RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**52-7832**
SRP Section:	**06.02.01.02 – Subcompartment Analysis**
Application Section:	**SRP 6.2.1.2**
Date of RAI Issue:	**06/23/2015**

Question No. 06.02.01.02-1

There is no reference to the reactor power level or initial primary or secondary coolant conditions used for the mass and energy releases in DCD Tier 2, Section 6.2.1.2. Requirements dictate and the SRP stipulates that assumptions made with regards to the mass and energy release maximize the subcompartment pressure. Provide, in the DCD, a list or table of initial parameters assumed in formulating the mass and energy release described in Section 6.2.1.2. The staff needs this information for making a safety conclusion regarding the integrity of the containment subcompartments and to conduct confirmatory analysis.

Response

The reactor power level or initial primary or secondary coolant conditions are based on those in the loss-of-coolant accident (LOCA) mass and energy analysis in DCD Tier 2, Subsection 6.2.1.3 to maximize the subcompartment pressure. The reactor power level is 102 percent full power including reactor coolant pump (RCP) heat, which is presented in DCD Tier 2, Table 6.2.1-20. The parameters of the initial conditions are the initial coolant pressure and the initial coolant enthalpy at the break location. The values of the initial conditions are calculated by the CEFLASH-4A code at time zero. In DCD Tier 2, Table 6.2.1-25, the initial pressure, initial temperature, and break area of each subcompartment break are presented. A summary table of the initial pressure and initial enthalpy is presented with the resulting mass and energy releases as follows:

Initial Conditions of Subcompartment Breaks (Note 1)

Break No. (Note 2)	Press (psia)	Enthalpy (Btu/lbm)	Area (ft^2)	Critical Flow (Note 5)	Mass and Energy Flow for APR1400 DC FSAR			
					(kg/sec)	(lbm/sec)	(kcal/sec)	(Btu/sec)
1. (Note 3)	1,100.	456	0.7612	H-F	5,792.2	12,769.5	1,467,342.	5,822,882.
2.	1,100.	456	0.181	H-F	1,377.3	3,036.4	348,908.	1,384,579.
3.	1,100.	456	0.181	H-F	1,377.3	3,036.4	348,908.	1,384,579.
4. (Note 4)	2,325.	1,110.9	0.3276	H-F	830.84	1,831.7	512,761.	2,034,801.
	2,325.	711.63	0.3276	H-F	1,924.6	4,243.0	760,895.	3,019,477.
5	2,325.	711.63	0.0645	H-F	378.95	835.42	149,815.	594,512.
	2,387.2	564.65	0.0645	H-F	696.29	1,535.03	21,8419.	866,757.
6.	2,387.2	564.65	0.03755	H-F	405.36	893.65	127,157.	504,600.
	2,387.2	564.65	0.03755	H-F	405.36	893.65	127,157.	504,600.
7.	2,312.9	564.65	0.01556	H-F	163.27	359.94	51,215.	203,238.

(Note) 1. Discharge coefficient 1.0 and sink pressure 14.6 psia are assumed.
(Note) 2. Break locations are as follows.

1. Break at Economizer FW Nozzle
2. Break at Downcomer FW Nozzle
3. Break at Blowdown Nozzle
4. Break at POSRV Nozzle
   a. For upper enthalpy (0~0.5 sec)
   b. For lower enthalpy (0.5~1 sec)
5. Break at PZR Spray Nozzle at PZR
   a. Nozzle
   b. Pipe end
6. Break at PZR Spray Nozzle at Cold Leg
   a. Nozzle
   b. Pipe end
7. Break at Letdown Nozzle

(Note) 3. Area based on 14-inch Schedule 120 pipe (ID = 11.812 inches).
(Note) 4. Area based on POSRV nozzle pipe (ID = 7.75 inches). Steam flow: 0~0.5 sec, Liquid flow: 0.5~1 sec.
(Note) 5. H-F: Henry-Fauske Critical Flow Table used.

Impact on DCD

DCD Tier 2, Table 6.2.1-25 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Table 6.2.1-25 (1 of 2)

Subcompartments and Postulated Pipe Break

Description	Break Location	Break Size I.D., m (ft)	Break Size Area, m^2 (ft^2)	Break Node	Break Type	Pressure [1], kg/cm^2A (psia)	Temperature [1], °C (°F)	Mass/Energy Multiplier	Critical Flow [6]
Steam generator	Feedwater economizer nozzle	0.3000 (0.9845)	0.07072 (0.7612)	13	DEGB [2]	77.34 (1100)	244.8 (472.6)	1.0	H−F
	Feedwater downcomer nozzle	0.1463 (0.4801) (3)	0.01682 (0.1810)	37	DEGB	77.34 (1100)	244.8 (472.6)	1.0	H−F
	Steam generator blowdown nozzle	0.1463 (0.4801)	0.01682 (0.1810)	13	DEGB	163.5 (2325)	24[illegible] 347.5 (657.5)	1.0	H−F
Pressurizer	POSRV nozzle	0.1969 (0.6458)	0.03044 (0.3276)	25	DEGB	163.5 (2325) (4)	347.8 (658.0) (4)	1.0	H−F
	Pressurizer spray nozzle	0.0873 (0.287)	0.00599 (0.0645)	24	DEGB	163.5 (2325) [3] (5) 167.84 (2387.2) [4]	[illegible]7.5 (657.5) [3] (5) 295.6 (564.2) [4]	1.0	H−F
Pressurizer spray valve	Pressurizer spray line	0.0667 (0.219)	0.003489 (0.03755)	1	DEGB	167.84 (2387.2)	295.6 (564.2)	1.0	H−F
Regenerative heat exchanger	CVCS letdown line	0.0430 (0.141)	0.001446 (0.01556)	1	DEGB	162.61 (2312.9)	295.6 (564.0)	1.0	H−F

ADD column

ADD column

Enthalpy, kJ/kg (Btu/lbm)
1060.66 (456)
1060.66 (456)
1060.66 (456)
2583.95 (1110.9)
1655.25 (711.6)
1655.25 (711.6)
1313.38 (564.7)
1313.38 (564.7)
1313.38 (564.7)

ADD column

Table 6.2.1-25 (2 of 2)

Description	Break Location	Break Size		Break Node	Break Type	Pressure (1), kg/cm²A (psia)	Temperature (1), °C (°F)	Mass/Energy Multiplier	Critical Flow (6)
		I.D., m (ft)	Area, m^2 (ft^2)						
Letdown heat exchanger	CVCS letdown line	0.0430 (0.141)	0.001446 (0.01556)	1	DEGB	162.61 (2,312.9)	295.6 (564.0)	1.0	H-F
Letdown heat exchanger valve	CVCS letdown line	0.0430 (0.141)	0.001446 (0.01556)	1	DEGB	162.61 (2,312.9)	295.6 (564.0)	1.0	H-F

ADD column

Enthalpy, kJ/kg (Btu/lbm)
1313.38 (564.7)
1313.38 (564.7)

(1) Postulated break condition

(2) Double ended guillotine break

(3) Steam flow : 0~0.5 sec, Liquid flow : 0.5~1 sec

~~(3)~~ (4) Condition of the pressurizer spray nozzle at the pressurizer.

~~(4)~~ (5) Condition of the pipe.

(6) H-F : Henry-Fauske Critical Flow Table used.

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Docket No. 52-046

RAI No.:	**52-7832**
SRP Section:	**06.02.01.02 – Subcompartment Analysis**
Application Section:	**06.02.01.02**
Date of RAI Issue:	**06/23/2015**

Question No. 06.02.01.02-2

SRP Section 6.2.1.2 states that nodalization schemes should be chosen such that no pressure gradient exists within a node, and that sensitivity studies should be conducted to verify convergence of the nodal scheme. Although such sensitivity studies are mentioned in DCD Tier 2, Section 6.2.1.2, no detail is provided. Provide, in a response, a detailed description of the sensitivity studies performed to arrive at the nodalizations used in DCD. In addition, provide a brief summary of the nodalization sensitivity in the DCD in order to confirm that nodal scheme used is appropriate.

Response

There are six subcompartments to be analyzed in the subcompartment pressurization analysis: steam generator subcompartment, pressurizer subcompartment, regenerative heat exchanger room, pressurizer spray valve room, letdown heat exchanger room, and letdown heat exchanger valve room.

With regard to the steam generator subcompartment, further nodalization sensitivity study is not needed because the steam generator subcompartment is subdivided into a sufficient number of nodes axially and circumferentially to account for the obstacles and the shape of the steam generator resulting in flow area and volume changes. Additionally, among the nodes that are in contact with a wall, pressure differentials between the peak pressure node and the adjacent nodes are small as shown in DCD Tier 2, Table 6.2.1-26.

For the regenerative heat exchanger room, pressurizer spray valve room, letdown heat exchanger room and letdown heat exchanger valve room, further nodalization sensitivity studies are not needed because these rooms have distinct boundaries that are defined as nodes based on room area changes. Components and obstructions are included in the modeling.

Nodalization sensitivity studies for these compartments are not required according to the guidelines provided in NUREG-0609, Section 3.2.

For the pressurizer subcompartment, the compartment is azimuthally divided into four sectors, and vertically divided into seven sectors in the basic nodalization model. The azimuthal divisions are based on the minimum area between nodes and the vertical nodal boundaries are selected where there are obstructions or area changes. The nodal diagram for the pressurizer subcompartment is shown in DCD Tier 2, Figure 6.2.1-22.

In the sensitivity study, the pressurizer subcompartment is divided into four sectors based on the location of grating where substantial loss coefficients and flow areas change. The analysis results show small differences between the peak differential pressures of basic and sensitivity models. Therefore, it is concluded that the nodal scheme is appropriately used in the subcompartment analysis.

A brief summary of the nodalization sensitivity study will be added to DCD Tier 2, Subsection 6.2.1.2.3.

Impact on DCD

DCD Tier 2, Subsection 6.2.1.2.3 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

b. The expansion loss coefficient and contraction loss coefficient are conservatively assumed to be 1.0 and 0.5, respectively.

c. The turning loss coefficient is calculated assuming a mitre bend.

Information about high-energy lines within each subcompartment that are assumed to rupture is shown in Table 6.2.1-25.

The conservative time-dependent M&E release data are calculated. For the two-phase fluid, the Moody critical flow model is used (Reference 7). For the subcooled water, the Henry-Fauske critical flow model is used (Reference 8). For the cases that are range from the subcooled water condition to the saturated water or two-phase condition, the larger value between two correlations is selected. These correlations are approved by NRC for the subcompartment analysis. Flow discharge coefficient is conservatively assumed to be 1.0. The M&E release data for the postulated pipe breaks are tabulated in Table 6.2.1-36.

A design margin of 40 percent is considered in the design of the subcompartment structure. Calculated peak differential pressures with the design margin are provided as inputs to the structural design. The pressurizer and steam generator inside containment are designed to avoid threatening the integrity of internal structures from a potential high-energy line break that is transferred to the component support structures and that results in asymmetric dynamics loads. Asymmetric pressure loads are included in the component support design. The time-dependent pressure responses, which are used to evaluate the effects on structures and equipment on representative nodes in the subcompartments, are shown in Figures 6.2.1-26 through 6.2.1-31, and a maximum differential pressure of each node in the subcompartments is provided in Table 6.2.1-26 through 6.2.1-31.

6.2.1.3 <u>Mass and Energy Release Analyses for Postulated Loss-of Coolant Accidents</u>

It is verified through results from nodal model sensitivity studies that appropriate nodal schemes were used in the subcompartment analysis. The differences between the calculated peak pressures are small.

LOC… …own,
refill, …

a. The blowdown period extends from time zero until the primary system depressurizes and equalizes with the containment pressure. During blowdown,

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Application Section:	**06.02.01.02**
Date of RAI Issue:	**06/23/2015**

Question No. 06.02.01.02-3

In the subcompartment analysis, most of the compartments have what are described as access doors or openings where the subcompartment interacts with the containment atmosphere. What assumptions are applied to the access openings with respect to gratings, doors, signage and other restrictions placed in the access openings, and how do these assumptions affect the flow area available (especially in compartments not otherwise open to the containment atmosphere)? Are any of the flow paths described subject to change (blowout, hinged doors changing orientation) following the application of a differential pressure? The staff needs this information in order to perform confirmatory analysis of the subcompartment pressure analyses.

Response

Rectilinear pattern gratings with 0.0381 meter (1.5 inch) deep x 0.0095 meter (0.375 inch) thick bearing bars spaced at 0.0349 meters (1.375 inches) on center with cross bars at 0.1016 meters (4 inches) on center are used with a 0.3 blockage ratio assumption in the subcompartment analysis. Wire mesh doors are modeled with the assumption that the flow areas are reduced by 35 percent.

There are no other restrictions such as blowout panels or dampers, or hinged doors located in the access openings. Therefore, no flow paths described are subject to changes following the application of a differential pressure in the reactor containment building.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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Question No. 06.02.01.02-4

The nodalization for the regenerative heat exchanger subcompartment (DCD Tier 2, Figure 6.2.1-24) is not clear. The room is described as having only one access point that interacts with the containment atmosphere in DCD Tier 2, Section 6.2.1.2.2, but is modeled as attached to a second room with access to two additional containment access points. Clarify in the description of DCD Tier 2, Section 6.2.1.2.2 how the regenerative heat exchanger subcompartment is modeled, including a description of the in-core instrumentation (ICI) chase. The staff needs this information to make a finding that the pressure calculation performed shows a reasonable assurance that design pressures will not be exceeded.

Response

Two access openings to the corridor are modeled as vent paths from nodes 2 to 3 in two directions: one is toward the north and the other is toward the south. One vent opening is modeled as a vent path from nodes 1 to 3.

The designation for node 2 will be changed from “Access Area to the ICI Chase” to “Corridor below Regenerative Heat Exchanger Subcompartment”.

Impact on DCD

DCD Tier 2, Subsection 6.2.1.2.2 and Figure 6.2.1-24 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

DBAs in the pressurizer subcompartment are pipe breaks in the spray nozzle and POSRV discharge line and are the potential sources of pressurization in the pressurizer subcompartment.

Because the LBB concept is applied to the pressurizer surge line, the dynamic effects of a pressurizer surge line break are not considered. The LBB analysis of the surge line is described in Subsection 3.6.3.1.

The pressurizer subcompartment has three vent paths to the containment atmosphere. One opening is the access door at El. 136 ft 8.75 in. The other two openings are the open top and the opening under the pressurizer.

The horizontal section view of the pressurizer subcompartment is shown in Figure 6.2.1-22.

Pressurizer Spray Valve Subcompartment

The pressurizer spray valve subcompartment is a reinforced concrete structure that is sealed except for the access door and one vent opening. The subcompartment encloses and supports pressurizer spray piping and valves and provides radiation shielding against outside exposure. The DBA in the subcompartment is a postulated break in the pressurizer spray piping, which is considered a potential source of pressurization in the pressurizer spray valve subcompartment.

The access door and the vent opening are assumed to be vent paths from this subcompartment to the annulus in the pressurizer spray valve subcompartment analysis.

A plan view of the pressurizer spray valve subcompartment is shown in Figure 6.2.1-23.

Regenerative Heat Exchanger Subcompartment

The regenerative heat exchanger subcompartment is a reinforced concrete structure that is sealed except for ~~the access door.~~ two access openings and one vent opening. It encloses and supports the heat exchanger and associated piping and provides radiati… A in the subcompartment is a postulated … stem

(CVCS) letdown line, and is considered a potential source of pressurization in the regenerative heat exchanger subcompartment.

The secti
6.2.1-24.

Two access openings are assumed to be vent paths from this subcompartment to the containment atmosphere via the steam generator subcompartment. One vent opening is modeled as a vent path to the containment atmosphere.

Letdown Heat Exchanger and Valve Subcompartments

The CVCS letdown heat exchanger subcompartment is a reinforced concrete structure that encloses and supports the letdown heat exchanger and associated piping and provides radiation shielding against outside exposure. The DBA in the letdown heat exchanger subcompartment is a postulated break in the CVCS letdown line and is considered a potential source of pressurization in the subcompartment.

The letdown heat exchanger subcompartment has one access door and one vent opening.

The CVCS letdown heat exchanger valve subcompartment is a reinforced concrete structure that encloses and supports the letdown valve and associated piping and provides radiation shielding against outside exposure. The DBA in the letdown heat exchanger valve subcompartment is a postulated break in the CVCS letdown line and is considered a potential source of pressurization in the subcompartment.

The letdown heat exchanger valve subcompartment has one access door and one vent opening.

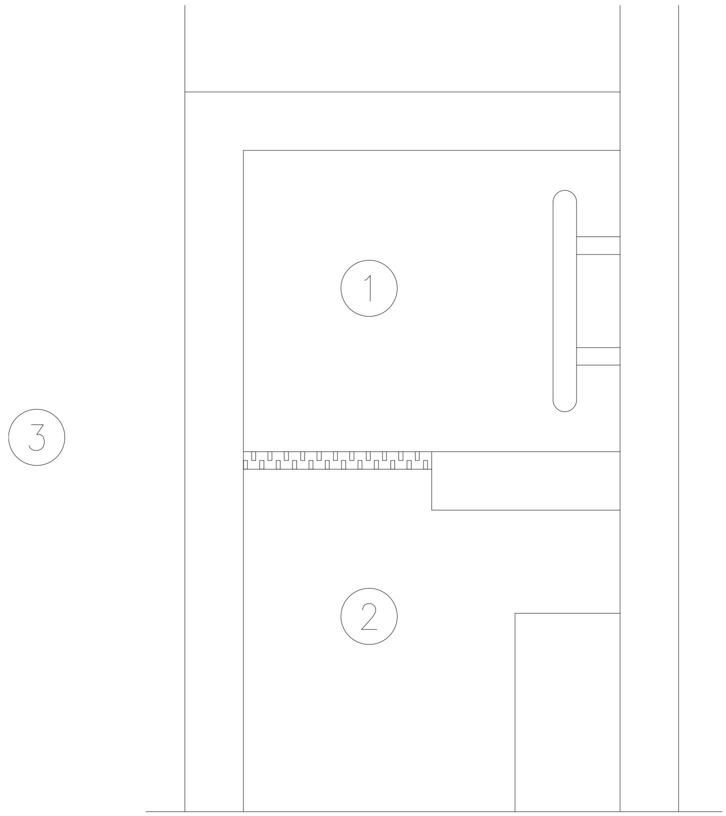
The plan views of the letdown heat exchanger and valve subcompartments are shown in Figure 6.2.1-25.

6.2.1.2.3 Design Evaluations

The computer program COMPARE-MOD1A (Reference 6) is used to perform the short-term subcompartment pressure transient analysis.

The volume thermodynamics and flow equations are for a homogeneous mixture, assumed to be in thermodynamic equilibrium. One hundred percent of the water entrainment for the

Security-Related Information – Withhold Under 10 CFR 2.390



Node 1: Regenerative Heat Exchanger Subcompartment (Break Node)

Node 2: ~~Access Area to the ICI Chase~~ Corridor below Regenerative Heat Exchanger Subcompartment

Node 3: Containment Atmosphere

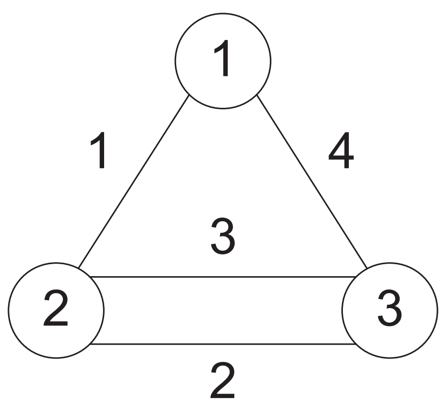


Figure 6.2.1-24 Sectional View and Nodal Model of the Regenerative Heat Exchanger Subcompartment

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Question No. 06.02.01.02-5

While the mass and energy release data for the postulated pipe breaks in various subcompartments are tabulated in the DCD, Regulatory Guide (RG) 1.206 (for COL applicants) also stipulates that a description of the computer program used to calculate the mass and energy (M&E) releases from a postulated pipe break be provided. It is mentioned that COMPARE-MOD1A is used to perform the short-term subcompartment transient pressure analysis. However, it is not clear which code was used to generate the M&E release data. Update the DCD with the code used to perform the mass and energy release calculation or reference another location in the DCD where it is described.

Response

The mass and energy releases for containment subcompartment are manually calculated by interpolating the critical flow tables of Moody or Henry-Fauske with the initial conditions (pressure and enthalpy) of each break in DCD Tier 2, Table 6.2.1-25 and by adding 1 percent margin to the critical flow. The calculated mass and energy releases are based on flow at the moment of break occurrence and are assumed to be maintained constant during the transient as long as the driving force of the break flow exists.

The critical flow tables of Moody or Henry-Fauske are from the CEFLASH-4A code, which is the licensing code of the LOCA mass and energy analysis in DCD Tier 2, Subsection 6.2.1.3 (Reference 9 in DCD Section 6.2.9). Related portions of the critical flow tables are presented in the following pages and the DCD update is provided in the attachment.

HENRY/FAUSKE CRITICAL FLOW TABLES

(Stagnation Pressure - 1000 psia)	
Stagnation Enthalpy (Btu/lbm)	Critical Mass Flux ($lbm/sec\text{-}ft^2$)
210.517	23150.110
312.695	21464.007
375.963	19501.020
419.455	17554.798
487.791	13379.993
542.551	9810.510
568.566	6813.215
607.589	5176.532
672.628	4291.912
737.666	3696.905
802.705	3277.440
867.743	2966.484
932.782	2726.280
997.821	2534.563
1062.859	2377.522
1192.936	2134.516
(Stagnation Pressure - 1200 psia)	
210.942	25422.775
292.347	24226.151
354.924	22646.667
419.604	20123.577
511.599	14591.389
571.853	10593.408
590.242	8254.198
633.149	6084.725
694.445	5126.006
755.741	4447.579
817.037	3956.356
878.333	3587.274
939.629	3300.133
1000.925	3070.088
1062.221	2881.309
1184.813	2589.030

(Stagnation Pressure - 2200 psia)	
Stagnation Enthalpy (Btu/lbm)	Critical Mass Flux ($lbm/sec\text{-}ft^2$)
213.075	34649.284
356.326	32057.302
442.374	29058.920
559.812	22439.349
643.381	16218.618
695.462	12844.819
712.530	11170.948
738.132	10410.529
780.802	9392.525
823.471	8446.301
866.141	7650.360
908.811	7004.818
951.480	6482.920
994.150	6057.265
1036.820	5705.857
1122.159	5163.890
(Stagnation Pressure - 2400 psia)	
213.503	36219.815
356.613	33634.913
510.760	27326.537
612.528	20464.371
674.611	15746.939
718.953	12996.687
738.192	11694.003
757.431	11316.755
795.909	10324.857
834.387	9327.321
872.866	8474.087
911.344	7771.945
949.822	7200.848
988.300	6734.362
1026.779	6349.683
1103.735	5759.240

MOODY CRITICAL FLOW TABLES

(Stagnation Pressure - 1000 psia)	
Stagnation Enthalpy (Btu/lbm)	Critical Mass Flux (lbm/sec-ft^2)
180.000	23330.000
323.000	20380.000
404.000	17420.000
492.000	11100.000
524.000	8700.000
542.400	7767.000
607.300	6398.200
672.300	5258.300
737.200	4430.300
802.200	3817.600
867.100	3349.800
932.000	2982.300
997.000	2686.600
1061.900	2443.700
1126.900	2240.700
1191.800	2068.700
(Stagnation Pressure - 1200 psia)	
180.000	25600.000
338.000	22450.000
426.000	19200.000
519.000	12080.000
554.000	9520.000
571.700	8543.000
632.900	7099.300
694.000	5967.500
755.200	5102.400
816.400	4442.100
877.500	3931.500
938.700	3527.500
999.900	3197.400
1061.100	2923.000
1122.200	2691.600
1183.400	2495.900

(Stagnation Pressure - 2200 psia)	
Stagnation Enthalpy (Btu/lbm)	Critical Mass Flux (lbm/sec-ft^2)
180.000	37700.000
392.000	30070.000
502.000	25100.000
618.000	15600.000
661.000	12280.000
694.800	10951.000
737.200	9960.500
779.700	9033.000
822.100	8225.800
864.600	7544.700
907.000	6961.600
949.400	6456.800
991.900	6017.000
1034.300	5631.300
1076.800	5290.600
1119.200	4987.800
(Stagnation Pressure - 2400 psia)	
180.000	36200.000
400.000	31150.000
516.000	26270.000
635.000	16200.000
679.000	12710.000
718.400	11245.000
756.700	10308.000
794.900	9489.700
833.200	8762.200
871.500	8122.000
909.700	7559.600
948.000	7064.400
986.300	6626.600
1024.600	6237.500
1062.800	5890.000
1101.100	5578.000

Impact on DCD

DCD Tier 2, Subsection 6.2.1.2.3 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

(CVCS) letdown line, and is considered a potential source of pressurization in the regenerative heat exchanger subcompartment.

The sectional view of regenerative heat exchanger subcompartment is shown in Figure 6.2.1-24.

Letdown Heat Exchanger and Valve Subcompartments

The CVCS letdown heat exchanger subcompartment is a reinforced concrete structure that encloses and supports the letdown heat exchanger and associated piping and provides radiation shielding against outside exposure. The DBA in the letdown heat exchanger subcompartment is a postulated break in the CVCS letdown line and is considered a potential source of pressurization in the subcompartment.

"AA" from page 6.2-24

The letdown heat exchanger subcompartment has one access door and one vent opening.

The mass and energy releases for containment subcompartment are manually calculated by interpolating the critical flow tables of Moody or Henry-Fauske with the initial conditions (pressure and enthalpy) of each break in Table 6.2.1-25 and by adding 1 percent margin to the critical flow.

The calculated M&E releases are based on flow at the moment of break occurrence and are assumed to be maintained constant during the transient as long as the driving force of the break flow exists.

The critical flow tables of Moody or Henry-Fauske are used in the CEFLASH-4A code, which is the licensing code of the LOCA mass and energy analysis in DCD Subsection 6.2.1.3 (Reference 9 in DCD Subsection 6.2.9).

Figure 6.2.1-25.

6.2.1.2.3 Design Evaluations

The computer program COMPARE-MOD1A (Reference 6) is used to perform the short-term subcompartment pressure transient analysis.

The volume thermodynamics and flow equations are for a homogeneous mixture, assumed to be in thermodynamic equilibrium. One hundred percent of the water entrainment for the

b. The expansion loss coefficient and contraction loss coefficient are conservatively assumed to be 1.0 and 0.5, respectively.

c. The turning loss coefficient is calculated assuming a mitre bend.

"AA" : Move to page 6.2-22

Information about high-energy lines within each subcompartment that are assumed to rupture is shown in Table 6.2.1-25.

~~The conservative time dependent M&E release data are calculated.~~ For the two-phase fluid, the Moody critical flow model is used (Reference 7). For the subcooled water, the Henry-Fauske critical flow model is used (Reference 8). For the cases that are range from the subcooled water condition to the saturated water or two-phase condition, the larger value between [the] two correlations is selected. These correlations are approved by [the] NRC for the subcompartment analysis. ~~Flow~~ [The flow] discharge coefficient is conservatively assumed to be 1.0. The M&E release data for the postulated pipe breaks are tabulated in Table 6.2.1-36.

A design margin of 40 percent is considered in the design of the subcompartment structure. Calculated peak differential pressures with the design margin are provided as inputs to structural design. The pressurizer and steam generator inside containment are designed to avoid threatening the integrity of internal structures from a potential high-energy line break that is transferred to the component support structures and that results in asymmetric dynamics loads. Asymmetric pressure loads are included in the component support design. The time-dependent pressure responses, which are used to evaluate the effects on structures and equipment on representative nodes in the subcompartments, are shown in Figures 6.2.1-26 through 6.2.1-31, and a maximum differential pressure of each node in the subcompartments is provided in Table 6.2.1-26 through 6.2.1-31.

6.2.1.3 Mass and Energy Release Analyses for Postulated Loss-of Coolant Accidents

LOCA M&E release analyses are categorized as the following time periods: blowdown, refill, reflood, post-reflood, and decay heat period.

a. The blowdown period extends from time zero until the primary system depressurizes and equalizes with the containment pressure. During blowdown,