'JECT	EAB and LPZ Doses	BY	DWM/WJE	DATE	3/20/96
	from a MILLSTONE	CHKED		DATE	
	UNIT 3 LOCA	CALC #	M3LOCA94/	01048	- R3 Rev 1
		SHEET	1	OF	29

Title Page

Calculation # : M3LOCA94 / 01048 - R3 , Rev. 1

Interface/ Distribution	date sent
NDSF	
CTP	

TITLE: EAB and LPZ Doses from a MILLSTONE UNIT 3 LOCA

Total Pages:	29 plus
Total # of Alphanumeric Revision Pages:	0
Total # of Attachment Pages:	0
Total # of Appendix Pages:	650
Total # of Document Pages:	679

Prepared by: W J Eakin — William J Eakin — Date 3/20/96

Prepared by: D W Marzilli — David W. Marzilli — Date 3/20/96

Reviewed by: Donald W. Miller — Donald W. Miller — Date 03/26/96

Full Review

Approved by: R. A Crandall — Raymond A. Crandall — Date 3/28/96

CCN # _____

Superseded by : _____

Method of review: Full Review

SUBJECT	EAB and LPZ Doses	BY	DWM/WJE	DATE	3/20/96
	From a MILLSTONE	CHKED		DATE	
	UNIT 3 LOCA	CALC #	M3LOCA94/	01048	- R3 Rev 1
		SHEET	2	OF	29

Calculation Data Sheet

NUSCo Calc # : M3LOCA94/ 01048 - R3
(prefix) (sequential number) (suffix)

Latest Revision # 1

A/E Calc #/ other : _____

CCN # _____

Superseded by : _____

Responsible discipline RADIOLOGICAL ENGINEERING QA (y/n) y

Plant	P.A. #	Component ID	computer code used	rev. #/level
			TACT III	

Building	PMMS code system	component	Reference Drawings	sh.	Reference Calculations

Comment _____

1. Table of Contents

2. List of Tables

3. Purpose:

This calculation is being performed to reanalyze the Millstone Unit 3 Design Basis Analysis (DBA) LOCA Doses using revised assumptions. Doses will be calculated for the EAB and LPZ. Upon approval this analysis will supersede QA Category #1 calculation M3LOCA94/01048-R3, Rev. 0 (Ref. 1). This calculation is being done in support of PTSCR #3-25-95 (Ref. 21).

This calculation also demonstrates the use of revised radiological source term assumptions. This radical change from past practice is being conducted as part of an industry (NEI) effort, coordinated with the NRC, to demonstrate the applicability of the Revised Source Term (RST) NUREG-1465 (Ref. 9) to existing light water reactors. Millstone 3 is a "pilot plant" in this effort. The assumptions included here are one approach to the application of the RST, which we are calling the "Timing Only" option.

4. Discussion

Revision 0 to this calculation (Ref. 1) was performed to support TSCR 3-16-94. Telephone comments made by the NRC indicate that the interpretation of SRP 6.5.2 Rev. 2 (Ref. 8) used in that calc was incorrect. The NRC has verbally indicated that, contrary to what the SRP indicates, one cannot use both 50% instantaneous plateout and particulate plateout removal of iodine in containment. Preliminary verbal indications are that the 50% plateout is not preferred. Thus, the spray removal method is used here.

TSCR 3-16-94 is still pending. Therefore the current licensing basis for Millstone 3 is supported and analyzed in QA Cat I Calculation #88-019-96RA, Rev. 2, Ref. 6. Upon issuance of the amendment for this (PTSCR 3-25-95) change, it is expected that TSCR 3-16-94 will be withdrawn/superseded.

There are three different classes of assumptions that change in this calc compared to Ref. 6.

1. Two major design assumptions change as a result of the PTSCR: the Containment Design Leakrate was changed from 0.3%/day to a proposed Tech. Spec. limit of 0.65%/day, and the Enclosure Building (SLCRS) drawdown time changes from 2 minutes to 30 minutes.

2. There are changes to detailed assumptions reflecting plant configuration changes and the results of updated calculations and references, (e.g., mixing rates and pH control).

3. The RST Timing Only assumptions are a significant change to the assumptions used in performing this calculation. However, one of the fundamental principals of the Timing Only proposal is that the methods remain the same, even though assumption values (e.g., release time) may change. The principal difference in the Timing Only proposal is in the time of release of radionuclides from the fuel, which changes from release of applicable inventory at t=0, to a release of the gap activity at t=30 sec and a release of the remaining applicable inventory at t=30 min. Details are specified in the assumptions section below.

5. Method:

5.1. TACT III

The TACT III (version 83.0) (Ref. 4) computer code was used in this analysis. TACT III (ver. 83) was validated per NEO 2.24/QS-3 and was last benchmarked on Sept. 14, 1995 since its prior benchmark of Mar. 15, 1995. TACT III "simulates the movement of radioactivity released from a reactor core as it migrates through user-defined regions (nodes) of the containment, is immobilized by filters and sprays, and leaks to the outside environment. Outputs are shown for the end of each time interval and include the

level of radioactivity in each node of the containment and in the environment, broken down as iodines, noble gases, and solids...; and the radiation dose to reference individuals at the exclusion radius, the boundary of the low population zone, and in the control room." (Ref. 4).

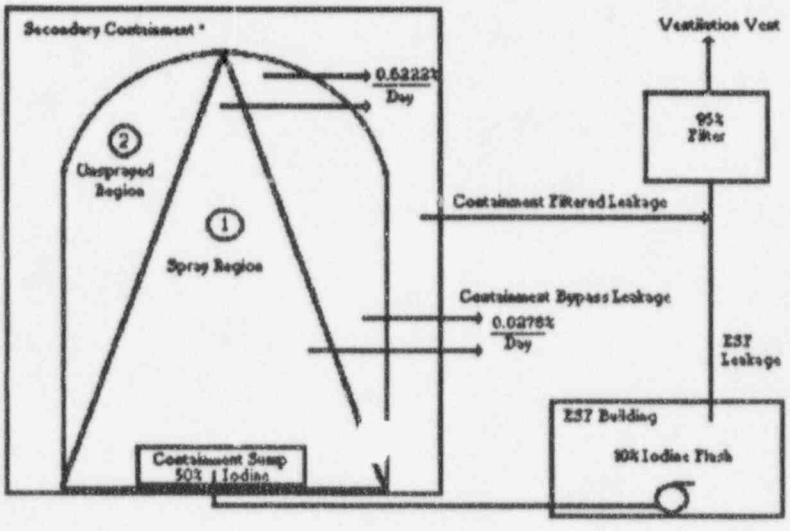
A two node (sprayed/unsprayed) containment model is used. Mixing rates have been calculated by Stone & Webster.

5.2. Release Cases

The MP3 LOCA dose is calculated from 3 separate component release cases (see Figure 1):

1) "Bypass Case"- Containment bypass leakage
2) "Filtered Case" - Containment filtered leakage
3) "ESF Case" - ESF Building leakage

Figure 1 Release Node Diagram



** All leakage into the secondary containment would be filtered and released from the ventilation vent after negative pressure is achieved.*

The releases are calculated from each component with a separate TACT run. The results are aggregated using EXECL 5.0. EXCEL is not Quality Software, therefore a listing of the functions and formulas used are included for each spreadsheet in Appendix A: EXCEL Spreadsheet Functions and Formulas.

5.3. Source Term Basis

The source core activity was taken from a Stone and Webster calculation (Ref. 17) used in the development of Table 15.0-7 in the FSAR (Ref. 10), consistent with other MP3 FSAR analyses. The net release fractions are 100% of the core noble gases and 50% of the iodines. The timing of the release reflects the Timing Only RST proposal, such that at t=30 secs the gap activity (5% noble gas and iodines) is instantaneously released and at t=30 mins the remainder of the activity, the "early in-vessel" release, (95% of the core noble gas and 45% of the iodines) is instantaneously released. This is compared to the earlier Reg. Guide 1.4 (Ref. 3) source term below in Table 1.

Table 1 Reg. Guide 1.4 vs. Timing Only Release

	Reg. Guide 1.4		Timing Only RST	
Release Time	Noble Gas	Iodine	Noble Gas	Iodine
t = 0	100%	50%		
t = 30 sec			5%	5%
t = 30 min			95%	45%
Total	100%	50%	100%	50%

The iodine form is 91% elemental, 5% particulate, and 4% organic as specified in SRP 6.5.2, Rev. 2.

5.4. Iodine Removal in Containment

Credit is taken for containment sprays in removing elemental and particulate iodine from the containment atmosphere. The spray removal and wall plate-out rates for iodines were calculated (Ref. 20) by Stone and Webster (S&W) using SRP 6.5.2, Rev. 2 methods (Ref. 8). Credit is taken for plateout of elemental iodine onto the wetted, unsprayed region of the containment (Ref. 20). The effectiveness of the sprays in removing elemental iodine ends at the time when the maximum allowed DF of 200 is reached (Ref. 8). The effectiveness of the sprays in removing particulate iodine is reduced in accordance with SRP 6.5.2, Rev. 2 methods (by a factor of 10) when a particulate DF of 50 is achieved.

5.4.1. DF Defined for Multiple Time Release

According to SRP 6.5.2 DF "...is defined as the maximum iodine concentration in the containment atmosphere divided by the concentration of iodine in the containment atmosphere at some time after decontamination" (time t=j). I-131 is used as representative of all iodines since it has a long half-life (8.05 days).

$$DF_j = \frac{(\text{Elem. Iodine in Cont.})(\%\ \text{I-131})\ @\ t = i}{(\text{Elem. Iodine in Cont.})(\%\ \text{I-131})\ @\ t = j} \quad \text{for } j>i$$

For the Reg. Guide 1.4 source term maximum concentration occurs at t=0, the release of the entire source term. The RST Timing Only source term releases the iodine in two puffs, one at 30 sec and one at 30 min. To calculate conservative DF's the maximum concentration is taken as the sum of the concentration at t=30 sec from the gap release plus the concentration component at t=30 min only from the "early in-vessel" release. Thus:

$$DF_j = \frac{(5\%\ \text{I-131}\ @\ t = 30\text{secs}) + (45\%\ \text{I-131 decayed to } t = 30\text{mins})}{(\text{Elem. Iodine in Cont.})(\%\ \text{I-131})\ @\ t = j}$$

This approach neglects the decay of the gap release that occurs for the first 30 min. By calculating the DF in this fashion we are effectively maximizing the numerator. For a fixed DF (either 200 or 50) the denominator is also maximized. This means that the maximum allowed DF is reached with the highest value of iodine in containment, i.e., earlier in the sequence. This is conservative in that credit for sprays is lessened by reducing/stopping the removal of iodine by the sprays earlier in the sequence. This is very conservative with respect to the philosophy of SRP 6.5.2, which limits credit for iodine removal by sprays to observed physics. However, for a pilot plant initial application the results of this more conservative approach allow insights into the RST Timing Only proposal.

The calculation of the critical DF values of 200 and 50 is done by iterating with TACT. Only the final run of each series, showing the calculated DF, is included in this package.

5.5. Dose Conversion Factors

The thyroid dose conversion factors (DCF's) currently used in the TACT III code date back to ICRP 2 (1959), (Ref. 4 & 5). ICRP 30 (Ref. 7) adult thyroid DCF's will be used in this analysis because they are more up-to-date and realistic. The TACT III results were adjusted using Excel 5 to derive the results with IRCP 30 DCF's.

6. Analysis:

6.1. Time Line

Table 2 is a timeline of significant events. It is intended to serve as a guide in putting the three component releases in perspective and showing the interdependence of each.

6.2. Assumptions

Listed in Table 3 through Table 7 are the assumptions used in this calculation. Some of the assumptions warrant more detailed discussion and are described further in subsequent sections.

SUBJECT	EAB and LPZ Doses	BY	DWM/WJE	DATE	3/20/96
	from a MILLSTONE	CHKED		DATE	
	UNIT 3 LOCA	CALC #	M3LOCA94/ 01048		- R3 Rev 1
		SHEET	9	OF	29

Table 2 Time Line of Significant Events

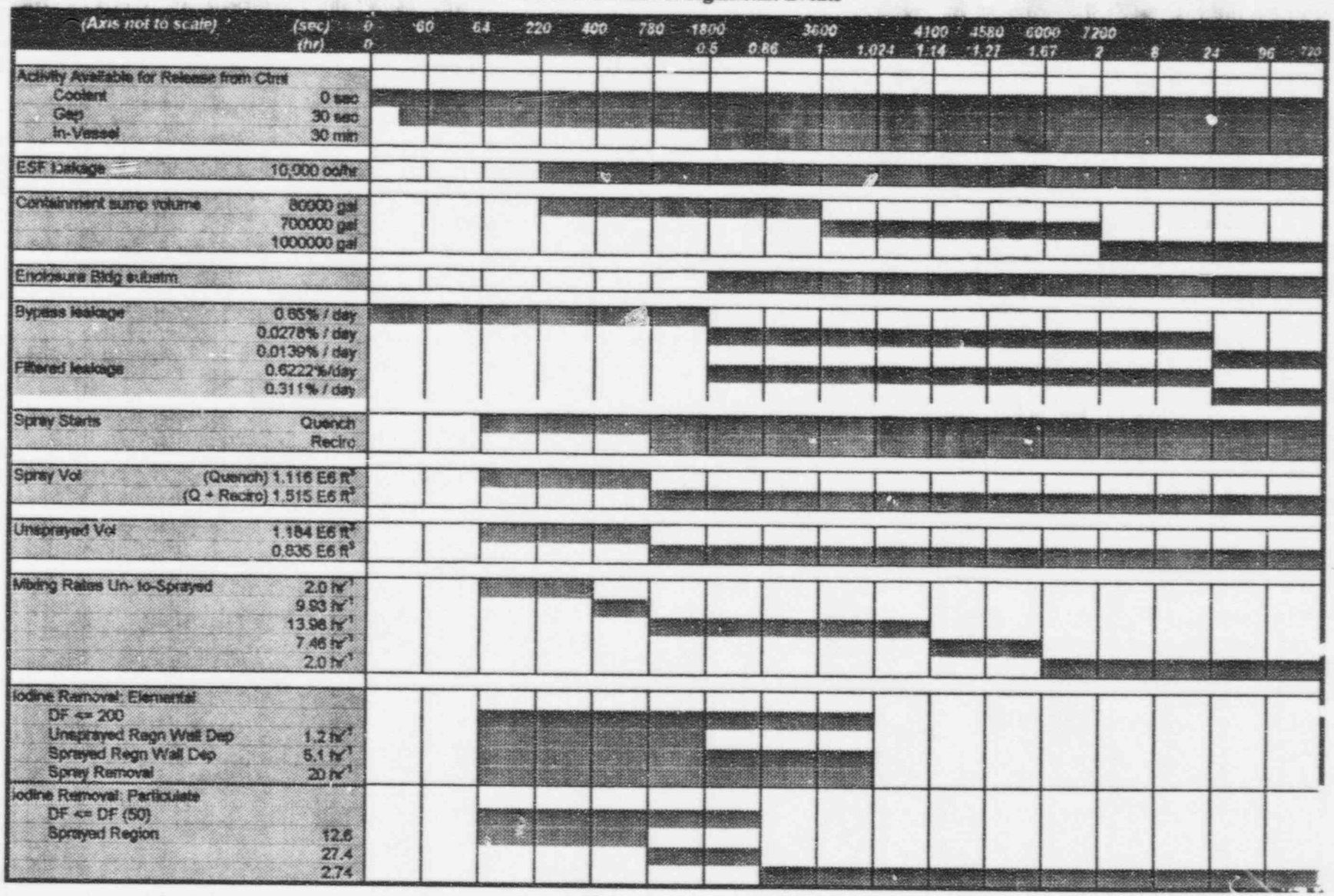


Table 3 General Assumptions - Apply to All Cases

Parameter	Value	Basis
Power Level	3636 MW thermal	Ref. 17, pg. 2
Core Inventory	(see Table 9 Release Activities)	Ref. 17, pg. 15
Core Release Fractions:		Timing Only RST Proposal
t = 30 sec	5% noble gases, 5% iodines	
t = 30 min	95% noble gases, 45% iodines	
Iodine Chemical Form:		Ref. 3, pg. 1.4-1
elemental	91%	
particulate	5%	
organic	4%	
Containment Leak Rate (L_a)	0.65%/day	PTSCR #3-25-95, Ref. 21
Enclosure building drawdown	30 min	PTSCR #3-25-95, Ref. 21
Offsite Breathing Rates:		Ref. 3, pg. 1.4-2
(0-8) hr	3.47E-4 (m^3/sec)	
(8-24) hr	1.75E-4	
(24-720) hr	2.32E-4	
LPZ X/Q's:		Ref. 2, pg. 5
(0-8) hr	2.91E-5 (sec/m^3)	
(8-24) hr	1.99E-5	
(24-96) hr	8.66E-6	
(96-720) hr	2.83E-6	
Dose Conversion Factors	(see Table 12)	ICRP30, Ref. 7

Table 4 Spray Assumptions - All Cases

Parameter	Value	Basis
Critical Iodine DF values		Ref. 8, pg. 6.5.2-12
Max elemental DF	200	
Crit particulate DF	50	
Spray Initiation		Ref. 10, 6.5.2.2,
Quench	64 sec	pg. 6.5-6
Recirculation	780 sec	pg. 6.2-48
Containment Volumes		
Free Air Volume	2.35E6 ft^3	Ref. 2, pg. 4
Spray Region (Node 1)		
Quench only	1.17E6 ft^3	Ref. 19, pg. 15
Quench + Recirc	1.52E6 ft^3	"
Unsprayed Regn (Node 2)		
Quench only	1.18E6 ft^3	"
Quench + Recirc	8.34E5 ft^3	"

Parameter	Value	Basis
Mixing rates:		Ref. 19, pg. 25
(0 - 400 sec)	2.00 (1/hr)	
(400 - 780 sec)	9.93	
(780 - 4100 sec)	13.98	
(4100 - 4580 sec)	7.46	
(4580 - 6000 sec)	7.46	
(> 6000 sec)	2.00	
Elem. Iodine Removal Coeff.:		Ref. 8,pg. 6.5.2-12 & Ref. 20, pg. 29
Sprayed Region (Node 1)		
λ_{spray}	20.0/hr	
$\lambda_{plate-out}$	5.4 /hr	
Unsprayed Regn (Node 2)		
$\lambda_{plate-out}$	1.2/hr	
Part. Iodine Removal Coeff.:		Ref. 8,pg. 6.5.2-12 & Ref. 20 pg. 28
During Quench spray		
$\lambda_{DF<50}$	12.8/hr	
During Quench + Recirc		
$\lambda_{DF<50}$	27.4/hr	
$\lambda_{DF>=50}$	2.74/hr	

Table 5 Bypass Case Assumptions

Parameter	Value	Basis
Bypass Release Rate		Ref. 10 Table 15.6-9, and Proposed Tech. Spec. PTSCR #3-25-95, Ref. 21 pg. 3/4 6-2; Ref. 3, item C.1.e
(0-0.5) hr	0.65%/day	
(0.5-24) hr	0.0278% /day	
(24-720) hr	0.0139% /day	
Bypass Leakage Fraction	0.04277*L_a	Ref. 10 Table 15.6-9 and Ref. 15, pg. 3/4 6-2
Release Point	containment (ground)	Ref. 10, 15.6.5.4, pg. 15.6-23
EAB X/Q's:		Ref. 2, pg. 5
(0-2) hr	5.42E-4 (sec/m^3)	

Table 6 Filtered Case Assumptions

Parameter	Value	Basis
Filtered Release Rate		Ref. 10 Table 15.6-9 and Ref. 21, pg. 3/4 6-2; Ref. 3, item C.1.e
(0.5-24) hr	0.6222% /day	
(24-720) hr	0.3111% /day	
Filter Efficiency	95% for all forms	Ref. 2, pg. 4
Release Point	ventilation vent	Ref. 10, 15.6.5.4,pg. 15.6-22
EAB X/Q's:		Ref. 2, pg. 5
(0-2) hr	4.30E-4 (sec/m^3)	

Table 7 ESF Case Assumptions

Parameter	Value	Basis
Core inventory into sump:	0% noble gas 50% iodines	Ref. 11 pg. 15.6.5-16 and Ref. 3
Sump volume:		Ref. 2, pg. 5
220 sec - 1 hr	80000 (gal)	
1 hr - 2 hr	700000	
>2 hr	1000000	
Iodine released from sump water	10%	Ref. 2 and Ref. 11
ESF leakage : twice the max operational leakage	10000 cc/hr	Ref. 2, pg. 6
Release Point	ventilation vent	Ref. 10, 9.4.3.2,pg. 9.4-17
ESF leakage begins	220 sec	Ref. 2, pg. 4
EAB X/Q's:		Ref. 2, pg. 5
(0-2) hr	4.30E-4 (sec/m^3)	

6.3. Containment Volumes, Mixing, and Sprays

6.3.1. Containment Volumes

This calculation requires the volumes of the sprayed region (node 1) and the volume of the unsprayed region (node 2) of containment. It should be noted that the volume of the sprayed and unsprayed regions changes when the sprays change from no spray, to quench only, to quench plus recirculation sprays. This is illustrated in Table 4 and Table 8.

Table 8 All Cases: Spray Volumes, Mixing and Filter Rates as a Function of Time

Time Period (hr)	Unsprayed Volume (ft^3)	Sprayed Volume (ft^3)	Turn-overs (1/hr)	Filtered Release Rate (%/day)	Mixing Rate (ft^3/min)	Unsprayed Filter Rate (ft^3/min)	Sprayed Filter Rate (ft^3/min)
0.018 - .111	1,183,800	1,166,200	2.00	0.	39460	0.	0.
.111 - .2167	1,183,800	1,166,200	9.93	"	195919	"	"
.2167 - .5	834,140	1,515,838	13.98	"	194355	"	"
.5 - 1.139	"	"	"	6.222	"	3.604	6.550
1.139 - 1.272	"	"	7.46	"	103711	"	"
1.272 - 1.667	"	"	"	"	"	"	"
1.667 - 24	"	"	2.00	"	27805	"	"
> 24	"	"	"	3.111	"	1.802	3.275

6.3.2. Mixing and Spray Effectiveness

Credit is taken for containment sprays in removing elemental iodine from the containment atmosphere. The quench sprays become effective within 64 seconds (Ref. 10) and the recirculation spray does not

initiate until 780 seconds (Ref. 10 and 19). The effectiveness of the sprays in removing elemental iodine ends at the time when the maximum allowed DF is reached (Ref. 8). The maximum allowed DF for elemental iodine is 200 when either the quench or recirculation sprays operate independently or together (Ref. 8).

During spray system operation, containment mixing occurs between the sprayed region and the unsprayed region. The mixing rate varies with time from 2 turnovers of the unsprayed volume region per hour up to 14 turnovers per hour (Ref. 19) as shown in Table 8. The mixing rate between the unsprayed to sprayed regions is calculated as follows:

Mixing Rate = (Unsprayed volume) x (turnover rate)

The filtered transfer rate from the sprayed and unsprayed regions to the environment through containment filtration leakage are calculated by taking the volume of each region multiplied by the filtered leak rate. For example, following 30 minutes when the enclosure building becomes subatmospheric, 0.6222% of the containment leakage per day (0.65%-0.0278%) will be filtered prior to release to the environment. Thirty minutes following the LOCA the sprayed region with quench and recirc sprays operating will be 1,515,858 cubic feet. Therefore the Sprayed Filter Rate following 30 minutes is calculated as follows:

$$\text{Sprayed Filter Rate}_{(30\ min - 24\ hr)} = (1{,}515{,}858\ ft^3)(.6222\%/day)$$
$$= 6.550E{+}00\ ft^3/min$$

At 24 hours into the event the release rates decrease to one half their original value (Ref. 3), therefore:

$$\text{Sprayed Filter Rate}(>24\ hr) = (6.550E{+}00\ ft3/min)(0.5)$$
$$= 3.275E{+}00\ ft^3/min$$

Table 8 above lists some major time dependent variables related to sprays and volumes and the related mixing rates and filter rates.

The spray removal and wall plate-out rates for elemental iodines were calculated by Stone and Webster (S&W) using SRP 6.5.2, Rev. 2 methods (Ref. 9). The maximum allowed spray removal rate defined in SRP 6.5.2, Rev. 2 is 20/hr. S&W calculated an elemental wall plate-out removal rate within the quench spray region of 5.1/hr and a spray removal rate of 20.0/hr for a total of 25.1/hr (Ref. 20). An elemental wall plate-out removal rate within the unsprayed region was calculated to be 1.2/hr up to 30 minutes following the LOCA, until the containment walls no longer behave as a heat sink (Ref. 20).

For particulate iodine S&W calculated an initial quench spray removal rate for particulate iodine of 12.6/hr (Ref. 20). Once recirc. sprays become effective, at 780 seconds, the particulate iodine removal rate increases to 27.4/hr (Ref. 20). As specified in SRP 6.5.2, Rev. 2 this rate decreases to one tenth of the total removal or 2.74/hr once the suspended aerosol mass of particulate iodine is depleted by a factor of 50. The time that occurs is discussed in "Time to Achieve Particulate Iodine Depletion of 50" on page 16.

6.4. Releases Into Containment

The source term is comprised of the magnitude, timing, and physical/chemical form of the radionuclide release from the fuel. These were summarized in Section "Source Term Basis" on page 6. Even though its contribution is negligible, the coolant activity is included in this analysis for completeness.

The normal coolant activity was taken from the FSAR Design Bases coolant activity Table 11.1-2 (Ref. 10). The magnitude of source core activity was taken from a Stone and Webster calculation 12179-RP-

194-0 (Ref. 17) which is the bases for FSAR Table 15.0-7 (Ref. 10). Table 9 lists the individual release activities for each release case taking into account the assumed release fractions and timing considerations.

Table 9 Release Activities

Isotope	Table 11.1-2 Rx Coolant (μCi/g)	RP-194-0 Core (Ci)	Release Fraction from Gap	Release Fraction from Fuel	0 second Coolant rel. (Ci)	30 second Gap release (Ci)	30 minute Fuel release (Ci)
I-131	2.6E+00	9.11E+07	0.05	0.45	6.10E+02	4.56E+06	4.10E+07
I-132	9.3E-01	1.30E+08	0.05	0.45	2.18E+02	6.50E+06	5.85E+07
I-133	4.2E+00	2.04E+08	0.05	0.45	9.85E+02	1.02E+07	9.18E+07
I-134	5.8E-01	2.38E+08	0.05	0.45	1.36E+02	1.19E+07	1.07E+08
I-135	2.2E+00	1.88E+08	0.05	0.45	5.16E+02	9.40E+06	8.46E+07
Kr-83m	4.5E-01	1.58E+07	0.05	0.95	1.06E+02	7.90E+05	1.50E+07
Kr-85m	1.7E+00	3.96E+07	0.05	0.95	3.99E+02	1.98E+06	3.76E+07
Kr-85	3.4E-02	8.83E+05	0.05	0.95	7.97E+00	4.42E+04	8.39E+05
Kr-87	1.2E+00	7.71E+07	0.05	0.95	2.81E+02	3.86E+06	7.32E+07
Kr-88	3.4E+00	1.08E+08	0.05	0.95	7.97E+02	5.40E+06	1.03E+08
Kr-89	1.1E-01	1.40E+08	0.05	0.95	2.58E+01	7.00E+06	1.33E+08
Xe-131m	1.1E-02	8.01E+04	0.05	0.95	2.58E+00	4.01E+03	7.61E+04
Xe-133m	6.1E-01	4.89E+06	0.05	0.95	1.43E+02	2.45E+05	4.65E+06
Xe-133	2.6E+01	2.03E+08	0.05	0.95	6.10E+03	1.02E+07	1.93E+08
Xe-135m	1.2E+00	5.50E+07	0.05	0.95	2.81E+02	2.75E+06	5.23E+07
Xe-135	5.1E+00	5.38E+07	0.05	0.95	1.20E+03	2.69E+06	5.11E+07
Xe-137	1.7E-01	1.83E+08	0.05	0.95	3.99E+01	9.15E+06	1.74E+08
Xe-138	6.0E-01	1.80E+08	0.05	0.95	1.41E+02	9.00E+06	1.71E+08

Because TACT III was run as a two node calculation (sprayed and unsprayed regions) the fraction of release into each node was calculated. The activity released from the core is assumed to be released instantaneously and be equally distributed throughout the containment atmosphere. At any release time, the activity is proportionally distributed in each node. Table 10 lists the calculated node fractions for the sprayed and unsprayed regions based on the volumes in each region. Prior to 780 seconds only the quench sprays are in use, after 780 seconds the sprayed volume increases due to both quench and recirc. sprays in use.

Table 10 Sprayed and Unsprayed Node Fractions

	64-780 sec ft3	>780 sec ft3	64-780 sec vol. fraction	>780 sec vol. fraction
Total cont.	2.35E+06	2.35E+06	-	-
Node 1	1.17E+06	1.52E+06	0.496	0.645
Node 2	1.18E+06	8.34E+05	0.504	0.355

The TACT III code requires the source to be broken down by the node into which it is released. Table 11 lists the activity in each node that is assumed to be instantaneously released and equally distributed into containment. These values were obtained by multiplying the total release activities as listed in Table 9 by the node fraction for that time step in Table 10.

Table 11 Isotopic Releases by Node

	Coolant t=0		Gap t=30 sec		In-Vessel t=30 min	
	Node 1	Node 2	Node 1	Node 2	Node 1	Node 2
I-131	3.03E+02	3.07E+02	2.26E+06	2.29E+06	2.64E+07	1.46E+07
I-132	1.08E+02	1.10E+02	3.23E+06	3.27E+06	3.77E+07	2.08E+07
I-133	4.89E+02	4.96E+02	5.06E+06	5.14E+06	5.92E+07	3.26E+07
I-134	6.75E+01	6.85E+01	5.91E+06	5.99E+06	6.91E+07	3.80E+07
I-135	2.56E+02	2.60E+02	4.66E+06	4.74E+06	5.46E+07	3.00E+07
Kr-83m	5.24E+01	5.32E+01	3.92E+05	3.98E+05	9.68E+06	5.33E+06
Kr-85m	1.98E+02	2.01E+02	9.83E+05	9.97E+05	2.43E+07	1.34E+07
Kr-85	3.96E+00	4.02E+00	2.19E+04	2.22E+04	5.41E+05	2.98E+05
Kr-87	1.40E+02	1.42E+02	1.91E+06	1.94E+06	4.72E+07	2.60E+07
Kr-88	3.96E+02	4.02E+02	2.68E+06	2.72E+06	6.62E+07	3.64E+07
Kr-89	1.28E+01	1.30E+01	3.47E+06	3.53E+06	8.58E+07	4.72E+07
Xe-131m	1.28E+00	1.30E+00	1.99E+03	2.02E+03	4.91E+04	2.70E+04
Xe-133m	7.10E+01	7.21E+01	1.21E+05	1.23E+05	3.00E+06	1.65E+06
Xe-133	3.03E+03	3.07E+03	5.04E+06	5.11E+06	1.24E+08	6.85E+07
Xe-135m	1.40E+02	1.42E+02	1.36E+06	1.39E+06	3.37E+07	1.85E+07
Xe-135	5.93E+02	6.02E+02	1.33E+06	1.36E+06	3.30E+07	1.81E+07
Xe-137	1.98E+01	2.01E+01	4.54E+06	4.61E+06	1.12E+08	6.17E+07
Xe-138	6.98E+01	7.09E+01	4.47E+06	4.53E+06	1.10E+08	6.07E+07

6.5. Decontamination Factors

TACT III was used iteratively to determine when the maximum allowed elemental iodine DF of 200 for spray effectiveness would be achieved. The same process was used to determine when particulate iodine would be depleted by a factor of 50 so as to adjust the particulate removal rate as specified in SRP 6.5.2, Rev. 2. To determine the respective DF's, the maximum concentration of elemental and particulate I-131 in containment must first be calculated. As discussed above, to conservatively accomplish this the curies of I-131 released into containment at each source timing stage were determined and summed to obtain an effective "maximum" concentration.

Time	TACT III run	Released Elem. Iodine (Ci)	Released Part. Iodine (Ci)	TACT I-131 (%)	"Maximum" Elem. Iodine (Ci)	"Maximum" Part. Iodine (Ci)
0 sec	Mar. 18, 1996 job#03161	2.243E+03	1.232E+02	24.75	5.551E+02	3.049E+01
30 sec	Mar. 18, 1996 job#03161	3.863E+07	2.122E+06	10.72	4.141E+06	2.275E+05
30 min	Mar. 18, 1996 job#03154	3.040E+08	1.670E+07	12.25	3.724E+07	2.046E+06
Total					4.138E+07	2.273E+06

6.5.1. Time to Achieve Maximum Elemental Iodine Spray DF=200

TACT III run dated Mar. 18, 1996, job #03129 is the final run in an iterative sequence which calculates the following results:

Component	At time t=	Result
"Initial" Elemental I-131	"Initial"	4.138E+7 curies
Total Elemental Iodine	3686 sec	1.497E+6 curies
Percent of I-131	3686 sec (1.024 hr)	13.89%

$$DF = (4.138E+7) / (1.497E+6\ Ci)(13.89\%)$$
$$DF_{t=3686\ sec} = 199.1$$

6.5.2. Time to Achieve Particulate Iodine Depletion of 50

TACT III was run to determine at what time is the suspended aerosol mass of particulate iodine depleted by a factor of 50. Computer run dated Mar. 18, 1996, job 03129, calculates the following results:

Component	At time t=	Result
"Initial" Particulate I-131	"Initial"	2.273E+6 curies
Total Particulate Iodine	3094 sec	3.404E+5 curies
Percent of I-131	3094 sec (0.8595 hr)	13.40%

therefore,

$$DF = (2.273E+6) / (3.404E+5\ Ci)(13.40\%)$$
$$DF_{t=3094\ sec} = 49.8$$

Therefore, as specified in SRP 6.5.2, Rev. 2, at 3094 seconds the removal rate of particulate iodine is decreased from 27.4/hr to 2.74/hr.

6.5.3. Containment Bypass Leakage

Bypass Leakage is defined by the NRC (Ref. 14) "as that leakage from the primary containment which can circumvent the secondary containment boundary and escape directly to the environment, i.e., bypasses the leakage collection and filtration systems of the secondary containment". Bypass leakage at a rate of 0.65%/day is assumed starting at t=0 and continuing at that rate until the enclosure building achieves subatmospheric conditions at 0.25" water at t=30 minutes. Once subatmospheric, the auxiliary building filtration system will handle the majority of the containment leakage. Tech. Specs define a bypass fraction of 0.042 L_a (Ref. 15) upon subatmospheric conditions. The FSAR lists the bypass fraction as 0.04277 L_a (Ref. 10). Because it is more conservative, i.e., calculated doses using 0.04277 will exceed those from Tech. Spec. conditions, the FSAR value was used in this analysis, increasing the unfiltered ground release portion of the 0.65%/day release. After 30 minutes the bypass leakage decreases to a rate of 0.0278%/day. It will continue at that rate until 24 hours following the LOCA where the leakage is decreased by one half to 0.0139%/day as defined by Reg. Guide 1.4 (Ref. 3). The assumptions used to calculate the containment bypass leakage portion of the LOCA dose are listed in Table 5.

6.5.4. Containment Filtered Leakage

Containment filtered leakage consists of activity filtered by the auxiliary building filter due to containment leakage and released from the turbine building ventilation vent. Filtered containment leakage begins at t=30 minutes at a rate of 0.6222%/day when the enclosure building achieves a negative pressure of 0.25" water. It will continue at that rate until 24 hours following the LOCA where the leakage is decreased by

one half to 0.3111%/day as defined by Reg. Guide 1.4 (Ref. 3). The assumptions used to calculate the containment filtered leakage portion of the LOCA dose are listed in Table 6.

6.5.5. ESF Leakage

Following a LOCA, long term cooling is provided through the use of ESF equipment. Much of this equipment exists outside of the primary containment and presents a potential source for leakage when water is pumped from the containment sump. Fission products contained in the sump water can be released from the water into the ESF Building atmosphere. The source term for the ESF portion of the LOCA dose assumes no noble gases and all of the released core iodines (effectively 50%) are in the sump water, 10% of that quantity is released from the water into the enclosure building atmosphere. Therefore, to obtain the iodine source term inventories, the values in Table 9 for the three stages of release (i.e., coolant activity at t=0, Gap activity at t=30 sec, and In-Vessel activity at t=30 min) were multiplied by 0.1 and released at their appropriate times. The assumptions used to calculate the ESF leakage portion of the LOCA dose are listed in Table 7.

6.6. Leak Rate Discussion

The enclosure building becomes subatmospheric achieving 0.25 inch water 30 minutes following a LOCA. Therefore up to 30 minutes, normal design leakage proposed at 0.65%/day will exist bypassing secondary containment (auxiliary building filtration). Following 30 minutes, when the enclosure building becomes subatmospheric, a bypass fraction of 0.04277 (Ref. 15) or bypass release rate of 0.0278%/day is assumed.

6.7. Thyroid Dose Conversion Factors

The adjustment from TACT III to ICRP 30 thyroid DCF's was done using the equation given below.

$$D_{Thy_i}^{ICRP30} = D_{Thy_i}^{TACT} * F_i * R_i$$

where,

$D_{Thy_i}^{ICRP30}$ = Thyroid dose for isotope i adjusted for ICRP 30 DCF's.

$D_{Thy_i}^{TACT}$ = Total Thyroid dose from TACT III for isotope i

F_i = Fraction of total iodine.

R_i = Ratio of ICRP 30 to TACT III dose conversion factors (see Table 12).

Table 12 Thyroid Dose Conversion Factors

ISOTOPE	TACT III (rem/Ci - inhaled)	ICRP 30 * (rem/Ci - inhaled)	RATIO (ICRP 30/TACT III)
I-131	1.49E+6	1.073E+6	0.718
I-132	1.43E+4	6.290E+3	0.440
I-133	2.69E+5	1.813E+5	0.674
I-134	3.73E+3	1.073E+3	0.288
I-135	5.60E+4	3.145E+4	0.562

*Note: 3.7E+12 used to convert from Sv/Bq to rem/Ci.

6.8. Computer Code Input Data Sets

The input data sets to the TACT III (version 83.0) computer code are given in Table 13 through Table 15.

Table 13 Tact III Input Data Set - (Containment Bypass Leakage)

Tact III Input Data Set - (Containment Bypass Leakage)

```
MP3 LOCA (BYPASS) GAP RELEASE AT 30 SEC AND IN-VESSEL AT 30 MINUTES
2 15 2 21 03 18 96 0 0
3636. 0.0      0.50 1.0 1.0    9.100E-01  4.000E-02  5.000E-02
1  2 0  0.000E-0   8.333E-03
2  2 2  3.030E+02  3.070E+02
2  2 3  1.080E+02  1.100E+02
2  2 4  4.890E+02  4.960E+02
2  2 5  6.750E+01  6.850E+01
2  2 6  2.560E+02  2.600E+02
2  2 9  5.240E+01  5.320E+01
2  2 10 1.980E+02  2.010E+02
2  2 11 3.960E+00  4.020E+00
2  2 12 1.400E+02  1.420E+02
2  2 13 3.960E+02  4.020E+02
2  2 14 1.280E+01  1.300E+01
2  2 15 1.280E+00  1.300E+00
2  2 16 7.100E+01  7.210E+01
2  2 17 3.030E+03  3.070E+03
2  2 18 1.400E+02  1.420E+02
2  2 19 5.930E+02  6.020E+02
2  2 20 1.980E+01  2.010E+01
2  2 21 6.980E+01  7.090E+01
3  2 0  1.166E+06  1.184E+06
10 3 1  0.0         0.0         3.946E+04
10 3 2  0.0         3.946E+04   0.0
11 3 1  6.500E-01   0.0         0.0
11 3 2  6.500E-01   0.0         0.0
17 6 0  5.420E-04   2.910E-05   3.470E-04  0.0  0.0  6.500E-01
1  2 0  8.333E-03   1.778E-02
2  2 2  2.260E+06  2.290E+06
2  2 3  3.230E+06  3.270E+06
2  2 4  5.060E+06  5.140E+06
2  2 5  5.910E+06  5.990E+06
2  2 6  4.660E+06  4.740E+06
2  2 9  3.920E+05  3.980E+05
2  2 10 9.830E+05  9.970E+05
2  2 11 2.190E+04  2.220E+04
2  2 12 1.910E+06  1.940E+06
2  2 13 2.680E+06  2.720E+06
2  2 14 3.470E+06  3.530E+06
2  2 15 1.990E+03  2.020E+03
2  2 16 1.210E+05  1.230E+05
2  2 17 5.040E+06  5.110E+06
2  2 18 1.360E+06  1.390E+06
2  2 19 1.330E+06  1.360E+06
2  2 20 4.540E+06  4.610E+06
2  2 21 4.470E+06  4.530E+06
1  2 0  1.778E-02  1.111E-01
5  2 0  2.510E+01  1.200E+00
7  2 0  1.260E+01  0.0
1  2 0  1.111E-01  2.167E-01
10 3 1  0.0         0.0         1.959E+05
10 3 2  0.0         1.959E+05   0.0
1  2 0  2.167E-01  5.000E-01
3  2 0  1.516E+06  8.341E+05
7  2 0  2.740E+01  0.0
10 3 1  0.0         0.0         1.943E+05
10 3 2  0.0         1.943E+05   0.0
1  2 0  5.000E-01  5.0002E-1
```

Tact III Input Data Set - (Containment Bypass Leakage)

```
2  2 2  2.640E+07  1.460E+07
2  2 3  3.770E+07  2.080E+07
2  2 4  5.920E+07  3.260E+07
2  2 5  6.910E+07  3.800E+07
2  2 6  5.460E+07  3.000E+07
2  2 9  9.680E+06  5.330E+06
2  2 10 2.430E+07  1.340E+07
2  2 11 5.410E+05  2.980E+05
2  2 12 4.720E+07  2.600E+07
2  2 13 6.620E+07  3.640E+07
2  2 14 8.580E+07  4.720E+07
2  2 15 4.910E+04  2.700E+04
2  2 16 3.000E+06  1.650E+06
2  2 17 1.240E+08  6.850E+07
2  2 18 3.370E+07  1.850E+07
2  2 19 3.300E+07  1.8[illegible]0E+07
2  2 20 1.120E+08  6.170E+07
2  2 21 1.100E+08  6.070E+07
5  2 0  2.510E+01  0.0
11 3 1  2.780E-02  0.0          0.0
11 3 2  2.780E-02  0.0          0.0
17 6 0  5.420E-04  2.910E-05  3.470E-04  0.0  0.0  2.780E-02
1  2 0  5.0002E-1  8.595E-01
1  2 0  8.595E-01  1.024E+00
7  2 0  2.740E+00  0.0
1  2 0  1.024E+00  1.139E+00
5  2 0  0.0         0.0
1  2 0  1.139E+00  1.667E+00
10 3 1  0.0         0.0          1.037E+05
10 3 2  0.0         1.037E+05    0.0
1  2 0  1.667E+00  2.000E+00
10 3 1  0.0         0.0          2.781E+04
10 3 2  0.0         2.781E+04    0.0
1  2 0  2.000E+00  8.000E+00
17 6 0  0.0         2.910E-05  3.470E-04  0.0  0.0  2.780E-02
1  2 0  8.000E+00  2.400E+01
17 6 0  0.0         1.990E-05  1.750E-04  0.0  0.0  2.780E-02
1  2 0  2.400E+01  9.600E+01
11 3 1  1.390E-02  0.0          0.0
11 3 2  1.390E-02  0.0          0.0
17 6 0  0.0         8.660E-06  2.320E-04  0.0  0.0  1.390E-02
1  2 0  9.600E+01  7.200E+02
17 6 0  0.0         2.630E-06  2.320E-04  0.0  0.0  1.390E-02
0/
□
```

Table 14 Tact III Input Data Set - (Containment Filtered Leakage)

Tact III Input Data Set - (Containment Filtered Leakage)

```
MP3 LOCA (FILTERED) GAP RELEASE AT 30 SEC AND IN-VESSEL AT 30 MINUTES
2 15 2 21 03 18 96 0 0
3636. 0.0      0.50 1.0 1.0   9.100E-01  4.000E-02  5.000E-02
1  2 0  0.000E-0   8.333E-03
2  2 2  3.030E+02  3.070E+02
2  2 3  1.080E+02  1.100E+02
2  2 4  4.890E+02  4.960E+02
2  2 5  6.750E+01  6.850E+01
2  2 6  2.560E+02  2.600E+02
2  2 9  5.240E+01  5.320E+01
2  2 10 1.980E+02  2.010E+02
2  2 11 3.960E+00  4.020E+00
2  2 12 1.400E+02  1.420E+02
2  2 13 3.960E+02  4.020E+02
2  2 14 1.280E+01  1.300E+01
2  2 15 1.280E+00  1.300E+00
2  2 16 7.100E+01  7.210E+01
2  2 17 3.030E+03  3.070E+03
2  2 18 1.400E+02  1.420E+02
```

Tact III Input Data Set - (Containment Filtered Leakage)

```
2  2 19 5.930E+02  6.020E+02
2  2 20 1.980E+01  2.010E+01
2  2 21 6.980E+01  7.090E+01
3  2 0  1.166E+06  1.184E+06
10 3 1  0.0        0.0        3.946E+04
10 3 2  0.0        3.946E+04  0.0
17 6 0  4.300E-04  2.910E-05  3.470E-04  0.0  0.0  0.000E-00
1  2 0  8.333E-03  1.778E-02
2  2 2  2.260E+06  2.290E+06
2  2 3  3.230E+06  3.270E+06
2  2 4  5.060E+06  5.140E+06
2  2 5  5.910E+06  5.990E+06
2  2 6  4.660E+06  4.740E+06
2  2 9  3.920E+05  3.980E+05
2  2 10 9.830E+05  9.970E+05
2  2 11 2.190E+04  2.220E+04
2  2 12 1.910E+06  1.940E+06
2  2 13 2.680E+06  2.720E+06
2  2 14 3.470E+06  3.530E+06
2  2 15 1.990E+03  2.020E+03
2  2 16 1.210E+05  1.230E+05
2  2 17 5.040E+06  5.110E+06
2  2 18 1.360E+06  1.390E+06
2  2 19 1.330E+06  1.360E+06
2  2 20 4.540E+06  4.610E+06
2  2 21 4.470E+06  4.530E+06
1  2 0  1.778E-02  1.111E-01
5  2 0  2.510E+01  1.200E+00
7  2 0  1.260E+01  0.0
1  2 0  1.111E-01  2.167E-01
10 3 1  0.0        0.0        1.959E+05
10 3 2  0.0        1.959E+05  0.0
1  2 0  2.167E-01  5.000E-01
3  2 0  1.516E+06  8.341E+05
7  2 0  2.740E+01  0.0
10 3 1  0.0        0.0        1.943E+05
10 3 2  0.0        1.943E+05  0.0
1  2 0  5.000E-01  5.0002E-1
2  2 2  2.640E+07  1.460E+07
2  2 3  3.770E+07  2.080E+07
2  2 4  5.920E+07  3.260E+07
2  2 5  6.910E+07  3.800E+07
2  2 6  5.460E+07  3.000E+07
2  2 9  9.680E+06  5.330E+06
2  2 10 2.430E+07  1.340E+07
2  2 11 5.410E+05  2.980E+05
2  2 12 4.720E+07  2.600E+07
2  2 13 6.620E+07  3.640E+07
2  2 14 8.580E+07  4.720E+07
2  2 15 4.910E+04  2.700E+04
2  2 16 3.000E+06  1.650E+06
2  2 17 1.240E+08  6.850E+07
2  2 18 3.370E+07  1.850E+07
2  2 19 3.300E+07  1.810E+07
2  2 20 1.120E+08  6.170E+07
2  2 21 1.100E+08  6.070E+07
5  2 0  2.510E+01  0.0
10 3 1  6.550E+00  0.0        1.943E+05
10 3 2  3.604E+00  1.943E+05  0.0
12 3 1  9.500E+01  0.0        0.0
12 3 2  9.500E+01  0.0        0.0
13 3 1  9.500E+01  0.0        0.0
13 3 2  9.500E+01  0.0        0.0
14 3 1  9.500E+01  0.0        0.0
14 3 2  9.500E+01  0.0        0.0
17 6 0  4.300E-04  2.910E-05  3.470E-04  0.0  0.0  6.222E-01
1  2 0  5.0002E-1  8.595E-01
1  2 0  8.595E-01  1.024E+00
7  2 0  2.740E+00  0.0
1  2 0  1.024E+00  1.139E+00
```

Tact III Input Data Set - (Containment Filtered Leakage)

```
5  2 0  0.0          0.0
1  2 0  1.139E+00    1.667E+00
10 3 1  6.550E+00    0.0          1.037E+05
10 3 2  3.604E+00    1.037E+05    0.0
1  2 0  1.667E+00    2.000E+00
10 3 1  6.550E+00    0.0          2.781E+04
10 3 2  3.604E+00    2.781E+04    0.0
1  2 0  2.000E+00    8.000E+00
17 6 0  0.0          2.910E-05    3.470E-04   0.0  0.0  6.222E-01
1  2 0  8.000E+00    2.400E+01
17 6 0  0.0          1.990E-05    1.750E-04   0.0  0.0  6.222E-01
1  2 0  2.400E+01    9.600E+01
10 3 1  3.275E+00    0.0          2.781E+04
10 3 2  1.802E+00    2.781E+04    0.0
17 6 0  0.0          8.660E-06    2.320E-04   0.0  0.0  3.111E-01
1  2 0  9.600E+01    7.200E+02
17 6 0  0.0          2.630E-06    2.320E-04   0.0  0.0  3.111E-01
0/
□
```

Table 15 Tact III Input Data Set - (ESF Leakage)

Tact III Input Data Set - (ESF Leakage)

```
MP3 LOCA (ESF) GAP RELEASE AT 30 SEC AND IN-VESSEL AT 30 MINUTES
1 10 2 8 02 20 96 0 0
3636. 0.0      0.05 0.0 0.0   9.100E-01  4.000E-02  5.000E-02
1  2 0  0.000E-0    8.333E-03
2  1 2  6.100E+01
2  1 3  2.180E+01
2  1 4  9.850E+01
2  1 5  1.360E+01
2  1 6  5.160E+01
3  1 0  1.069E+04
17 6 0  4.300E-04   2.910E-05  3.470E-04  0.0  0.0  0.0
1  2 0  8.333E-03   6.110E-02
2  1 2  4.560E+05
2  1 3  6.500E+05
2  1 4  1.020E+06
2  1 5  1.190E+06
2  1 6  9.400E+05
1  2 0  6.110E-02   5.000E-01
10 2 1  5.886E-03   0.0
12 1 1  9.500E+01
13 1 1  9.500E+01
14 1 1  9.500E+01
1  2 0  5.000E-01   5.0002E-1
2  1 2  4.100E+06
2  1 3  5.850E+06
2  1 4  9.180E+06
2  1 5  1.070E+07
2  1 6  8.460E+06
1  2 0  5.0002E-1   1.000E+00
1  2 0  1.000E+00   2.000E+00
3  1 0  9.357E+04
1  2 0  2.000E+00   8.000E+00
3  1 0  1.337E+05
17 6 0  0.0 2.910E-05  3.470E-04  0.0  0.0  0.0
1  2 0  8.000E+00   2.400E+01
17 6 0  0.0 1.990E-05  1.750E-04  0.0  0.0  0.0
1  2 0  2.400E+01   9.600E+01
17 6 0  0.0 8.660E-06  2.320E-04  0.0  0.0  0.0
1  2 0  9.600E+01   7.200E+02
17 6 0  0.0 2.630E-06  2.320E-04  0.0  0.0  0.0
0/
```

6.9. Results of Computer Runs

Using the assumptions described within this document, each component of the LOCA dose was run using TACT III. The TACT III input data sets in Section 6.8 were run on the Wethersfield IBM 3090 mainframe computer. The dose components were summed to obtain total Millstone EAB and LPZ doses as a result of a MP3 LOCA. The thyroid doses adjusted for ICRP 30 DCF's in each time interval are listed inTable 16 through Table 18 with corresponding data. The summary of both thyroid and whole body dose results appear in Table 19 and Table 20. The containment bypass leakage TACT III results are given in computer output job number 03129, Mar. 18, 1996. The containment filtered leakage TACT III results are given in computer output job number 03140, Mar. 18, 1996. The ESF leakage TACT III results are given in computer output job number 05104, Feb. 26, 1996.

Table 16 ICRP 30 Thyroid Dose Adjustment (Containment Bypass Leakage)

DCF Ratio				
0.718	0.440	0.674	0.288	0.562

	TACT III Iodine Dose Fraction					
Time Interval (Hrs)	I-131	I-132	I-133	I-134	I-135	Combined Factor
0.0 - 0.008333	7.534E-01	2.581E-03	2.196E-01	4.191E-04	2.394E-02	*7.0366E-01*
0.008333 - 0.01778	6.657E-01	9.091E-03	2.693E-01	4.313E-03	5.162E-02	*6.9373E-01*
0.01778 - 0.1111	6.662E-01	8.974E-03	2.692E-01	4.163E-03	5.145E-02	*6.9383E-01*
0.1111 - 0.2167	6.673E-01	8.730E-03	2.690E-01	3.857E-03	5.106E-02	*6.9408E-01*
0.2167 - 0.5	6.693E-01	8.356E-03	2.685E-01	3.415E-03	5.040E-02	*6.9451E-01*
0.5 - 0.8595	6.733E-01	7.704E-03	2.671E-01	2.720E-03	4.909E-02	*6.9522E-01*
0.8595 - 1.024	6.773E-01	6.968E-03	2.660E-01	2.063E-03	4.766E-02	*6.9603E-01*
1.013 - 1.139	6.789E-01	6.685E-03	2.555E-01	1.839E-03	4.708E-02	*6.9633E-01*
1.139 - 1.667	6.823E-01	6.119E-03	2.643E-01	1.444E-03	4.583E-02	*6.9689E-01*
1.667 - 2	6.867E-01	5.423E-03	2.626E-01	1.030E-03	4.419E-02	*6.9756E-01*
2 - 8	7.141E-01	2.531E-03	2.491E-01	1.977E-04	3.408E-02	*7.0094E-01*
8 - 24	7.859E-01	2.172E-04	2.001E-01	7.384E-07	1.381E-02	*7.0700E-01*
24 - 96	9.200E-01	5.712E-07	7.898E-02	7.040E-13	9.994E-04	*7.1435E-01*
96 - 720	9.971E-01	1.025E-16	2.867E-03	4.324E-38	2.152E-07	*7.1785E-01*

Combined Factor(t) = Summation of [DCF Ratio(i) x Iodine Dose Fraction(i)] over i for time interval (t), where i=iodine isotope

	Bypass Release Thyroid Doses (Rem)			
	TACT III		ICRP 30	
Time Interval (Hrs)	EAB	LPZ	EAB	LPZ
0.0 - 0.008333	5.120E-04	2.749E-05	*3.603E-04*	*1.934E-05*
0.008333 - 0.01778	4.901E+00	2.631E-01	*3.400E+00*	*1.825E-01*
0.01778 - 0.1111	3.292E+01	1.767E+00	*2.284E+01*	*1.226E+00*
0.1111 - 0.2167	2.086E+01	1.120E+00	*1.448E+01*	*7.774E-01*
0.2167 - 0.5	1.764E+01	9.469E-01	*1.225E+01*	*6.576E-01*
0.5 - 0.8595	1.912E+01	1.027E+00	*1.329E+01*	*7.140E-01*
0.8595 - 1.024	1.852E+00	9.942E-02	*1.289E+00*	*6.920E-02*
1.013 - 1.139	1.129E+00	6.062E-02	*7.862E-01*	*4.221E-02*
1.139 - 1.667	5.120E+00	2.749E-01	*3.568E+00*	*1.916E-01*
1.667 - 2	3.188E+00	1.712E-01	*2.224E+00*	*1.194E-01*
2 - 8		2.920E+00		*2.047E+00*
8 - 24		2.344E+00		*1.657E+00*
24 - 96		2.225E+00		*1.589E+00*
96 - 720		1.889E+00		*1.356E+00*
		Total	*7.413E+01*	*1.063E+01*

ICRP 30 EAB(t), or LPZ(t) = TACT III EAB(t), or LPZ(t), x Combined Factor(t) for time interval (t)

Table 17 ICRP 30 Thyroid Dose Adjustment (Containment Filtered Leakage)

DCF Ratio				
I-131	I-132	I-133	I-134	I-135
0.718	0.440	0.674	0.288	0.562

	TACT III Iodine Dose Fraction					
Time Interval (Hrs)	I-131	I-132	I-133	I-134	I-135	Combined Factor
0.0 - 0.008333	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.0000E+00
0.008333 - 0.01778	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.0000E+00
0.01778 - 0.1111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.0000E+00
0.1111 - 0.2167	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.0000E+00
0.2167 - 0.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.0000E+00
0.5 - 0.8595	6.733E-01	7.704E-03	2.671E-01	2.725E-03	4.909E-02	6.9522E-01
0.8595 - 1.024	6.773E-01	6.968E-03	2.660E-01	2.063E-03	4.786E-02	6.9603E-01
1.013 - 1.139	6.789E-01	6.685E-03	2.655E-01	1.839E-03	4.708E-02	6.9633E-01
1.139 - 1.867	6.823E-01	6.119E-03	2.643E-01	1.444E-03	4.583E-02	6.9689E-01
1.867 - 2	6.867E-01	5.423E-03	2.626E-01	1.030E-03	4.419E-02	6.9756E-01
2 - 8	7.141E-01	2.531E-03	2.491E-01	1.978E-04	3.406E-02	7.0094E-01
8 - 24	7.859E-01	2.175E-04	2.001E-01	7.396E-07	1.382E-02	7.0701E-01
24 - 96	9.199E-01	5.733E-07	7.908E-02	7.068E-13	1.002E-03	7.1435E-01
96 - 720	9.971E-01	1.051E-16	2.929E-03	4.433E-38	2.204E-07	7.1789E-01

Combined Factor(t) = Summation of [DCF Ratio(i) x Iodine Dose Fraction(i)] over i for time interval (t), where i=iodine isotope

	Filtered Release Thyroid Doses (Rem)			
	TACT III		ICRP 30	
Time Interval (Hrs)	EAB	LPZ	EAB	LPZ
0.0 - 0.008333	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0.008333 - 0.01778	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0.01778 - 0.1111	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0.1111 - 0.2167	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0.2167 - 0.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0.5 - 0.8595	1.698E+01	1.149E+00	1.180E+01	7.988E-01
0.8595 - 1.024	1.644E+00	1.112E-01	1.144E+00	7.740E-02
1.013 - 1.139	1.002E+00	6.782E-02	6.977E-01	4.722E-02
1.139 - 1.867	4.545E+00	3.075E-01	3.167E+00	2.143E-01
1.867 - 2	2.829E+00	1.915E-01	1.973E+00	1.336E-01
2 - 8		3.264E+00		2.288E+00
8 - 24		2.613E+00		1.847E+00
24 - 96		2.465E+00		1.761E+00
96 - 720		2.031E+00		1.458E+00
		Total	1.879E+01	8.626E+00

ICRP 30 EAB(t), or LPZ(t) = TACT III EAB(t), or LPZ(t), x Combined Factor(t) for time interval (t)

Table 18 ICRP 30 Thyroid Dose Adjustment (ESF Leakage)

DCF Ratio				
I-131	I-132	I-133	I-134	I-135
0.718	0.440	0.674	0.288	0.562

	TACT III Iodine Dose Fraction					
Time Interval (Hrs)	I-131	I-132	I-133	I-134	I-135	Combined Factor
0.0 - 0.008333	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	*0.0000E+00*
0.008333 - 0.06111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	*0.0000E+00*
0.06111 - 0.5	6.695E-01	8.439E-03	2.681E-01	3.523E-03	5.044E-02	*6.9448E-01*
0.5 - 1	6.753E-01	7.324E-03	2.666E-01	2.378E-03	4.837E-02	*6.9565E-01*
1 - 2	6.834E-01	5.962E-03	2.639E-01	1.359E-03	4.545E-02	*6.9711E-01*
2 - 8	7.142E-01	2.526E-03	2.491E-01	1.967E-04	3.406E-02	*7.0100E-01*
8 - 24	7.859E-01	2.169E-04	2.000E-01	7.353E-07	1.381E-02	*7.0693E-01*
24 - 96	9.200E-01	5.703E-07	7.896E-02	7.010E-13	9.989E-04	*7.1434E-01*
96 - 720	9.971E-01	1.023E-16	2.865E-03	4.304E-38	2.150E-07	*7.1785E-01*

Combined Factor(t) = Summation of [DCF Ratio(i) x Iodine Dose Fraction(i)] over i for time interval (t), where i=iodine isotope.

ESF Release Thyroid Doses (Rem)				
	TACT III		ICRP 30	
Time Interval (Hrs)	EAB	LPZ	EAB	LPZ
0.0 - 0.008333	0.000E+00	0.000E+00	*0.000E+00*	*0.000E+00*
0.008333 - 0.06111	0.000E+00	0.000E+00	*0.000E+00*	*0.000E+00*
0.06111 - 0.5	1.097E-01	7.423E-03	*7.618E-02*	*5.155E-03*
0.5 - 1	1.235E+00	8.359E-02	*8.591E-01*	*5.815E-02*
1 - 2	2.782E-01	1.882E-02	*1.939E-01*	*1.312E-02*
2 - 8		7.470E-02		*5.236E-02*
8 - 24		6.001E-02		*4.242E-02*
24 - 96		1.140E-01		*8.143E-02*
96 - 720		9.677E-02		*6.947E-02*
		Total	*1.129E+00*	*3.221E-01*

ICRP 30 EAB(t), or LPZ(t) = TACT III EAB(t), or LPZ(t), x Combined Factor(t) for time interval (t).

Table 19 EAB 0-2 Hour Dose Calculation Summary

Release Path	Thyroid (rem)	Whole Body (rem)
Bypass Leakage	7.413E+01	1.212E+00
Filtered Leakage	1.877E+01	9.181E+00
ESF Leakage	1.129E+00	5.253E-03
TOTAL	**9.403E+01**	**1.040E+01**

Table 20 LPZ 0-30 Day Dose Calculation Summary

Release Path	Thyroid (rem)	Whole Body (rem)
Bypass Leakage	1.063E+01	1.444E-01
Filtered Leakage	9.053E+00	2.182E+00
ESF Leakage	3.221E-01	6.471E-04
TOTAL	**2.001E+01**	**2.327E+00**

7. Conclusion

A summary of calculated thyroid and whole body doses from a Millstone Unit 3 Design Basis LOCA appear in Table 19 and Table 20. These doses are within the 10CFR 100 limits of 300 rem to the thyroid and 25 rem to the whole body.

8. Calculation Checklist

Calculation Identifying Number _____ Revision ____

1.	**Preparation**		**Initials**
	1.1	Section 6.1.2	WJE/DWM
	1.2	Section 6.1.3	WJE/DWM
	1.3	Section 6.1.4	WJE/DWM
	1.4	Section 6.4.6	WJE/DWM

2.	**Verification**		
	2.1	Section 6.2.2.1	DWM
	2.2	Section 6.2.2.2	DWM
	2.3	Section 6.2.2.3	DWM
	2.4	Section 6.2.2.4	DWM
	2.5	Section 6.2.2.5	DWM
	2.6	Section 6.2.2.6	DWM
	2.7	Section 6.2.2.7	DWM
	2.8	Section 6.2.2.8	DWM
	2.9	Section 6.2.2.9	DWM - correctness of input, method & coding
	2.10	Section 6.2.2.10	NA
	2.11	Section 6.2.2.11	DWM
	2.12	Section 6.2.2.15	DWM

3.	**Approval**		**Initial & Date**
	3.1	Section 6.3.1	RC 3-27-96
	3.2	Section 6.3.2	RC 3-27-96
	3.3	Section 6.3.3	RC 3-27-96
	3.4	Section 6.3.4	RC 3-27-96
	3.5	Section 6.3.5	RC 3-27-96
	3.6	Section 6.3.6	RC 3-27-96

4.	**Non-QA Applications**		**Initial & Date**
	4.1	Section 5.4 waived	_____
	4.2	Section 6.1.4.7 waived	_____
	4.3	Section 6.2 waived	_____

Basis for Waiver(s)

_____

_____

9. References

1. "EAB and LPZ Doses from a MILLSTONE UNIT 3 LOCA", QA Category 1 Calculation #M3LOCA94/01048 -R3, Rev. 0, Sept. 9, 1994.

2. "2 Hour EAB and 30 day LPZ Doses from a Unit 3 LOCA", S&W Calculation 12179.12 UR(B)-227-2, Sept. 13, 1982.

3. Regulatory Guide 1.4, Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors, Rev. 2, 1974.

4. TACT III, Atmospheric Transport Code System, Oak Ridge National Laboratory, CCC-447, version 83.0.

5. Report of Committee II on Permissible Dose for Internal Radiation, ICRP Publication 2, Permagon Press, New York, 1959.

6. "EAB and LPZ Doses from a Unit 3 LOCA", QA Cat. I Calculation #88-019-96RA, Rev. 2, Nov2, 1993.

7. Annals of the ICRP, Limits for Intakes of Radionuclides by Workers, ICRP30 Supplement to Part 1, Volume 3, No. 1-4, Permagon Press, New York, First Edition, 1980.

8. NRC Standard Review Plan 6.5.2, Rev. 2"Containment Spray as a Fission Product Cleanup System", NUREG-0800, Dec 1988.

9. "Accident Source Terms for Light-Water Nuclear Power Plants", NUREG-1465, February 1995.

10. Millstone Nuclear Power Station Unit 3 Final Safety Analysis Report.

11. NRC Standard Review Plan 15.6.5, Appendix B, "Radiological Consequences of a Design Basis Loss of Coolant Accident: Leakage from Engineered Safety Feature Components Outside of Containment", Rev. 1, July 1981.

12. DiNunno, J.J. et. al., Calculation of Distance Factors for Power and Test Reactor Sites, TID-14844, U. S. Atomic Energy Commission, March 23, 1962.

13. Code of Federal Regulations, 10CFR Part 100 - Reactor Site Criteria.

14. NRC Branch Technical Position CSB 6-3, "Determination of Bypass Leakage Paths in Dual Containment Plants", Rev. 2, July 1981.

15. Millstone Nuclear Power Station Unit 3 Technical Specifications, section 3.6.1.2, Amendment 89.

16. NRC Standard Review Plan 6.5.3, Rev. 2, "Fission Product Control Systems and Structures", NUREG-0800, July 1981.

17. S&W Calculation 12179-RP-194-0, FSAR Source Term, July 27, 1977.

18. "Transient Sump pH and Iodine Partition Coefficients following a LOCA", S&W Calculation 03703.1971 US(B)-350-0.

19. "Mixing Rate Between Sprayed and Unsprayed Regions within Containment", S&W Calculation 03703.1971 US(B)-349.0, Sept. 1, 1994.

20. "Calculation of Particulate, Elemental, and Plate-out Iodine Removal Coefficients for Elevated Containment Pressure Case", S&W Calculation 17273.09 US(B)-341-1, Sept. 1, 1994.
21. PTSCR #3-25-95.

10. Appendix A: EXCEL Spreadsheet Functions and Formulas

	A	B	C	D	E	F	G	H	I	J	K
1											
2											
3		Table 11.1-2	UR(B)-227-2	Release	Release	0 second	30 second	30 minute			
4	Isotope	Rx Coolant	Core	Fraction	Fraction	Cool rel	Gap release	Fuel release			
5		(uCi/g)	(Ci)	from Gap	from Fuel	(Ci)	(Ci)	(Ci)			
6	I-131	2.6	91100000	0.05	0.45	=B6/1000000*454*$J$30	=C6*D6	=C6*E6			
7	I-132	0.93	130000000	0.05	0.45	=B7/1000000*454*$J$30	=C7*D7	=C7*E7			
8	I-133	4.2	204000000	0.05	0.45	=B8/1000000*454*$J$30	=C8*D8	=C8*E8			
9	I-134	0.58	238000000	0.05	0.45	=B9/1000000*454*$J$30	=C9*D9	=C9*E9			
10	I-135	2.2	186000000	0.05	0.45	=B10/1000000*454*$J$30	=C10*D10	=C10*E10			
11											
12	Kr-83m	0.46	15800000	0.05	0.95	=B12/1000000*454*$J$30	=C12*D12	=C12*E12			
13	Kr-85m	1.7	[illegible]000000	0.05	0.95	=B13/1000000*454*$J$30	=C13*D13	=C13*E13			
14	Kr-85	0.034	[illegible]00	0.05	0.95	=B14/1000000*454*$J$30	=C14*D14	=C14*E14			
15	Kr-87	1.2	[illegible]000	0.05	0.95	=B15/1000000*454*$J$30	=C15*D15	=C15*E15			
16	Kr-88	3.4	106[illegible]3000	0.05	0.95	=B16/1000000*454*$J$30	=C16*D16	=C16*E16			
17	Kr-89	0.11	140000000	0.05	0.95	=B17/1000000*454*$J$30	=C17*D17	=C17*E17			
18	Xe-131m	0.011	80100	0.05	0.95	=B18/1000000*454*$J$30	=C18*D18	=C1[illegible]			
19	Xe-133m	0.61	4890000	0.05	0.95	=B19/1000000*454*$J$30	=C19*D19	=C1[illegible]			
20	Xe-133	26	203000000	0.05	0.95	=B20/1000000*454*$J$30	=C20*D20	=C20[illegible]			
21	Xe-135m	1.2	55000000	0.05	0.95	=B21/1000000*454*$J$30	=C21*D21	=C21*E21			
22	Xe-135	5.1	53800000	0.05	0.95	=B22/1000000*454*$J$30	=C22*D22	=C22*E22			
23	Xe-137	0.17	183000000	0.05	0.95	=B23/1000000*454*$J$30	=C23*D23	=C23*E23			
24	Xe-138	0.6	18000000	0.05	0.95	=B24/1000000*454*$J$30	=C24*D24	=C24*E24			
25											
26		0-780 sec	>780 sec	0-780 sec	>780 sec				Table 11.1-3	Table 11.1-3	
27		ft3	ft3	vol. fraction	vol. fraction				Rx. Coolant	Rx. Coolant	
28	Total cont.	2350000	2350000						ft3	lb	
29	Node 1	1166200	1515838	=B29/B28	=C29/C28				w/o pressurizer	10920	470000
30	Node 2	=B28-B29	=C28-C29	=B30/B28	=C30/C28				w/ pressurizer	12000	=I30/29*J29
31											
32										TACIII Decay Checks	
33		TACT node 1	TACT node 2	TACT node 1	TACT node 2	TACT node 1	TACT node 2			Decayed	Decayed
34	Isotope	0 sec	0 sec	30 sec	30 sec	30 min	30 min		Decay	30 sec	30 min
35		(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	Half Life	Factor	(Ci)	(Ci)
36	I-131	=$D$29*F6	=$D$30*F6	=$D$29*G6	=$D$30*G6	=$E$29*H6	=$E$30*H6	8.04 days	=0.693/(8.04*24)	=(D36+E36)*(EXP(-30/3600*136))	=(F36+G36)*(EXP(-30/60*136))
37	I-132	=$D$29*F7	=$D$30*F7	=$D$29*G7	=$D$30*G7	=$E$29*H7	=$E$30*H7	2.3 hrs	=0.693/2.3	=(D37+E37)*(EXP(-30/3600*137))	=(F37+G37)*(EXP(-30/60*137))
38	I-133	=$D$29*F8	=$D$30*F8	=$D$29*G8	=$D$30*G8	=$E$29*H8	=$E$30*H8	20.8 hrs	=0.693/20.8	=(D38+E38)*(EXP(-30/3600*138))	=(F38+G38)*(EXP(-30/60*138))
39	I-134	=$D$29*F9	=$D$30*F9	=$D$29*G9	=$D$30*G9	=$E$29*H9	=$E$30*H9	52.6 mins	=0.693/(52.6/60)	=(D39+E39)*(EXP(-30/3600*139))	=(F39+G39)*(EXP(-30/60*139))
40	I-135	=$D$29*F10	=$D$30*F10	=$D$29*G10	=$D$30*G10	=$E$29*H10	=$E$30*H10	6.61 hrs	=0.693/6.61	=(D40+E40)*(EXP(-30/3600*140))	=(F40+G40)*(EXP(-30/60*140))
41	Total Iodine	=SUM(B36:B40)	=SUM(C36:C40)	=SUM(D36:D4[illegible]	=SUM(E36:E40)	=SUM(F36:F40)	=SUM(G36:G40)			=SUM(J36:J40)	=SUM(K36:K40)
42	Kr-83m	=$D$29*F12	=$D$30*F12	=$D$29*G12	=$D$30*G12	=$E$29*H12	=$E$30*H12	1.83 hrs	=0.693/1.83	=(D42+E42)*(EXP(-30/3600*142))	=(F42+G42)*(EXP(-30/60*142))
43	Kr-85m	=$D$29*F13	=$D$30*F13	=$D$29*G13	=$D$30*G13	=$E$29*H13	=$E$30*H13	4.48 hrs	=0.693/4.48	=(D43+E43)*(EXP(-30/3600*143))	=(F43+G43)*(EXP(-30/60*143))
44	Kr-85	=$D$29*F14	=$D$30*F14	=$D$29*G14	=$D$30*G14	=$E$29*H14	=$E$30*H14	10.72 yrs	=0.693/(10.72*365*24)	=(D44+E44)*(EXP(-30/3600*144))	=(F44+G44)*(EXP(-30/60*144))
45	Kr-87	=$D$29*F15	=$D$30*F15	=$D$29*G15	=$D$30*G15	=$E$29*H15	=$E$30*H15	76.3 mins	=0.693/(76.3/60)	=(D45+E45)*(EXP(-30/3600*145))	=(F45+G45)*(EXP(-30/60*145))
46	Kr-88	=$D$29*F16	=$D$30*F16	=$D$29*G16	=$D$30*G16	=$E$29*H16	=$E$30*H16	2.84 hrs	=0.693/2.84	=(D46+E46)*(EXP(-30/3600*146))	=(F46+G46)*(EXP(-30/60*146))
47	Kr-89	=$D$29*F17	=$D$30*F17	=$D$29*G17	=$D$30*G17	=$E$29*H17	=$E$30*H17	3.15 mins	=0.693/(3.15/60)	=(D47+E47)*(EXP(-30/3600*147))	=(F47+G47)*(EXP(-30/60*147))
48	Xe-131m	=$D$29*F18	=$D$30*F18	=$D$29*G18	=$D$30*G18	=$E$29*H18	=$E$30*H18	11.9 days	=0.693/(11.9*24)	=(D48+E48)*(EXP(-30/3600*148))	=(F48+G48)*(EXP(-30/60*148))
49	Xe-133m	=$D$29*F19	=$D$30*F19	=$D$29*G19	=$D$30*G19	=$E$29*H19	=$E$30*H19	2.187 days	=0.693/(2.188*24)	=(D49+E49)*(EXP(-30/3600*149))	=(F49+G49)*(EXP(-30/60*149))
50	Xe-133	=$D$29*F20	=$D$30*F20	=$D$29*G20	=$D$30*G20	=$E$29*H20	=$E$30*H20	5.245 days	=0.693/(5.245*24)	=(D50+E50)*(EXP(-30/3600*150))	=(F50+G50)*(EXP(-30/60*150))
51	Xe-135m	=$D$29*F21	=$D$30*F21	=$D$29*G21	=$D$30*G21	=$E$29*H21	=$E$30*H21	15.29 mins	=0.693/(15.29/60)	=(D51+E51)*(EXP(-30/3600*151))	=(F51+G51)*(EXP(-30/60*151))
52	Xe-135	=$D$29*F22	=$D$30*F22	=$D$29*G22	=$D$30*G22	=$E$29*H22	=$E$30*H22	9.09 hrs	=0.693/9.09	=(D52+E52)*(EXP(-30/3600*152))	=(F52+G52)*(EXP(-30/60*152))
53	Xe-137	=$D$29*F23	=$D$30*F23	=$D$29*G23	=$D$30*G23	=$E$29*H23	=$E$30*H23	3.85 mins	=0.693/(3.85/60)	=(D53+E53)*(EXP(-30/3600*153))	=(F53+G53)*(EXP(-30/60*153))
54	Xe-138	=$D$29*F24	=$D$30*F24	=$D$29*G24	=$D$30*G24	=$E$29*H24	=$E$30*H24	14.17 mins	=0.693/(14.17/60)	=(D54+E54)*(EXP(-30/3600*154))	=(F54+G54)*(EXP(-30/60*154))
55	Total NG									=SUM(J42:J54)	=SUM(K42:K54)

	A	B	C	D	E	F	G
1				Table			
2				Filtered Leakage			
3				Release, 30 sec GAP Release.			
4							
5							
6				DCF Ratio			
7		I-131	I-132	I-133	I-134	I-135	
8		0.718	0.44	0.674	0.268	0.562	
9							
10							
11				TACT III Iodine Dose Fraction			Combined
12	Time Interval (Hrs)	I-131	I-132	I-133	I-134	I-135	Factor
13	0.0 - 0.008333	0	0	0	0	0	=$B$8*B13+$C$8*C13+$D$8*D13+$E$8*E13+$F$8*F13
14	0.008333 - 0.01778	0	0	0	0	0	=$B$8*B14+$C$8*C14+$D$8*D14+$E$8*E14+$F$8*F14
15	0.01778 - 0.1111	0	0	0	0	0	=$B$8*B15+$C$8*C15+$D$8*D15+$E$8*E15+$F$8*F15
16	0.1111 - 0.2167	0	0	0	0	0	=$B$8*B16+$C$8*C16+$D$8*D16+$E$8*E16+$F$8*F16
17	0.2167 - 0.5	0	0	0	0	0	=$B$8*B17+$C$8*C17+$D$8*D17+$E$8*E17+$F$8*F17
18	0.5 - 0.8595	0.6734	0.007701	0.2671	0.002724	0.04808	=$B$8*B18+$C$8*C +$D$8*D18+$E$8*E18+$F$8*F18
19	0.8595 - 1.024	0.6774	0.006955	0.2659	0.002055	0.04763	=$B$8*B19+$C$8*C19+$D$8*D19+$E$8*E19+$F$8*F19
20	1.013 - 1.139	0.679	0.006671	0.2654	0.00183	0.04704	=$B$8*B20+$C$8*C20+$D$8*D20+$E$8*E20+$F$8*F20
21	1.139 - 1.667	0.6824	0.006106	0.2642	0.001438	0.0456	=$B$8*B21+$C$8*C21+$D$8*D21+$E$8*E21+$F$8*F21
22	1.667 - 2	0.6868	0.005411	0.2626	0.00102A	0.04416	=$B$8*B22+$C$8*C22+$D$8*D22+$E$8*E22+$F$8*F22
23	2 - 8	0.7142	0.002526	0.2491	0.0001989	0.03405	=$B$8*B23+$C$8*C23+$D$8*D23+$E$8*E23+$F$8*F23
24	8 - 24	0.7859	0.000217	0.2001	0.0000007382	0.01381	=$B$8*B24+$C$8*C24+$D$8*D24+$E$8*E24+$F$8*F24
25	24 - 96	0.9199	0.0000005724	0.07008	0.0000000000007039	0.001002	=$B$8*B25+$C$8*C25+$D$8*D25+$E$8*E25+$F$8*F25
26	96 - 720	0.9971	0.00000000000000001052	0.002937	4.428E-38	0.0000002209	=$B$8*B26+$C$8*C26+$D$8*D26+$E$8*E26+$F$8*F26
27	sits(i) x Iodine Dose Fractions(j) over						
28							
29							
30							
31			TACT III		ICRP 30		
32	Time Interval (Hrs)	EAB	LPZ	EAB	LPZ		
33	0.0 - 0.008333	0.000512	0.00002749	=B33*$G13	=C33*$G13		
34	0.008333 - 0.01778	4.901	0.2831	=B34*$G14	=C34*$G14		
35	0.01778 - 0.1111	32.92	1.767	=B35*$G15	=C35*$G15		
36	0.1111 - 0.2167	20.86	1.12	=B36*$G16	=C36*$G16		
37	0.2167 - 0.5	17.64	0.9469	=B37*$G17	=C37*$G17		
38	0.5 - 0.8595	18.96	1.148	=B38*$G18	=C38*$G18		
39	0.8595 - 1.024	1.643	0.1112	=B39*$G19	=C39*$G19		
40	1.013 - 1.139	1.002	0.0678	=B40*$G20	=C40*$G20		
41	1.139 - 1.667	4.543	0.3075	=B41*$G21	=C41*$G21		
42	1.667 - 2	2.829	0.1914	=B42*$G22	=C42*$G22		
43	2 - 8		3.283		=C43*$G23		
44	8 - 24		2.613		=C44*$G24		
45	24 - 96		2.799		=C45*$G25		
46	96 - 720		2.296		=C46*$G26		
47			Total	=SUM(D33:D46)	=SUM(E33:E46)		
48	ICRP 30 EAB(i, or LPZ(i) * TACT III						

	A	B	C	D	E	F	G
1							
2				**Table**			
3				**Bypass Leakage**			
4				**Release, 30 sec. GAP Release.**			
5							
6							
7				**DCF Ratio**			
8		**I-131**	**I-132**	**I-133**	**I-134**	**I-135**	
9		0.718	0.44	0.674	0.268	0.562	
10							
11							
12				**TACT III Iodine Dose Fraction**			
13	**Time Interval (Hrs)**	**I-131**	**I-132**	**I-133**	**I-134**	**I-135**	***Combined Factor***
14	0.0 - 0.008333	0.7534	0.002581	0.2196	0.0004191	0.02394	*=$B$8*B13+$C$8*C13+$D$8*D13+$E$8*E13+$F$8*F13*
15	0.008333 - 0.01778	0.6857	0.009091	0.2693	0.004313	0.05162	*=$B$8*B14+$C$8*C14+$D$8*D14+$E$8*E14+$F$8*F14*
16	0.01778 - 0.1111	0.6662	0.008974	0.2692	0.004183	0.05145	*=$B$8*B15+$C$8*C15+$D$8*D15+$E$8*E15+$F$8*F15*
17	0.1111 - 0.2167	0.6673	0.00873	0.269	0.003857	0.05106	*=$B$8*B16+$C$8*C16+$D$8*D16+$E$8*E16+$F$8*F16*
18	0.2167 - 0.5	0.6693	0.008356	0.2685	0.003415	0.0504	*=$B$8*B17+$C$8*C17+$D$8*D17+$E$8*E17+$F$8*F17*
19	0.5 - 0.8595	0.6733	0.007704	0.2671	0.002725	0.04909	*=$B$8*B18+$C$8*C18+$D$8*D18+$E$8*E18+$F$8*F18*
20	0.8595 - 1.024	0.6773	0.006968	0.266	0.002063	0.04766	*=$B$8*B19+$C$8*C19+$D$8*D19+$E$8*E19+$F$8*F19*
21	1.013 - 1.139	0.6789	0.006885	0.2655	0.001839	0.04708	*=$B$8*B20+$C$8*C20+$D$8*D20+$E$8*E20+$F$8*F20*
22	1.139 - 1.667	0.6823	0.008119	0.2643	0.001444	0.04583	*=$B$8*B21+$C$8*C21+$D$8*D21+$E$8*E21+$F$8*F21*
23	1.667 - 2	0.6867	0.005423	0.2626	0.00103	0.04419	*=$B$8*B22+$C$8*C22+$D$8*D22+$E$8*E22+$F$8*F22*
24	2 - 8	0.7141	0.002531	0.2491	0.0001977	0.03408	*=$B$8*B23+$C$8*C23+$D$8*D23+$E$8*E23+$F$8*F23*
25	8 - 24	0.7859	0.0002172	0.2001	0.0000007384	0.01381	*=$B$8*B24+$C$8*C24+$D$8*D24+$E$8*E24+$F$8*F24*
26	24 - 96	0.92	0.0000005712	0.07896	0.000000000000704	0.0009894	*=$B$8*B25+$C$8*C25+$D$8*D25+$E$8*E25+$F$8*F25*
27	96 - 720	0.9971	0.0000000000000001025	0.002867	4.324E-36	0.0000002152	*=$B$8*B26+$C$8*C26+$D$8*D26+$E$8*E26+$F$8*F26*
28	*e(to) x Iodine Dose Fraction(t) over*						
29							
30							
31			**TACT III**		**ICRP 30**		
32	**Time Interval (Hrs)**	**EAB**	**LPZ**	***EAB***	***LPZ***		
33	0.0 - 0.008333	0.700512	0.00002749	*=B33*$G13*	*=C33*$G13*		
34	0.008333 - 0.01778	4.901	0.2831	*=B34*$G14*	*=C34*$G14*		
35	0.01778 - 0.1111	32.92	1.787	*=B35*$G15*	*=C35*$G15*		
36	0.1111 - 0.2167	20.86	1.12	*=B36*$G16*	*=C36*$G16*		
37	0.2167 - 0.5	17.64	0.9469	*=B37*$G17*	*=C37*$G17*		
38	0.5 - 0.8595	19.12	1.027	*=B38*$G18*	*=C38*$G18*		
39	0.8595 - 1.024	1.852	0.09942	*=B39*$G19*	*=C39*$G19*		
40	1.013 - 1.139	1.129	0.06062	*=B40*$G20*	*=C40*$G20*		
41	1.139 - 1.667	5.12	0.2749	*=B41*$G21*	*=C41*$G21*		
42	1.667 - 2	3.188	0.1712	*=B42*$G22*	*=C42*$G22*		
43	2 - 8		2.92		*=C43*$G23*		
44	8 - 24		2.344		*=C44*$G24*		
45	24 - 96		2.225		*=C45*$G25*		
46	96 - 720		1.689		*=C46*$G26*		
47			***Total***	*=SUM(D33:D46)*	*=SUM(E33:E46)*		
48	*ICRP 30 EAB(t), or LPZ(t) = TACT III*						

	A	B	C	D	E	F	G
1				Table			
2				ESF Leakage			
3				Release, 30 sec. GAP Release.			
4							
5							
6				DCF Ratio			
7		I-131	I-132	I-133	I-134	I-135	
8		0.718	0.44	0.674	0.268	0.562	
9							
10							
11				TACT III Iodine Dose Fraction			Combined
12	Time Interval (Hrs)	I-131	I-132	I-133	I-134	I-135	Factor
13	0.0 - 0.008333	0	0	0	0	0	=$B$8*B13+$C$8*C13+$D$8*D13+$E$8*E13+$F$8*F13
14	0.008333 - 0.08111	0	0	0	0	0	=$B$8*B14+$C$8*C14+$D$8*D14+$E$8*E14+$F$8*F14
15	0.08111 - 0.5	=0.6685	0.008439	0.2681	0.003523	0.05044	=$B$8*B15+$C$8*C15+$D$8*D15+$E$8*E15+$F$8*F15
16	0.5 - 1	0.6753	0.007324	0.2666	0.002378	0.04837	=$B$8*B16+$C$8*C16+$D$8*D16+$E$8*E16+$F$8*F16
17	1 - 2	0.6834	0.005962	0.2639	0.001359	0.04545	=$B$8*B17+$C$8*C17+$D$8*D17+$E$8*E17+$F$8*F17
18	2 - 8	0.7142	0.002526	0.2491	0.0001967	0.03406	=$B$8*B18+$C$8*C18+$D$8*D18+$E$8*E18+$F$8*F18
19	8 - 24	0.7859	0.0002169	0.2	0.0000007353	0.01381	=$B$8*B19+$C$8*C19+$D$8*D19+$E$8*E19+$F$8*F19
20	24 - 96	0.92	0.0000005703	0.07896	0.000000000000701	0.0009989	=$B$8*B20+$C$8*C20+$D$8*D20+$E$8*E20+$F$8*F20
21	96 - 720	0.9971	0.00000000000000001023	0.002665	4.304E-38	0.000000215	=$B$8*B21+$C$8*C21+$D$8*D21+$E$8*E21+$F$8*F21
22	*Combined Factor(I) = Summation of I*						
23							
24							
25							
26			TACT III		*ICRP 30*		
27	Time Interval (Hrs)	EAB	LPZ	*EAB*	*LPZ*		
28	0.0 - 0.008333	0	0	*=B28*$G13*	*=C28*$G13*		
29	0.008333 - 0.08111	0	0	*=B29*$G14*	*=C29*$G14*		
30	0.08111 - 0.5	0.1097	0.007423	*=B30*$G15*	*=C30*$G15*		
31	0.5 - 1	1.235	0.08359	*=B31*$G16*	*=C31*$G16*		
32	1 - 2	0.2782	0.01882	*=B32*$G17*	*=C32*$G17*		
33	2 - 8		0.0747		*=C33*$G18*		
34	8 - 24		0.06001		*=C34*$G19*		
35	24 - 96		0.114		*=C35*$G20*		
36	96 - 720		0.09677		*=C36*$G21*		
37			*Total*	*=SUM(D28:D38)*	*=SUM(E28:E36)*		
38	*ICRP 30 EAB(I), or LPZ(I) = TACT III*						

11. Appendix B: Reviewer's Comments

Reviewer's Comment	Resolution
1. (2/25/96) - When mixing volumes change, the corresponding activities should have changed also.	Agreed. However, this would have meant a larger amount of activity would have been in the sprayed region and a lesser amount in the unsprayed region. Changing in this fashion would reduce the thyroid dose. Thus, the calc is conservative as is.
2. (2/25/96) - See attached pages	The errors in inputs were corrected. New TACT runs were run and the old results and outputs were replaced.
3. (3/20/96 - PREPARERS COMMENT:) In the process of completing the Control Room Dose calculation using this calculation as a reference, an inconsistency was noted between S&W calc. #UR(B)-227-2 and FSAR Table 15.0-7. The S&W calc. which was used as the source term reference had Xe-138 listed incorrectly (10 times too small).	A new earlier reference was found (S&W calc. 12179-RP-194-0) which listed Xe-138 correctly. This new reference was included in this calc. and all calculations were revised accordingly.

SUBJECT	EAB and LPZ Doses from a MILL STONE UNIT 3 LOCA	BY	DWM/WJE	DATE	2/25/96
		CHKED		DATE	
		CALC #	M3LOCA94/ 01048		- R3
		SHEET	20	OF	30

Tact III Input Data Set - (Containment Filtered Leakage)

```
2  2 19 5.930E+02  6.020E+02
2  2 20 1.980E+01  2.010E+01
2  2 21 6.980E+01  7.090E+01
3  2 0  1.166E+06  1.184E+06
10 3 1  0.0        0.0        3.946E+04
10 3 2  0.0        3.946E+04  0.0
17 6 0  4.300E-04  2.910E-05  3.470E-04  0.0  0.0  0.000E-00
1  2 0  8.333E-03  1.778E-02
2  2 2  2.260E+06  2.290E+06
2  2 3  3.230E+06  3.270E+06
2  2 4  5.060E+06  5.140E+06
2  2 5  5.910E+06  5.990E+06
2  2 6  4.660E+06  4.740E+06
2  2 9  3.920E+05  3.980E+05
2  2 10 9.830E+05  9.970E+05
2  2 11 2.190E+04  2.220E+04
2  2 12 1.910E+06  1.940E+06
2  2 13 2.680E+06  2.720E+06
2  2 14 3.470E+06  3.530E+06
2  2 15 1.990E+03  2.020E+03
2  2 16 1.210E+05  1.230E+05
2  2 17 5.040E+06  5.110E+06
2  2 18 1.360E+06  1.390E+06
2  2 19 1.330E+06  1.360E+06
2  2 20 4.540E+06  4.610E+06
2  2 21 4.470E+05  4.530E+05
1  2 0  1.778E-02  1.111E-01
5  2 0  2.510E+01  1.200E+00
7  2 0  1.260E+01  0.0
1  2 0  1.111E-02  2.167E-01
10 3 1  0.0        0.0        1.959E+05
10 3 2  0.0        1.959E+05  0.0
1  2 0  2.167E-01  5.000E-01
3  2 0  1.516E+06  8.341E+05
7  2 0  2.740E+01  0.0
10 3 1  0.0        0.0        1.943E+05
10 3 2  0.0        1.943E+05  0.0
1  2 0  5.000E-01  5.0002E-1
2  2 2  2.640E+07  1.460E+07
2  2 3  3.770E+07  2.080E+07
2  2 4  5.920E+07  3.260E+07
2  2 5  6.910E+07  3.800E+07
2  2 6  5.460E+07  3.000E+07
2  2 9  9.680E+06  5.330E+06
2  2 10 2.430E+07  1.340E+07
2  2 11 5.410E+05  2.980E+05
2  2 12 4.720E+07  2.600E+07
2  2 13 6.620E+07  3.640E+07
2  2 14 8.580E+07  4.720E+07
2  2 15 4.910E+04  2.700E+04
2  2 16 3.000E+06  1.650E+06
2  2 17 1.240E+08  6.850E+07
2  2 18 3.370E+07  1.850E+07
2  2 19 3.300E+07  1.810E+07
2  2 20 1.120E+08  6.170E+07
2  2 21 1.100E+07  6.070E+06
5  2 0  2.510E+01  0.0
10 3 1  6.550E+00  0.0        1.943E+05
10 3 2  3.604E+00  1.943E+05  0.0
12 3 1  9.500E+01  0.0        0.0
12 3 2  9.500E+01  0.0        0.0
13 3 1  9.500E+01  0.0        0.0
13 3 2  9.500E+01  0.0        0.0
14 3 1  9.500E+01  0.0        0.0
14 3 2  9.500E+01  0.0        0.0
17 6 0  4.300E-04  2.910E-05  3.470E-04  0.0  0.0  6.222E-01
1  2 0  5.0002E-1  8.595E-01
1  2 0  8.595E-01  1.024E+00
7  2 0  2.740E+00  0.0
1  2 0  1.024E+00  1.139E+00
```

$\frac{1}{100} \times 1.5116 \times 10^{5}\,ft^3 \times 0.6225\,^{gal}/_{day} \times \frac{1\,day}{24\,hr} \times \frac{1\,hr}{60\,min} = 6.55\,gpm$

$\frac{1}{100} \times 8.341 \times 10^{5}\,ft^3 \times 0.6225\,^{gal}/_{day} \times \frac{1\,day}{24\,hr} \times \frac{1\,hr}{60\,min} = 3.604$

Tact III Input Data Set - (Containment Filtered Leakage)

```
5  2 0  0.0          0.0
1  2 0  1.139E+00    1.667E+00
10 3 1  6.550E+00    0.0          1.037E+05
10 3 2  3.604E+00    1.037E+05    0.0
1  2 0  1.667E+00    2.000E+00
10 3 1  6.550E+00    0.0          2.781E+04
10 3 2  3.604E+00    2.781E+04    0.0
1  2 0  2.000E+00    8.000E+00
17 6 0  0.0          2.910E-05    3.470E-04    0.0  0.0  6.222E-01
1  2 0  8.000E+00    2.400E+01
17 6 0  0.0          1.990E-05    1.750E-04    0.0  0.0  6.222E-01
1  2 0  2.400E+01    9.600E+01
10 3 1  3.275E+00    0.0          2.781E+04                          1.802 ?
10 3 2  2.493E+00    2.781E+04    0.0
17 6 0  0.0          8.660E-06    2.320E-04    0.0  0.0  3.111E-01
1  2 0  9.600E+01    7.200E+02
17 6 0  0.0          2.630E-06    2.320E-04    0.0  0.0  3.111E-01
0/
```

Table 15 Tact III Input Data Set - (ESF Leakage)

Tact III Input Data Set - (ESF Leakage)

```
MP3 LOCA (ESF) GAP RELEASE AT 30 SEC AND IN-VESSEL AT 30 MINUTES
1 10 2 8 02 20 96 0 0
3636. 0.0      0.05 0.0 0.0   9.100E-01  4.000E-02  5.000E-02
1  2 0  0.000E-0   8.333E-03
2  1 2  6.100E+01
2  1 3  2.180E+01
2  1 4  9.850E+01
2  1 5  1.360E+01
2  1 6  5.160E+01
3  1 0  1.069E+04
17 6 0  4.300E-04  2.910E-05  3.470E-04  0.0  0.0  0.0
1  2 0  8.333E-03  6.110E-02
2  1 2  4.560E+05
2  1 3  6.500E+05
2  1 4  1.020E+06
2  1 5  1.190E+06
2  1 6  9.400E+05
1  2 0  6.110E-02  5.000E-01
10 2 1  5.886E-03  0.0
12 1 1  9.500E+01
13 1 1  9.500E+01
14 1 1  9.500E+01
1  2 0  5.000E-01  5.0002E-1
2  1 2  4.100E+06
2  1 3  5.850E+06
2  1 4  9.180E+06
2  1 5  1.070E+07
2  1 6  8.460E+06
1  2 0  5.0002E-1  1.000E+00
1  2 0  1.000E+00  2.000E+00
3  1 0  9.357E+04
1  2 0  2.000E+00  8.000E+00
3  1 0  1.337E+05
17 6 0  0.0          2.910E-05  3.470E-04  0.0  0.0  0.0
1  2 0  8.000E+00    2.400E+01
17 6 0  0.0          1.990E-05  1.750E-04  0.0  0.0  0.0
1  2 0  2.400E+01    9.600E+01
17 6 0  0.0          8.660E-06  2.320E-04  0.0  0.0  0.0
1  2 0  9.600E+01    7.200E+02
17 6 0  0.0          2.630E-06  2.320E-04  0.0  0.0  0.0
0/
```

12. Appendix C: TACT III Output

Docket No. 50-423
B15648

Attachment 3

Millstone Nuclear Power Station, Unit No. 3

Millstone 3 LOCA: Comparison of Different Source Term Scenarios

April 1996

Millstone Nuclear Power Station, Unit No. 3
Millstone 3 LOCA: Comparison of Different Source Term Scenarios

The Millstone 3 NEI Source Term Initiative analysis uses the Timing Extended (TEx) Source Term presented above. In order to provide a context for evaluating the TEx source term additional scenarios have been run using different assumptions. The results from those scenarios are presented here.

Three scenarios are presented in addition to the submittal analysis. They are outlined below:

Case 1 "Base" Configuration

The "base" plant configuration is analyzed using the current licensing source term and a one minute drawdown time. (This case is presented to reflect some refinements in models, calculated parameters, etc., from previously submitted calculations. Those modeling changes are incorporated in all four cases here.)

Case 2 Current Source, Proposed Drawdown

This case incorporates the proposed drawdown time with the Case 1 ("Base") configuration.

Case 3 Submittal Analysis

The analysis done to support the licensing amendment request (Attachment 3). This case incorporates the TEx source term and the proposed drawdown time.

Case 4 TEx Source, Current Drawdown

This case incorporates the new source term with the Case 1 ("Base") configuration.

All the analyses use consistent assumptions except where noted. (The containment leak rate is taken to be the proposed 0.65%/day.

The results from the analyses are presented in the table below:

CALCULATED EAB AND LPZ DOSES (Rem)

	Current Source		Revised Source	
	Case 1 ("Base")	**Case 2**	**Case 3 (Submittal)**	**Case 4**
Drawdown	1 min.	30 min.	30 min.	1 min.
EAB 0-2 hr				
Thyroid	67	574	94	45
Whole Body	17	21	10	10
LPZ 0-30 day				
Thyroid	18	45	20	18
Whole Body	2.8	2.9	2.3	2.3

Observations

At an intuitive level the proposed change in drawdown times makes sense given our current mechanistic understanding of the source term. Recognizing this allows some interesting observations to be made.

Whole Body Doses, all cases

The change in whole body cases is negligible for LPZ doses, and not vast for any EAB case. The decrease in the TEx cases can be attributed to decreases integration duration.

Case 1 (Base) to Case 4 (TEx Source, Current Drawdown)

This comparison isolates the effect of the new source term compared to the base case analysis. The table shows that applying the TEx source term to the current configuration reduces the calculated thyroid dose by about one third for the EAB and the whole body EAB dose by about 40%.

Case 1 (Base) to Case 2 (Current Source, Proposed Drawdown)

This comparison shows that a change that makes sense from a safety standpoint is not possible using the current source term as the basis for analysis. The EAB thyroid dose goes up by an order of magnitude.

Case 1 (Base) to Case 3 (Submittal)

The submittal results in an increase in calculated EAB thyroid doses. By using a full RST source term (timing + physical and chemical form) doses would have been lower than calculated in Case 3, possibly even lower than Case 1 (Base). This is indicative of the tradeoff that takes place when using a simplified approach such as the Timing Extended source term.