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August 2, 1984

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Docket Nos.: 50-352
50-353

Subject: Limerick Generating Station, Units 1 and 2 Information for Containment Systems Branch (CSB) and Accident Evaluation Branch (AEB) Regarding SGTS Drawdown

Reference: (1) Telecon Between L. Bell (NRC/AEB) and D. R. Helwig (PECO), 7/11/84

File: GOVT 1-1 (NRC)

Dear Mr. Schwencer:

In the reference (1) telecon, Mr. Bell of your staff requested that we provide revised FSAR pages which reflect an increase to the reactor enclosure design inleakage rate from 50 to 100 percent free volume per day and a doubling of the SGTS fan flow during drawdown of the Unit 1 reactor enclosure. In response to that request, I am enclosing draft revised FSAR pages.

The information contained on these draft FSAR changes will be incorporated into the FSAR, exactly as it appears on the attachments, in the revision scheduled for August, 1984.

Very truly yours,

Eugene J. Bradley

B001
1/1

EJB:pkc

Attachment/cc: See Attached Service List

cc:	Judge Lawrence Brenner	(w/o enclosure)
	Judge Richard F. Cole	(w/o enclosure)
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	Mr. James Wiggins	(w/o enclosure)
	Mr. Timothy R. S. Campbell	(w/o enclosure)
	Ms. Phyllis Zitzer	(w/o enclosure)
	Judge Peter A. Morris	(w/o enclosure)

TABLE 1.3-4 (Cont'd)

	LIMERICK	SUSQUEHANNA	ZIMMER 1	PEACH BOTTOM
Design temperature of suppression chamber, °F	220	220	275	281
Downcomer vent pressure loss factor	2.18	2.5	2.17	6.21
Break area/total vent area	0.0159	0.016	0.008	0.019
Calculated maximum pressure after blowdown to drywell, psig	44.0	44	40.4	40
Calculated maximum suppression chamber pressure after LOCA blowdown, psig	30.6	29	35.6	25
Initial suppression pool temperature rise during LOCA blowdown, °F	43	40	35	32
Leakage rate, % free volume/day	0.5	0.5	0.635 at 45 psig and 340°F	0.5
SECONDARY CONTAINMENT (See FSAR Section 3.8)				
Type	Controlled leakage, roof level release	Controlled leakage, elevated release	Controlled leakage, elevated release	Controlled leakage, elevated release
Construction				
Lower levels	Reinforced concrete	Reinforced concrete	Reinforced concrete	Reinforced concrete
Upper levels	Reinforced concrete superstructure and siding	Steel superstructure and siding	Steel superstructure and siding	Steel superstructure and siding
Roof	Reinforced concrete	Steel decking	Steel decking	Steel decking
Internal design pressure, psig below atmospheric	0.25	0.25	0.25	0.25
Design inleakage rate, % free volume/day at 0.25 in. w.g.: Reactor Enclosure	~~250~~ 100	100	100	100
Refueling Area	50	100	100	100

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refueling area provide primary containment for the unit being refueled.

6.2.3.1 Design Bases

a. The conditions that could exist following a LOCA or fuel handling accident require the establishment of a method of controlling any fission products that may leak into the secondary containment.

b. The functional capability of the ventilation system to maintain negative pressure in the secondary containment with respect to the outdoors is discussed in Sections 6.5.1.1 and 9.4.2.

c. The seismic design, leaktightness, and internal and external design pressures of the secondary containment structure are discussed in Section 6.2.3.2 and Chapter 3.

d. The capability for periodic inspection and functional testing of the secondary containment structure is discussed in Chapter 16.

6.2.3.2 System Design

6.2.3.2.1 Secondary Containment Design

The secondary containment is designed and constructed in accordance with the design criteria outlined in Chapter 3. All of the major structural walls are constructed of reinforced concrete. All of the major structural floor slabs and roof slabs are constructed of reinforced concrete supported by structural steel framing.

The reactor enclosure 100 I and II) insert a

~~The~~ secondary containment (zones are designed to limit the inleakage to ~~50~~ percent of their zone free volume per day ~~at~~ a negative interior pressure of 0.25 in. wg, while operating the standby gas treatment system (SGTS). Following a LOCA or a fuel handling accident, the affected zone is maintained at this negative pressure by operation of the SGTS. The secondary containment zones are identified in Figures 6.2-27 through 6.2-35.

secondary containment (Figure 6.2-52) Unit #1

An analysis of the post-LOCA pressure transient in the reactor enclosure~~s~~ was performed. The length of time following isolation signal initiation of the SGTS that the pressure in the secondary containment would exceed minus 0.25 in. wg. is ~~12.5~~ 2.25 minutes. ~~based on drawing down both units at the same time.~~ Insert b

~~The drawdown time is significantly extended because of the additional reactor enclosure heat load resulting from RERS~~

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insert (a) (6.2.3.2.1)

THE REFUELING AREA SECONDARY CONTAINMENT

and (Zone III) is designed to limit the inleakage to 50 percent of its zone free volume per day. These inleakage rates are based on ...

insert b

SECONDARY CONTAINMENT

ONLY THE UNIT 1

based on drawing down reactor enclosure which will be the case prior to unit 2 operation. Before unit 2 fuel load, design modifications will be made to ensure a 2.25 minute drawdown during two unit operation.

A MAXIMUM SGTS FLOWRATE OF 2800 CFM WAS USED FOR THE DRAWDOWN ANALYSIS. AS DISCUSSED IN SECTION 6.5.1.1.1.f, THIS MAXIMUM SGTS FLOWRATE CORRESPONDS TO THE FIRST 3 MINUTES AFTER AN ACCIDENT, WHEN RERS IS NOT YET IN OPERATION.

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initiation at three minutes. At two minutes, the SGTS has reduced the reactor enclosure to a negative pressure, but the additional heat load of the RERS fan motors at three minutes causes the reactor enclosure pressure to rise again ~~to a positive pressure~~ before reaching minus 0.25 in. wg. at ~~13.5~~ minutes (Figure 6.2-~~[illegible]~~). The RERS is specifically provided to reduce reactor enclosure airborne activity post-LOCA, and it is considered desirable to initiate the system as soon as possible after an accident. However, this extends the period in which direct exfiltration is assumed from the reactor enclosure in the conservative offsite dose calculations in Chapter 15. 5.5

The guidelines stated in the Standard Review Plan 6.2.3 have been followed in calculating the drawdown time as noted:

1.a. (1) The heat transfer coefficients found in Branch Technical Position CSB 6-1 apply to an atmosphere with high-energy blowdown where condensation on the primary containment surface is expected. Because the drawdown analysis was only ~~12.5~~ 2.25 minutes long, the primary containment heat load was calculated as the steady state load during normal operation when there are no condensation effects. This is accurate because LOCA conditions inside the primary containment will not affect the exterior surface temperature of the 6-foot containment wall significantly in ~~12.5~~ 2.25 minutes. For steady state heat load a conservative value was assumed.

(2) Steady state conduction and convection was calculated.

(3) Radiant heat transfer was considered.

b. Adiabatic boundary conditions were used.

c. There will be negligible expansion of the 6-foot thick primary containment concrete walls in ~~12.5~~ 2.25 minutes.

d. Inleakage was considered.

e. No credit was taken for outleakage.

f. The analysis was based on the assumptions and delays indicated in the acceptance criteria.

g. Heat loads generated within the secondary containment were considered.

h. Fan performance characteristics were considered.

TABLE 6.2-14

SECONDARY CONTAINMENT
DESIGN DATA

REACTOR ENCLOSURE VENTILATION ZONES I AND II, AND REFUELING AREA VENTILATION ZONE III

Free volume, ft^3: Zones I and II 1,800,000 each
Zone III 2,200,000

Pressure

Normal operation: Negative 0.25 in:wg

Post-accident: Negative 0.25 in:wg

Leak rate at post-accident pressure: 0.5 air changes/day (Zone III)
1.0 air change/day (Zones I and II)

SGTS Exhaust fans - common

Number: 2

Type: centrifugal, single inlet single width (SISW)

Secondary containment atmosphere filtration prior to release to outdoors via SGTS fans

Number: 2

Type: Zone I and II prefilter, high efficiency particulate air (HEPA), charcoal, HEPA in RERS followed by HEPA, charcoal, HEPA in SGTS
Zone III prefilter(1), high efficiency particulate air (HEPA), charcoal, HEPA in SGTS

TRANSIENT ANALYSIS

Initial Conditions

Pressure: negative 0.25 in. wg

Temperature: 104°F

Outside air temperature: 95°F

Thickness of secondary containment wall: 36 in.

Thickness of primary containment wall: 72 in.

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Replace figure with the attached

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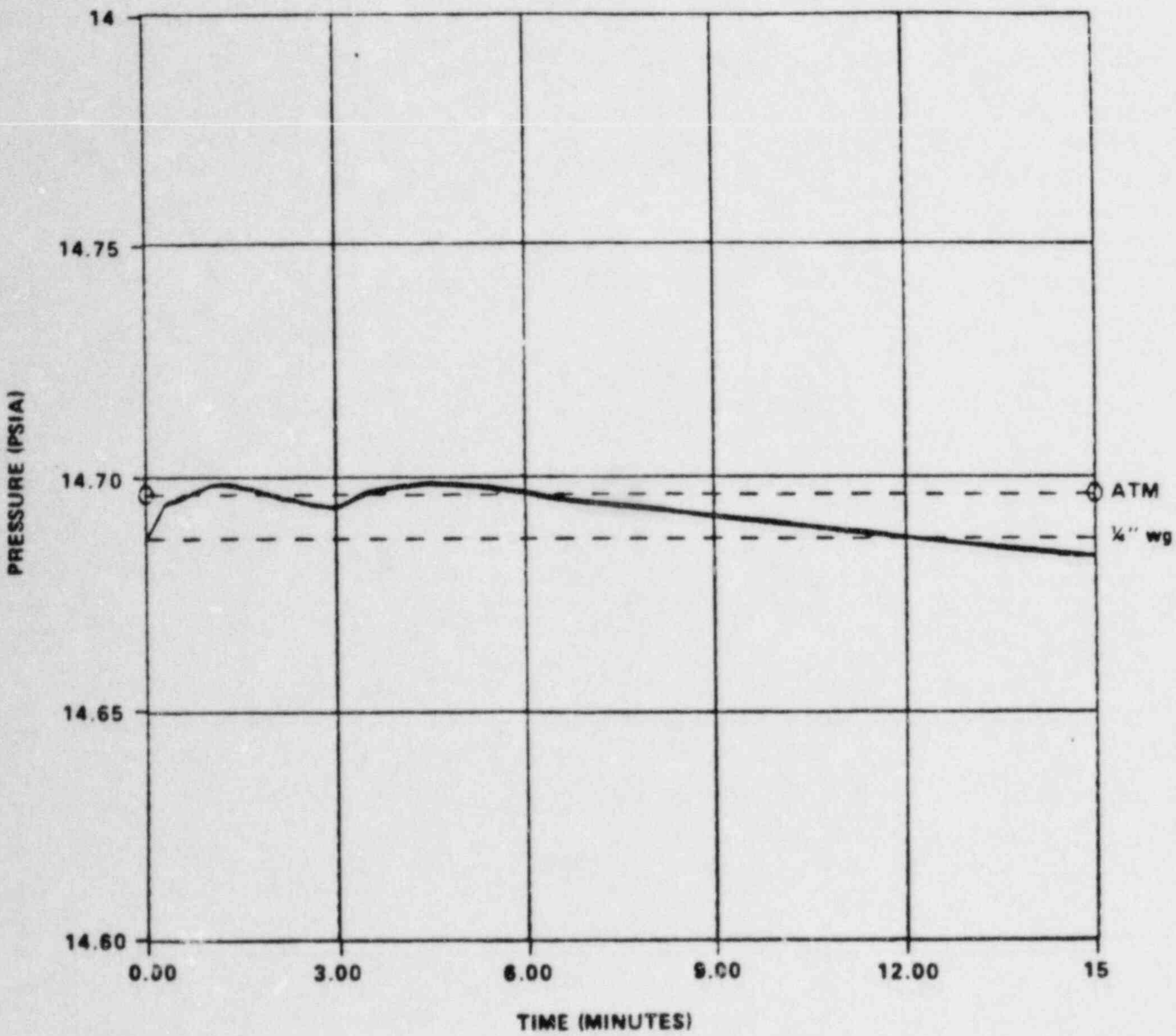


LIMERICK GENERATING STATION
UNITS 1 AND 2
FINAL SAFETY ANALYSIS REPORT

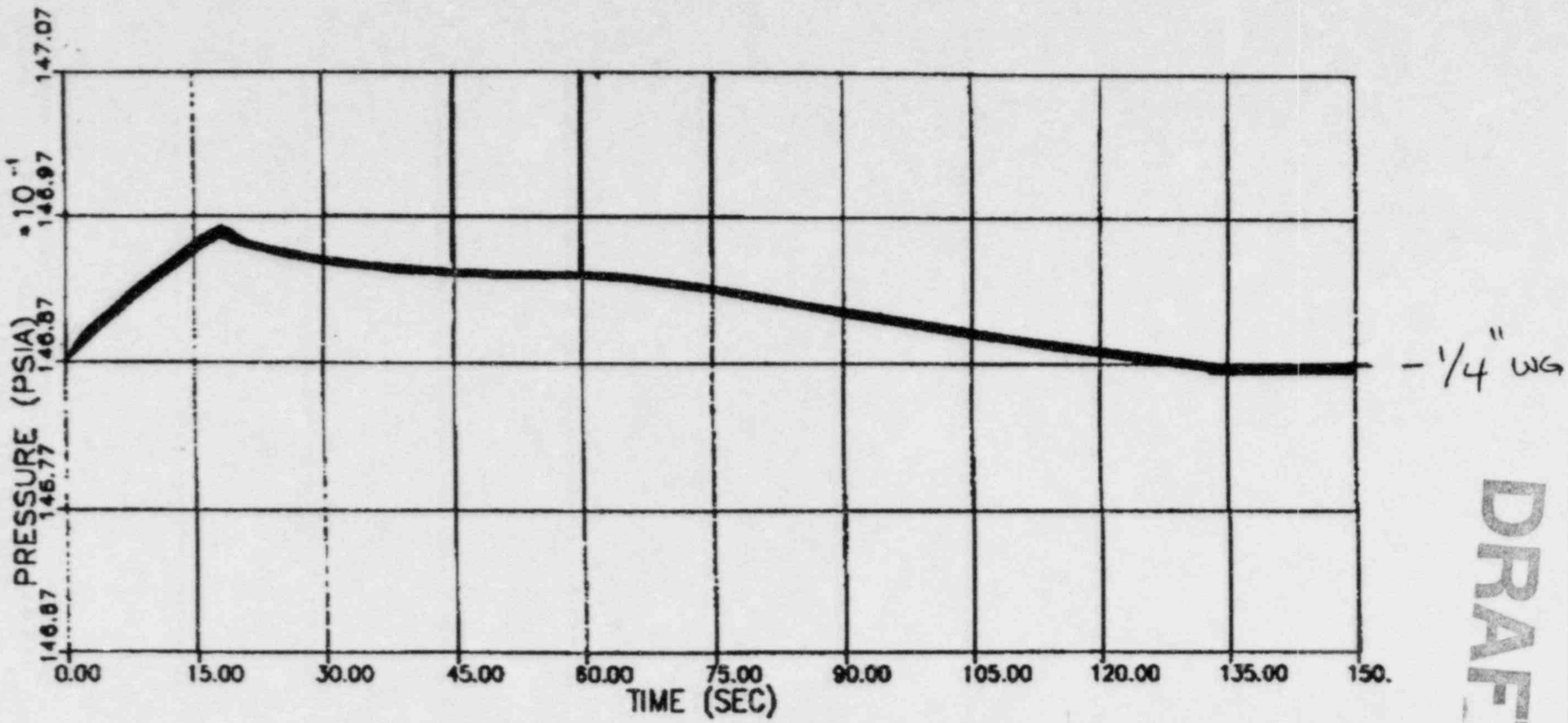
REACTOR ENCLOSURE DRAWDOWN

FIGURE 6.2-52

REV. 15, 12/82

FSAR FIGURE 6.2-52

REACTOR ENCLOSURE DRAWDOWN



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As described in Section 9.4.2.1, the secondary containment consists of three ventilation zones. Zones I and II surround the primary containment of Units 1 and 2, respectively, below the floor at El. 352 ft. Zone III consists of the common refueling area above the floor at El. 352 ft.

The SGTS is designed to accomplish the following objectives:

a. Exhaust sufficient filtered air from the reactor enclosure ~~(Zone I and/or II)~~ or refueling area ~~(Zone III)~~ to maintain a negative pressure of about 0.25 inches w.g. in the affected volumes during secondary containment isolation (see Section 9.4.2 for discussion of the secondary containment isolation signals)

b. Filter the air exhausted to remove radioactive particulates and both radioactive and nonradioactive forms of iodine from the following areas:

   1. Reactor enclosure (Zone I and Zone II)

   2. Refueling area (Zone III)

   3. Main steam isolation valve leakage control system discharge area, following filtration by the reactor enclosure recirculation system

   4. Primary containment during purging and ventilating

   5. Discharge from the high pressure coolant injection (HPCI) barometric condenser

c. Ensure that the failure of any component of the filtration train, assuming loss of offsite power, cannot impair the ability of the system to perform its safety function

d. Remain intact and functional in the event of a safe shutdown earthquake (SSE)

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e. Automatically start in response to any one of the following signals:

1. LOCA signal as described in Section 9.4.2, LOCA signal takes precedence and blocks all signals from the refueling area. If no LOCA signal has been received, the SGTS exhausts either the refueling area or the reactor enclosure based on the ordered signal priority falling in 2 through 5.

2. High radiation level in refueling area exhaust air

3. High radiation level in reactor enclosure (Zone I or Zone II) exhaust air

4. Low differential pressure in the reactor enclosure (Zone I or Zone II)

5. Low differential pressure in refueling area (Zone III)

(The SGTS fans can also be started manually in the control room by tripping the refueling area isolation system or the reactor enclosure isolation system or by setting an SGTS filter in cooldown mode and starting an SGTS fan.)

f. The design bases employed for sizing the filters, fans, and associated ductwork are as follows:

1. Each filter train is sized and specified for treating the incoming air-steam mixture at 11,000 cfm maximum and 135°F for drywell purge (drywell purge is discussed in Section 9.4.5). The SGTS fans are sized for 3000 cfm maximum flow at 7 inches w.g. static pressure, WITH THE RERS IN OPERATION. THE SGTS FLOW WILL BE APPROXIMATELY 2800 CFM AT 7 INCHES W.G. STATIC PRESSURE, WITHOUT RERS IN OPERATION (RERS IS INITIATED 3 MINUTES AFTER THE START OF AN ACCIDENT).

2. The system capacity is maintained with all filters fully loaded (dirty).

3. For high efficiency particulate air (HEPA) filters, maximum free velocity does not exceed 300 fpm with

provided for use in conjunction with the SGTS filter trains. Each fan has a controllable capacity of 500 to 3000 cfm, which is sufficient to restore and maintain the ~~Unit 1 and Unit 2~~ reactor enclosures ~~(Zones I and II)~~ or the common refueling area ~~(Zone III)~~ at the required negative pressure in relation to atmospheric pressure during secondary containment isolation. The air flow varies in response to secondary containment differential pressure controls, which modulate a control damper in the run-around bypass duct provided for each fan.

The SGTS is actuated automatically in its safety-related mode of operation. Both SGTS filter trains are maintained in the open position. Upon receipt of a secondary containment isolation signal (Section 6.5.1.1.1.e), both of the SGTS fans are started and the associated controls are activated to open or modulate appropriate dampers and valves so that the system function is accomplished. Following the initial fan start, the operators may elect to place one of the SGTS fans in the standby position.

For its non-safety-related mode of operation (described in Section 6.5.1.a), two redundant 100% capacity drywell purge fans are provided for use in conjunction with the SGTS filter trains. Each fan has a capacity of 11,000 cfm which is sufficient for the drywell purge operation.

The SGTS is manually actuated for its non-safety related mode of operation.

If one of the SGTS filter train isolation valves fails closed, the redundant filter train is automatically placed into operation. If one of the SGTS fans fails to establish flow, because of either fan or fan damper failure, the standby SGTS fan automatically starts.

9.4-2

The SGTS is shown schematically on Figure 9.4.2. Specific SGTS component design parameters are shown in Table 6.5-1.

The equipment and materials conform to the applicable requirements and recommendations of the guides, codes, and standards listed in Section 3.2. Conformance with Regulatory Guide 1.52 is discussed in Table 6.5-2.

Components for each SGTS train are designed as discussed in the following paragraphs.

TABLE 6.5-9

INSTRUMENTATION FOR ESF ATMOSPHERE CLEANUP SYSTEMS

GUIDELINES PER SRP TABLE 6.5.1-1			INSTRUMENTATION PROVIDED IN LGS DESIGN[1]		
SENSING LOCATION	LOCAL READOUT/ALARM	CONTROL ROOM PANEL	SGTS	RERS	CONTROL ROOM EMERGENCY FRESH AIR
Unit inlet or outlet	Flow rate (indication)	-	Not provided[2]	Flow rate indication at outlet	Flow Rate indication at outlet
Unit inlet or outlet	-	Flow rate (recorded indication, high and low alarms	Flow indication at outlet Low flow alarm [2][3][4]	Low flow alarm[3][5]	low flow alarm [3][4]
Electrical heater	Status indication	-	Status indication in the control room	N/A	Not provided (Trouble alarm in the control room)[7]
Space between heater and prefilter	Temperature (indication high and low alarm signals)	-	Indication only[6]	N/A	Indication only[6]
Space between heater and prefilter	-	Temperature (indication high and low alarms, trip alarm signals)	Provided	N/A	Not provided[9]
Prefilter	Pressure drop (indication, high alarm signal)	-	Indication only [8][10]	Indication only[8][10]	Indication only[8][10]
First HEPA	Pressure drop (indication, high alarm signal)	-	Indication only [8][10]	Same as SGTS[8][10]	Same as SGTS[8][10]
First HEPA	-	Pressure drop (recorded indication)	Not provided[10]	Not provided [10]	Not provided[10]
Space between adsorber and second HEPA	Temperature (two stage high alarm signal)	-	Not provided[6]	Not provided [6]	Not provided[6]
Space between adsorber and second HEPA	-	Temperature (two stage high alarm signal)	Three stage high alarm and indication	Same as SGTS	Same as SGTS
Second HEPA	Pressure drop (indication, high alarm signal)	-	Indication only [8][10]	Same as SGTS[8][10]	Same as SGTS[8][10]

Info only

TABLE 6.5-9 (cont'd)

GUIDELINES PER SRP TABLE 6.5.1-1		INSTRUMENTATION PROVIDED IN LGS DESIGN			
SENSING LOCATION	LOCAL READOUT/ALARM	CONTROL ROOM PANEL	SGTS	RERS	CONTROL ROOM EMERGENCY FRESH AIR
Fan	(Optional hand switch and status indication)	-	Not provided	Not provided	Not provided
Fan	-	Hand switch, status indication	Provided	Provided	Provided
Valve/damper operator	(Optional status indication)	-	Not provided	Not provided	Not provided
Valve/damper operator	-	Status indication	Provided	Provided	Provided
Deluge valves	Hand switch, status indication	-	Manual valves Indication only	Same as SGTS	Same as SGTS
Deluge valves	-	Hand switch, status indication	Alarm(11)	Same as SGTS(11)	Same as SGTS(11)
System inlet to outlet	-	Summation of pressure drop across total system, high alarm signal.	Provided	Provided	Provided

(1) Regulatory Guide 1.52, ANSI-N509, and Standard Review Plan Table 6.5.1 were originally issued after the Limerick system design and therefore were not specifically considered in the design.

(2) The SGTS flow rate is variable to draw down and maintain the reactor enclosure/refueling area at a negative 0.25 in.wg. Local flow indication does not provide meaningful information in terms of system operability. Flow indication is provided in the control room where this information, in addition to the reactor enclosure/refueling area pressure differential indicators, is available for operator evaluation of system performance.

(3) Low flow switch operates on loss of flow only.

(4) The SGTS does not operate during normal plant operation. Maximum SGTS flow occurs only for the first 10 minutes of drawdown. As thermodynamic equilibrium is approached within the reactor enclosure during isolation, the SGTS flow decreases to the design inleakage rate, which is less than half the rated capacity of SGTS fans.

2.25

(5) The RERS does not operate during normal plant operation. The RERS flow is recirculated within the reactor enclosure during isolation and is not directly released to the environment.

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The assumptions and calculation methodology used are as follows:

a. Spiking factor

The activity released from the fuel to the coolant as a consequence of reactor scram and vessel depression was based on measurements during plant shutdowns (Ref 15.6-2). It was shown that for a 95 percentile probability, a total of 7 Ci of I-131 is released to the coolant for every 1 µCi/sec of prespike I-131 release. This conservative ratio was applied for all the iodine isotopes for the dose analysis. The prespike iodine releases were those that correspond to a 0.35 Ci/sec noble gases release, a design basis accident assumption.

b. Iodine concentration in coolant

The total iodine released from the fuel to the coolant was assumed to take place in a span of 5 hours, resulting in continued buildup of coolant activity during that period. The coolant activity during 0-2 hours was assumed to be constant and equal to that at the end of the first hour. The coolant activity during 2 to 5 hours was assumed to be equal to that at the end of 3-1/2 hours. This is a conservative assumption, since the rate of increase in coolant activity decreases with time.

c. Partition factor

It was assumed that 100% of the activity in the coolant that flashed into steam remains airborne and that 10% of the activity carried by the coolant water into the secondary containment becomes airborne (corresponding to a conservative partition factor of 0.1).

d. Activity in secondary containment and released to the environment

The secondary containment one volume was [redacted] assumed to consist of ~~both~~ reactor enclosure~~s and the common refueling area~~, as discussed in Section 15.6.5.5.1.2. The activity airborne in the secondary containment was assumed to be uniformly mixed ~~in the air volume passing through~~ by the reactor enclosure recirculation system (RERS) ~~of both units~~ with an ~~combined~~ airflow of ~~120,000~~ 60,000 scfm and a 95% efficient filter. Secondary containment air is released to the environment via the SGTS at the rate of one ~~half~~ secondary containment volume change per day. The SGTS filter has an efficiency of 99%. The SGTS draws air from the RERS exhaust. The activity airborne in the secondary containment and the activity released to the environment are presented in Tables 15.6-2 and 15.6-4, respectively.

concentration throughout the volume resulted relatively quickly (minutes) indicating almost complete mixing in a room sized volume.

Convective air mixing due to thermal gradients is also discussed in NUREG-1575 (Ref. 15.6-8) for hydrogen. A concentration gradient of less than 0.25% was found for a temperature differential of 5°F. It is expected that convective air mixing effects would be similar for iodine and hydrogen. However, it is also expected that the temperature differentials within the reactor enclosure would be larger than 5°F, and also of many and varied geometrical configurations. Considering that any containment leakage sources are also likely to be heat sources, mixing by convection should be a major effect.

Forced air mixing will result from two systems, local ESF fan coolers and the RERS. Local coolers will remove heat and mix the air in selected rooms of the reactor enclosure as indicated in Section 9.4.5 and the RERS will mix the air as described in Section 6.5.1.3. The fan coolers will be operational for heat removal within minutes after the accident. The RERS, which is initiated 3 minutes after the accident, will mix the air between the various compartments of the reactor enclosure and the HEPA, and charcoal filters will remove particulates and iodines from the air.

SRP 6.5.3 Section III.2.C indicates that mixing credit for small annulus type secondary containments typical of some PWRs and Mark III BWRs will not be given, and that for large BWR reactor enclosures a positive period (implying unfiltered exfiltration) is not assumed. In accordance with this guidance, and as explained in Section 6.5.3, the Limerick evaluation assumes that the assumed 50% mixing within the large reactor enclosure at all times during the period when the reactor enclosure pressure is above minus 1/4 inch, as well as when it is below. However, it will also be conservatively assumed that there is unfiltered exfiltration at ~~0.5~~ 1 air ~~changes~~ change/day ~~(625 cfm)~~ 1250 cfm, in addition to the SGTS exhaust, during periods when the pressure is above minus 1/4 inch w.g.

c. Plateout within the reactor enclosure

Iodine and particulates in the reactor enclosure atmosphere will also be removed from the air by many

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reduce the amount of airborne activity available for release to the atmosphere.

f. As discussed in Section 6.2.3, no bypass leakage around the SGTS filters is assumed for this analysis.

g. Because each unit is equipped with redundant containment hydrogen recombiners, as discussed in Section 6.2.5, calculation of hydrogen purge doses is not necessary.

h. Leakage from the MSIV-LCS: The MSIV-LCS routes any leakage through the MSIVs to the steam tunnel where it mixes with the steam tunnel air before being filtered and mixed by the RERS and then exhausted by the SGTS. The maximum permissible leakage is specified in the Limerick Technical Specifications and is ~~less than~~ consistent with the 11.5 ~~50~~ scfh per valve conservatively assumed for this safety analysis. Leakage past the inboard MSIVs is assumed to begin immediately after the accident to simplify this analysis. In reality a delay would be associated with this release. A total of ~~200~~ 46 scfh has been assumed for the four main steam lines. This MSIV leakage is in addition to the 0.5 percent per day containment leakage.

The fission product activity in the reactor enclosure at any time (t) is a function of the leakage rate from the primary containment, cleanup in the reactor enclosure, and the volumetric discharge rate from the reactor enclosure. Upon receipt of appropriate signals, the reactor enclosure ventilation isolation valves isolate the reactor enclosure atmosphere in 3 to 5 seconds. This rapid closure time prevents possible uncontrolled escape of radioactivity. Upon reactor enclosure isolation, the RERS is designed to circulate the reactor enclosure air to provide iodine removal by the charcoal filters and a delay mechanism whereby radioisotopes are retained in the reactor enclosure and undergo radioactive decay rather than direct escape through the SGTS. A further function of the RERS is to provide thorough mixing of the recirculated flow to ensure that the SGTS cannot extract an unmixed quantity of radioactivity. Any fission product removal effects in the reactor enclosure, such as plateout, are neglected. However, the effects of decay are considered. A mixing efficiency of 50% has conservatively been assumed in the analyses, although a higher efficiency is expected.

The system removal efficiency is designed to be in excess of 99% removal of all forms of iodine and 0.3 micron or larger particulates. The SGTS has a design flow of ~~one half~~ one air change per day of the reactor enclosure. The SGTS draws air from the exhaust of the reactor enclosure recirculation system.

The following equations describe the activity buildup in the reactor enclosure due to primary containment leakage.

$$\frac{dA_{c2}}{dt} = \lambda_1 A_1 - (\lambda_D + \lambda_{c2}) A_{c2} \qquad (15.6\text{-}3)$$

where

A_{c2} = Activity in reactor enclosure at time t, Ci

λ_{21} = SGTS vent rate from reactor enclosure, hr^{-1}

λ_{22} = Recirculation removal rate, hr^{-1}

λ_{23} = Unfiltered releases from reactor enclosure during drawdown phase, hr^{-1}

λ_P = Plateout removal rate, hr^{-1}

λ_{c2} = $\lambda_{21} + \lambda_{22} + \lambda_{23} + \lambda_P$

The solution of Equation 15.6-3 is

$$A_{c2} = \frac{\lambda_1 A_0}{(\lambda_1 + \lambda_B - \lambda_{c2}) DF_c} \left[e^{-(\lambda_D + \lambda_{c2})t} - e^{-(\lambda_D + \lambda_1 + \lambda_B)t} \right] \qquad (15.6\text{-}4)$$

where

DF_c = Iodine decontamination factor for leakage through cracks

Activity contributed from recirculation leakage of the ECCS is modeled as follows. Following a LOCA, 50% of the core iodine

Considering that approximately 40% of the released liquid flashes to steam, it is conservatively assumed that 40% of the released iodine activity is airborne initially. However, as a result of plateout and condensation effects, only 50% of the activity initially airborne remains available for release to the environment.

As a consequence of reactor scram and depressurization, additional iodine activity is released from those rods that experienced cladding perforation during normal operation. Measurements performed (Ref 15.6-2) at operating BWRs during reactor shutdown have been used to develop an analytical model for the prediction of iodine and noble gas spiking as a consequence of reactor scram and vessel depressurization.

Because no measurements have been obtained during a pressure transient as rapid as the LOCA, it is difficult to predict the actual release rate from the fuel as a consequence of iodine spiking. It is, therefore, arbitrarily assumed that 100% of the spiking source term is released during the time period that 40% of the discharged coolant is flashing into steam.

It is also assumed that plateout and condensation removes 50% of the airborne iodine activity in the primary containment. The total activity airborne in the containment is presented in Table 15.6-17.

15.6.5.5.2.2 Fission Product Transport to the Environment

The leak rate from the containment to the reactor enclosure is 0.5%/day, where 50% mixing efficiency is assumed to occur. Release rate from the reactor enclosure to the environment via a 95% iodine efficient recirculation filter and a 99% iodine efficient SGTS filter is ~~50%~~ 100% of the reactor enclosure volume per day. The activity buildup in the reactor enclosure is presented in Table 15.6-18. The integrated isotopic activity released to the environment is less than that presented in Table 15.6-19.

15.6.5.5.3 Results

15.6.5.5.3.1 Offsite Doses

The radiological exposures resulting from the activity released to the environment as a consequence of the LOCA have been determined for the design basis and realistic cases. The design

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TABLE 15.6-2 (Page 1 of 2)

INSTRUMENT LINE BREAK ACCIDENT: PARAMETERS TABULATED FOR POSTULATED ACCIDENT ANALYSES

	DESIGN BASIS ASSUMPTIONS	REALISTIC BASIS ASSUMPTIONS
I. Data and Assumptions used to Estimate Radioactive Source from Postulated Accidents		
A. Power Level	NA	NA
B. Burnup	NA	NA
C. Fission Product Release from Fuel (fuel damaged)	NA	None
D. Release of Activity by Nuclide to the Environment	Table 15.6-~~3~~4	Table 15.6-~~4~~6
E. Iodine Fractions		
(1) Organic	NA	0
(2) Elemental	NA	1
(3) Particulate	NA	0
F. Reactor Coolant Activity Before the Accident	15.6.4.5.1	15.6.4.5.2
II. Data and Assumptions Used to Estimate Activity Released		
A. Primary Containment Leak Rate (%/day)	NA	NA
B. Secondary Containment Release Rate (%/day)	100 ~~5~~	100 ~~50~~
C. Valve Movement Times	NA	NA
D. Adsorption and Filtration Efficiencies (SGTS SYSTEM)		
(1) Organic iodine	99	99
(2) Elemental iodine	99	99
(3) Particulate iodine	99	99
(4) Particulate fission products	99	99
E. Recirculation System Parameters		
(1) Flow rate (cfm)	60,000/unit	60,000/unit
(2) Mixing efficiency	50	50
(3) Filter efficiency	95	95
F. Containment Spray Parameters (flow rate, drop size, etc)	NA	NA
G. Secondary Containment Volume (ft^3)		
Reactor enclosure, Unit 1	1.8×10^6	1.8×10^6
~~Reactor enclosure, Unit 2~~	~~1.8×10^6~~	~~1.8×10^6~~
~~Refueling area~~	~~2.2×10^6~~	~~2.2×10^6~~

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TABLE 15.6-2 (Cont'd) (Page 2 of 2)

	DESIGN BASIS ASSUMPTIONS	REALISTIC BASIS ASSUMPTIONS
H. All Other Pertinent Data and Assumptions	~~5.0x10~~ NA	~~5.0x10~~ NA
III. Dispersion Data		
A. EAB/LPZ Distance (m)	731/2043	731/2043
B. X/Qs for Time Intervals of		
(1) 0-2 hrs - EAB	2.9×10^{-4}	1.2×10^{-4}
(2) 0-8 hrs - LPZ	4.0×10^{-5}	2.0×10^{-5}
(3) 8-24 hrs - LPZ	2.9×10^{-5}	1.6×10^{-5}
(4) 1-4 days - LPZ	1.4×10^{-5}	9.0×10^{-6}
(5) 4-30 days - LPZ	5.4×10^{-6}	4.2×10^{-6}
IV. Dose Data		
A. Method of Dose Calculation	Section 15.10	Ref 15.6-3
B. Dose Conversion Assumptions	Section 15.10	Ref 15.6-3
C. Peak Activity ~~Concentrations~~ in ~~Secondary Containment~~	Table 15.6-~~4~~ 3	Table 15.6-~~4~~ 5
D. Doses	Table 15.6-7	Table 15.6-7

REACTOR ENCLOSURE

TABLE 15.6-3

INSTRUMENT LINE FAILURE:
ACTIVITY AIRBORNE IN ~~SECONDARY CONTAINMENT~~ REACTOR ENCLOSURE(1)

DESIGN BASIS ANALYSIS

ISOTOPE	2 HRS	5 HRS	8 HRS	1 DAY	4 DAYS	30 DAYS
131	~~1.96~~ 6.76 x 10^{-1}	~~5.60~~ 1.82 x 10^{0}	~~1.42~~ 1.57 x 10^{-5}	~~4.40~~ 1.53 x 10^{-32}	0.0	0.0
I-132	~~2.28~~ 1.15 x 10^{1}	~~2.36~~ 2.35 x 10^{1}	~~2.48~~ 8.24 x 10^{-5}	~~6.98~~ 6.67 x 10^{-34}	0.0	0.0
I-133	~~1.43~~ 5.14 x 10^{0}	~~3.65~~ 1.33 x 10^{1}	~~8.47~~ 1.05 x 10^{-4}	~~1.64~~ 6.40 x 10^{-32}	0.0	0.0
I-134	~~3.64~~ 1.18 x 10^{1}	~~8.01~~ 4.81 x 10^{1}	~~2.10~~ 3.89 x 10^{-5}	~~2.46 x 10-10~~ 0.0	0.0	0.0
I-135	~~2.29~~ 9.03 x 10^{0}	~~4.56~~ 2.18 x 10^{1}	~~8.98~~ 1.39 x 10^{-4}	~~5.42~~ 2.69 x 10^{-32}	0.0	0.0
TOTAL	~~9.82~~ 5.81 x 10^{1}	~~1.20~~ 1.08 x 10^{2}	~~2.12~~ 3.81 x 10^{-4}	~~2.62~~ 1.07 x 10^{-31}	0.0	0.0

(1) Units for activities are in curies.

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TABLE 15.6-4

INSTRUMENT LINE FAILURE:
ACTIVITY RELEASED TO THE ENVIRONMENT(1)

DESIGN BASIS ANALYSIS

0-2 HRS	2-5 HRS	5-8 HRS	8-24 HRS	1-4 DAYS	4-30 DAYS
4.91 ~~5.59~~ x 10^{-5}	2.15 ~~2.94~~ x 10^{-4}	1.95 ~~9.28~~ x 10^{-5}	1.68 ~~2.42~~ x 10^{-10}	0.0 ~~7.49 x 10-[illegible]~~	0.0
8.46 ~~6.85~~ x 10^{-4}	2.81 ~~1.47~~ x 10^{-3}	2.34 ~~3.24~~ x 10^{-4}	8.20 ~~3.41~~ x 10^{-10}	0.0 ~~9.58 x 10-12~~	0.0
3.74 ~~4.10~~ x 10^{-4}	1.58 ~~1.94~~ x 10^{-3}	1.41 ~~5.92~~ x 10^{-4}	1.12 ~~1.41~~ x 10^{-9}	0.0 ~~2.72 x 10-[illegible]~~	0.0
2.36 ~~1.17~~ x 10^{-3}	5.86 ~~8.32~~ x 10^{-3}	4.20 ~~9.10~~ x 10^{-4}	3.47 ~~2.47~~ x 10^{-10}	0.0 ~~2.24 x 10-[illegible]~~	0.0
6.58 ~~6.05~~ x 10^{-4}	2.59 ~~2.52~~ x 10^{-3}	2.78 ~~7.04~~ x 10^{-4}	1.45 ~~1.35~~ x 10^{-9}	0.0 ~~8.52 x 10-[illegible]~~	0.0
4.29 ~~2.98~~ x 10^{-3}	1.31 ~~7.05~~ x 10^{-2}	1.05 ~~1.80~~ x 10^{-3}	3.90 ~~3.36~~ x 10^{-9}	0.0 ~~4.33 x 10-[illegible]~~	0.0

for activities are in curies.

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TABLE 15.6-5

INSTRUMENT LINE FAILURE:
ACTIVITY AIRBORNE IN ~~SECONDARY CONTAINMENT~~ REACTOR ENCLOSURE(1)

REALISTIC ANALYSIS

ISOTOPE	2 HRS	5 HRS	8 HRS	1 DAY	4 DAYS	30 DAYS
I-131	~~5.50~~ 1.93 $\times 10^{-1}$	~~1.60~~ 5.20 $\times 10^{-1}$	~~4.07~~ 4.48 $\times 10^{-6}$	~~1.26~~ 4.39 $\times 10^{-33}$	0.0	0.0
I-132	~~0.52~~ 3.29 $\times 10^{0}$	~~6.75~~ 6.71 $\times 10^{0}$	~~2.09~~ 2.35 $\times 10^{-5}$	~~2.00~~ 1.91 $\times 10^{-34}$	0.0	0.0
I-133	~~4.08~~ 1.47 $\times 10^{0}$	~~1.04~~ 3.80 $\times 10^{0}$	~~2.42~~ 3.00 $\times 10^{-5}$	~~4.07~~ 1.83 $\times 10^{-32}$	0.0	0.0
I-134	~~1.04~~ 9.07 $\times 10^{0}$	~~2.52~~ 1.37 $\times 10^{1}$	~~6.00~~ 1.11 $\times 10^{-5}$	~~[illegible] x 10-[illegible]~~ 0.0	0.0	0.0
I-135	~~0.55~~ 2.58 $\times 10^{0}$	~~1.30~~ 6.23 $\times 10^{0}$	~~2.45~~ 3.47 $\times 10^{-5}$	~~1.55~~ 7.69 $\times 10^{-33}$	0.0	0.0
TOTAL	~~2.81~~ 1.66 $\times 10^{1}$	~~3.43~~ 3.10 $\times 10^{1}$	~~5.05~~ 1.09 $\times 10^{-4}$	~~7.50~~ 3.06 $\times 10^{-32}$	0.0	0.0

(1) Units for activities are in curies.

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TABLE 15.6-6

INSTRUMENT LINE BREAK:
ACTIVITY RELEASED TO THE ENVIRONMENT(1)

REALISTIC ANALYSIS

ISOTOPE	0-2 HRS	2-5 HRS	5-8 HRS
I-131	1.40 ~~1.59~~ x 10-5	6.15 ~~8.41~~ x 10-[illegible]	5.57 ~~2.66~~ x 10-~~[illegible]~~6
I-132	2.42 ~~1.96~~ x 10-4	8.04 ~~4.19~~ x 10-4	6.67 ~~7.16~~ x 10-[illegible]
I-133	1.07 ~~1.17~~ x 10-4	4.50 ~~5.55~~ x 10-4	4.04 ~~[illegible].69~~ x 10-~~[illegible]~~5
I-134	6.75 ~~3.33~~ x 10-4	1.69 ~~2.38~~ x 10-~~[illegible]~~3	1.22 ~~2.60~~ x 10-~~[illegible]~~4
I-135	1.88 ~~[illegible]~~ x 10-4	7.41 ~~[illegible].20~~ x 10-4	6.51 ~~2.01~~ x 10-~~[illegible]~~5
TOTAL	1.23 ~~8.52~~ x 10-~~[illegible]~~3	3.73 ~~2.02~~ x 10-[illegible]	3.00 ~~5.14~~ x 10-~~[illegible]~~4

ISOTOPE	8-24 HRS	1-4 DAYS	4-30 DAYS
I-131	4.81 ~~5.92~~ x 10-~~[illegible]~~11	~~2.14 x 10-[illegible]~~ 0.0	0.0
I-132	2.34 ~~9.73~~ x 10-~~[illegible]~~10	~~2.74 x 10-[illegible]~~ 0.0	0.0
I-133	3.19 ~~4.02~~ x 10-~~[illegible]~~10	~~7.76 x 10-[illegible]~~ 0.0	0.0
I-134	9.92 ~~6.24~~ x 10-~~[illegible]~~11	~~6.39 x 10-22~~ 0.0	0.0
I-135	4.15 ~~3.86~~ x 10-~~[illegible]~~10	~~2.44 x 10-[illegible]~~ 0.0	0.0
TOTAL	1.12 ~~[illegible].61~~ x 10-~~[illegible]~~9	~~1.24 x 10-[illegible]~~ 0.0	0.0

(1) Units for activities are in curies.

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TABLE 15.6-7

INSTRUMENT LINE FAILURE: RADIOLOGICAL EFFECTS

DESIGN BASIS ANALYSIS

	WHOLE-BODY DOSE (rem)	INHALATION DOSE (rem)
Exclusion Area Boundary (731 meters - 2-hr dose)	5.79 ~~3.03~~ x 10^{-7}	2.23 ~~2.98~~ x 10^{-5}
Low Population Zone (2043 meters - 30-day dose)	3.37 ~~1.81~~ x 10^{-7}	1.76 ~~2.60~~ x 10^{-5}

REALISTIC ANALYSIS

	WHOLE-BODY DOSE (rem)	INHALATION DOSE (rem)
Exclusion Area Boundary (731 meters - 2-hr dose)	6.96 ~~1.03~~ x 10^{-8}	2.75 ~~4.76~~ x 10^{-6}
Low Population Zone (2043 meters - 30-day dose)	4.81 ~~3.38~~ x 10^{-8}	2.51 ~~4.97~~ x 10^{-8}

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TABLE 15.6-13

LOSS-OF-COOLANT ACCIDENT: PARAMETERS
TABULATED FOR POSTULATED ACCIDENT ANALYSES

	DESIGN BASIS ASSUMPTIONS	REALISTIC BASIS ASSUMPTIONS
I. Data and Assumptions Used to Estimate Radioactive Source from Postulated Accidents		
A. Power Level	3458	3458
B. Burnup	NA	NA
C. Fission Products Released from Fuel (fuel damaged)	100%	0
D. Release of Activity by Nuclide to the Environment	Table 15.6-~~14~~ 16	Table 15.6-~~18~~ 19
E. Iodine Fractions		
(1) Organic	0.04	0.01
(2) Elemental	0.91	0.99
(3) Particulate	0.05	0.00
F. Reactor Coolant Activity Before the Accident	Section 15.6.5.5.1	Section 15.6.5.5.~~1~~ 2
II. Data and Assumptions Used to Estimate Activity Released		
A. Primary Containment Leak Rate excluding MSIVs (%/day)	0.5	0.5
B. Secondary Containment Release Rate(1)		
(1) During 2.25 Drawdown (0-~~[illegible]~~ min)	2800 ~~[illegible]~~ cfm	NA
(2) After Drawdown 2.25 (~~[illegible]~~ min - 30 days)	1250 ~~[illegible]~~ cfm 100 (~~[illegible]~~%/day)	NA
(3) Unfiltered Release During Drawdown 2.25 (0-~~[illegible]~~ min)	1250 ~~[illegible]~~ cfm 100 (~~[illegible]~~%/day)	NA
(4) Release Rate for Realistic Analysis	NA	100% ~~[illegible]~~/day
C. Valve Movement Times	NA	NA
D. SGTS Adsorption and Filtration Efficiency (%)	99	99
E. Recirculation System Parameters		
(1) Flow rate (cfm)	6.0×10^4	6.0×10^4
(2) Mixing efficiency	50%	50%
(3) Filter efficiency	95%	95%
F. Containment Spray Parameters	NA	NA

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TABLE 15.6-13 (Cont'd)

	DESIGN BASIS ASSUMPTIONS	REALISTIC BASIS ASSUMPTIONS
(flow rate, drop size, etc)		
G. Containment Volumes(ft^3)		
Primary	3.975 ~~4.103~~ x 10^5	3.975 ~~4.103~~ x 10^5
Secondary (Total)		
Unit 1 reactor enclosure	1.8 x 10^6	1.8 x 10^6
H. All Other Pertinent Data and Assumptions	~~None~~	~~None~~
MSIV leakage per valve	11.5 SCFH	11.5 SCFH
III. Dispersion Data		
A. EAB/LPZ Distance (m)	731/2043	731/2043
B. X/Qs for Time Intervals of		
(1) 0-2 hrs - EAB	6.9 x 10^{-4}	1.2 x 10^{-4}
(2) 0-8 hrs - LPZ	4.0 x 10^{-5}	2.0 x 10^{-5}
(3) 8-24 hrs - LPZ	2.9 x 10^{-5}	1.6 x 10^{-5}
(4) 1-4 days - LPZ	1.4 x 10^{-5}	9.0 x 10^{-6}
(5) 4-30 days - LPZ	5.4 x 10^{-6}	4.2 x 10^{-6}
IV. Dose Data		
A. Method of Dose Calculation	Section 15.10	Ref 15.6-3
B. Dose Conversion Assumptions	Section 15.10	Ref 15.6-3
C. Peak Activity ~~Concentrations~~ in Primary Containment	Table 15.6-~~16~~ 14	Table 15.6-~~19~~ 17
D. Peak Activity in Reactor Enclosure	Table 15.6-15	Table 15.6-18
~~D.~~ E. Doses	Table 15.6-20	Table 15.6-20

NOTES:

(1) ALTHOUGH THE REACTOR ENCLOSURE DRAWDOWN TIME IS 2.25 MINUTES (FSAR SECTION 6.2.3.2.1), THE LOCA DOSES WERE CONSERVATIVELY BASED ON A DRAWDOWN TIME OF APPROXIMATELY 5 MINUTES.

TABLE 15.6-14

LOSS-OF-COOLANT ACCIDENT: ACTIVITY AIRBORNE IN PRIMARY CONTAINMENT[1]

DESIGN BASIS ANALYSIS

ISOTOPE	2 HRS	8 HRS	1 DAY	4 DAYS	30 DAYS
I--131	3.959+006	3.869+006	3.639+006	2.762+006	2.533+005
I--132	3.299+006	5.339+005	4.152+003	1.339-006	.000
I--133	8.365+006	6.846+006	4.012+006	3.623+005	3.224-004
I--134	2.145+006	1.849+004	5.780-007	9.756-027	.000
I--135	6.579+006	3.502+006	6.520+005	3.379+002	1.135-026
KR-83M	6.729+006	6.925+005	1.611+003	2.278-009	.000
KR--85	1.418+006	1.416+006	1.410+006	1.385+006	1.189+006
KR-85M	3.290+007	1.299+007	1.089+006	1.557+001	.000
KR--87	2.713+007	1.029+006	1.674+005	1.490-015	.000
KR--88	6.812+007	1.589+007	3.280+005	8.538-003	.000
KR--89	6.045-004	.000	.000	.000	.000
XE131M	8.925+005	8.782+005	8.412+005	6.931+005	1.293+005
XE133M	4.659+006	4.299+006	3.468+006	1.319+006	3.036+002
XE-133	1.922+008	1.857+008	1.694+008	1.121+008	3.121+006
XE135M	2.650+005	3.160-002	1.088-020	.000	.000
XE-135	1.592+008	1.007+008	2.966+007	1.213+005	2.430-016
XE-137	6.175-002	2.646-030	.000	.000	.000
XE-138	4.665+005	1.052-002	4.269-023	.000	.000
TOTAL	5.183+008	3.383+008	2.145+008	1.187+008	4.693+006

[1] Units for activities are in curies.

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TABLE 15.6-15

LOSS-OF-COOLANT ACCIDENT: ACTIVITY AIRBORNE IN REACTOR ENCLOSURE[1]

DESIGN BASIS ANALYSIS

ISOTOPE	2 HRS	8 HRS	1 DAY	4 DAYS	30 [illegible]
I--131	3.936+002	3.748+002	4.229+002	4.146+002	3.703+001
I--132	3.196+002	5.172+001	4.825-001	2.010-010	.000
I--133	8.104+002	6.632+002	4.662+002	5.438+001	4.714-008
I--134	2.078+002	1.791+000	6.717-006	1.464-030	.000
I--135	6.374+002	3.393+002	7.577+001	5.072-002	1.659-030
KR-83M	2.945+003	9.616+002	3.981+000	6.511-012	.000
KR--85	6.206+002	1.966+003	3.484+003	3.961+003	3.400+003
KR-85M	1.440+004	1.803+004	2.690+003	4.452-002	.000
KR--87	1.188+004	1.427+003	4.134-001	4.260-018	.000
KR--88	2.982+004	2.207+004	8.102+002	2.441-005	.000
KR--89	2.646-007	.000	.000	.000	.000
XE131M	3.907+002	1.219+003	2.078+003	1.981+003	3.697+002
XE133M	2.039+003	5.969+003	8.566+003	3.771+003	8.681-001
XE-133	8.412+004	2.578+005	4.185+005	3.203+005	8.926+003
XE135M	1.160+002	4.387-005	2.688-023	.000	.000
XE-135	6.967+004	1.398+005	7.327+004	3.468+002	6.948-019
XE-137	2.703-005	3.674-033	.000	.000	.000
XE-138	2.042+002	1.461-005	1.055-025	.000	.000
TOTAL	2.186+005	4.507+005	5.103+005	3.309+005	1.273+004

(1) Units for activities are in curies.

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TABLE 15.6-16

LOSS-OF-COOLANT ACCIDENT: ACTIVITY RELEASED TO THE ENVIRONMENT(1)

DESIGN BASIS ANALYSIS

ISOTOPE	2 HRS	8 HRS	1 DAY	4 DAYS	30 DAYS
I-131	6.61×10^{-1}	9.48×10^{-2}	2.52×10^{-1}	1.37×10^{0}	4.07×10^{0}
I-132	9.75×10^{-1}	3.68×10^{-2}	7.07×10^{-3}	7.01×10^{-5}	0
I-133	1.48×10^{0}	1.84×10^{-1}	3.53×10^{-1}	6.33×10^{-1}	6.78×10^{-2}
I-134	1.62×10^{0}	1.08×10^{-2}	9.42×10^{-5}	3.62×10^{-10}	0
I-135	1.33×10^{0}	1.18×10^{-1}	1.12×10^{-1}	3.37×10^{-2}	2.01×10^{-6}
Kr-83m	3.34×10^{2}	1.04×10^{3}	2.61×10^{2}	9.00×10^{-1}	1.43×10^{-12}
Kr-85	5.34×10^{1}	6.76×10^{2}	3.85×10^{3}	2.34×10^{4}	1.91×10^{5}
Kr-85m	1.38×10^{3}	9.42×10^{3}	1.18×10^{4}	1.63×10^{3}	2.40×10^{-2}
Kr-87	1.64×10^{3}	2.89×10^{3}	2.49×10^{2}	6.45×10^{-2}	0
Kr-88	2.05×10^{3}	1.61×10^{4}	9.34×10^{3}	2.90×10^{2}	8.39×10^{-6}
Kr-89	2.75×10^{1}	1.75×10^{-4}	0	0	0
Xe-131m	3.37×10^{2}	4.22×10^{2}	2.34×10^{3}	1.28×10^{4}	4.99×10^{4}
Xe-133m	1.77×10^{2}	2.12×10^{3}	1.05×10^{4}	3.70×10^{4}	2.34×10^{4}
Xe-133	7.26×10^{3}	8.97×10^{4}	4.82×10^{5}	2.32×10^{6}	4.52×10^{6}
Xe-135m	1.60×10^{2}	4.26×10^{0}	1.42×10^{-6}	0	0
Xe-135	6.22×10^{3}	5.85×10^{4}	1.60×10^{5}	8.61×10^{4}	3.78×10^{2}
Xe-137	4.61×10^{1}	2.16×10^{-7}	0	0	0
Xe-138	3.86×10^{2}	6.68×10^{0}	4.27×10^{-7}	0	0
TOTAL	2.08×10^{4}	1.80×10^{5}	6.71×10^{5}	2.48×10^{6}	4.79×10^{6}

(1) Units for activities are in curies.

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TABLE 15.6-17

LOSS-OF-COOLANT ACCIDENT: ACTIVITY AIRBORNE IN PRIMARY CONTAINMENT(1)

REALISTIC ANALYSIS

ISOTOPE	2 HRS	8 HRS	1 DAY	4 DAYS	30 DAYS
I--131	3.741+002	3.656+002	3.439+002	2.610+002	2.394+001
I--132	3.115+002	5.041+001	3.920-001	1.265-010	.000
I--133	8.321+002	6.810+002	3.991+002	3.604+001	3.207-008
I--134	1.991+002	1.717+000	5.367-006	9.059-031	.000
I--135	6.890+002	3.618+002	6.828+001	3.539-002	1.189-030
KR-83M	3.238+002	3.333+001	2.755-002	1.096-013	.000
KR--85	3.738+002	3.733+002	3.718+002	3.653+002	3.135+002
KR-85M	1.252+003	4.943+002	4.144+001	5.927-004	.000
KR--87	1.111+003	4.216+001	6.854-003	6.103-020	.000
KR--88	2.877+003	6.712+002	1.385+001	3.606-007	.000
KR--89	2.672-008	.000	.000	.000	.000
XE131M	5.013+001	4.933+001	4.725+001	3.893+001	7.261+000
XE133M	2.424+002	2.236+002	1.804+002	6.863+001	1.579-002
XE-133	8.723+003	8.428+003	7.689+003	5.086+003	1.417+002
XE135M	6.758+000	8.057-007	2.775-025	.000	.000
XE-135	7.189+003	4.546+003	1.339+003	5.478+000	1.097-020
XE-137	2.802-006	1.201-034	.000	.000	.000
XE-138	2.296+001	5.178-007	2.101-022	.000	.000
TOTAL	2.458+004	1.633+004	1.049+004	5.862+003	4.864+002

(1) Units for activities are in curies.

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TABLE 15.6-18

LOSS-OF-COOLANT ACCIDENT: ACTIVITY AIRBORNE IN ~~SECONDARY CONTAINMENT~~ REACTOR ENCLOSURE(1)

REALISTIC ANALYSIS

ISOTOPE	2 HRS	8 HRS	1 DAY	4 DAYS	30 DAYS
I--131	2.288-002	2.237-002	2.104-002	1.597-002	1.465-003
I--132	1.905-002	3.085-003	2.399-005	7.738-015	.000
I--133	5.090-002	4.167-002	2.442-002	2.205-003	1.963-012
I--134	1.218-002	1.051-004	3.284-010	5.488-035	.000
I--135	4.214-002	2.245-002	4.179-003	2.166-006	7.201-035
KR-83M	1.418-001	4.628 002	1.916 004	3.134-016	.000
KR--85	1.637-001	5.183-001	9.185-001	1.041+000	8.965-001
KR-85M	5.483-001	6.863-001	1.024-001	1.694-006	.000
KR--87	4.866-001	5.855-002	1.693-005	1.745-022	.000
KR--88	1.260+000	9.321-001	3.421-002	1.031-009	.000
KR--89	1.170-011	.000	.000	.000	.000
XE131M	2.195-002	6.850-002	1.167-001	1.113-001	2.076-002
XE133M	1.061-001	3.106-001	4.457-001	1.962-001	4.516-005
XE-133	3.820+000	1.170+001	1.899:001	1.454+001	4.051-001
XE135M	2.959-003	1.119-009	6.854-028	.000	.000
XE-135	3.148+000	6.313+000	3.309+000	1.566-002	3.138-023
XE-137	1.227-009	.000	.000	.000	.000
XE-138	1.005-002	7.190-010	5.191-030	.000	.000
TOTAL	9.855+000	2.073+001	2.397+001	1.593+001	1.324+000

(1) Units for activities are in curies.

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TABLE 15.6-~~16~~ 19

LOSS-OF-COOLANT ACCIDENT: ACTIVITY RELEASED TO THE ENVIRONMENT(1)

REALISTIC ANALYSIS

~~DESIGN BASIS~~ ANALYSIS

ISOTOPE	2 HRS	8 HRS	1 DAY	4 DAYS	30 DAYS
I--131	1.668-006	5.658-006	1.447-005	5.518-005	1.579-004
I--132	1.837-006	2.193-006	4.201-007	3.293-009	1.062-018
I--133	3.809-006	1.154-005	2.152-005	2.772-005	2.752-006
I--134	1.955-006	6.353-007	5.526-009	1.727-014	.000
I--135	3.367-006	7.819-006	7.244-006	1.656-006	8.588-010
KR-83M	1.595-002	5.008-002	1.207-002	4.332-005	6.891-017
KR--85	1.402-002	1.779-001	1.016+000	6.179+000	5.037+001
KR-85M	5.228-002	3.586-001	4.476-001	5.809-002	9.115-007
KR--87	6.237-002	1.185-001	1.020-002	2.642-006	2.667-023
KR--88	1.279-001	6.367-001	3.946-001	1.223-002	3.542-010
KR--89	6.999-004	7.716-014	.000	.000	.000
XE131M	1.883-003	2.365-002	1.315-001	7.191-001	2.804+000
XE133M	9.173-003	1.102-001	5.440-001	1.924+000	1.218+000
XE-133	3.284-001	4.072+000	2.188+001	1.053+002	2.053+002
XE135M	3.626-003	1.084-004	3.622-011	2.160-029	.000
XE-135	2.840-001	2.642+000	6.783+000	3.889+000	1.709-002
XE-137	1.328-003	9.786-012	.000	.000	.000
XE-138	1.785-002	3.290-004	2.101-011	1.480-031	.000
TOTAL	9.195-001	8.191+000	3.122+001	1.180+002	2.597+002

(1) Units for activities are in curies.

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TABLE 15.6-20

LOSS-OF-COOLANT ACCIDENT:
RADIOLOGICAL EFFECTS

DESIGN BASIS ANALYSIS

	WHOLE-BODY DOSE (rem)	INHALATION DOSE (rem)
Exclusion Area Boundary (731 meters - 2-hr dose)	6.7×10^{-1} ~~5.1 x 10-1~~	1.5×10^{-1} ~~1.58 x 10-1~~
Low Population Zone (2043 meters - 30-day dose)	1.7 ~~1.68~~	4.0×10^{-2} ~~2.81 x 10-2~~

REALISTIC ANALYSIS

	WHOLE-BODY DOSE (rem)	INHALATION DOSE (rem)
Exclusion Area Boundary (731 meters - 2-hr dose)	1.2×10^{-5} ~~3.27 x 10-4~~	1.6×10^{-7} ~~1.15 x 10-7~~
Low Population Zone (2043 meters - 30-day dose)	4.4×10^{-5} ~~3.00 x 10-5~~	6.0×10^{-7} ~~8.81 x 10-7~~

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TABLE 15.6-22

LOSS-OF-COOLANT ACCIDENT:
CONTROL ROOM DOSES

DESIGN BASIS ANALYSIS

	THYROID (rem)	SKIN BETA (rem)	WHOLE-BODY GAMMA (rem)
OPERATOR DOSES	~~2.97×10^{-3}~~ 4.3×10^{-3}	~~2.61~~ 7.6	~~3.72×10^{-1}~~ 3.8×10^{-1}

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TABLE 15.6-27 (Page 1 of 2)

LOSS OF COOLANT ACCIDENT: SEQUENCE OF EVENTS FOR RADIOLOGICAL CONSEQUENCE ANALYSIS(1)

Time | **Events and Assumptions**

0 — DBA LOCA is initiated.

- Instantaneous RG 1.3 source term assumed.
- Instanteneous suppression pool DF assumed.
- No leakage to atmosphere assumed due to transport time for activity to travel from core to outside atmosphere.

18 Sec. — SGTS is initiated.

[redacted]

- Activity leaks from containment with leakage pathway DF.
- Transport of activity from leak points (penetration rooms) to exhaust and exfiltration points (outside walls) diffusion and convective mixing result in an assumed 50% mixing in the reactor enclosure.
- Elemental iodine plateout = 2.75/hr on reactor building surfaces, UP TO DF = 50.
- Reactor enclosure air exfiltrates unfiltered at 1250 ~~625~~ CFM (ONE air changes/day).
- SGTS exhausts ~~1500~~ 2800 cfm through 95% RERS filter train and 99% SGTS filter train.

INSERT, NEXT PAGE →

3 min. TO END OF ACCIDENT — RERS is initiated

[redacted] ~~RERS heat load transient begins to raise the pressure again. Pressure goes positive from 3.5 minutes to 6 minutes then becomes negative but above - 1/4 in.~~

- PRESSURE IN REACTOR ENCLOSURE REMAINS AT -1/4 in. w.g.
- 50% mixing in reactor enclosure guaranteed by RERS operation and natural transport, diffusion and mixing mechanisms.
- RERS filtration (95%) of reactor enclosure air.
- Iodine plateout on reactor enclosure surfaces up to DF = 50.
- [redacted].
- SGTS exhausts [redacted] 1250 cfm through 95% RERS and 99% SGTS.

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TABLE 15.6-27 (cont'd)

2.25 ~~12.5~~ min. [redacted]	Reactor enclosure reaches -1/4 in. w.g. - Unfiltered exfiltration ceases. - SGTS exhausts ~~625~~ 250 cfm through 95% RERS and 99% SGTS filters. [redacted]
	- IODINE PLATEOUT ON REACTOR ENCLOSURE SURFACES UP TO DF = 50. - 50% MIXING IN REACTOR ENCLOSURE DUE TO NATURAL TRANSPORT, DIFFUSION, AND MIXING MECHANISMS.

NOTES:

(1) THE SEQUENCE OF EVENTS REFLECT AN ACTUAL REACTOR ENCLOSURE DRAWDOWN TIME OF 2.25 MINUTES (SECTION 6.2.3.2.1). HOWEVER, THE LOCA DOSES WERE CONSERVATIVELY BASED ON A SEQUENCE OF EVENTS CONSISTENT WITH A REACTOR ENCLOSURE DRAWDOWN TIME OF APPROXIMATELY 5 MINUTES.

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QUESTION 480.22 (Section 6.2.3)

FSAR Section 6.2.3.2.1, page 6.2-40, states "An analysis of the post-LOCA pressure transient in the secondary containment will be performed to determine the length of time following isolation signal initiation of the SGTS that the pressure in the secondary containment would exceed minus 0.25 in. wg." Provide the results of this analysis of the pressure and temperature response of the secondary containment to a loss-of-coolant accident (LOCA) occurring inside the primary containment, and describe specifically how each of the guidelines of SRP Section 6.2.3 Item II.1 has been followed.

RESPONSE

REACTOR ENCLOSURE

Section 6.2.3.2.1 has been changed to provide the results of the post-LOCA secondary containment pressure transient analysis. The LOCA radiological analyses in Chapter 15 have been changed to account for the radiation released from the secondary containment during the time that the pressure exceeds minus 0.25 in. wg.

In addition to the pressure transient analysis, a detailed review has been performed to identify potential leakage paths from either the primary containment or the secondary containment to the common refueling area. This review resulted in the following changes which ensure that no leakage paths exist:

a. A vent path from the reactor well to the reactor enclosure was added

b. Normally closed valves on the reactor well skimmer drain lines were added.

C. PROVISIONS HAVE BEEN MADE TO ASSURE THAT THERE IS NO FLOW PATH THROUGH THE DRAIN SYSTEM BETWEEN THE REFUELING AREA AND THE REACTOR ENCLOSURE SECONDARY CONTAINMENT.

REACTOR ENCLOSURE

Periodic tests are performed in accordance with the plant Technical Specifications to verify that the secondary containment inleakage is less than ~~50~~ 100 percent of its free volume per day at a negative interior pressure of 0.25 in. wg.

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QUESTION 480.24 (Section 6.2.3)

The FSAR states in Section 6.2.3.2.1 that the reactor enclosure is designed to limit the inleakage to 50% of the reactor enclosure free volume per day at a negative interior pressure of 0.25 in. wg. while the SGTS is operating. Verify that this stated inleakage limit applies also to the refueling area, or provide a separate inleakage limit for the refueling area in terms of a percentage of the refueling area free volume per day (reference SRP Section 6.2.3 Item II.3.b and BTP CSB 6-3 Position B.4).

RESPONSE

only

The inleakage limit of 50 percent of the zone free volume per day at a negative interior pressure of 0.25 in.wg. while the SGTS is operating [redacted] applies to the refueling area. Section 6.2.3.2.1 has been clarified to reflect this fact.

An inleakage limit of 100 percent of the zone free volume per day applies to the reactor enclosures.