

CANFLEX -NU

1

Thermalhydraulic Analysis
of Steam Generator Multi Tube Rupture Event
for Wolsong NPP Unit 1 Loaded with CANFLEX -NU

103-16

(CANFLEX -NU)

가

(Steam Generator Tube Rupture, SGTR) 1

가

1

10

SBLOCA

1

CANFLEX -NU

Abstracts

This study was done as part of the safety analysis for full CANFLEX-NU loaded core in Wolsong NPP unit 1. Steam generator tube rupture accident is characterized by the primary coolant leakage to steam and feed water system and fission inventory being reached directly to public bypassing containment. This accident can be divided into two cases of "Single Tube Rupture Accident" and "Multiple Tube Rupture Accident". The amount of coolant leakage in single tube rupture accident is compensated by normal D₂O feed system and thermal-hydraulic behavior is remained steady state. But it is known that multiple tube rupture accident which as many as 10 tubes are failed follows thermal hydraulic behavior of small LOCA. So detailed analysis of both thermal hydraulics and trip coverage was done for multiple S/G tube rupture accident.

1.

1

1 가

SBLOCA

5

2,3,4

83

가

1

, 2,3,4

가

, 1

2,3,4

2.

가

CATHENA(cat3_5rev1)

CANFLEX -NU

가. 가

1) 1 (Primary Heat Transport System): 가 (Pressurizer), (Degasser Condenser), (Degasser Cooler), (Feed & Bleed System) 가

2) 2 (Secondary Heat Transport System): (Turbine Governor Valve) (Feedwater Control Valve)

가

3) (Reactor Regulating System) : 103%

4) (Reactor Shutdown System): 가

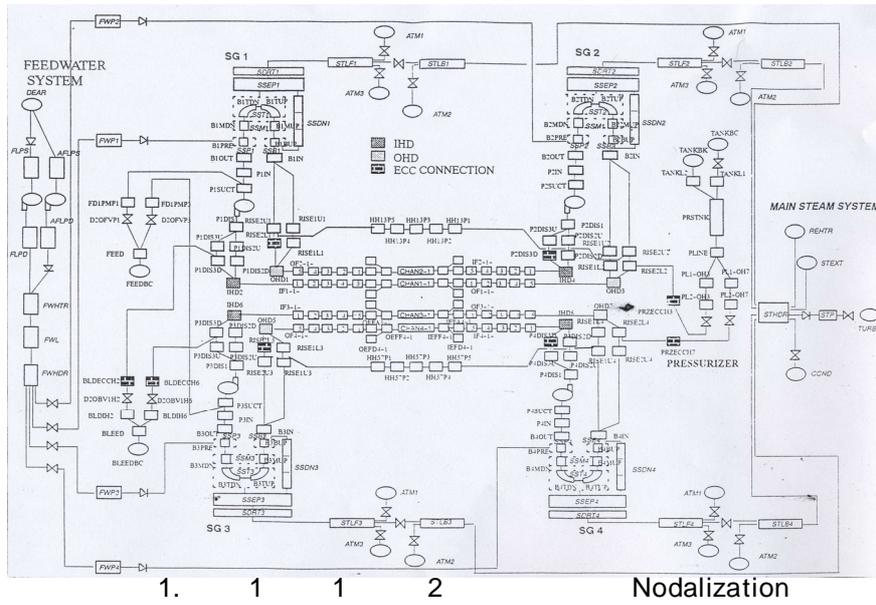
1

5) (Emergency Core Cooling System): (ECI), (SGCC) ECI SGCC 가

1) : 4 (Single Averaged Model)

1 Nodalization 1

103%



1. (103%)

	1	2	3	4
(MPa(a))	11.36	11.36	11.36	11.36
()	268	268	268	268
(MPa(a))	10.02	10.03	10.10	10.02
()	311	311	311	311
(%)	4.8	4.6	4.7	4.8
(MPa(a))	9.57	9.58	9.57	9.57
(MPa)	1.82	1.81	1.82	1.82
(kg/s)	1901.8	1893.9	1897.3	1893.6
(MW)	527.89	527.89	527.89	527.89
(MW)	16.1			
2 (MW)	530.7	530.8	530.1	532.5
가	12.45			
(MPa(a))	4.69	4.69	4.69	4.69
()	260	260	260	260
(kg/s)	1074.76			
(kg/s)	985.37			
()	186	186	186	186
	5.46:1	5.46:1	5.46:1	5.46:1

2) :

. O6

가 7.3MW 935kW

O6_mod

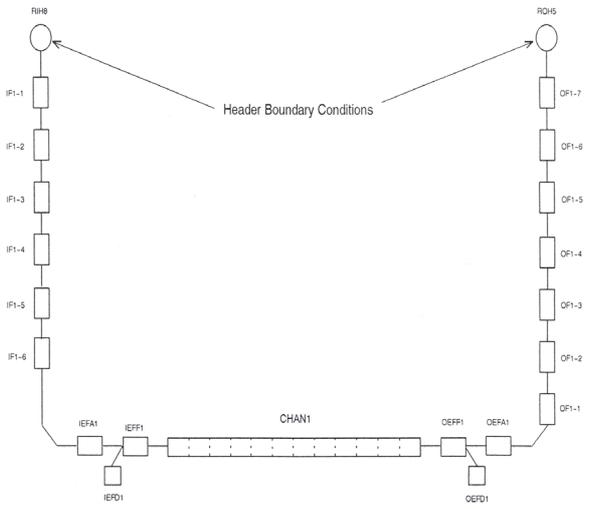
가

가

. O6

Nodalization 2

2



2. O6 Nodalization

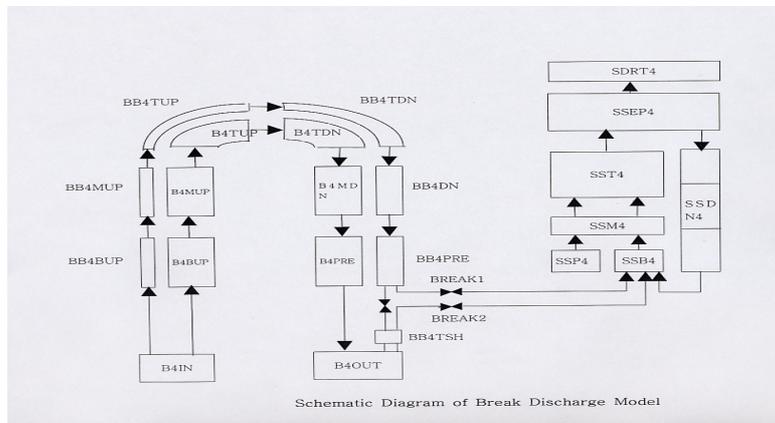
2. (103%)

		O6_mod
(103%) :	
(MPa)		11.36
(MJ/kg)		2.50
(MJ/kg)		1.13
		0.0
(MPa)		10.02
(MJ/kg)		2.53
(MJ/kg)		1.35
		0.373
	(MW)	7.3
	(kg/s)	25.07

3) : 29.28m³(31846.61kg) 가 ,
 가 (2.83m³) 가 .
 가 26.45m³(28771.78kg) .

4) : 4 ,
 3358 U , 3348 U
 10 U . 10 U
 (Guillotine Break) 가 .

2 가 3 1



3. Nodalization

5) (TRIP Coverage) : 25%, 50%, 75%, 100%, 103%

(Control), (Adjuster) (Liquid Zone
Absorber) (RRS) (Mechanical Control)

3.

가. 10

1 가 1

2

(SGLC)

(SGPC)

2

가

가 가

가

가

1

2

가

2

(CSDV)

가

2

CSDV

가

가 (149)

4.

가.

1

2

2

가

1)

1) FSAR

가

가 100%

(film boiling)

가 600

가 600

5.

, 가 가 (7.26m)

가 (4, 5), 1

(RIH) :

11.36MPa, (ROH): 10.02MPa

ROH 1

(Low PHT Pressure Trip)

8.7MPa

3.9MPa

가 LOCA (5.25MPa)

(6) 2

Turbine Governor Valve가

(4.7MPa) (7),

2

(8).

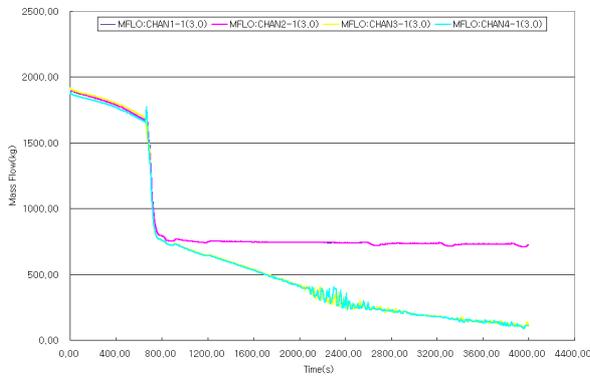
(ASDV)

(CSDV)

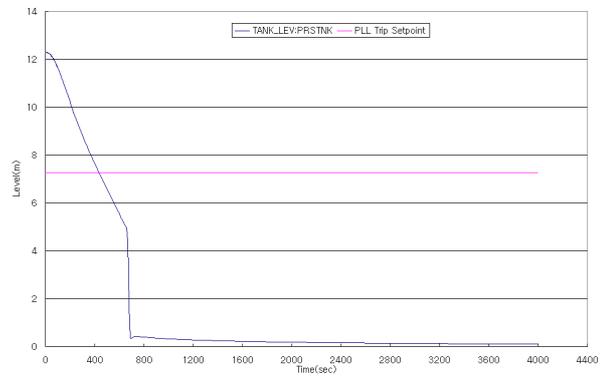
CSDV가

2

(9)



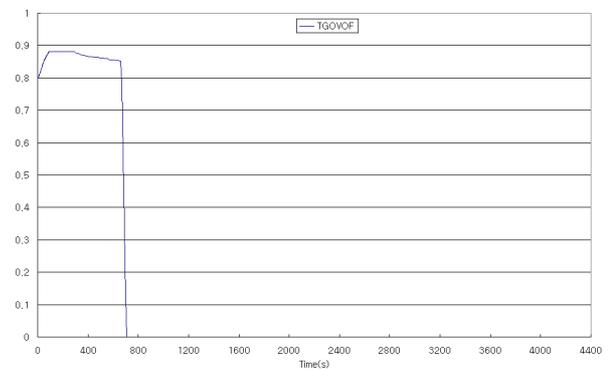
4.



5. 가

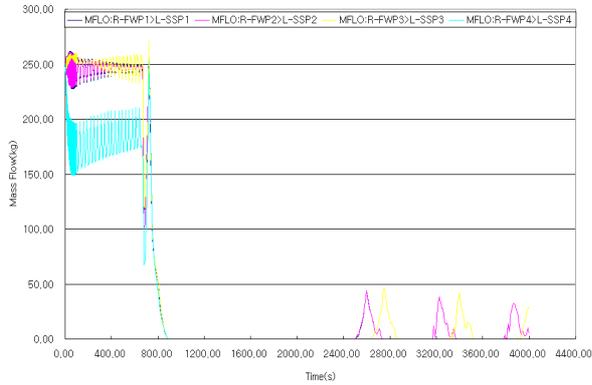


6. 1

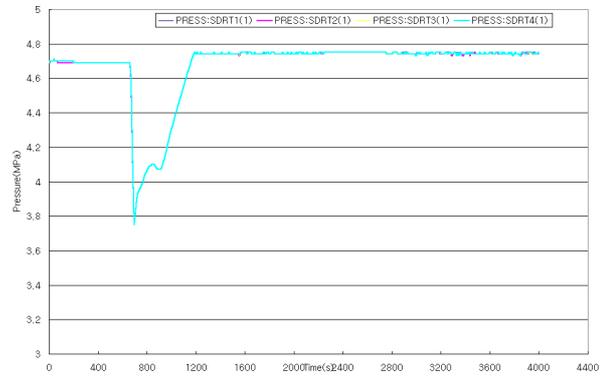


7.

Open Fraction



8. 2

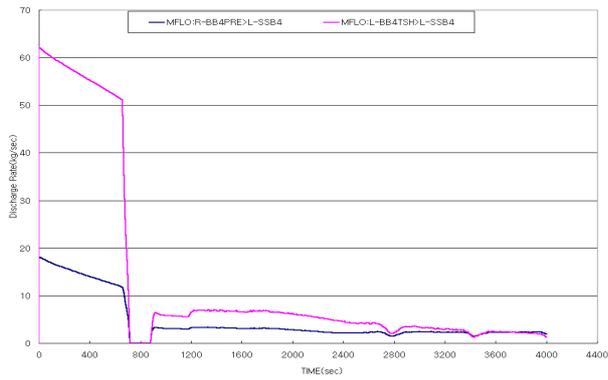


9. 2

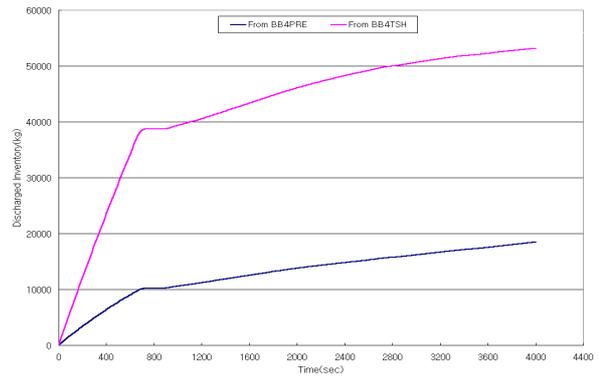
3 , 가
 492.7 . 659.4 가
 1 가
 697.1 .
 705.7 . 1 2,3,4 가
 가
 3.

()	
0.0	
492.7	1 2 가 ()
600.0	()
659.4	
663.4	1 2 ()
697.1	(LOCA) , ,
705.7	
1200.1	
1600.0	(, 15)
3190.0	(가 149 ,)

10 11 .
 19kg/s 62kg/s 81kg/s가
 2
 가 1 , 2 6kg/s .



10.



11.

O6_mod

12

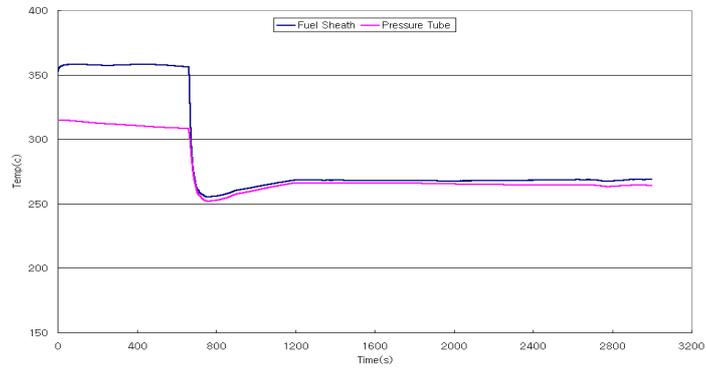
가 4

가

가

가 358.1 °C, 314.9 °C

800 °C 600 °C



12.

25%FP

103%FP

(RRS)

13

가

3

2

가 2

RRS_Operating, SDS1

25% 50% 75% 100% 103%

					가
					1
					1

RRS_Operating, SDS2

25% 50% 75% 100% 103%

					가
					1

RRS_Frozen, SDS1

25% 50% 75% 100% 103%

					가
					1
					1
					1

RRS_Frozen, SDS2

25% 50% 75% 100% 103%

					가
					1
					1

13.

6.

CANFLEX -NU 가 1
 , 1 ()
 . 2,3,4
 (SBLOCA) . 25%

7.

1. 1 FSAR,
2. 2,3,4 FSAR,
3. 86 -03500 -AR -034 "Steam Generator Tube Rupture, wolsong NPP234", AECL, 1995
4. W1 -CANFLEX -AR -010 "CATHENA Above Header Model(wolsong -1 CANFLEX -NU)", KOPEC, 2002
5. W1 -CANFLEX -AR -002 'CATHENA Trip Coverage Analysis Model(wolsong -1 CANFLEX -NU)', KOPEC, 2002
6. W1 -CANFLEX -AR -011 'CATHENA Secondary Side Model((wolsong -1 CANFLEX -NU)", KOPEC, 2002.
7. B.N.Hanna, Editor, RC -982 -4/COG -93 -140,"CATHENA Input Reference",AECL,1992
8. J.P.Mallory, Editor, RC -982 -5/COG -93 -140"CATHENA GENHTP Input Reference", AECL,1992
9. A. Abdul -Razzak, et al, "CATHENA Simulations of Steam Generator Tube Rupture", AECL -Sheridan Park