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EVALUATION OF TWO
COMBUSTIBLE GAS CONTROL STRATEGIES
USING NCAD

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ABSTRACT

A Nitrogen Containment Atmosphere Dilution (NCAD) system is installed at some Boiling Water Reactors (BWRs) which have a Mark I Containment. This system is designed to be used to mitigate the consequences of certain postulated events which generate combustible gasses. The radiological release consequences of two different strategies for using the NCAD system have been evaluated and are reported herein. The two strategies are (1) the Purge Strategy, where nitrogen is injected into the primary containment and the containment is simultaneously vented at low pressure, and (2) the Pressurization Strategy, where nitrogen is injected into the primary containment without simultaneous containment venting, but at some time later the containment is depressurized. The strategies are evaluated using licensing basis assumptions; realistic analyses would result in much lower doses than reported herein. Both strategies are able to effectively control containment oxygen concentration to below 5% by volume, but the radiological release consequences vary between the two strategies. The consequences of the Pressurization Strategy depend upon when containment depressurization is performed. A comparison of the whole body and thyroid dose consequences for each strategy is made for a sample BWR/4; the consequence evaluation considers both elevated and ground level release locations. The evaluation determines the Crossover Point, which is defined to be the time of containment depressurization for the Pressurization Strategy at which the radiological release consequences of the two strategies are equivalent. The evaluation provides a technical basis for the BWR Owners' Group (BWROG) Emergency Procedures Committee and the NRC Staff to reach consensus on the best strategy to employ for utilizing the NCAD system to control combustible gas inside the primary containment.

1.0 INTRODUCTION

A Nitrogen Containment Atmospheric Dilution (NCAD) system is installed at some Boiling Water Reactors (BWRs) which have a Mark I containment. The offsite radiological release consequences of certain postulated events that generate combustible gasses have been evaluated and documented in plant Safety Analysis Reports (SARs), licensing analyses, etc., utilizing the NCAD system as one feature of the event mitigation. The BWR Owners' Group (BWROG) Emergency Procedure Guidelines (EPGs), Revision 4 (Reference 1), also address use of the NCAD system to respond to events that generate combustible gasses. However, the EPG specification of NCAD system use and the SAR assumed use of the NCAD system are not consistent.

This inconsistency was identified by the Staff in the letter which transmitted the Safety Evaluation Report on EPG Revision 4 in September 1988 (Reference 2). In response to this issue, the BWROG Emergency Procedures Committee (EPC) sponsored an evaluation to compare two strategies for use of the NCAD system. The purpose of the study is to provide a documented technical basis for determining the actions which should be specified in the combustible gas control portion of the EPGs.

Representatives of the EPC and Staff met in September 1992, to discuss the results of this evaluation. This report describes the analysis that was performed and documents the results as requested by the Staff at that meeting. It is intended that the information contained in this report enable the EPC and the NRC Staff to reach consensus on the best strategy to employ for using the NCAD system.

2.0 APPROACH

This report documents the results of an evaluation to determine the radiological release consequences from two different NCAD utilization strategies for a limiting Design Basis Accident (DBA) Loss-of-Coolant Accident (LOCA) event. The analysis is based on a conservative "licensing basis" approach for evaluation of post-LOCA radiological release consequences at the Low Population Zone (LPZ) for a typical BWR having a Mark I containment. If a realistic mechanistic analysis had been used, fuel failures would not be anticipated and the source term for calculating offsite doses would be reduced to that expected during rapid shutdown (iodine spiking). The resulting offsite doses would be much less than those reported herein. The licensing basis approach, with its higher release rates, was used to provide a meaningful comparison between the two NCAD utilization strategies.

The LOCA evaluated is a double-ended recirculation line break with fission product generation and radiolytic hydrogen and oxygen production as specified by regulatory requirements for DBA radiological release consequences analysis. Neither of the two strategies evaluated exactly matches either the EPG action specifications or the DBA analysis assumptions, but the evaluation none the less provides a technical basis for assessing the adequacy of EPG actions. It is presumed that the strategy which produces the lower radiological release at the LPZ is the more effective strategy.

The two strategies which were evaluated are designated as (1) the Purge Strategy, where nitrogen is injected into the primary containment to maintain a non-combustible mixture with simultaneous containment venting to maintain a low containment pressure, and (2) the Pressurization Strategy, where nitrogen is injected into the primary containment to maintain a non-combustible mixture without simultaneous containment venting so that containment pressure increases. A summary of the two strategies is shown in Table 1.

Table 1. Summary of Two NCAD Strategies

Feature	Purge Strategy	Pressurization Strategy
Nitrogen injection initiated	When containment oxygen concentration reaches 5%	When containment oxygen concentration reaches 5%
Containment vented	As soon as nitrogen injection is started; vent flow is exhausted through SGTS	At some time into the event when the containment must be depressurized; vent flow rate is assumed to exceed SGTS capacity
Containment leakage	To secondary containment at the maximum rate allowed by Technical Specifications, then exhausted through SGTS	To secondary containment at the maximum rate allowed by Technical Specifications, then exhausted through SGTS

For both strategies it is assumed that the primary containment is initially inerted with nitrogen (i.e. oxygen concentration is less than 4% by volume), and that during the event a non-combustible mixture is maintained by limiting oxygen concentration to no greater than 5% by volume.

For the Purge Strategy, the results of this evaluation are presented in terms of integrated thyroid dose and integrated whole body dose, as a function of time, at the LPZ. For the Purge Strategy, this is the sum of the dose from containment leakage at the maximum rate allowed by Technical Specifications plus the additional dose from the release due to venting of primary containment through the Standby Gas Treatment System (SGTS). The vent effluent is processed through the SGTS which filters the vented gasses and reduces the magnitude of the calculated radioactivity release.

For the Pressurization Strategy, the results are presented as total thyroid dose and total whole body dose at the LPZ after the containment is depressurized, expressed as a function of the time at which containment depressurization is specified to occur. The total doses are the sum of the integrated dose from containment leakage at the maximum rate allowed by Technical Specifications until the time of containment depressurization, plus the additional dose from the release associated with depressurizing the primary containment. Other than containment leakage, this strategy assumes that all radioactive products are completely contained within the containment until it is depressurized, which maximizes the radioactive decay for these products prior to their release.

For the Pressurization Strategy, it is assumed that when the containment is rapidly depressurized, the containment vent flow rate exceeds the SGTS capacity. This results in a loss of the ability to filter the vent flow from the containment before it is discharged to the environment. Therefore, when the containment is depressurized, this strategy results in an unfiltered release.

The point in time at which depressurizing the containment will result in the total dose from the Pressurization Strategy equaling the integrated dose from the Purge Strategy is defined to be the Crossover Point. If containment depressurization is performed prior to the Crossover Point, then the Purge Strategy results in the lower radiological release consequences. If containment depressurization is performed after the Crossover Point, then the Pressurization Strategy results in the lower radiological release consequences.

3.0 INPUTS TO THE EVALUATION

A typical BWR/4 with a Mark I containment was selected for evaluation. Data for the sample plant extracted from licensing basis analyses are shown in Table 2. The SGTS filter efficiency of 95% for the sample plant is a nominal industry value (industry range is 90% to 99% filter efficiency, with most plants in the 95% to 99% range). The fission product release fractions were obtained using Regulatory Guide (RG) 1.7 (Reference 3) and RG 1.3 (Reference 4). Fission product decay energies deposited in the coolant as a function of time were obtained from Standard Review Plan (SRP) 6.2.5 (Reference 5).

Table 2. Data for Sample Plant Analysis

Reactor power (MWt)	2537
Initial inventory fractions in containment atmosphere per RG 1.3:	
Noble gases (%)	100
Iodines (%)	25
Maximum primary containment leak rate excluding MSIV leakage (%/day) allowed by Tech Specs	1.2
SGTS iodine filter efficiency (%)	95
Height for SGTS release (m)	125
Volume (ft^3) in: Drywell	146000
Wetwell	113000
Total	259000
Initial average temperature (°F, °R) in:	
Drywell	135, 595
Wetwell	85, 545
Initial pressure (psig, psia) in: Drywell	0.75, 15.45
Wetwell	0.75, 15.45
Initial total gas (lb-moles) in: Drywell	353.3
Wetwell	298.6
Total	651.9
Oxygen volume fraction	0.04
Initial oxygen (lb-moles)	26.1

Dispersion Factors, χ/Q (sec/m^3)

Time	For Ground Release	For Elevated Release
0-2 hours	3.1E-4	1.7E-6
2-8 hours	1.7E-4	9.4E-7
8-24 hours	2.3E-5	3.9E-7
24-96 hours	1.1E-5	2.0E-7
96-720 hours	4.5E-6	8.0E-8

Table 2. Data for Sample Plant (continued)

Thyroid Inhalation Dose Conversion Factor (DCF) per ICRP-30 (rem/ci)

I-131	1.08E+6
I-132	6.44E+3
I-133	1.80E+5
I-134	1.07E+3
I-135	3.13E+4

Note: The thyroid inhalation DCF per International Commission on Radiological Protection (ICRP) Publication 30, is the same as in Federal Guidance Report 11 (Reference 6).

Fission Product Inventory (Ci/MW)

I-131	2.631E+4
I-132	3.845E+4
I-133	5.502E+4
I-134	6.056E+4
I-135	5.195E+4
Kr-83m	3.137E+3
Kr-85m	6.734E+3
Kr-85	3.015E+2
Kr-87	1.292E+4
Kr-88	1.830E+4
Kr-89	2.276E+4
Xe-131m	1.582E+2
Xe-133m	2.305E+3
Xe-133	5.528E+4
Xe-135m	1.042E+4
Xe-135	7.148E+3
Xe-137	4.852E+4
Xe-138	4.610E+4

4.0 EVENT DESCRIPTION

The event evaluated is a double-ended recirculation line break LOCA with licensing basis (i.e., DBA) prescribed combustible gas generation. Containment oxygen concentration initially remains below the 5% deflagration threshold because of the initial inerted condition. Hydrogen concentration is initially zero, but is calculated to exceed the 6% deflagration threshold within a few minutes due to the metal-water reaction rate prescribed for DBA analyses (metal-water reaction produces hydrogen gas and zirconium oxide, but no oxygen gas). Radiolysis then produces both hydrogen and oxygen gas, and the 5% oxygen deflagration threshold is reached within a period of a few hours to a few days, depending upon various plant-specific design characteristics.

Assumptions used in the analysis are as follows:

- The reactor is initially operating at 100% rated power.
- Primary containment oxygen concentration is initially 4% by volume.
- Inhalation dose conversion factors are obtained from Federal Guidance Report 11 (Reference 6).
- The drywell and wetwell airspace are treated as a single volume.
- Containment heat removal capability is sufficient to remove all energy generated within the containment; containment pressurization is due solely to the introduction of nitrogen gas and the generation of gasses by radiolysis within the containment.
- No steam is present within the containment to dilute the combustible gasses.
- No dilution of oxygen in the containment atmosphere occurs by hydrogen produced from metal-water reaction.
- Technical Specification maximum allowable containment leakage exists and is constant (independent of containment pressure).
- All containment leakage is into the secondary containment and is processed through the Standby Gas Treatment System (SGTS) prior to being released to the environment.

The post-LOCA radiolytic oxygen production calculated for the sample plant, using RG 1.7 and SRP 6.2.5 assumptions, is shown in Figure 1. The containment oxygen concentration as a function of time after the LOCA occurs, assuming that there is no dilution of oxygen by NCAD, is shown in Figure 2. From Figure 2, oxygen concentration reaches the 5% threshold approximately 15 hours after the event begins. To simplify the calculations it is assumed that the operator takes action to initiate NCAD one-half day into the event, recognizing that the operator could be expected to initiate the action prior to oxygen concentration reaching 5%.

For the assumptions made in this evaluation, the Pressurization Strategy is independent of the containment pressure response. The evaluated strategy does not assume that containment pressure is maintained below some specified value

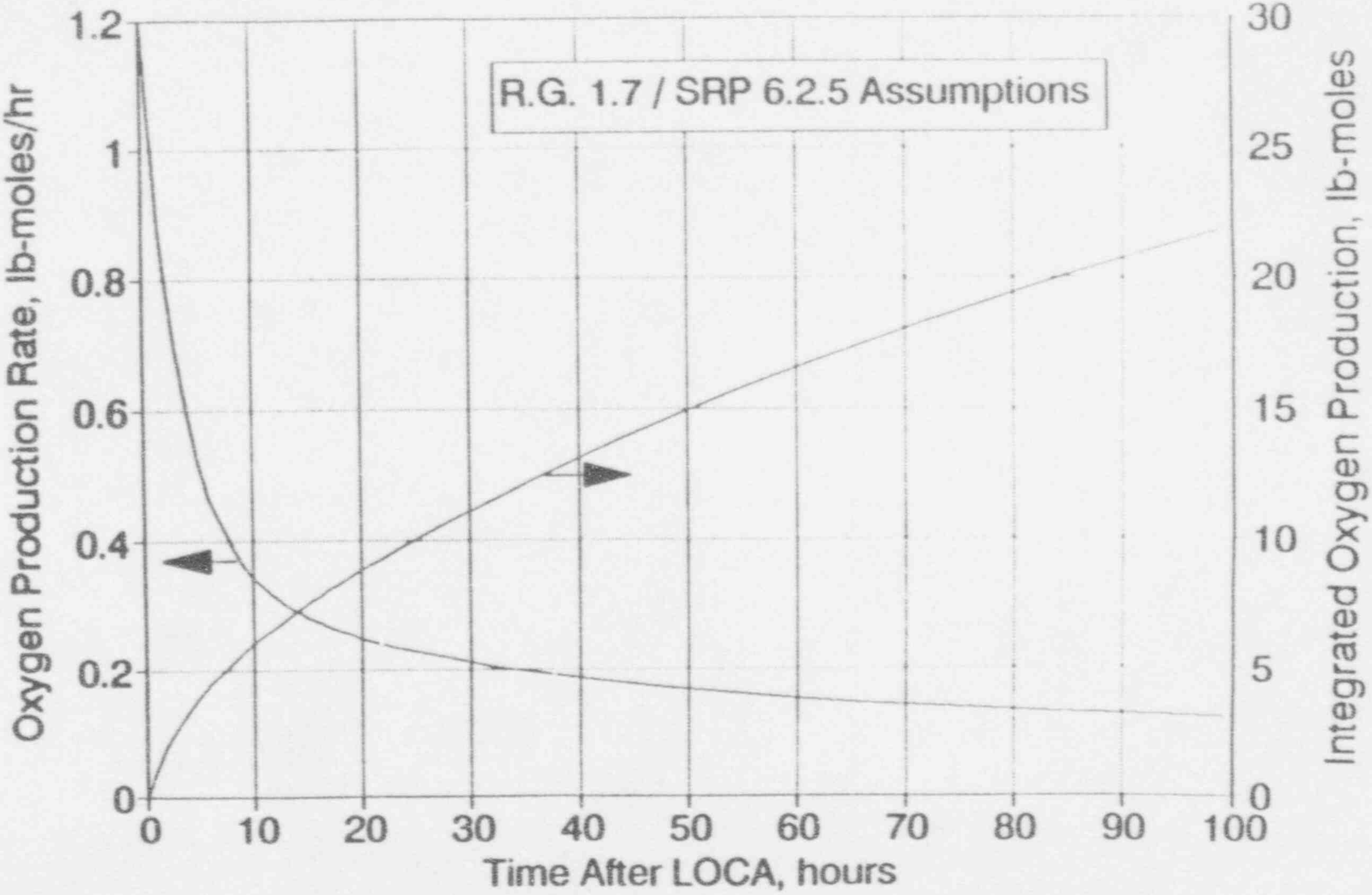


Figure 1. Post-LOCA Radiolytic Oxygen Production

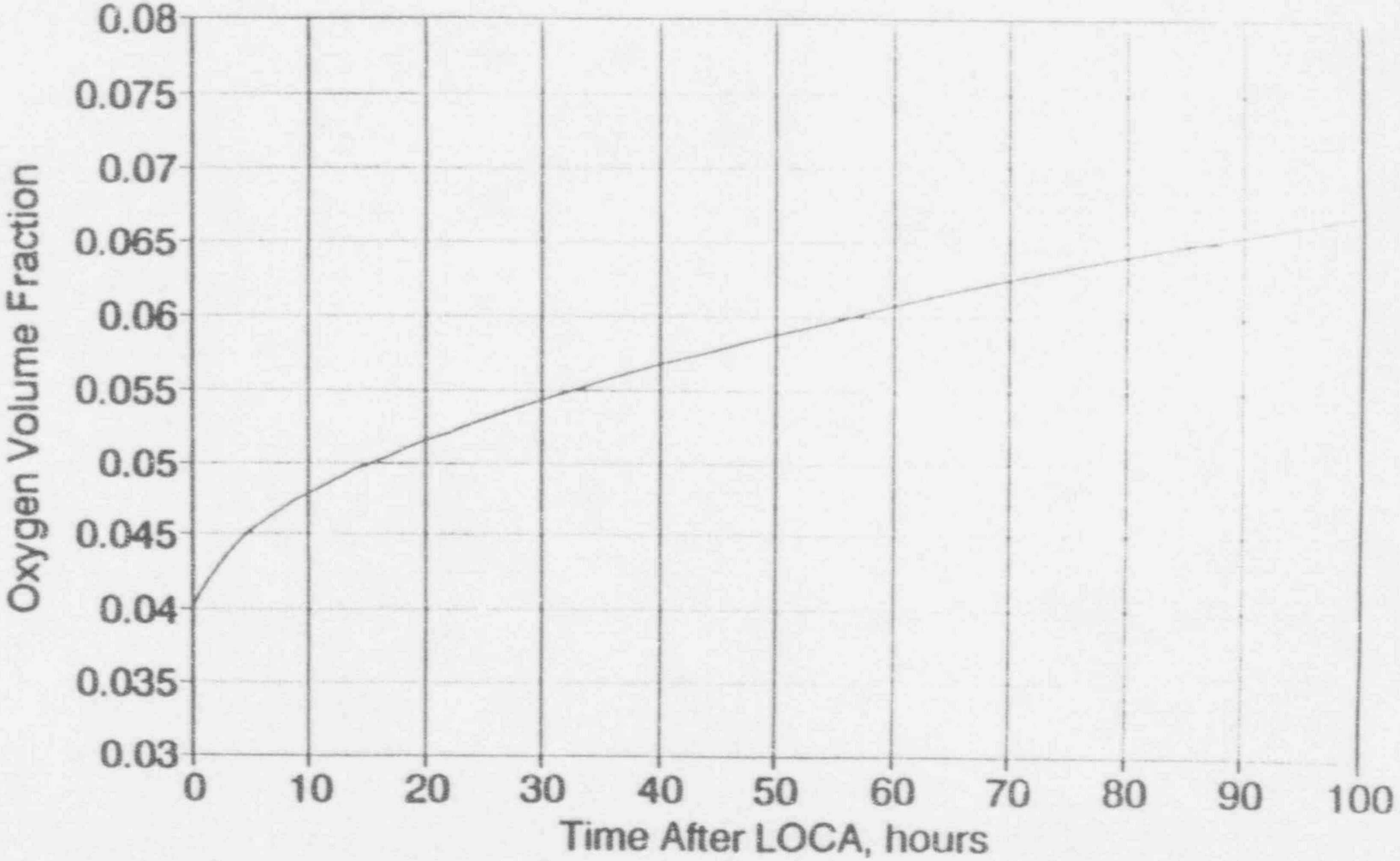


Figure 2. Post-LOCA Oxygen Concentration Without Dilution by NCAD System

(e.g. 50% of containment design pressure) by venting at elevated pressure. This approach maximizes the benefit of radioactivity decay during holdup in the containment. Therefore, there is no need to calculate the time to reach a specified pressure (e.g. 50% of design), or the effects of containment spray or heat removal on the containment pressure response for the Pressurization Strategy.

5.0 MITIGATION OF THE EVENT USING THE PURGE STRATEGY

The Purge Strategy mitigates the event by simultaneously injecting nitrogen and venting the containment to maintain oxygen concentration no greater than 5% by volume. Nitrogen injection continues at the rate necessary to limit oxygen concentration in primary containment to 5% throughout the event. Venting of the primary containment is performed, concurrently, at the rate necessary to maintain containment pressure low (near atmospheric). The containment vent path is through the SGTS which filters the effluent gasses and reduces the magnitude of the radioactive release. Primary containment leakage is into the secondary containment; it is then processed through the SGTS before being discharged to the atmosphere through the plant stack.

The post-LOCA oxygen concentration in containment without dilution by NCAD (as shown in Figure 2) reaches 5% by volume at approximately 15 hours into the event. The Purge Strategy evaluation assumes that the operator takes action to initiate nitrogen injection and containment venting before the 5% threshold is reached: at one-half day into the event. The corresponding nitrogen injection rate and vent rate are shown in Figure 3; the total vent rate to maintain primary containment pressure low as shown in Figure 3 is provided by the sum of containment leakage and containment venting.

A stepwise release model is used to represent the time dependent containment activity removal rate as shown in Figure 4. The integrated thyroid and whole body doses at the LPZ which were calculated for the Purge Strategy are [illegible] in Figures 5 and 6, respectively. After approximately 10 days, the additional dose accumulated is relatively insignificant due to the reduction with time of the licensing basis dispersion factors (refer to Table 2 for χ/Q values, Section 3). Figures 5 and 6 also show the integrated dose from containment leakage alone to illustrate the incremental effect on the total integrated dose.

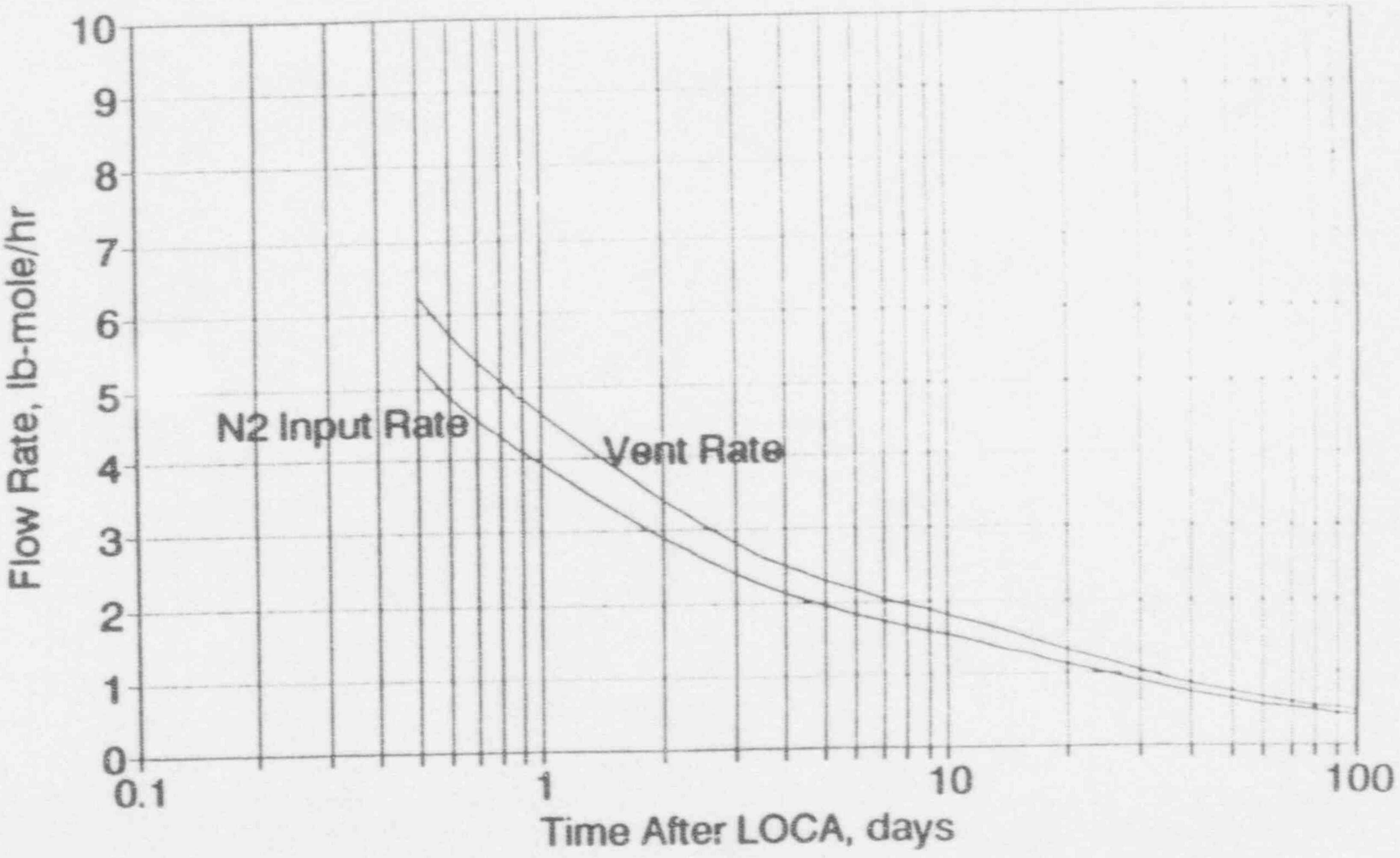


Figure 3. Nitrogen Injection Rate and Containment Vent Rate, NCAD System Initiated at One-half Day after the LOCA Occurs

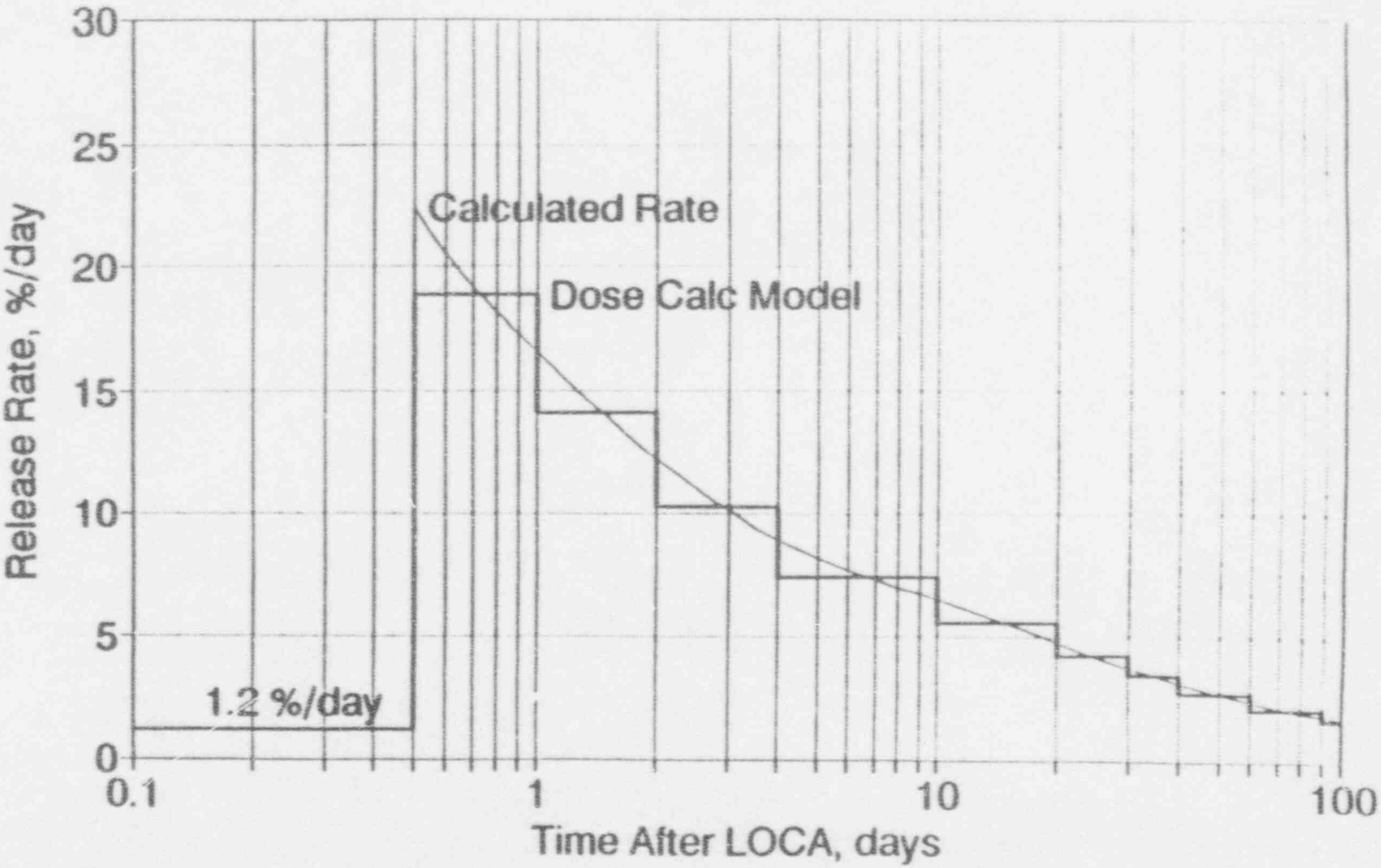
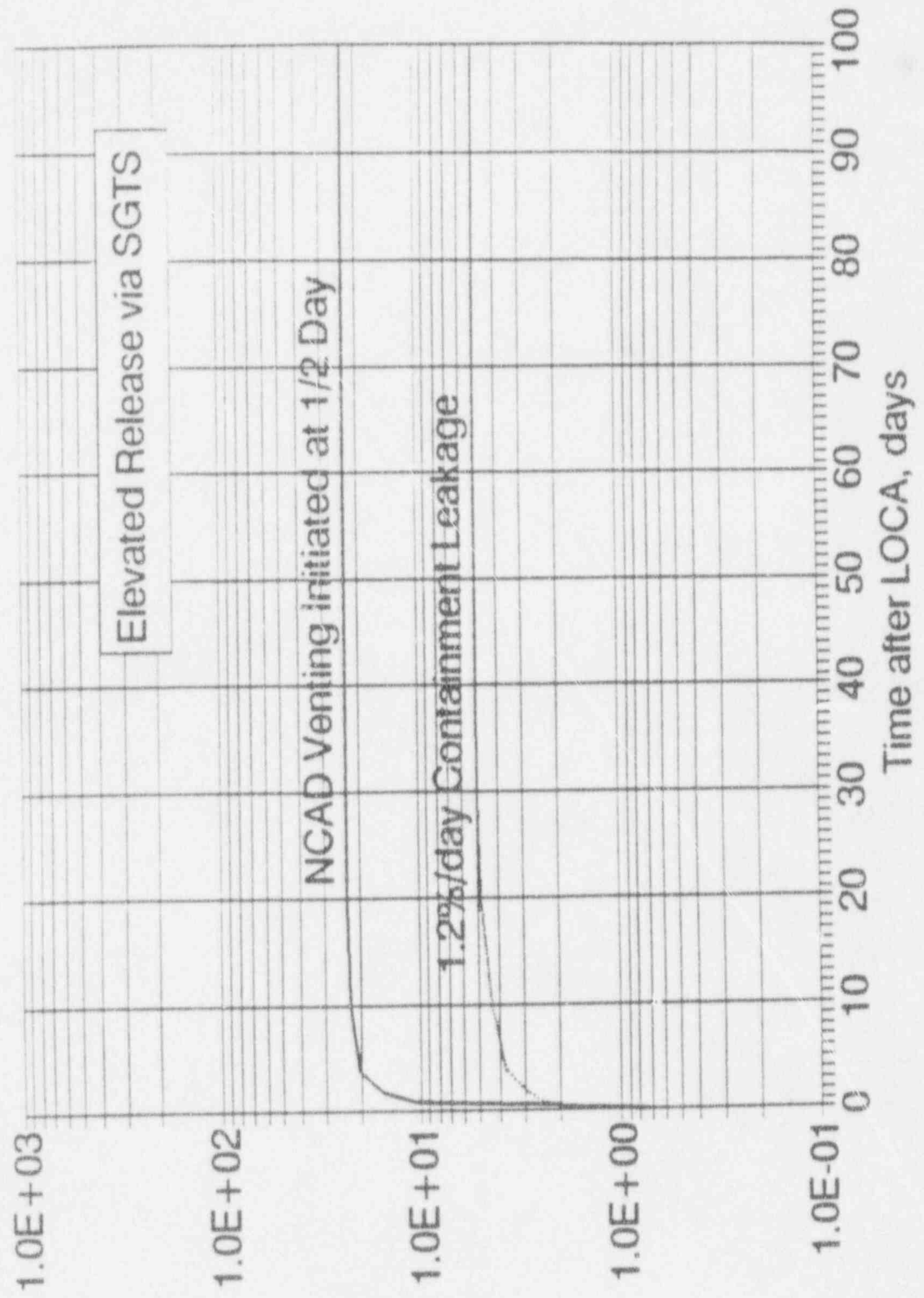


Figure 4. Containment Activity Removal Rate, NCAD System Initiated at One-half Day after the LOCA Occurs

Figure 5. Purge Strategy Integrated Thyroid Dose at the LPZ vs. Time



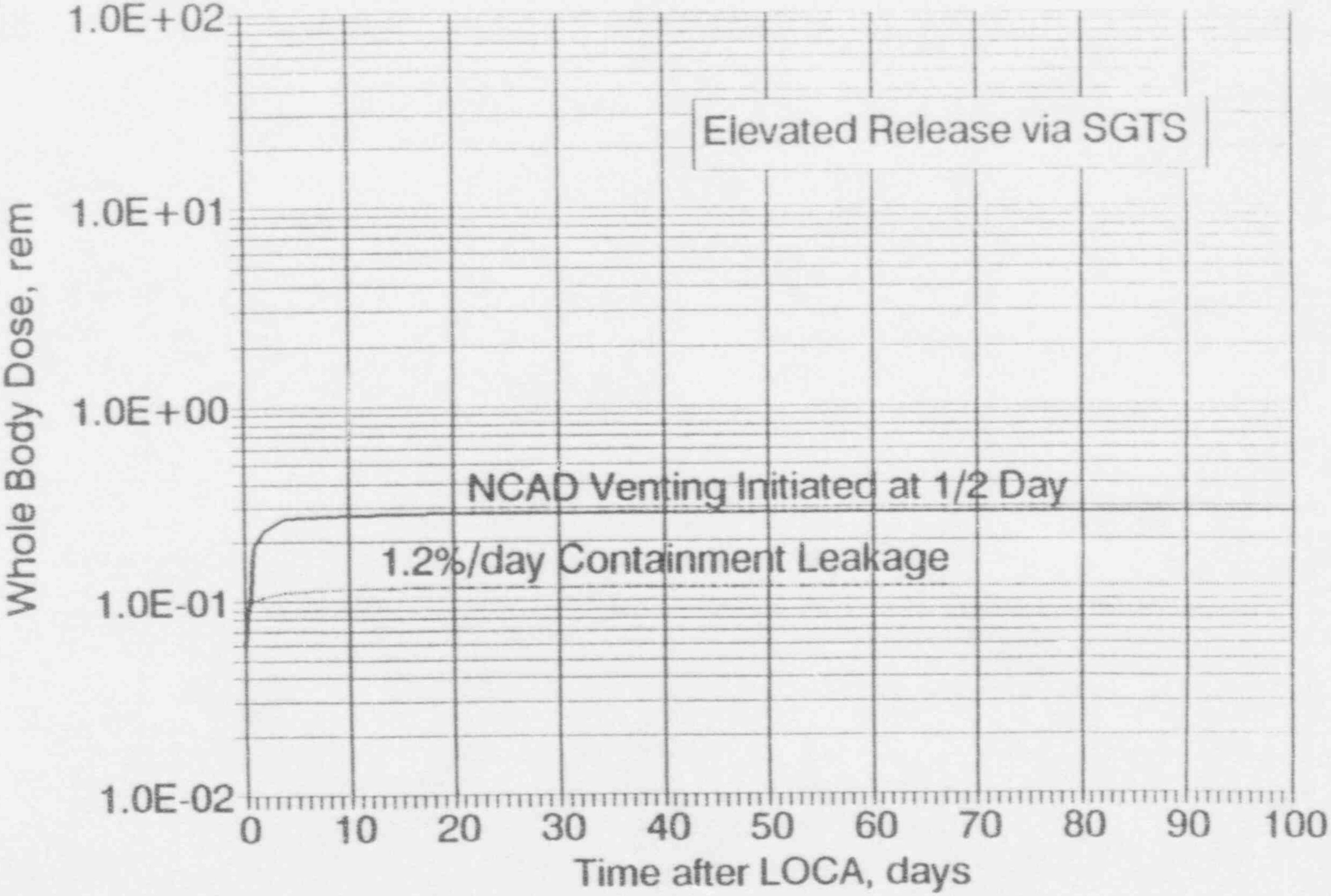


Figure 6. Purge Strategy Integrated Whole Body Dose at the LPZ vs. Time

6.0 MITIGATION OF THE EVENT USING THE PRESSURIZATION STRATEGY

The Pressurization Strategy mitigates the event by injecting nitrogen into containment at the rate required to maintain oxygen concentration no greater than 5% by volume throughout the event. Nitrogen injection is performed without venting which results in containment pressurization under this strategy.

The Pressurization Strategy assumes that at some time later in the event (after nitrogen injection has been initiated) it will be necessary to depressurize the containment. Calculations for the Pressurization Strategy consider containment depressurization times from one-half to 100 days after the start of the event.

Until the containment is depressurized, the only radiological release to the environment for this strategy is from primary containment leakage into the secondary containment, which is processed through the SGTS before being discharged to the atmosphere through the plant stack. When the containment is eventually depressurized, the resulting vent flow rate is assumed to exceed the capacity of the SGTS as follows: (a) if the SGTS ductwork fails inside secondary containment, an unfiltered ground level release occurs, or (b) if the high flow rate disables the SGTS filtering capability but leaves the SGTS ductwork intact, an unfiltered elevated release occurs. Therefore, the total doses (for thyroid and for whole body) were calculated for both an unfiltered ground level release and an unfiltered elevated release. The calculation for the Pressurization Strategy assumes that the operator cannot determine in advance when containment depressuirzation will be required and has no control in selecting meterological conditions when the depressurization occurs; therefore, the total dose for the Pressurization Strategy has been calculated assuming dispersion factors for ground level and elevated release locations which are applicable to the 0-2 hour time period following the event (refer to Table 2 for χ/Q values, Section 3).

The post-LOCA oxygen concentration in containment without dilution by NCAD (as shown in Figure 2) reaches 5% by volume at approximately 15 hours into the event. The Pressurization Strategy evaluation (like the Purge Strategy evaluation) assumes that the operator takes action to initiate nitrogen injection before the 5% threshold is reached: at one-half day into the event. The corresponding nitrogen injection rate for the Pressurization Strategy is the same as for the Purge Strategy, and is shown in Figure 3.

The integrated thyroid and integrated whole body doses (vs. time) due to containment leakage alone are the same for the Pressurization Strategy as for the Purge Strategy (previously shown in Figures 5 and 6). There is no other radiological release to the environment for the Pressurization Strategy until the containment is depressurized. When containment depressurization is performed, containment pressure is reduced to atmospheric pressure. Therefore, the total containment inventory is not vented since non-condensables equivalent to one atmosphere remain inside the containment. The fraction of containment inventory which is vented in the process of depressurizing the containment depends upon how much combustible gas has been generated and the total amount of nitrogen that has been injected into containment since the LOCA occurred. The total gas in containment without venting and the associated vent fraction, each as a function of time after the start of the event that containment depressurization is performed, are shown in Table 3.

Table 3. Pressurization Strategy Total Mass of Gas in Containment and Fraction of Gas Vented for Containment Depressurization at Specified Time

Time Post-LOCA (days)	Total Mass of Gas in Containment Without Venting (lb-moles)	Fraction of Gas Vented Due to Depressurization
0.0	651.9	
0.5	672.0	0.0299
1	735.3	0.1135
2	829.9	0.2145
4	967.4	0.3262
10	1266.7	0.4854
20	1637.9	0.6020
30	1919.9	0.6604
40	2147.3	0.6964
50	2339.5	0.7213
60	2507.6	0.7400
70	2658.3	0.7548
80	2795.6	0.7668
90	2922.2	0.7769
100	3039.7	0.7855

The total mass of gas and fraction of gas vented (as listed in Table 3) are used to determine the thyroid and whole body doses at the LPZ due to containment depressurization. The thyroid and whole body dose increments resulting from containment depressurization are provided in Table 4 for containment depressurization times from 0.5 to 100 days after the event has occurred. Table 4 provides incremental doses from containment depressurization for both elevated and ground level release locations as previously described.

Table 4. Pressurization Strategy Thyroid and Whole Body Dose Increments at the LPZ for Containment Depressurization at Specified Time

Time Post-LOCA (days)	Thyroid Dose (rem) for Elevated Release	Thyroid Dose (rem) for Ground Level Release	Whole Body Dose (rem) for Elevated Release	Whole Body Dose (rem) for Ground Level Release
0.5	3.8E+02	7.0E+04	6.3E-01	1.2E+02
1	1.3E+03	2.4E+05	1.3E+00	2.3E+02
2	2.0E+03	3.7E+05	1.4E+00	2.5E+02
4	2.4E+03	4.4E+05	1.2E+00	2.2E+02
10	1.9E+03	3.5E+05	8.1E-01	1.5E+02
20	9.0E+02	1.6E+05	3.2E-01	5.9E+01
30	3.7E+02	6.7E+04	1.2E-01	2.2E+01
40	1.5E+02	2.7E+04	4.4E-02	7.9E+00
50	5.7E+01	1.0E+04	1.6E-02	3.0E+00
60	2.2E+01	4.0E+03	6.2E-03	1.1E+00
70	8.3E+00	1.5E+03	2.5E-03	4.5E-01
80	3.2E+00	5.8E+02	1.0E-03	1.9E-01
90	1.2E+00	2.2E+02	5.0E-04	9.2E-02
100	4.5E-01	8.2E+01	2.9E-04	5.3E-02

The values in Table 4 are combined with the dose attributable to containment leakage prior to depressurization to determine the total dose at the LPZ for the Pressurization Strategy. The calculated values are provided in Table 5 as a function of the time at which primary containment depressurization is performed.

Table 5. Pressurization Strategy Total Thyroid and Whole Body Doses at the LPZ for Containment Depressurization at Specified Time

Time Post-LOCA (days)	Total Thyroid Dose (rem) for Elevated Release	Total Thyroid Dose (rem) for Ground Level Release	Total Whole Body Dose (rem) for Elevated Release	Total Whole Body Dose (rem) for Ground Level Release
0.5	4.1E+02	7.0E+04	9.0E-01	1.2E+02
1	1.3E+03	2.4E+05	1.4E+00	2.3E+02
2	2.0E+03	3.7E+05	1.5E+00	2.5E+02
4	2.4E+03	4.4E+05	1.4E+00	2.2E+02
10	1.9E+03	3.5E+05	9.3E-01	1.5E+02
20	9.1E+02	1.6E+05	4.4E-01	5.9E+01
30	3.7E+02	6.7E+04	2.4E-01	2.2E+01
40	1.5E+02	2.7E+04	1.6E-01	8.0E+00
50	6.2E+01	1.0E+04	1.4E-01	3.1E+00
60	2.7E+01	4.0E+03	1.3E-01	1.2E+00
70	1.3E+01	1.5E+03	1.2E-01	5.7E-01
80	8.3E+00	5.8E+02	1.2E-01	3.1E-01
90	6.3E+00	2.2E+02	1.2E-01	2.1E-01
100	5.6E+00	8.8E+01	1.2E-01	1.7E-01

Figures 7 and 8 show a plot of the data presented in Table 5 for total thyroid and total whole body doses, respectively. Figure 7 shows that the peak value for total thyroid dose occurs when containment depressurization is initiated at approximately 5 days following the start of the event. As time increases beyond 5 days, the total thyroid dose decreases due to the longer time for radioactivity decay of the fission products which are held up in the containment. The same effect is shown for total whole body dose except that the peak value occurs at approximately 2 days following the start of the event. The peak is earlier because the whole body dose is more strongly influenced by the Noble Gases (which have shorter half-lives than the Iodines) than the thyroid dose.

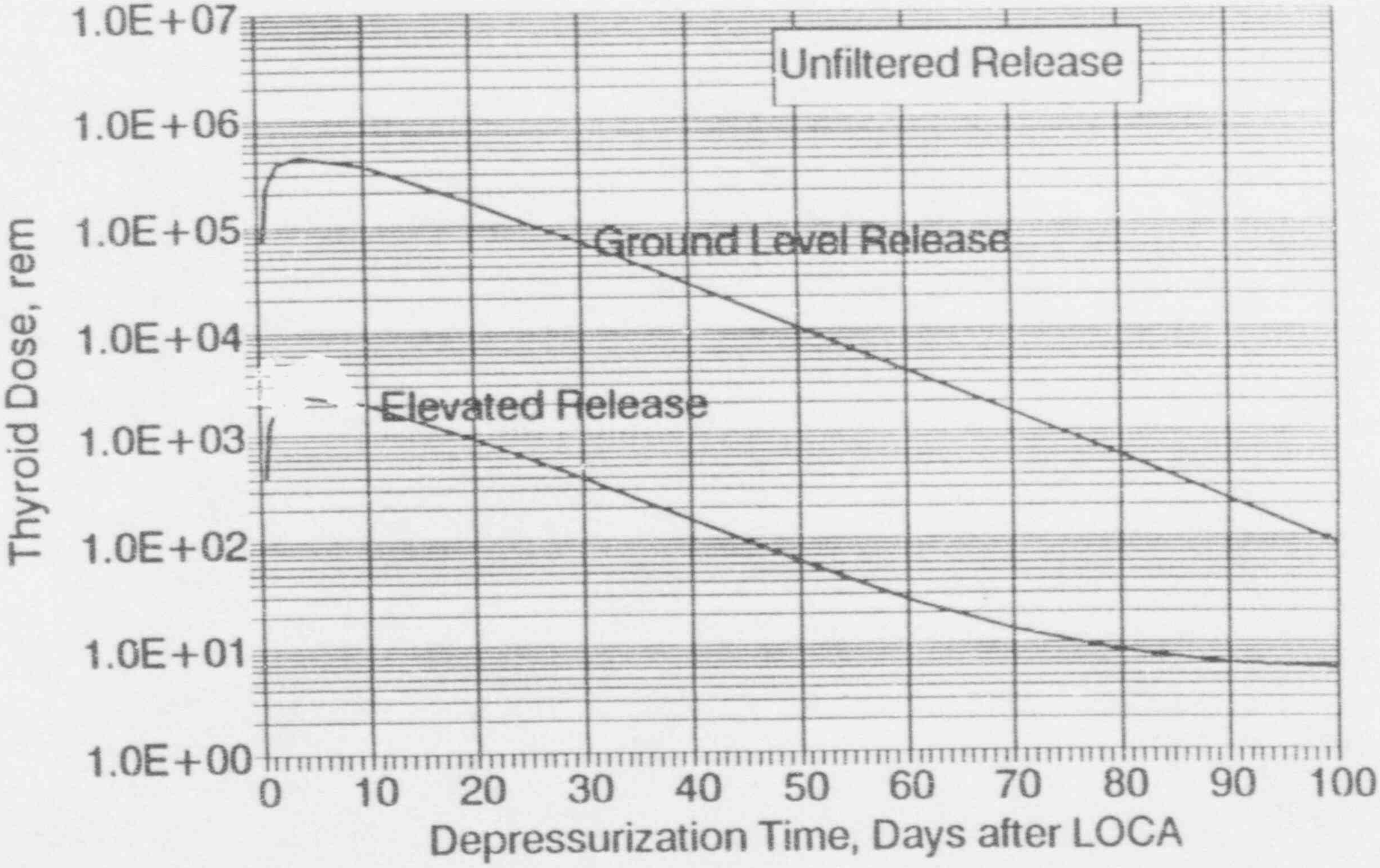


Figure 7. Pressurization Strategy Total Thyroid Dose at the LPZ as a Function of Containment Depressurization Time

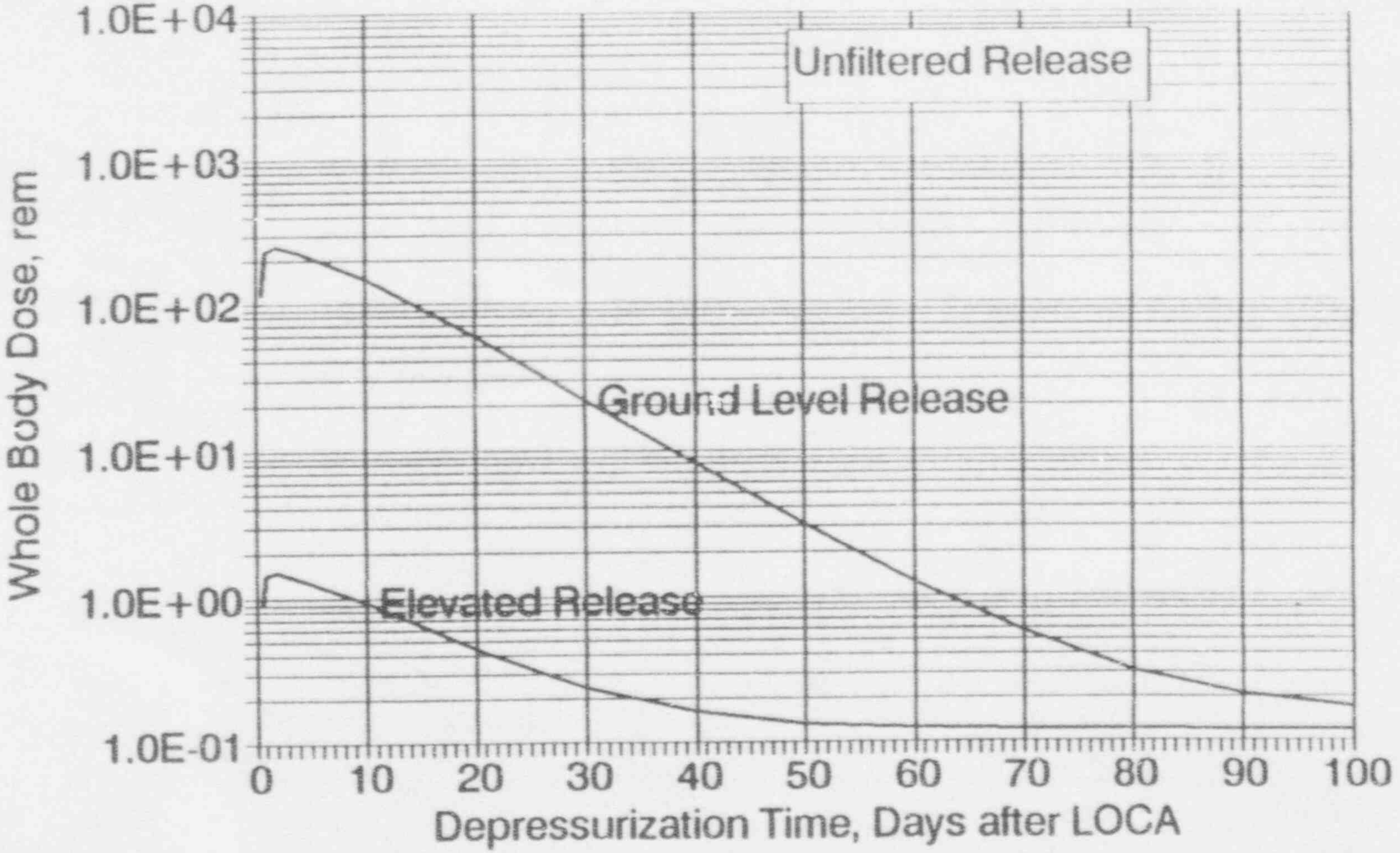


Figure 8. Pressurization Strategy Total Whole Body Dose at the LPZ as a Function of Containment Depressurization Time

7.0 SUMMARY OF CALCULATED RADIOLOGICAL CONSEQUENCES

The Crossover Point, which is defined to be the time at which depressurizing the containment will result in the total dose at the LPZ for the Pressurization Strategy equaling the integrated dose at the LPZ for the Purge Strategy, is shown in Table 6 for the sample plant.

Table 6. Crossover Point: Time of Containment Depressurization for which the Total Dose Resulting from the Pressurization Strategy Equals the Integrated Dose Resulting from the Purge Strategy

Release Location	Thyroid Dose Crossover Point	Whole Body Dose Crossover Point
Elevated	62 days	28 days
Ground Level	>100 days	82 days

The Purge Strategy results in an earlier radiological release, but one that is relatively low since all of the exhaust flow from the containment is processed through the SGTS before being released to the atmosphere. The Pressurization Strategy clearly results in a lower total radiological release if it is never necessary to depressurize the containment. However, the unfiltered discharge associated with containment depressurization provides a relatively large magnitude radiological release. Therefore, the time at which containment depressurization is performed determines which strategy results in the lower total radiological release.

The validity of the strategy comparison is not limited to the sample plant analyzed. The numerical results would change if different plant data (e.g. containment leak rate, SGTS fiter efficiency, stack height, etc.) were analyzed or if different assumptions were used. For example, performing this same analysis for a plant with more favorable dispersion factors (χ/Q) would result in lower calculated doses for both strategies. Similarly, if realistic fission product release fractions or realistic hydrogen and oxygen generation rates were used, the calculated doses for both strategies would also be reduced. Therefore, the general conclusion from the sample plant analysis that there is a radiological consequences crossover between the two strategies is broadly applicable.

8.0 CONCLUSIONS

Implementation of the Pressurization Strategy results in lower calculated radiological release consequences than the Purge Strategy provided that containment depressurization is not performed prior to the Crossover Points shown in Table 6 (Section 7.0). Conversely, implementation of the Purge Strategy results in lower radiological release consequences than the Pressurization Strategy if the containment is depressurized prior to the Crossover Points shown in Table 6.

The likelihood (i.e., probability) that containment depressurization will be required during execution of the Pressurization Strategy has not been evaluated. However, events which are severe enough to result in significant hydrogen and oxygen production may lead to an emergency procedure instruction to vent primary containment. The likelihood that containment depressurization will be required certainly increases as the duration of the event increases, and it is reasonable to expect that containment depressurization will be necessary before the Crossover Points shown in Table 6 are reached. Therefore, it is believed that use of the Purge Strategy will generally result in lower radiological release consequences as compared to use of the Pressurization Strategy.

The Purge Strategy minimizes the amount of uncontrolled and unmonitored fission products that are released, and maintains the maximum margin to containment failure from a hydrogen deflagration or other overpressure event. Furthermore, the difficulty of executing the Pressurization Strategy, and other control complications associated with pressurizing the containment, support the conclusion that the Purge Strategy is the more effective strategy for using the NCAD system to control combustible gas concentrations in the containment.

9.0 REFERENCES

1. NEDO-31331, "BWROG Emergency Procedure Guidelines, Revision 4", March 1987.

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