 hr	0.5-1 hr	1-2 hrs	2-8 hrs	8-24 hrs	1-4 days	4-30 days
EAB							
Ground [1]	1.70E-03			–NA–	–NA–	–NA–	–NA–
Stack Normal [2]	—	1.54E-4	9.17E-5	–NA–	–NA–	–NA–	–NA–
Stack Fumig. [2]	2.03E-04	—	—	–NA–	–NA–	–NA–	–NA–
LPZ							
Ground [3]	5.25E-05			2.23E-05	1.47E-05	5.95E-06	1.63E-06
Stack [4]	2.55E-05		1.87E-05	1.01E-05	1.09E-06	6.90E-07	4.61E-07
CONTROL ROOM							
Ground [5]	3.67E-03		2.19E-03	7.57E-04	3.93E-03	2.71E-04	2.04E-04
Stack Normal [6]	—	1.05E-06	8.70E-07	4.79E-7	2.34E-7	1.23E-7	6.90E-08
Stack Fumig. [6]	2.39E-04	—	—	—	—	—	—

[1] SKIRON-II. Max. 0-2 hr. Previously calculated and 0-2 hr NRC reviewed (Ref. 9 and 10).
[2] SKIRON-II. Stack release previously calculated. 0-2 hr values NRC reviewed (Ref. 9 and 10).
[3] AEOLUS-3. In view of the 5 mile distance, the RB Bypass, Siding & MSIV LPZ χ/Q are the same.
[4] SKIRON-II. Previously calculated and applied in CRDA. NRC reviewed (Ref. 9 and 10).
[5] Murphy-Campe based. Previously calculated and applied in CRDA. NRC reviewed (Ref.9 and 10). This values have been preserved in order to assess the impact of AST on the current licensing basis results.
[6] Stack release. NRC reviewed. (Ref. 9 and 10)

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Table 2-14 (Revision 1)
Fission Product Inventory
(Refueling Accident)

Isotope	Ci/MWt t = 0	Ci/MWt Adjusted [1]	Ci/MWt t = 24 hr
Br-83	4.24E+03	*	*
Kr-83M	4.24E+03	same	15.6
Br-85	9.61E+03	*	*
Kr-85M	9.71E+03	same	239
Kr-85	5.05E+02	1.01E+03	1010
Kr-87	1.94E+04	same	0.038
Kr-88	2.75E+04	same	72.3
Kr-89	3.46E+04	same	negligible
Te-131M	4.31E+03	*	*
I-131	2.85E+04	4.56E+04	42105
Xe-131M	3.18E+02	same	327
Te-132	3.97E+04	*	*
I-132	4.05E+04	same	33065
Te-133M	2.30E+04	*	*
Te-133	3.39E+04	*	*
I-133	5.79E+04	same	26656
Xe-133M	1.76E+03	same	1594
Xe-133	5.78E+04	same	55528
Te-134	5.31E+04	*	*
I-134	6.43E+04	same	negligible
I-135	5.39E+04	same	4351
Xe-135M	1.14E+04	same	negligible
Xe-135	2.33E+04	same	15285
Xe-137	5.07E+04	same	negligible
Xe-138	5.05E+04	same	negligible

[1] **Adjusted for increased gap fraction per RG 1.183.**

* Considered as parent only

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Table 3-1 (Revision 1)
LOCA Radiological Consequence Analysis

(rem TEDE)

Dose Component	Offsite Dose		Control Room Dose
	EAB	LPZ	
SGTS Single Failure Case			
Direct Primary Containment Leakage [1]	1.8	0.08	2.8
Release Via RB and Plant Stack	1.3	0.44	0.036
Release Via Main Steam Lines and MC	0.035	0.008	0.53
TOTAL SGTS Failure	3.14	0.53	3.40
MSIV Single Failure			
Direct Primary Containment Leakage [1]	1.1	0.053	1.4
Release Via RB and Plant Stack	1.3	0.44	0.036
Release Via Main Steam Lines and MC	0.039	0.008	0.56
TOTAL MSIV Failure	2.44	0.50	2.00
Regulatory Limit	25	25	5
Current Analysis (Regulatory Limit) -[2] rem	4.30E-01 (25) Gamma 9.4E+01 (300) Thyroid	2.80E-01 (25) Gamma 8.4E+00 (300) Thyroid	3.0E-03 (5) Gamma 2.02E+01 (30) Thyroid

1 Primary leakage direct to the environment includes the reactor building bypass and reactor building siding pathways.

2 Current analysis two hour doses were evaluated at the maximum off site distance of 1900 meters due to the topographical considerations since there is no effective stack height at this distance. Thirty day doses at 8050 meters. (Reference 4, Table 14.9.4)

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Table 3-4 (Revision 1)
Control Rod Drop Accident Radiological Consequence Analysis

(rem TEDE)

Case	Offsite Dose		Control Room Dose
	EAB	LPZ	
Case 1	2.7E-01	1.8E-02	3.5E-01
Case 2	1.7E-01	2.1E-02	1.3E-03
Case 3	1.1E-01	6.0E-02	4.8E-02
Case 1 + Case 3	3.8E-01	7.8E-02	4.0E-01
Case 2 + Case 3	2.8E-01	8.1E-02	4.9E-02
Regulatory Limit	6.3	6.3	5
Current Analysis (Regulatory Limit) [1]- rem	1.5E-02 (25) Gamma 2.3E-02 (300) Beta 3.0E+00 (300) Thyroid	7.4E-03 (25) Gamma 1.2E-02 (300) Beta 1.8E+00 (300) Thyroid	9.7E-03 (5) Gamma 3.7E-01 (30) Beta 28 (30) Thyroid

[1] The current analysis values provided for the Control Room correspond to Case 1 + Case 3 and for the EAB and LPZ to Case 3 (References 9 and 10)