

Coupled Analysis of YGN 3&4 Single RCP Locked Rotor Accident
using MARS/MASTER

, , , , , , ,

150

/ , MARS/MASTER 3&4

3

MASTER

MARS 1

MARS

가

MARS/MASTER

, MARS/MASTER

Abstract

YGN 3&4 single reactor coolant pump (RCP) locked rotor accident is analyzed using the coupled multi-dimensional analysis system of reactor system thermal-hydraulics and core kinetics, MARS/MASTER. Three-dimensional core kinetics is analyzed using MASTER module and the reactor vessel thermal-hydraulics is simulated using the multi-dimensional module of MARS while the other reactor systems are analyzed using the one-dimensional module of MARS. Transient calculations are performed for the three seconds delay assumption of loss of offsite power. Through the analysis of the results, it has been demonstrated that the MARS/MASTER coupled analysis system is capable of simulating the realistic response of the reactor system, and that the coupled transient analysis using MARS/MASTER can afford a feasible safety margin to minimum departure from nucleate boiling (MDNBR).

1.

, ANS IV .

-

(MDNBR: Minimum Departure from Nucleate Boiling Ratio)

가

[1]

2

3&4

Coastdown

3&4

3

가

가

[2]. 3

가

가

가

MARS/MASTER /

3&4

MARS/MASTER

가 , MARS/MASTER

2. MARS/MASTER

가 ,
가
MARS/MASTER[3]
MARS[4] 3
MASTER[5]
MARS 1 3 USNRC
RELAP5[6] COBRA-TF[7] MARS
Restructuring
MASTER 2 , 3
Rectangular Hexagonal Microscopic depletion ,
Xenon dynamics Slow Transient Fast Transient
, Seamless Interfaced COBRA-IV 가
가
MARS/MASTER DLL(Dynamic Link Library)[8]
, MARS MASTER
DLL
3
Mapping , MARS
MASTER MASTER
3 MARS 가
MARS/MASTER OECD/NEA MSLB Benchmark Problem
[9].

3. MARS/MASTER

3&4 2815 MWt , 2
4 , 2 U-
1 가 ,
177 가

가

MARS

1

MASTER 3

1 1

MARS nodalization

146 Volume 150 Junction

2

Nodalization

62 Channel 97 Gap

6 Channel

3

Ring

MASTER

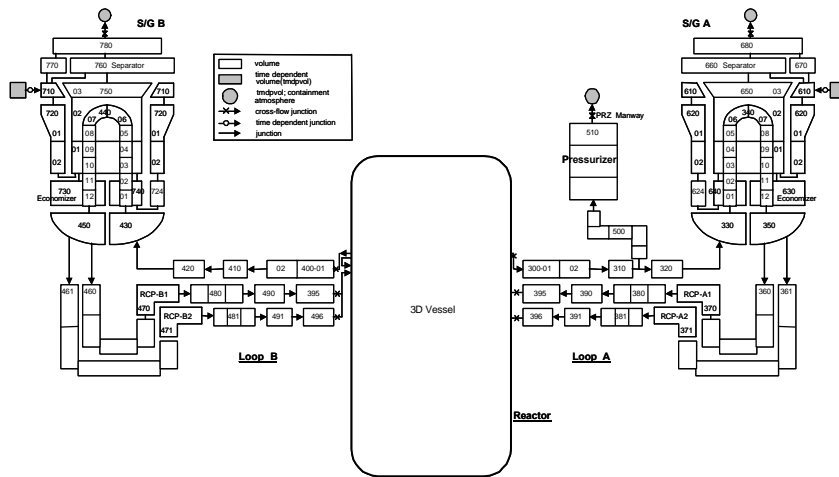
177

64

26

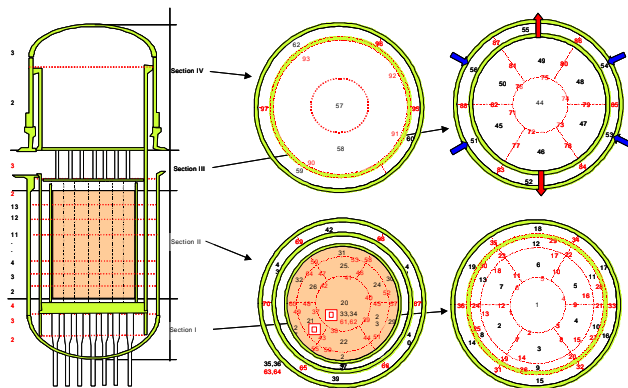
3 3

MASTER



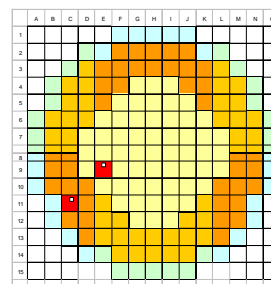
1. MARS

1



2. MARS

3



Axial Nodalization

T/H	Neutronics
13	22-25
1	
2	
3	
4	
5	
6	
7	
8	14-15
9	
7	12-13
10	
11	
12	
13	
14	
15	
3	5-7
2	2-5

3. MASTER

3

4. MARS/MASTER

가 , 가

가

Coastdown 가

2 가

가

2.

Event	LOOP with 3sec Delay				Coincident LOOP with TBN Trip	
	MARS/MASTER		FSAR		MARS/MASTER	
	Time(s)	Value	Time(s)	Value	Time(s)	Value
Seizure of Single RCP	0.0	-	0.0 sec	-	0.0	-
Low RCS Flow Trip Signal	0.22	-	0.24 sec	-	0.22	-
Reactor Trip Break Open	1.43	-	1.44 sec	-	1.43	-
CEA Begins to Drop	1.94	-	1.94 sec	-	1.94	-
Minimum DNBR	1.02	1.5856	2.0	0.9168	2.86	1.5721
LOOP	4.44	-	4.44	-	1.43	-
Maximum RCS Pressure	3.9	164.9 bar	5.64	171.9 bar	4.2	165.7 bar
MSSV Open, Intact SG	18.5	87.7 bar	14.9	88 bar	14.2	88.1 bar
MSSV Open, Broken SG	17.2	87.7 bar	15.7	88 bar	13.8	88.1 bar

가

4

3&4 2 가

50% 가

50%

Coastdown

5

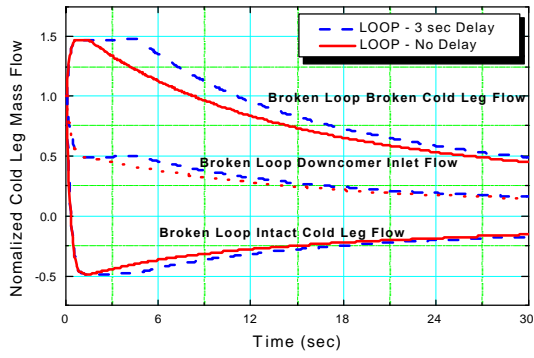
Westinghouse

80%

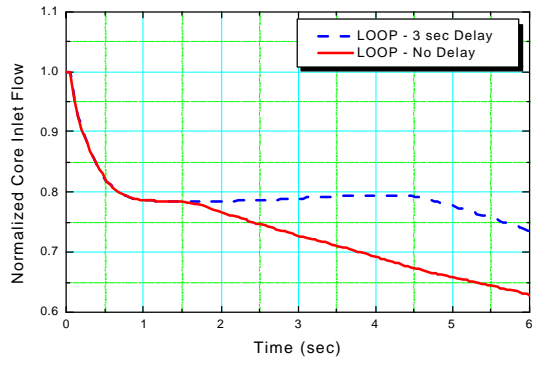
1 가
가

3&4

Westinghouse



4.



5.

6 7 가
가

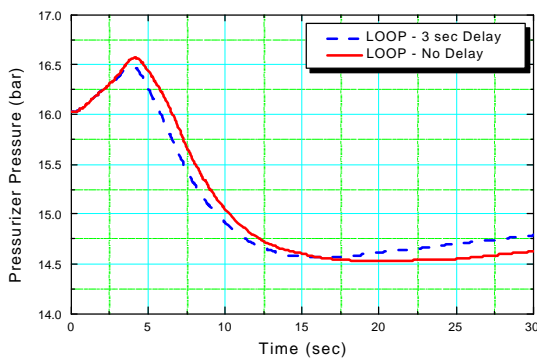
가

가

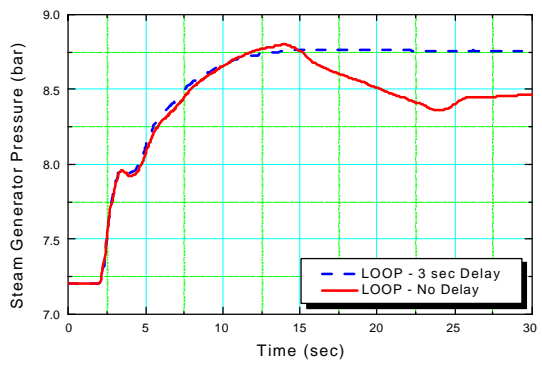
가

88 bar 가

가



6. 가



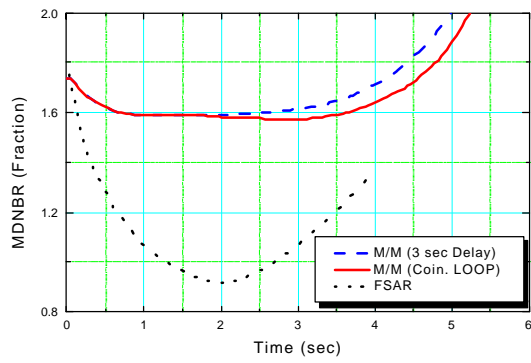
7.

80%

가

5
Coastdown

가 , 1.02 1.586 , 1.733 3 2.86 1.572
 , 1.3
 MARS/MASTER
 , 0.161
 , 가



8.

MARS/MASTER

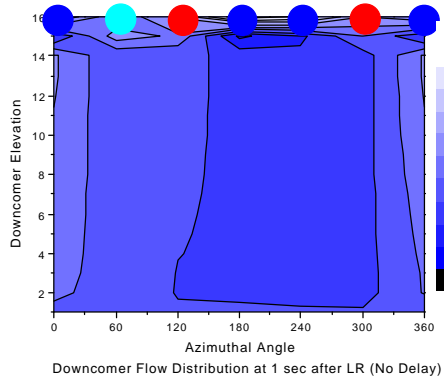
3

9 (1)

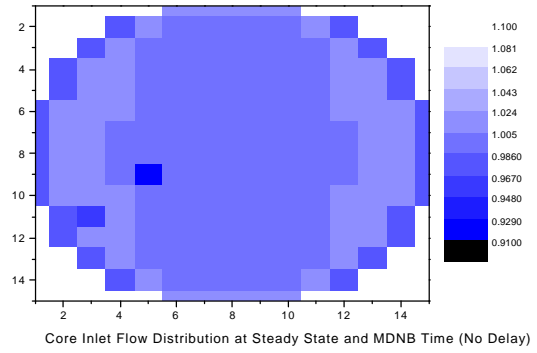
flow skirt

[12]. 10

가



9. 1

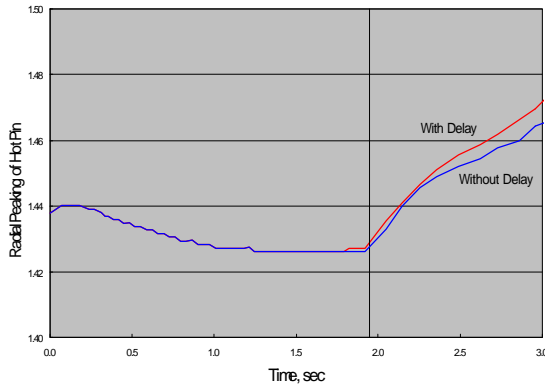


10. MDNB

가 . ,
11 12

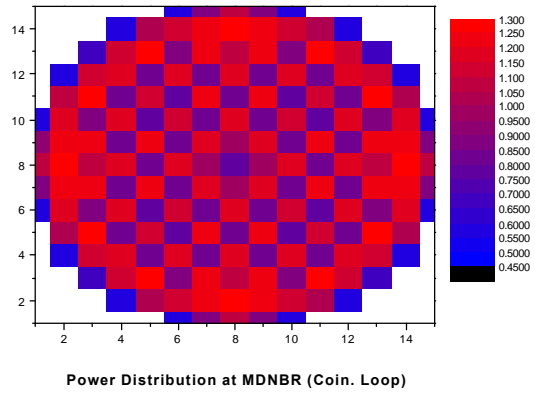
가 . ,
1.02
가
, MARS/MASTER

가 . ,
1.83



11.

, MARS/MASTER



12. MDNBR

MASTER

가 , MARS/
MARS/MASTER

5.

MARS/MASTER

3&4

가

MARS/MASTER

MARS/MASTER

MARS/MASTER

가

, MARS

가

MARS/MASTER

, MARS/MASTER

가

1. 3&4

2. “ 5,6 가”, 71231-316, 1997

3. Jeong, J-J, *et. al.*, “Development of a Draft Version of MARS/MASTER; A Coupled Code of MARS 1.3 and MASTER 2.0,” *Proc. Korean Nucl. Soc. Fall Mtg.*, Seoul, Korea, Oct. 30 – 31, 1998, p. 157 (Paper 86 in CDROM), 1998.

4. Lee, W.J. *et. al.*, “Improved Features of MARS 1.4 and Verification,” KAERI/TR-1386/99, Korea Atomic Energy Research Institute, 1999.

5. Cho, B.O. *et. al.*, “MASTER-2.0: Multi-purpose Analyzer for Static and Transient Effects of Reactors,” KAERI/TR-1211/99, Korea Atomic Energy Research Institute, Jan. 1999.

6. The Thermal Hydraulics Group, “RELAP5/MOD3 Code Manual”, NUREG/CR-5535, 1998

7. M.J. Thurgood, *et. al.*, “COBRA/TRAC – A Thermal-Hydraulics Code for Transient Analysis of Nuclear REactor Vessels and Primary Coolant Systems”, NUREG/CR-3046, PNL-4385, 1983

8. "Digital Fortran Language Reference Manual", Digital Equipment Corporation", 1997
9. J.J. Jeong, *et. al.*, MARS/MASTER Solution to OECD Main Steam Line Break Benchmark Exercise III", to be published, J of KNS, Vol. 32, No. 3, 2000
10. I.H. Song, *et. al.*, Design Data for Safety Analysis for Yonggwang Nuclear Units 3&4, 10487-RE-DD012-00 Rev. 4, KAERI/ABB-CE
11. "CE Critical Heat Flux: Critical Heat Flux for CE Fuel Assemblies with Standard Spacer Grids, Part 1, Uniform Axial Power Distribution", CENPD-162-8-A, Supplement 1-A, 1977
12. C.B. Martin, *et. al.*, "System 80+ Reactor Vessel Boron Mixing Following a Small Break LOCA assuming Restart of One RCP", ABB-CE, 1994