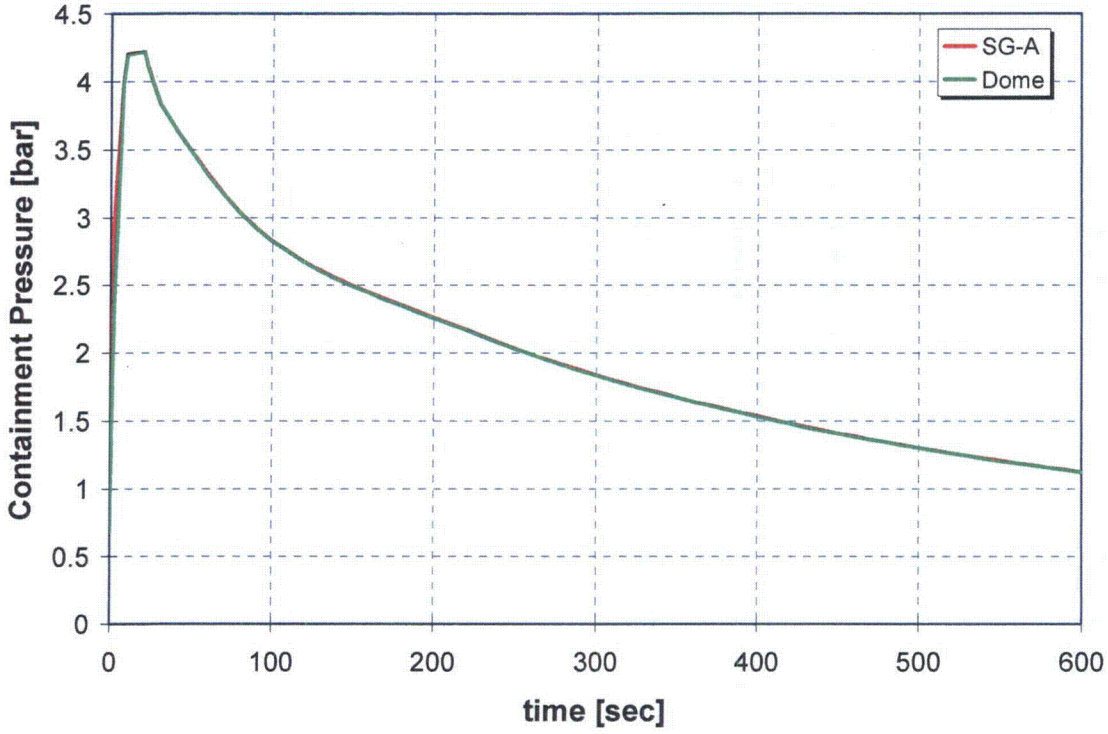
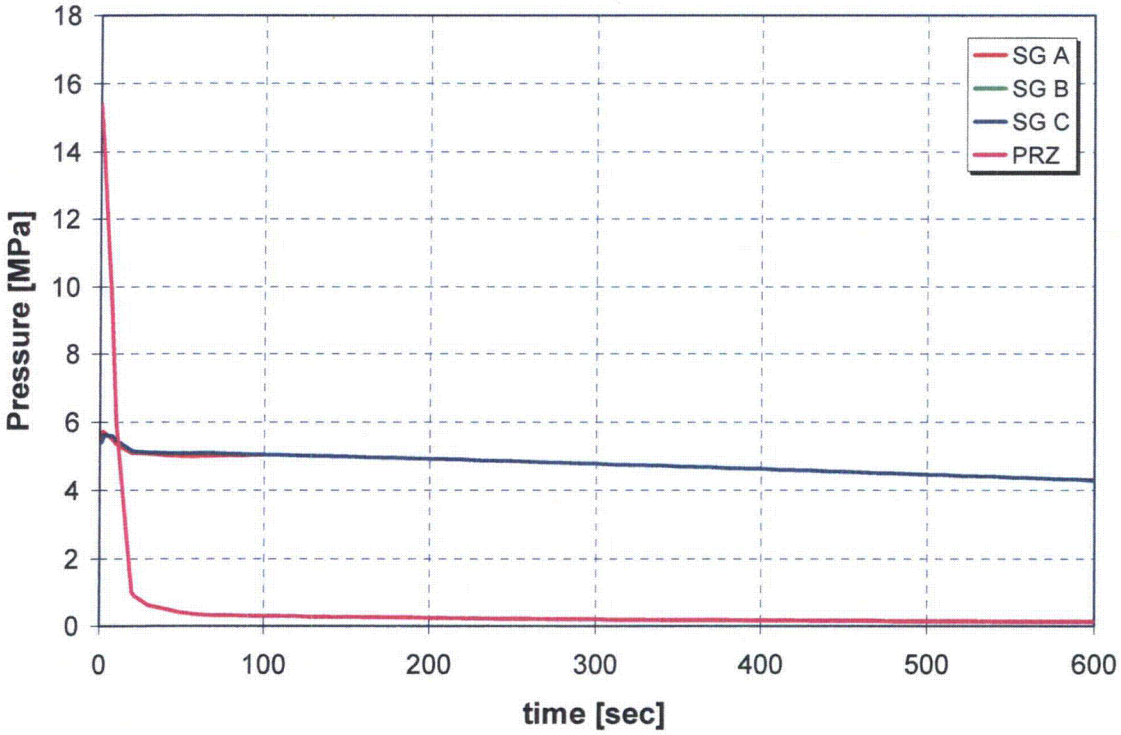
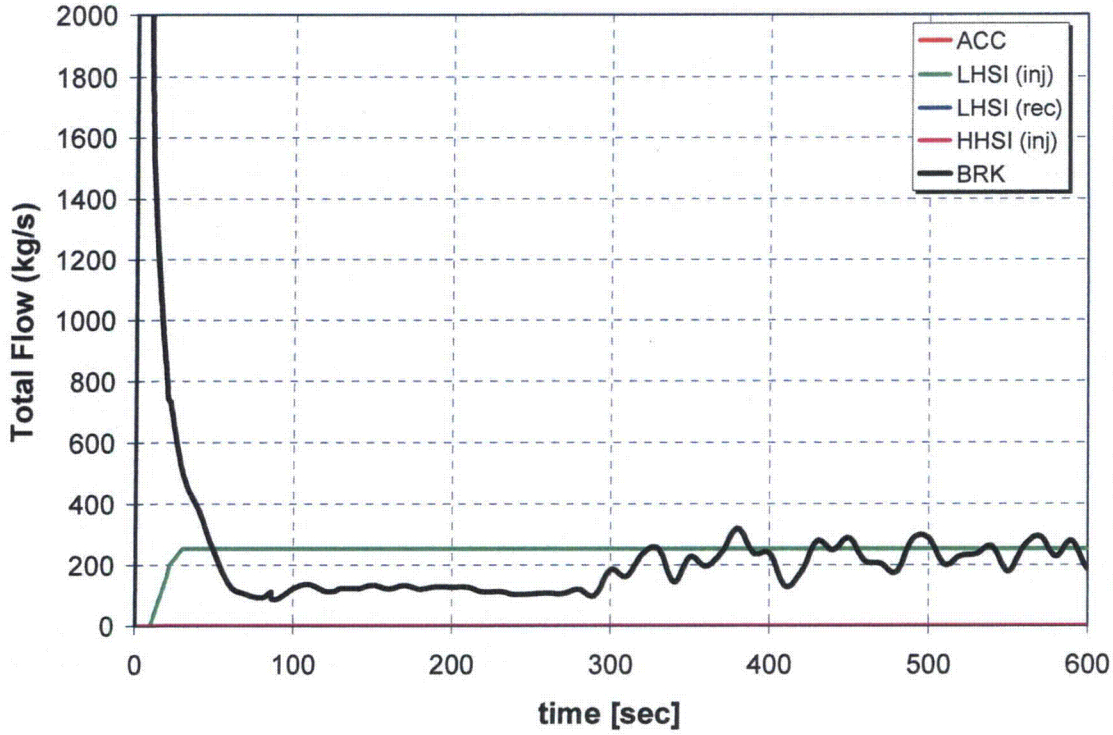
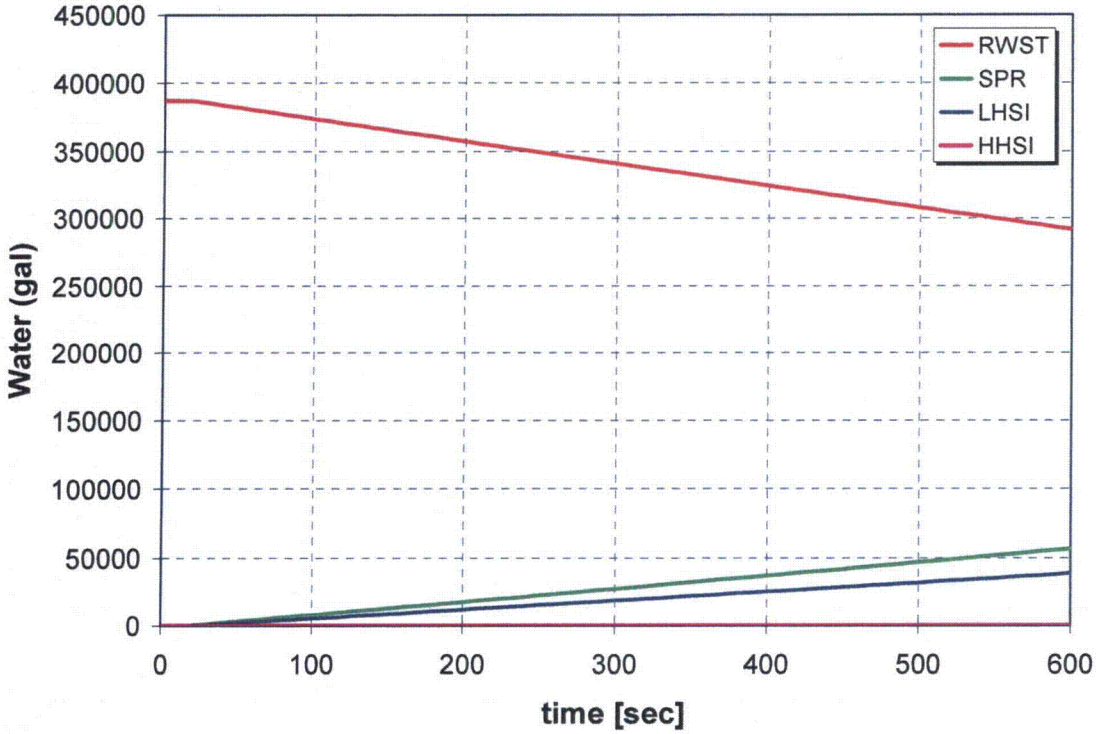
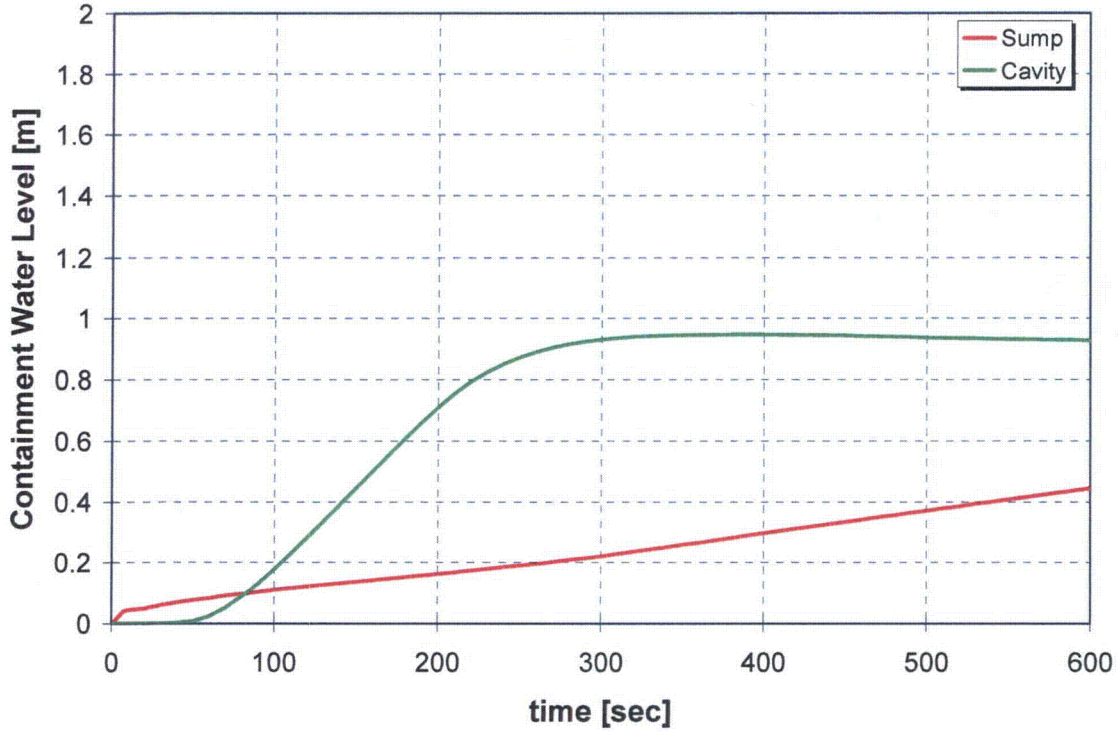
A.6.10 Case 10: Double-Ended Cold Leg Break LOCA, No HHSI, One LHSI, and No ACC

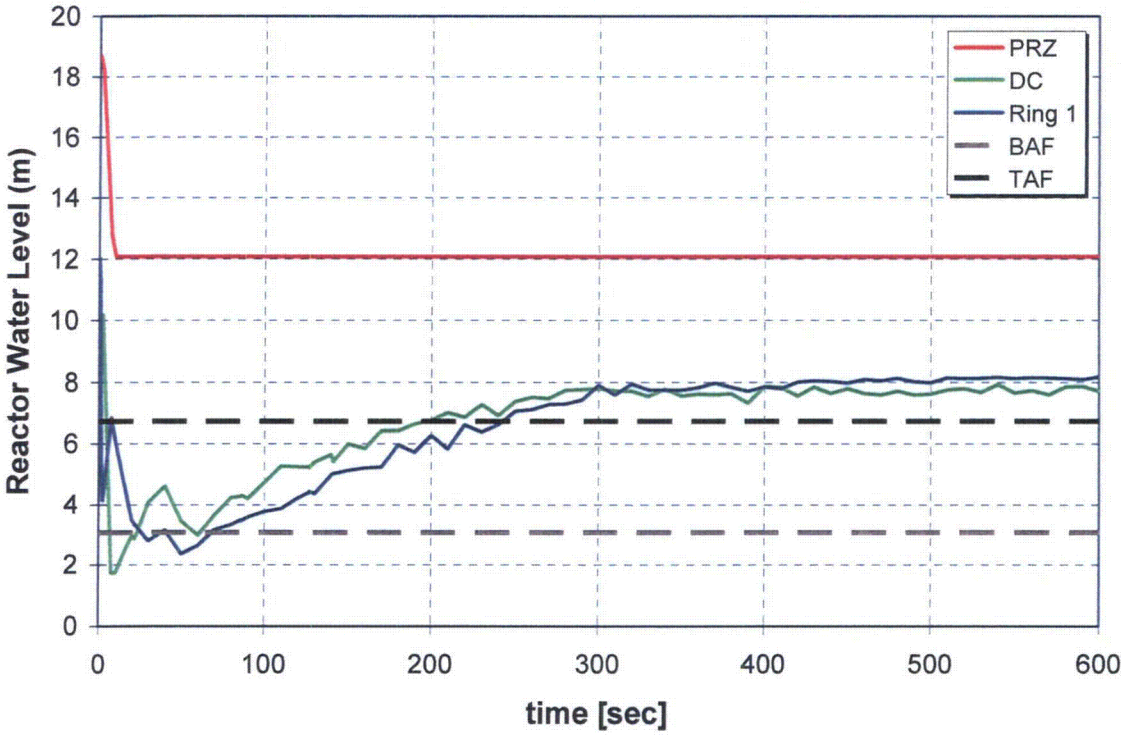


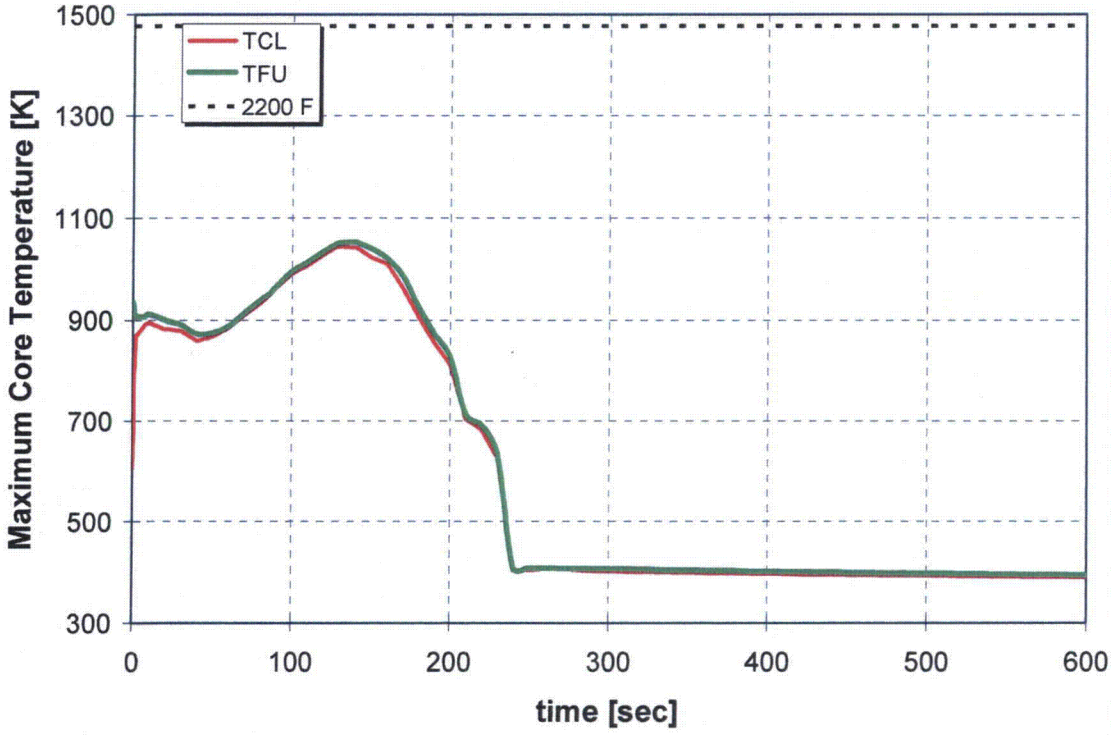



ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
100
200
300
400
500
600
time [sec]

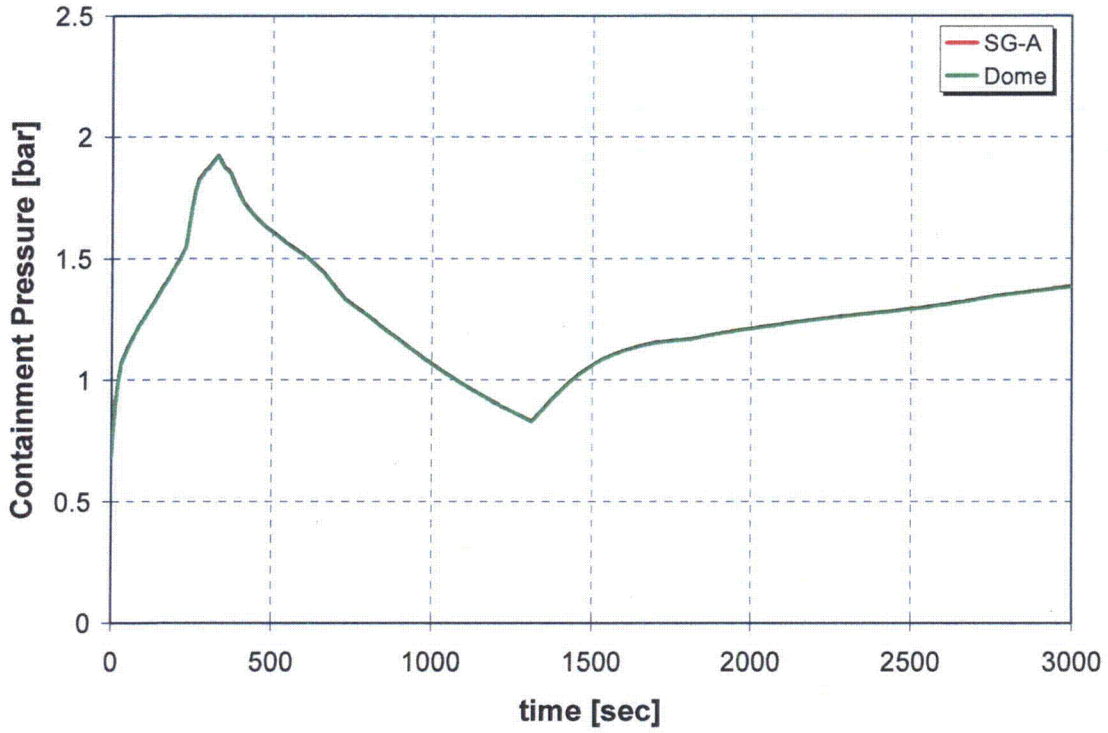

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
100
200
300
400
500
600
time [sec]

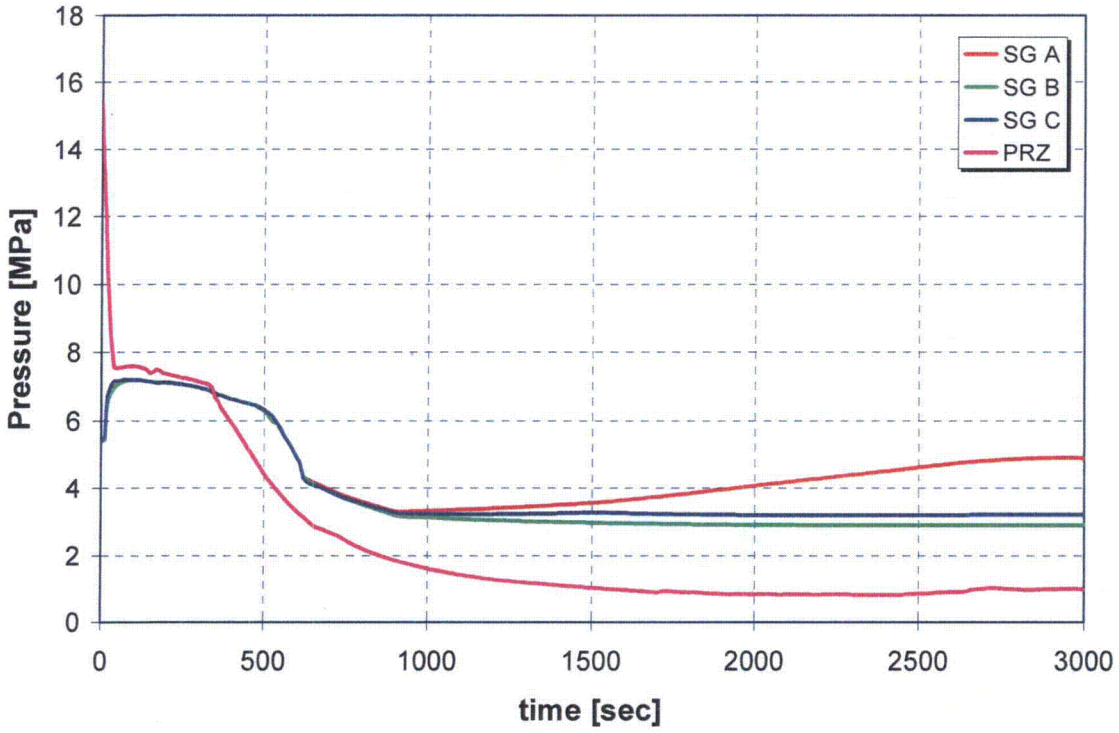

Containment Water Level [m]
time [sec]
Sump
Cavity
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
100
200
300
400
500
600

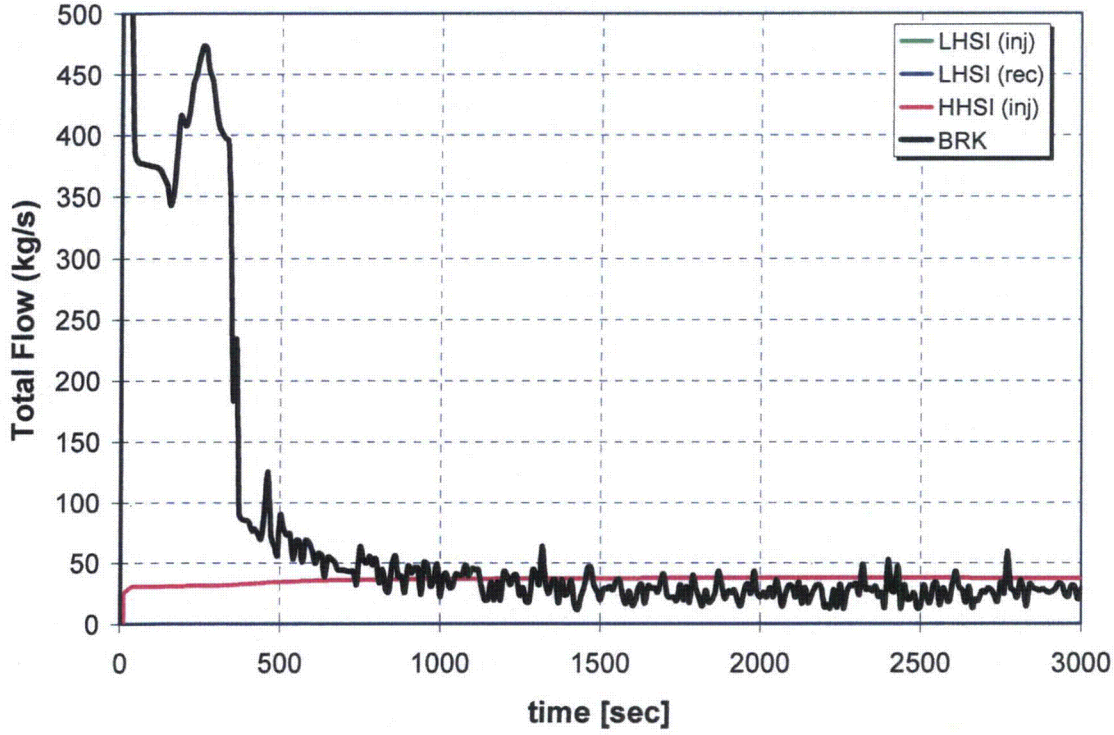

Reactor Water Level (m)
time [sec]
PRZ
DC
Ring 1
BAF
TAF
0
2
4
6
8
10
12
14
16
18
20
0
100
200
300
400
500
600

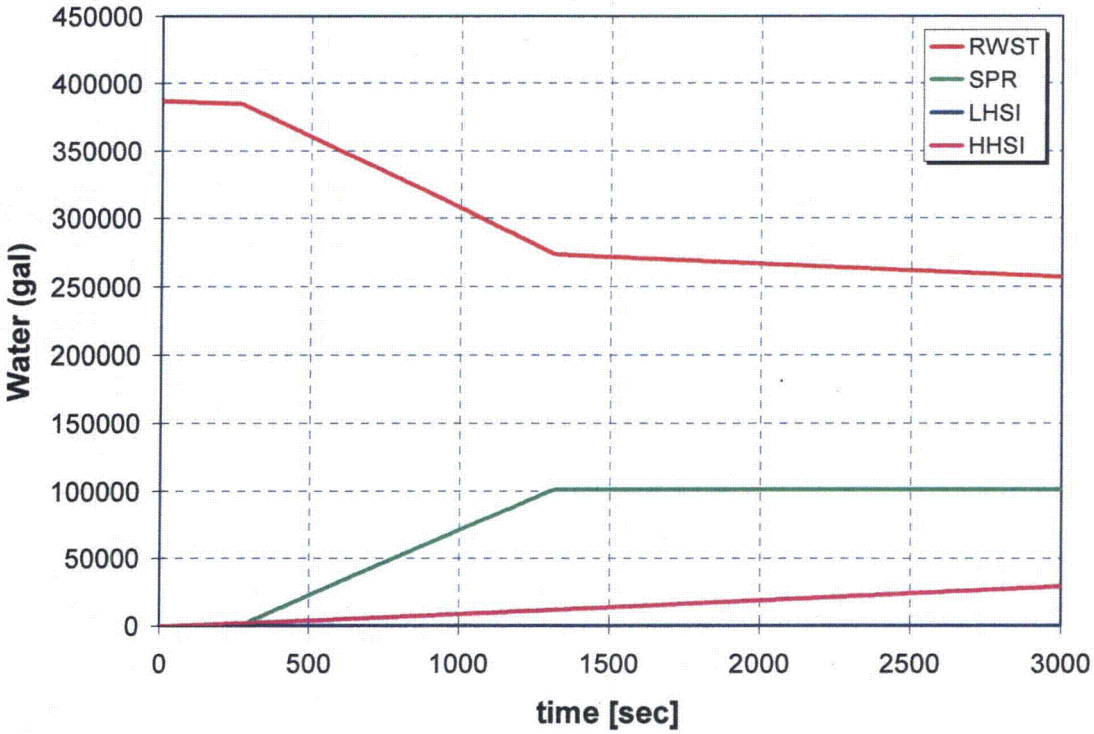

TCL
TFU
2200 F
Maximum Core Temperature [K]
1500
1300
1100
900
700
500
300
0
100
200
300
400
500
600
time [sec]

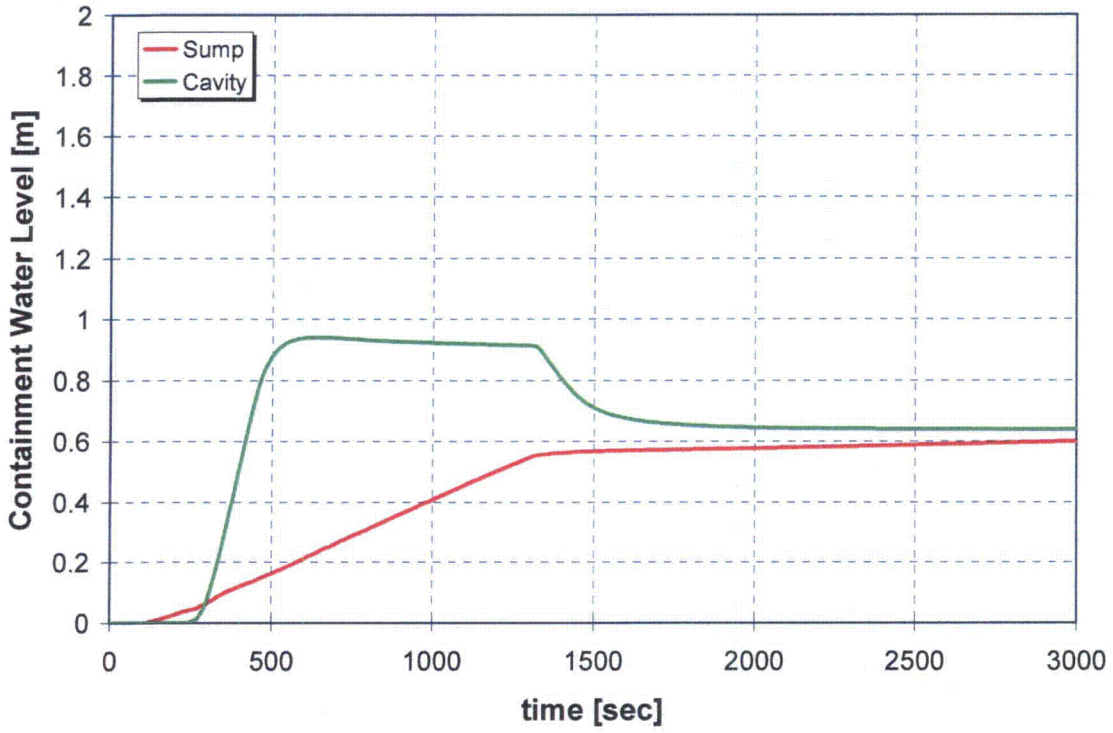
A.6.11 Case 11: 4-Inch Break LOCA, One HHSI, No LHSI, and No ACC

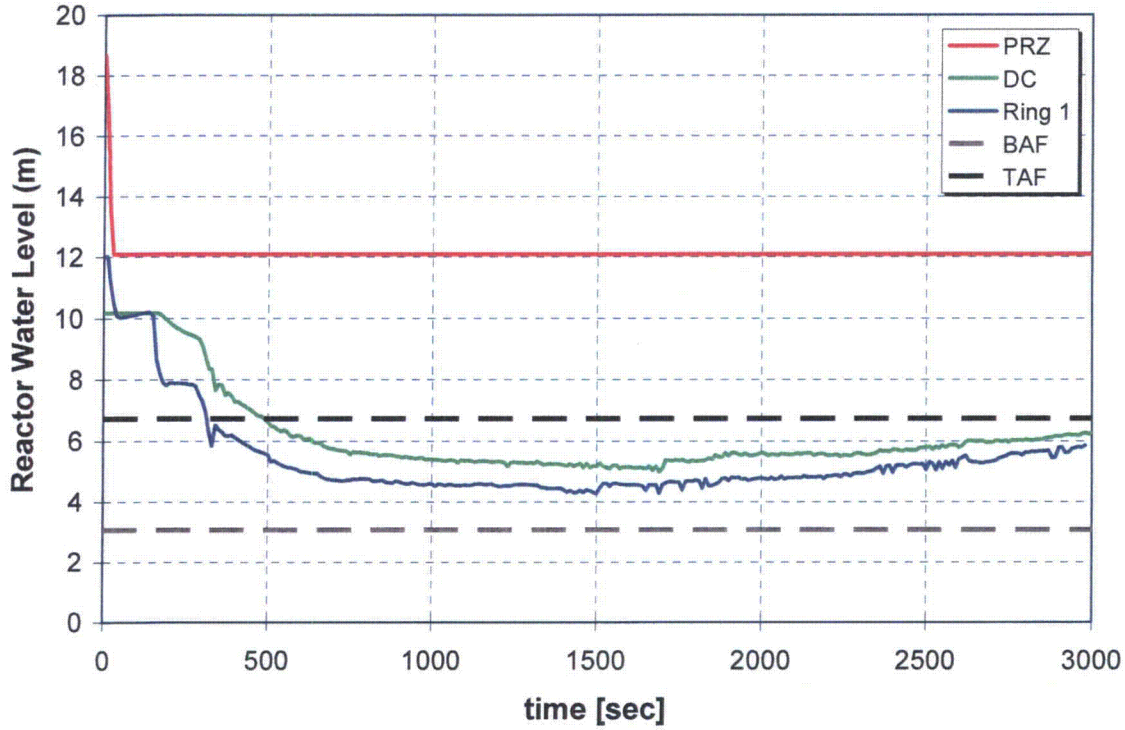


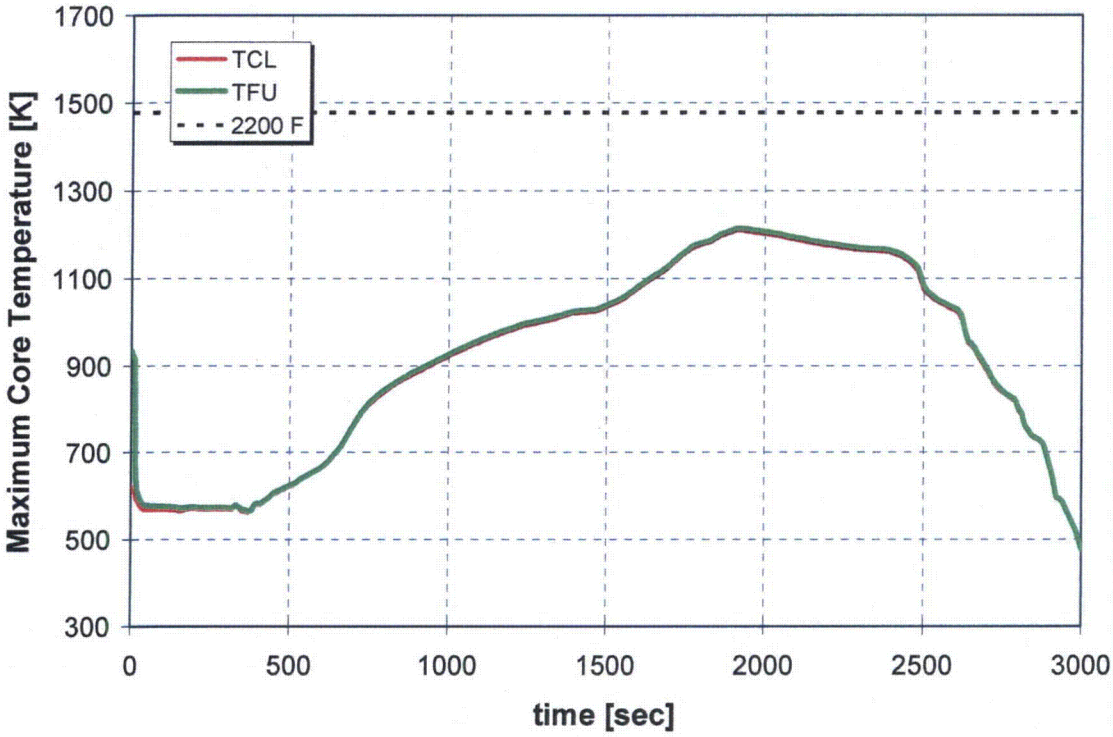



LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
time [sec]

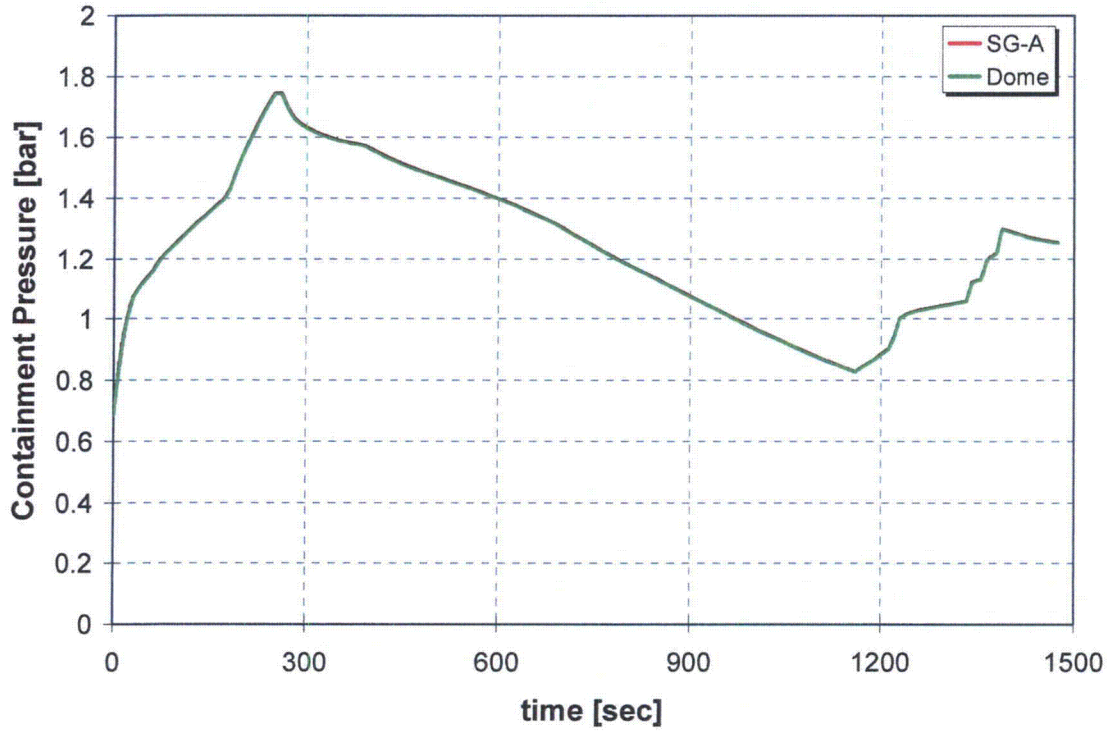

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
500
1000
1500
2000
2500
3000
time [sec]

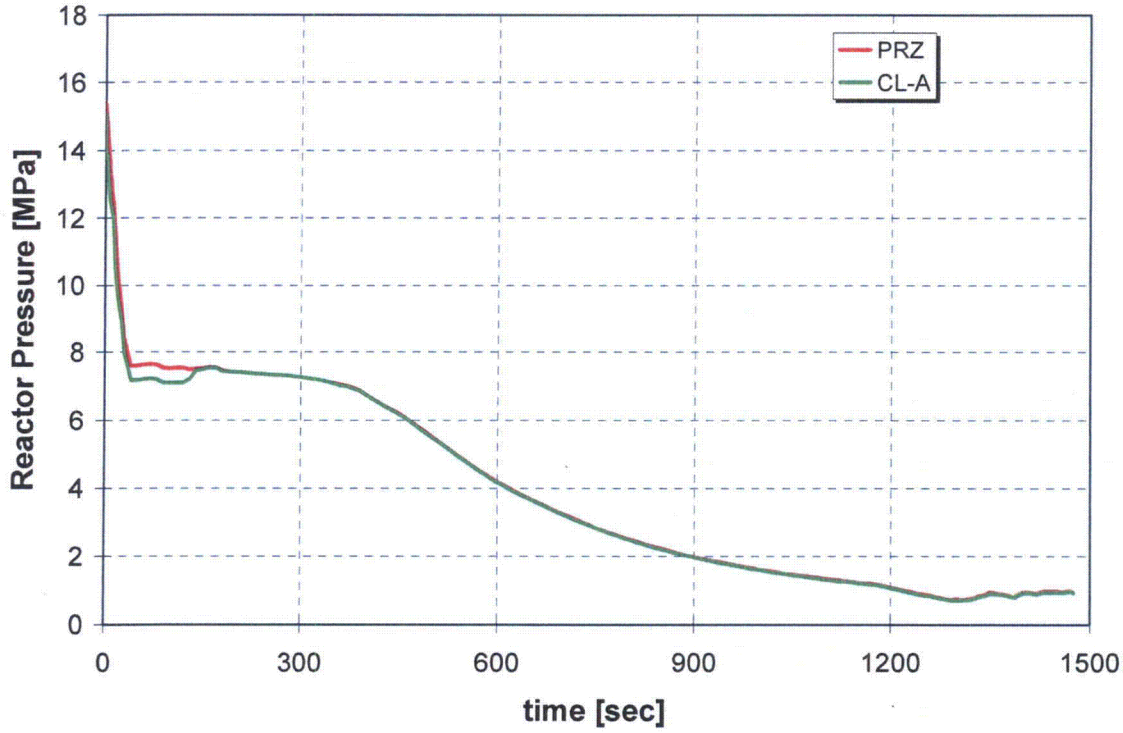

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
time [sec]

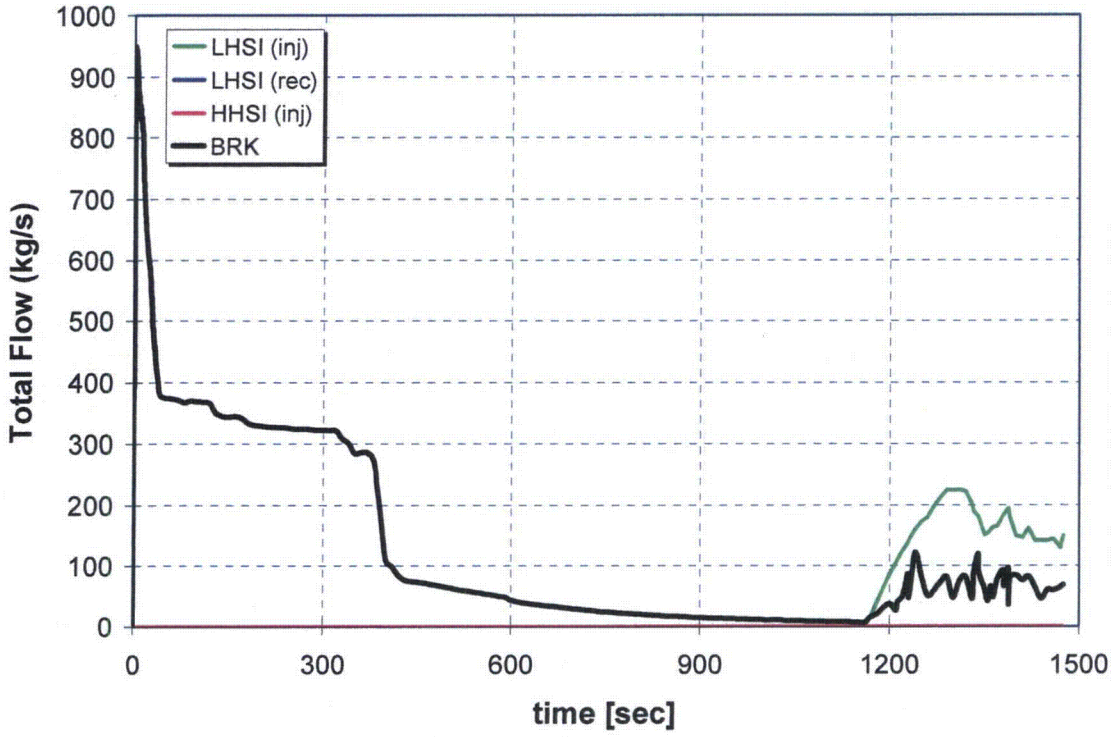

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
time [sec]

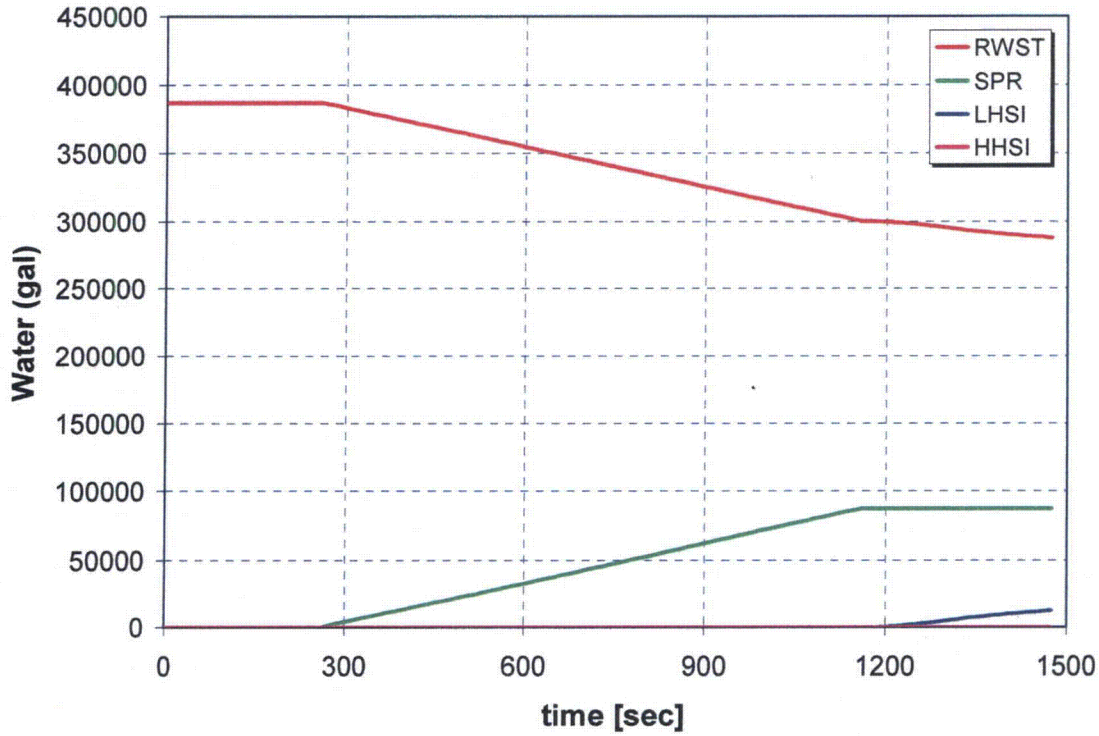

TCL
TFU
2200 F
Maximum Core Temperature [K]
1700
1500
1300
1100
900
700
500
300
0
500
1000
1500
2000
2500
3000
time [sec]

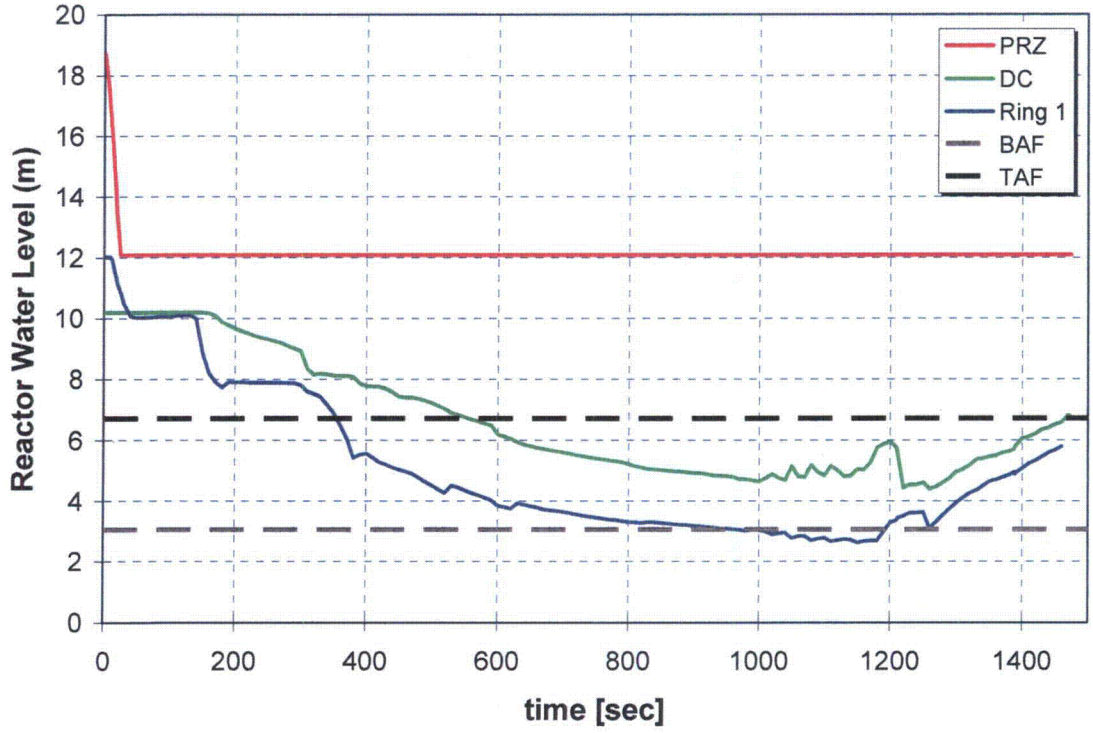
A.6.12 Case 12: 4-Inch Break LOCA, No HHSI, One LHSI, and No ACC

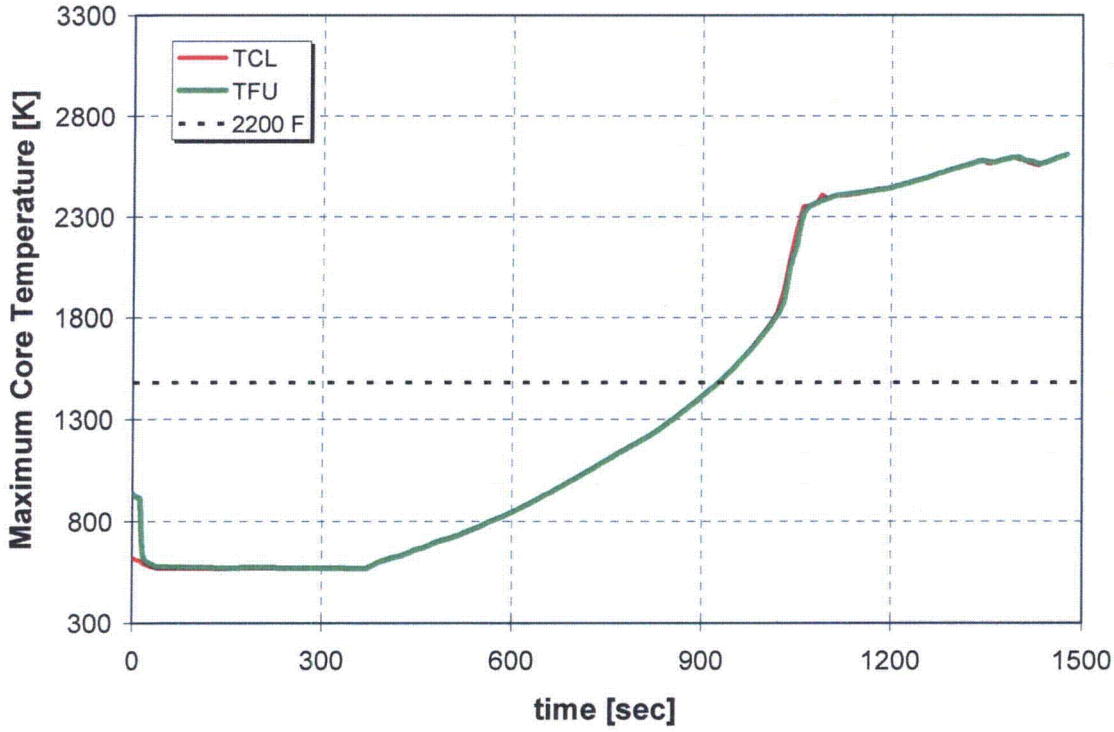




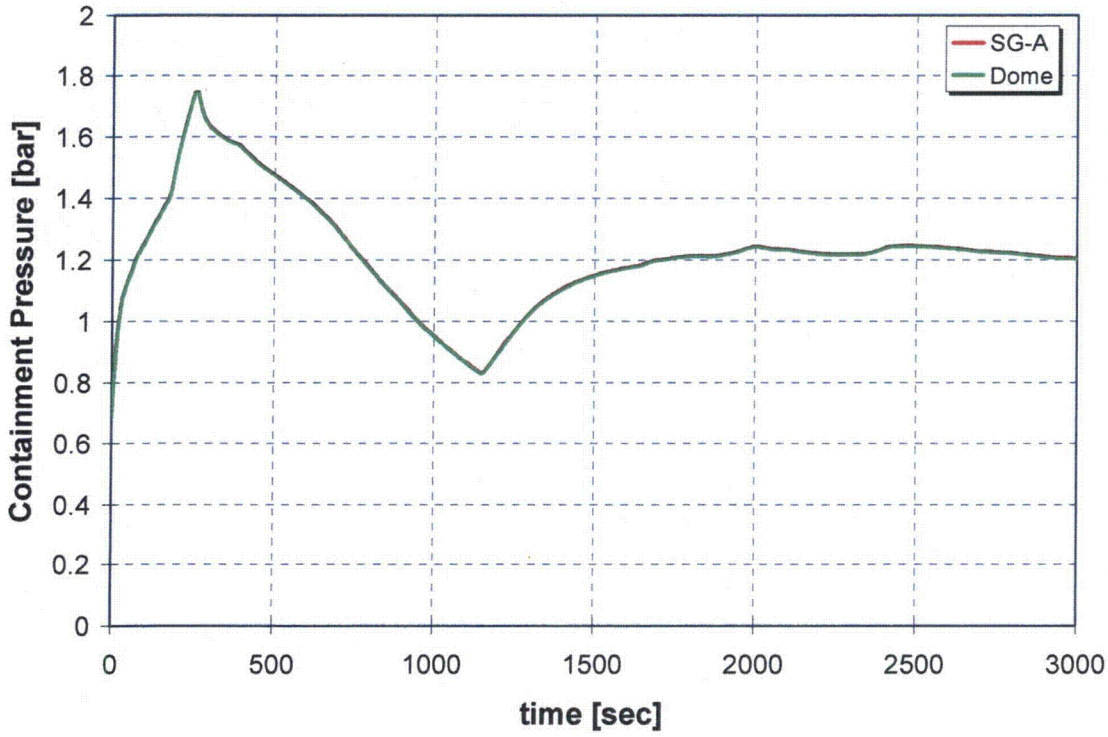

LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
1000
900
800
700
600
500
400
300
200
100
0
0
300
600
900
1200
1500
time [sec]

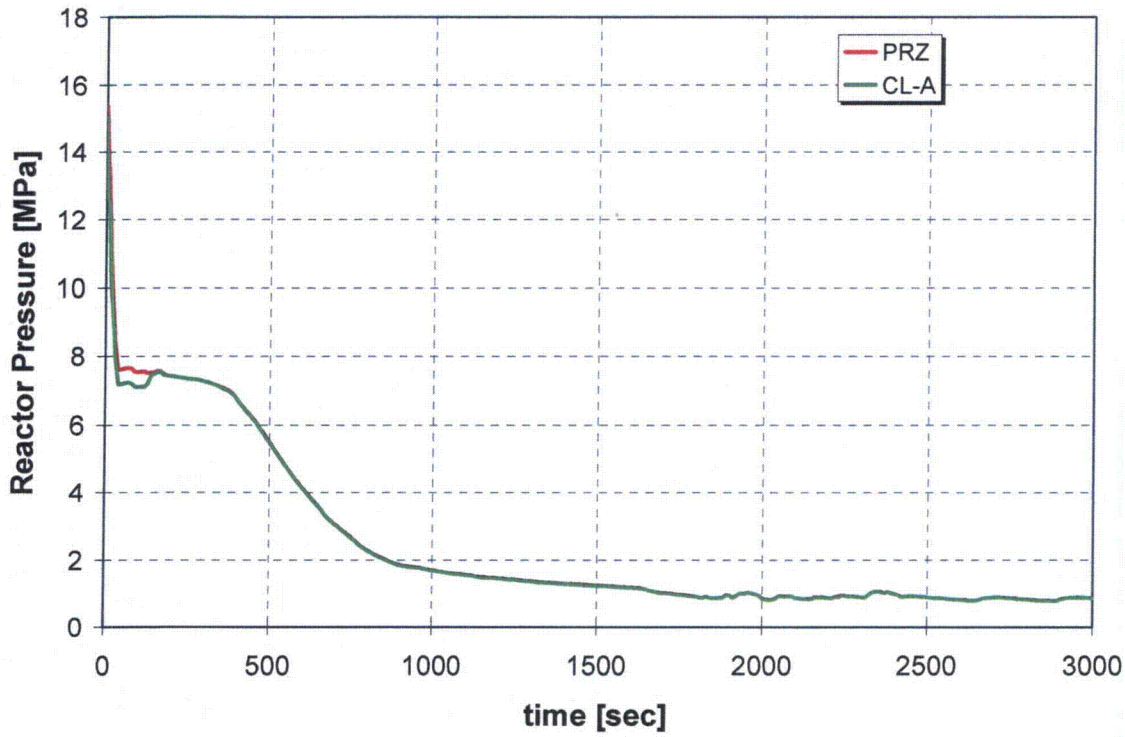

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
300
600
900
1200
1500
time [sec]

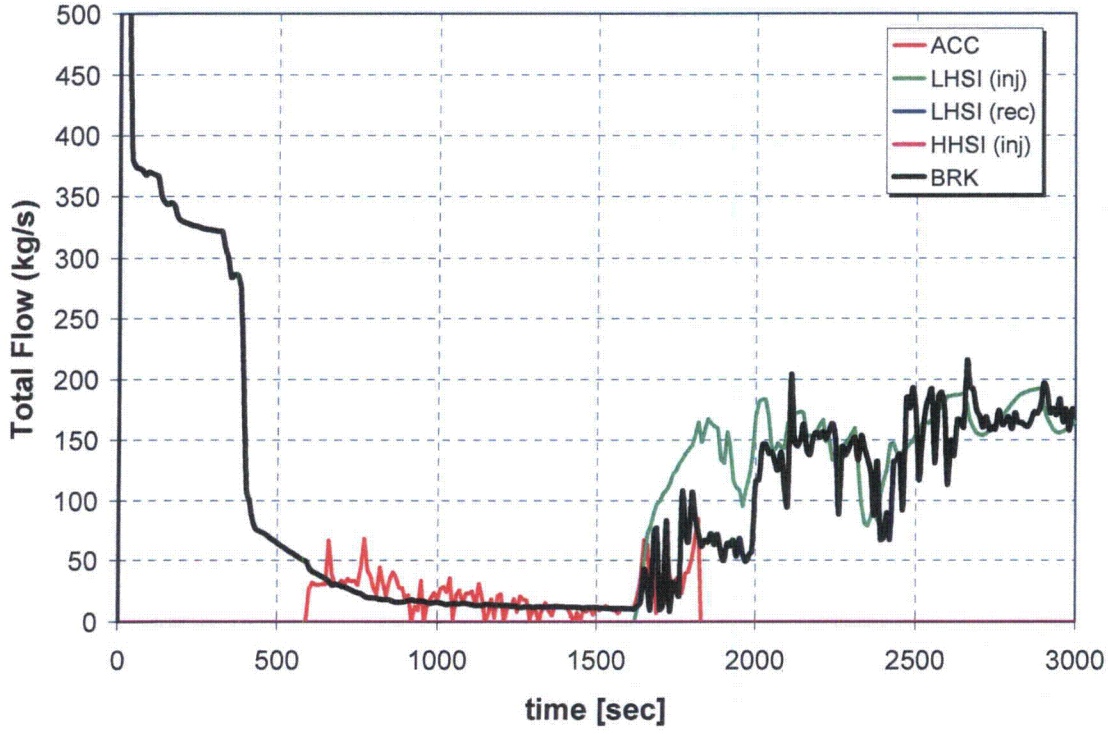

Reactor Water Level (m)
time [sec]
PRZ
DC
Ring 1
BAF
TAF
0
2
4
6
8
10
12
14
16
18
20
0
200
400
600
800
1000
1200
1400

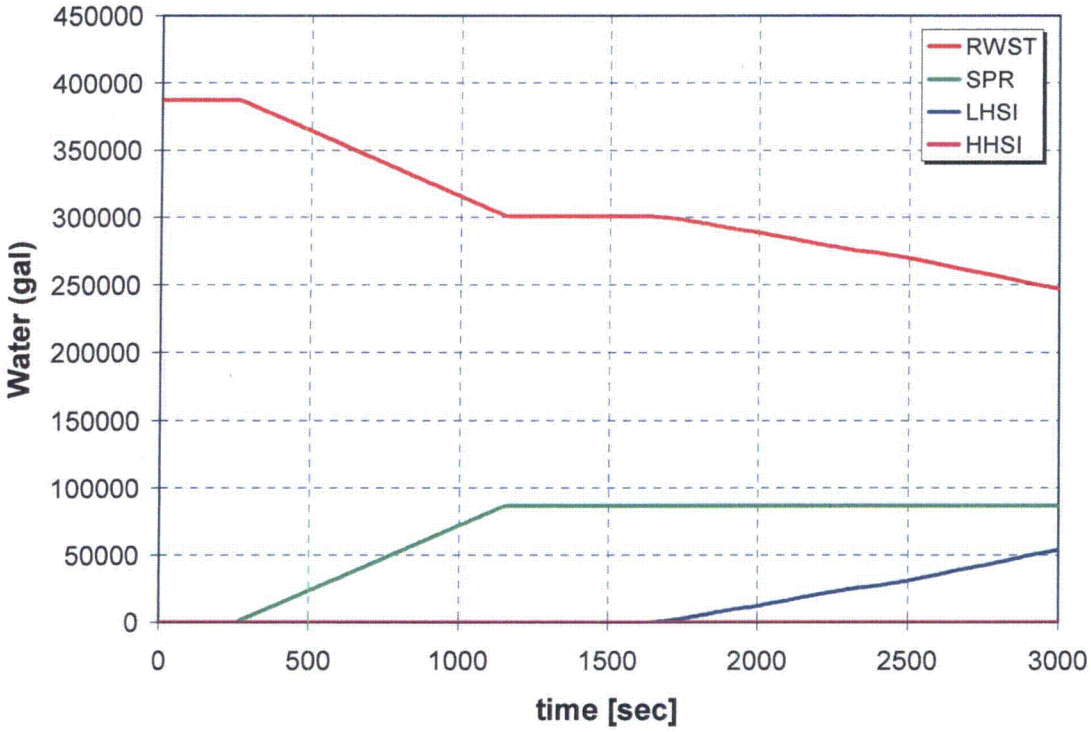

Maximum Core Temperature [K]
time [sec]
TCL
TFU
2200 F
300
800
1300
1800
2300
2800
3300
0
300
600
900
1200
1500

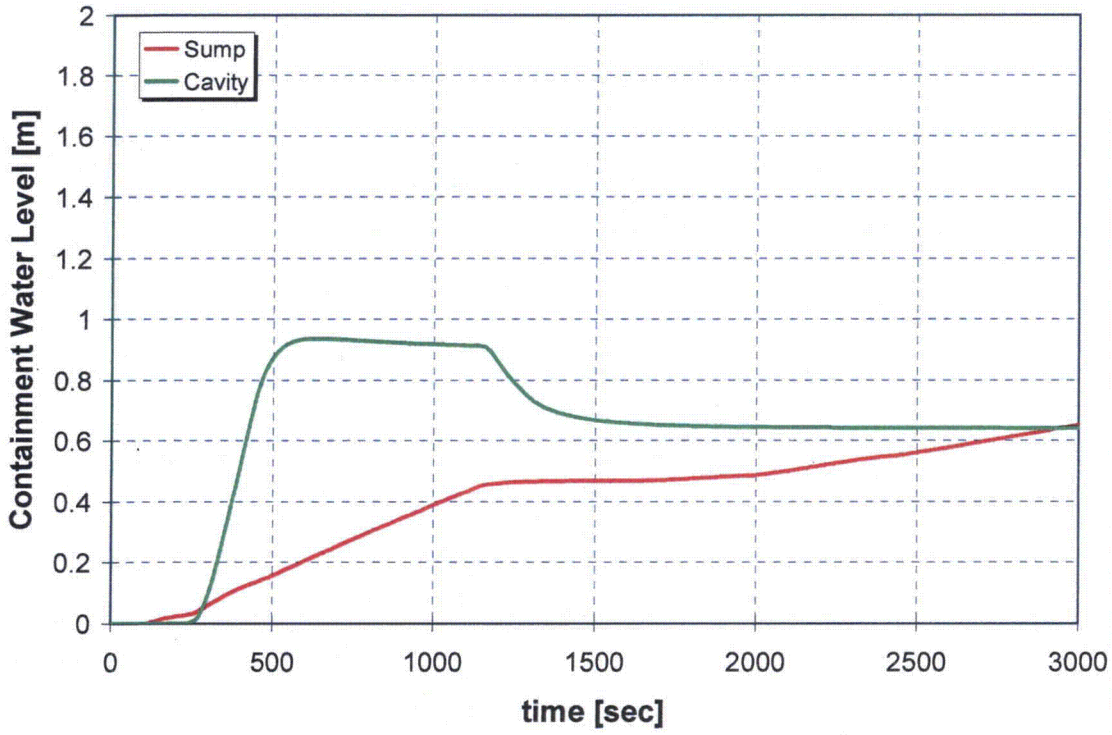
A.6.13 Case 13: 4-Inch Break LOCA, No HHSI, One LHSI, and One ACC

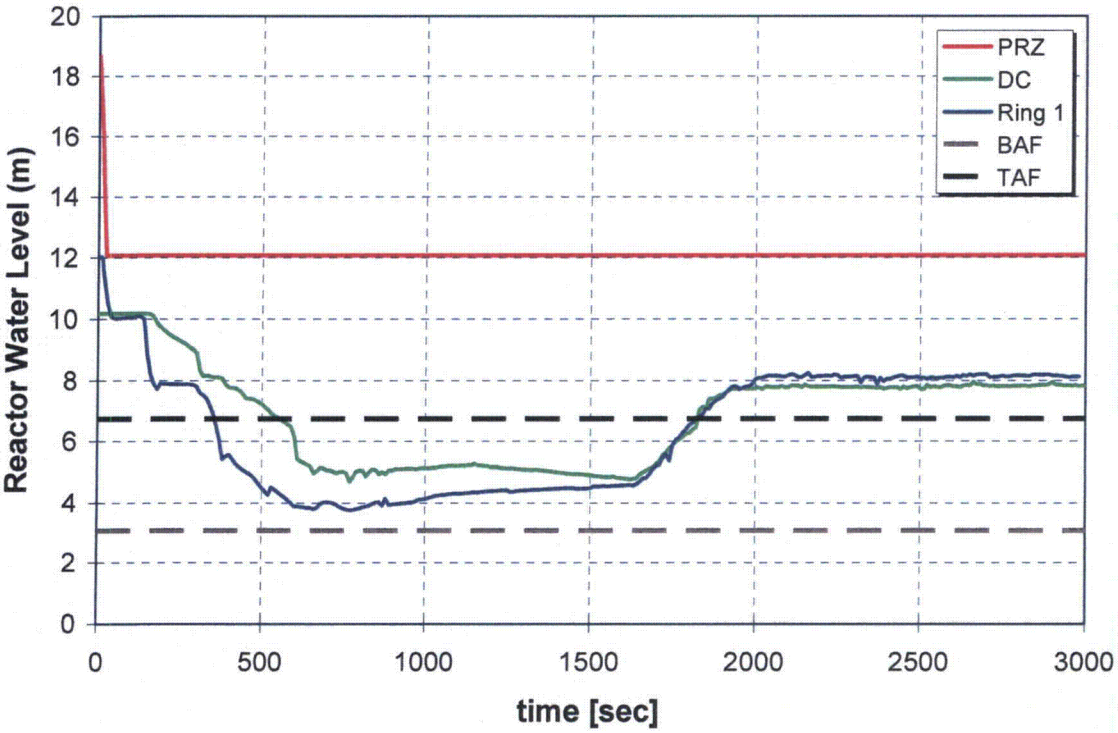


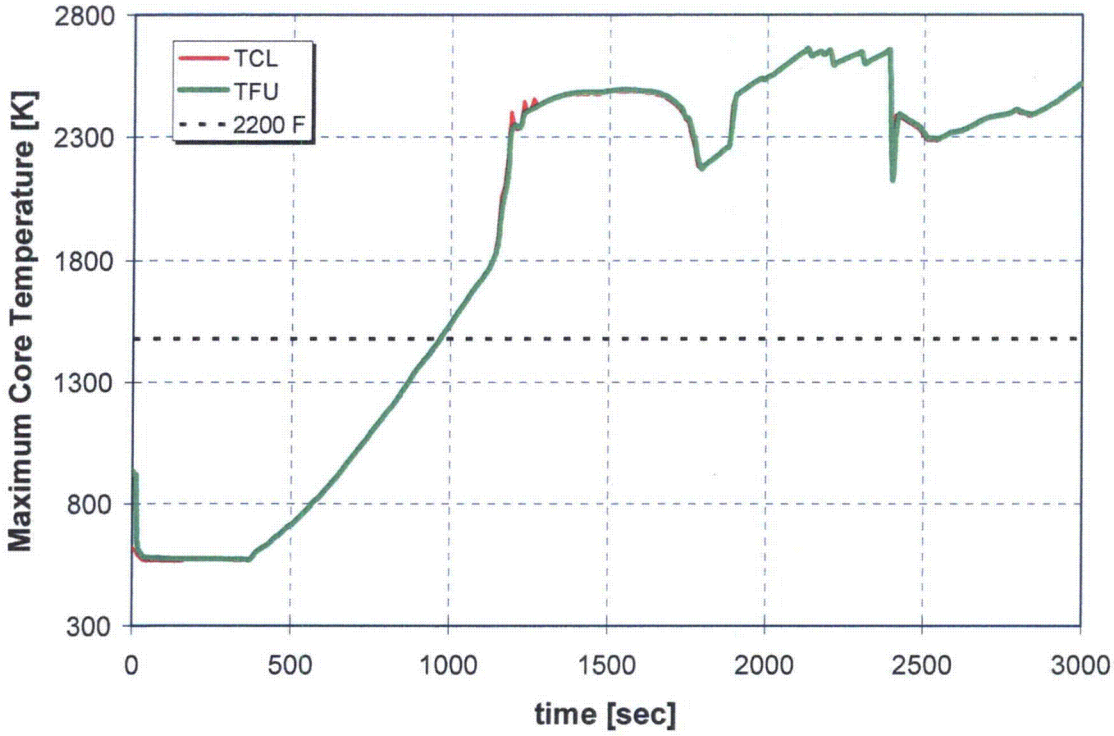



Total Flow (kg/s)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
time [sec]
ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK

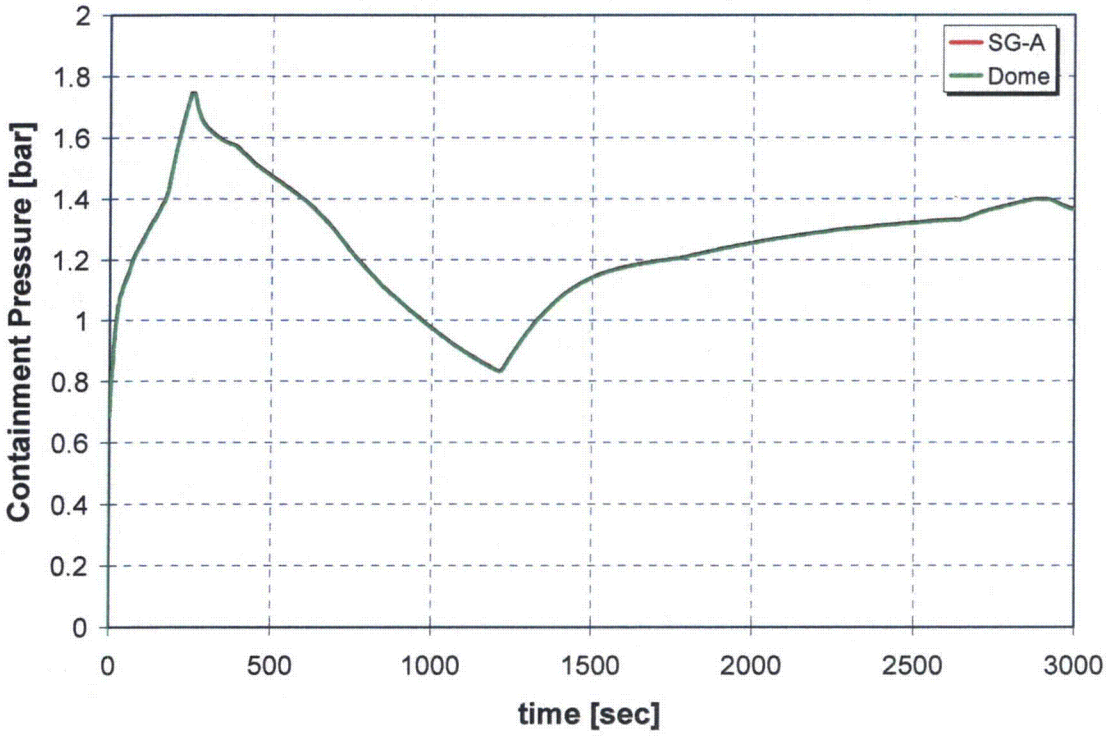

Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
500
1000
1500
2000
2500
3000
time [sec]
RWST
SPR
LHSI
HHSI

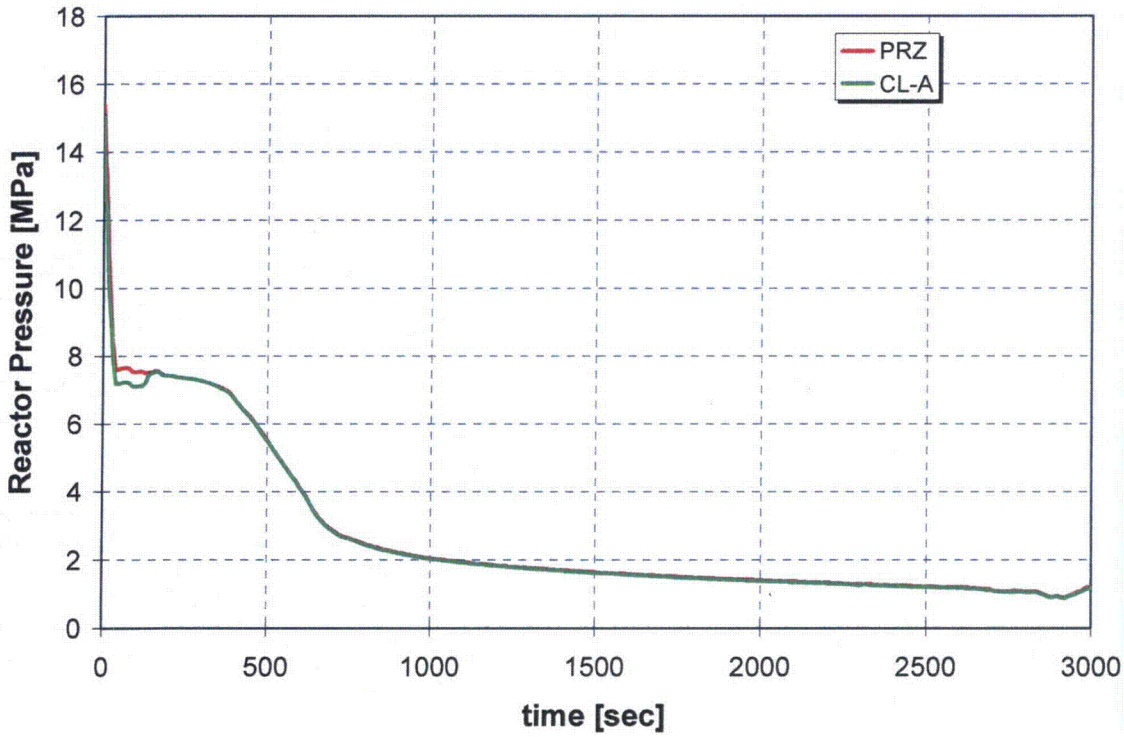

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
time [sec]

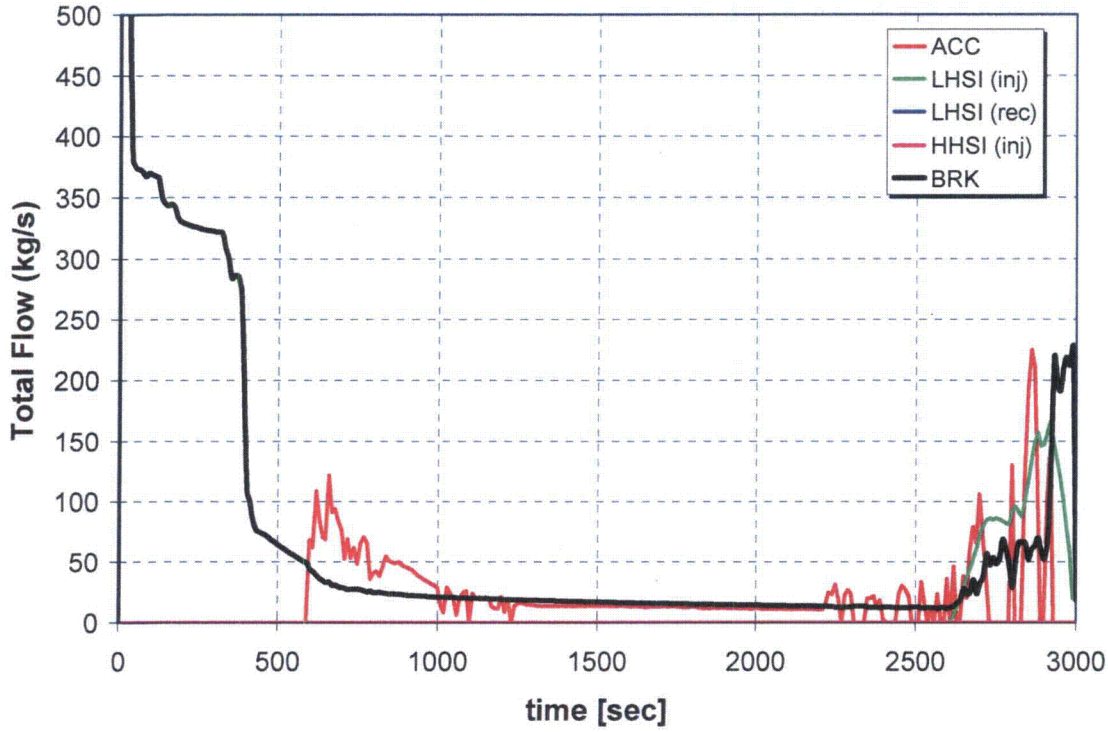

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
time [sec]

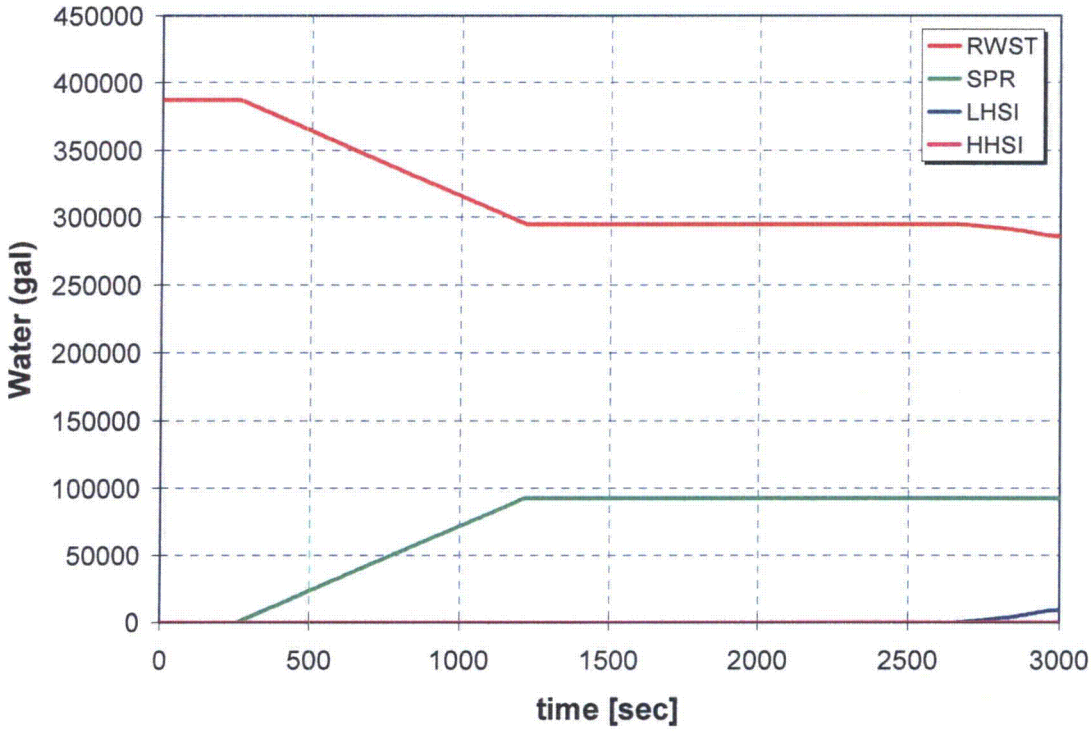

TCL
TFU
2200 F
Maximum Core Temperature [K]
2800
2300
1800
1300
800
300
0
500
1000
1500
2000
2500
3000
time [sec]

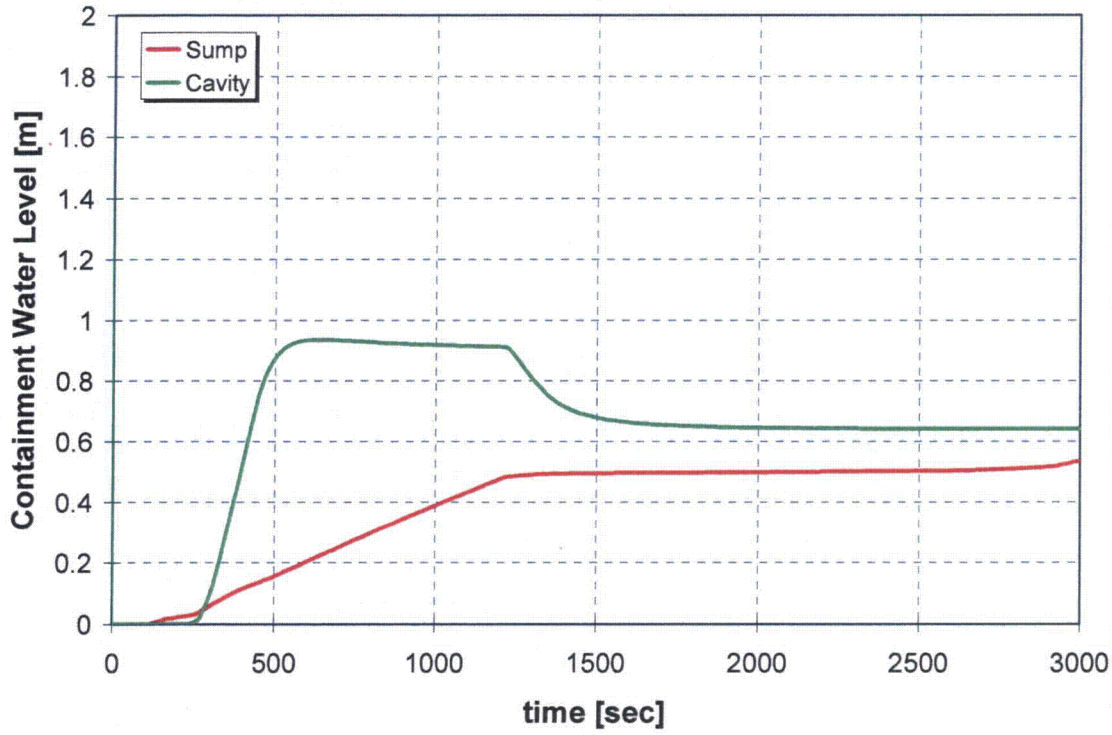
A.6.14 Case 14: 4-Inch Break LOCA, No HHSI, One LHSI, and Two ACC

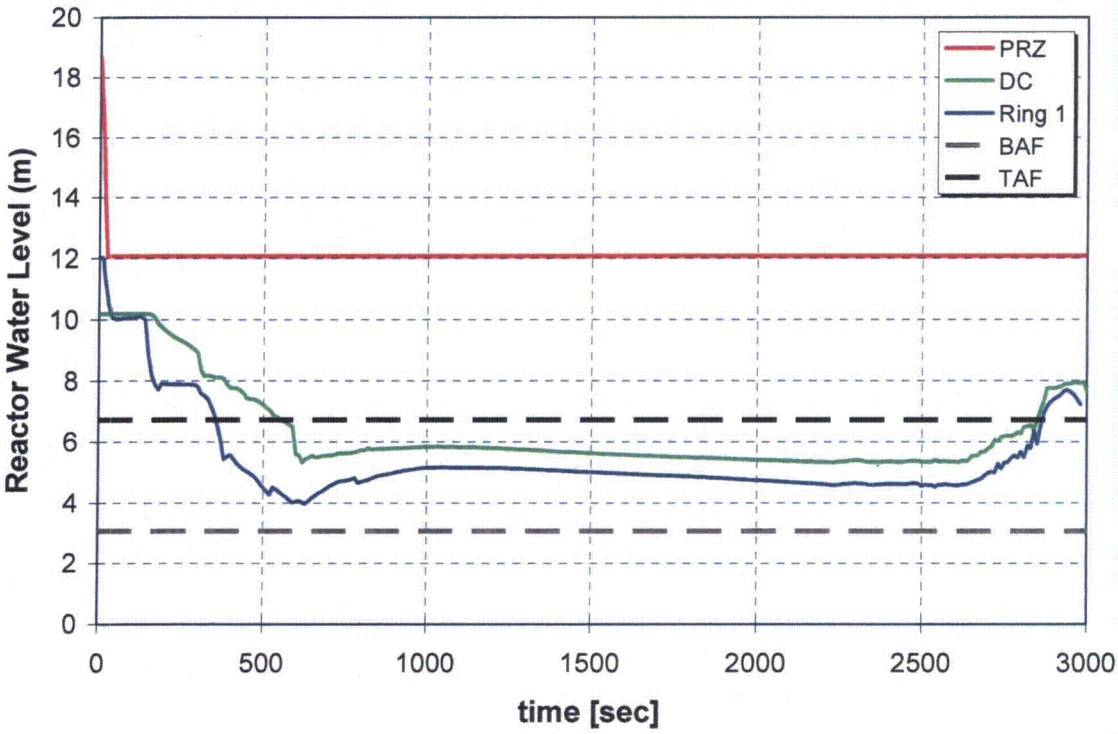


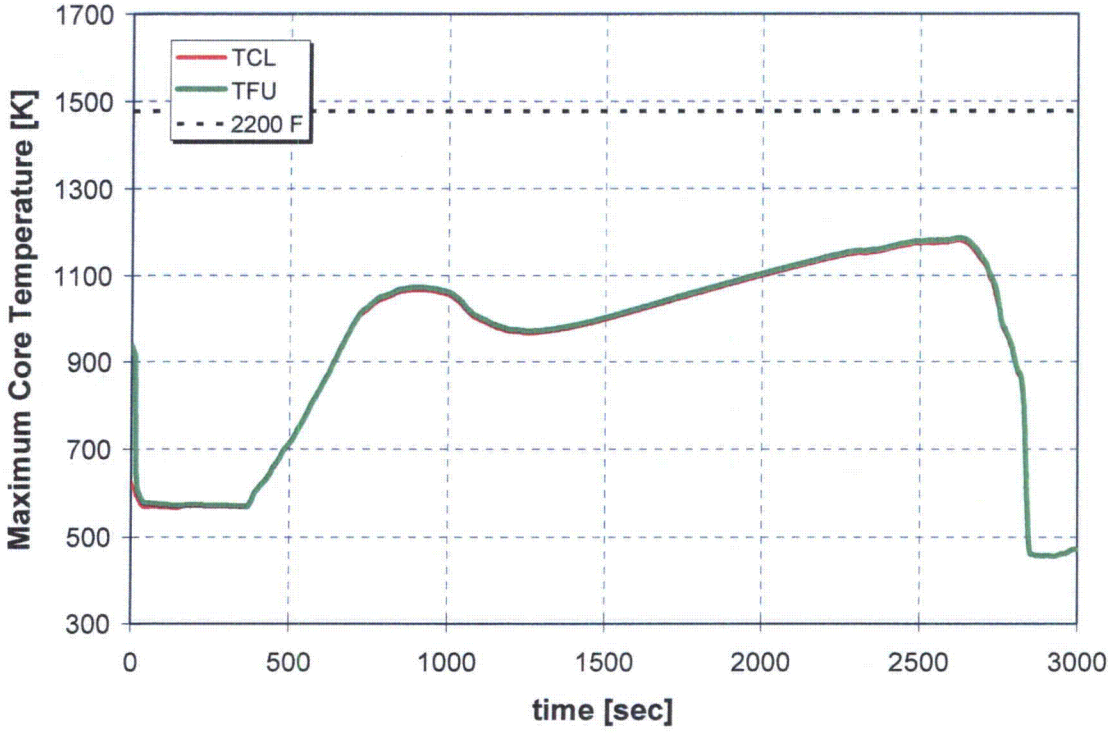



ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
time [sec]

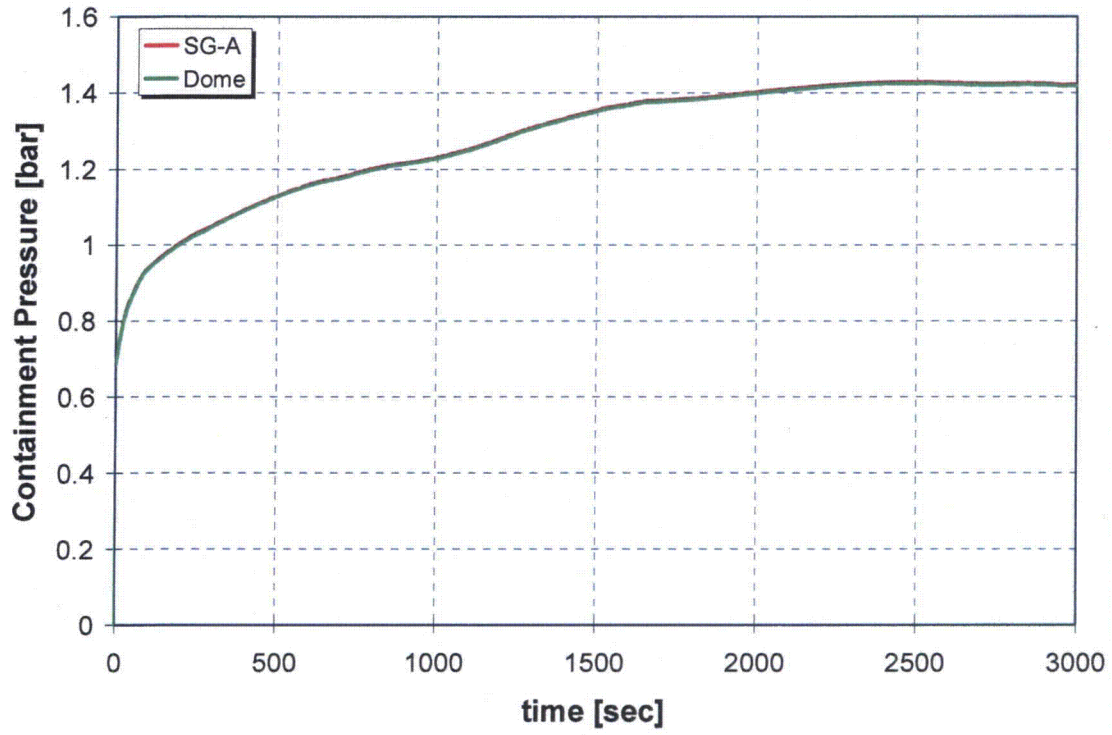

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
500
1000
1500
2000
2500
3000
time [sec]

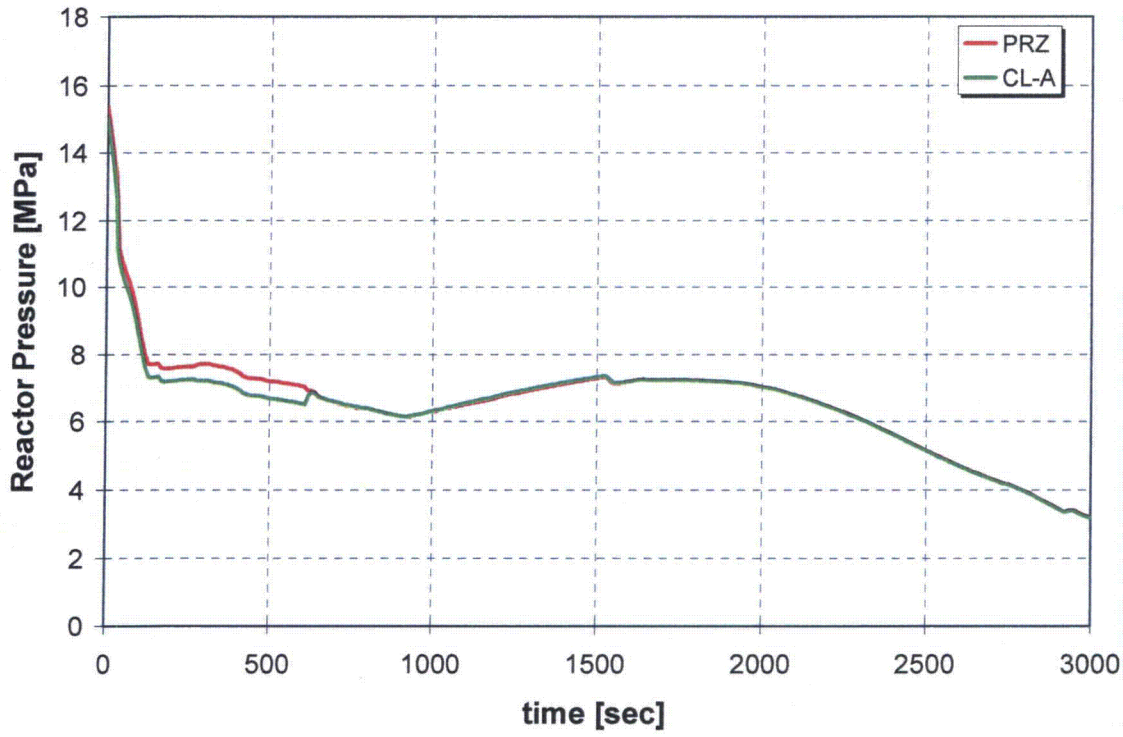

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
time [sec]

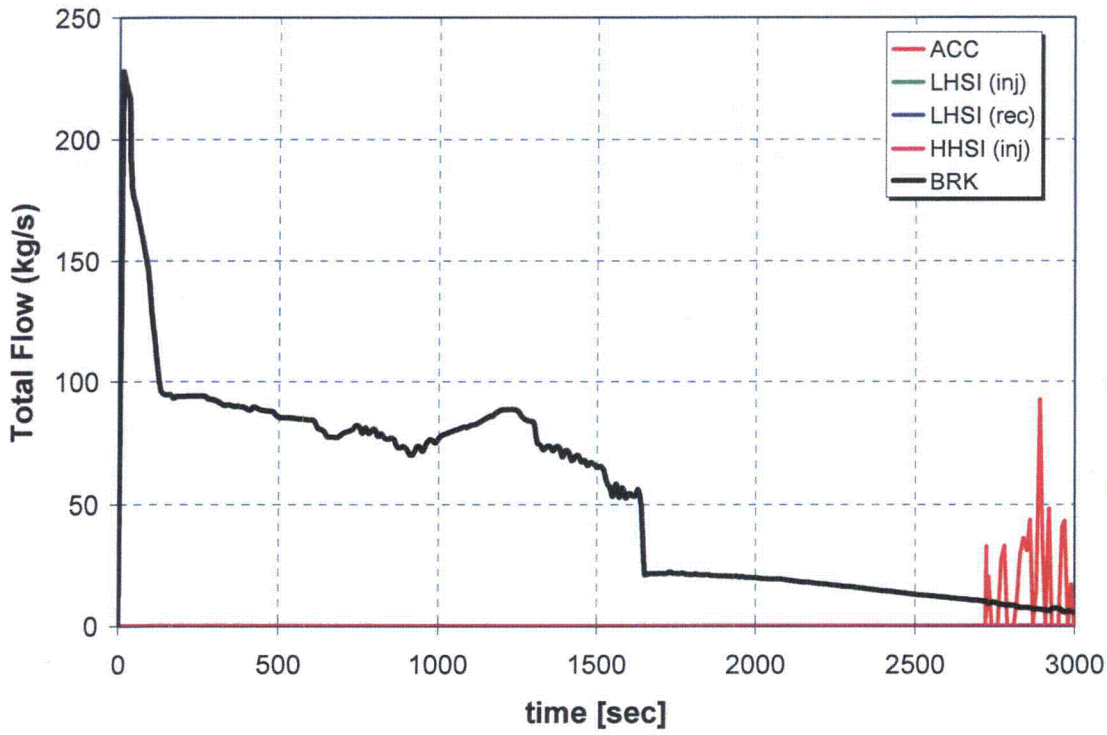

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
time [sec]

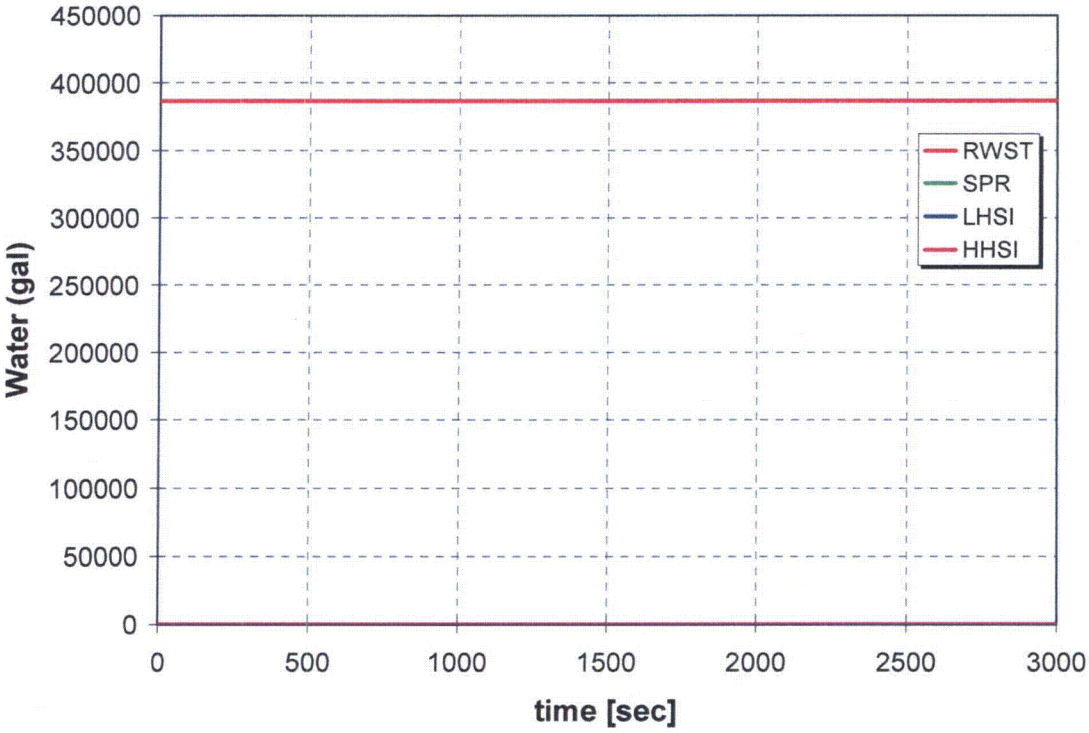

TCL
TFU
2200 F
Maximum Core Temperature [K]
1700
1500
1300
1100
900
700
500
300
0
500
1000
1500
2000
2500
3000
time [sec]

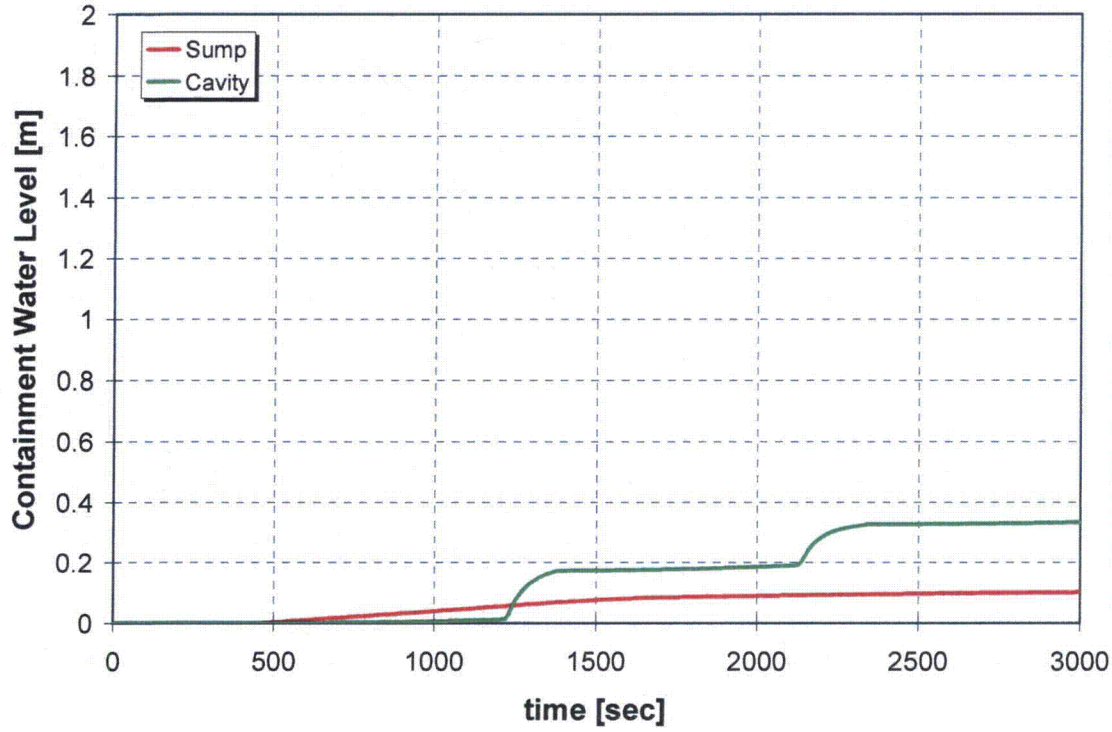
A.6.15 Case 15: 2-Inch Break LOCA, No HHSI, One LHSI, and Two ACC

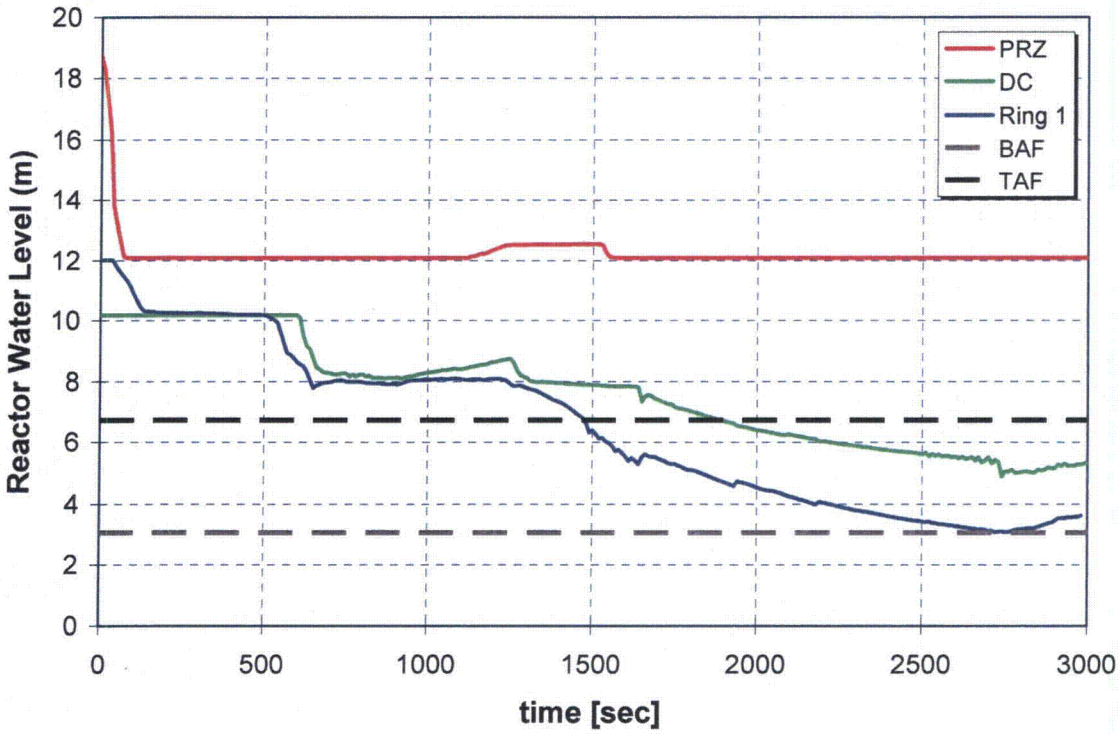


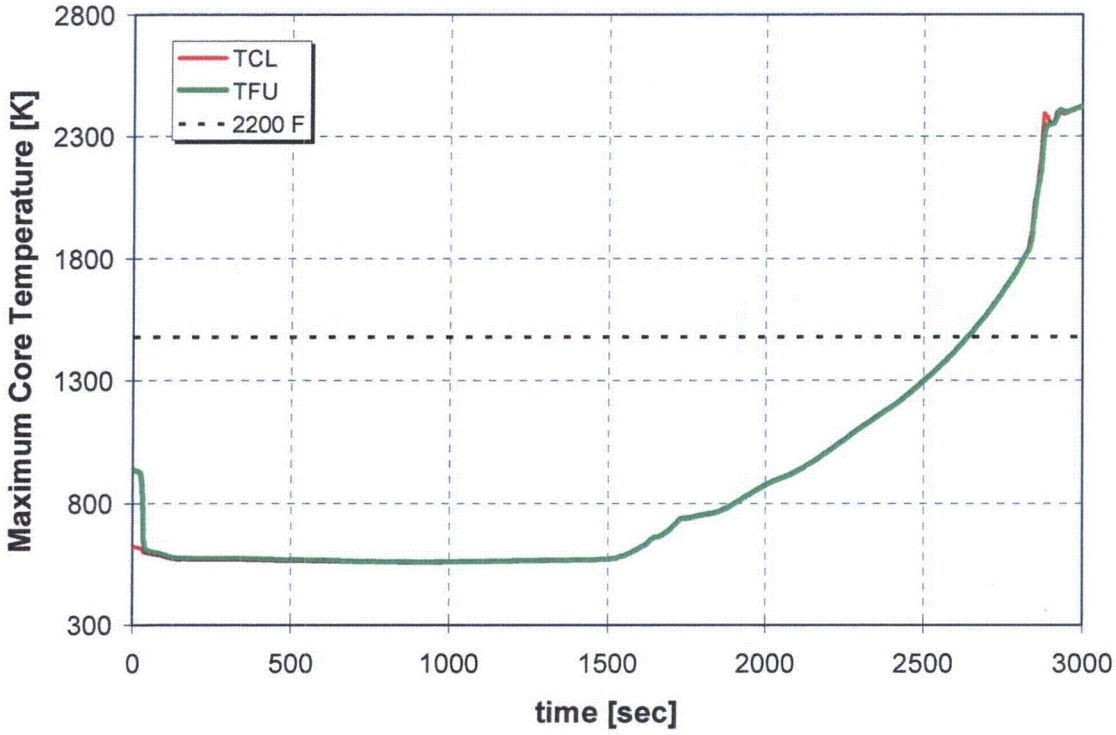



250
200
150
100
50
0
Total Flow (kg/s)
0
500
1000
1500
2000
2500
3000
time [sec]
ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK

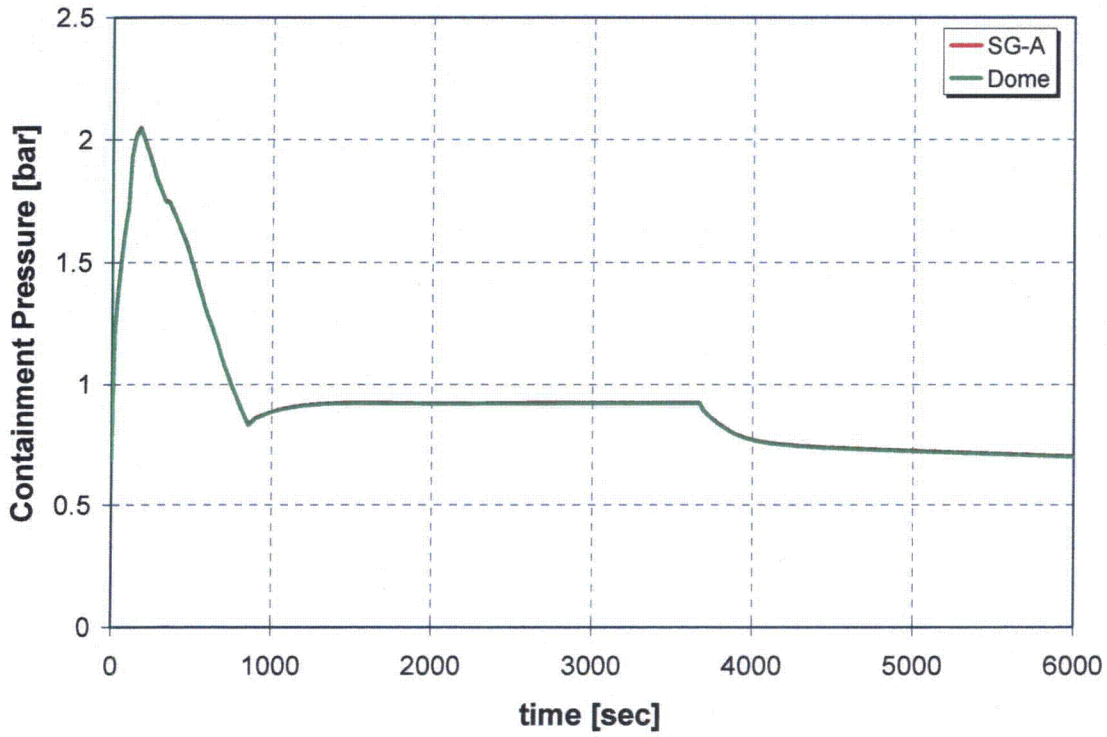

450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Water (gal)
0
500
1000
1500
2000
2500
3000
time [sec]
RWST
SPR
LHSI
HHSI

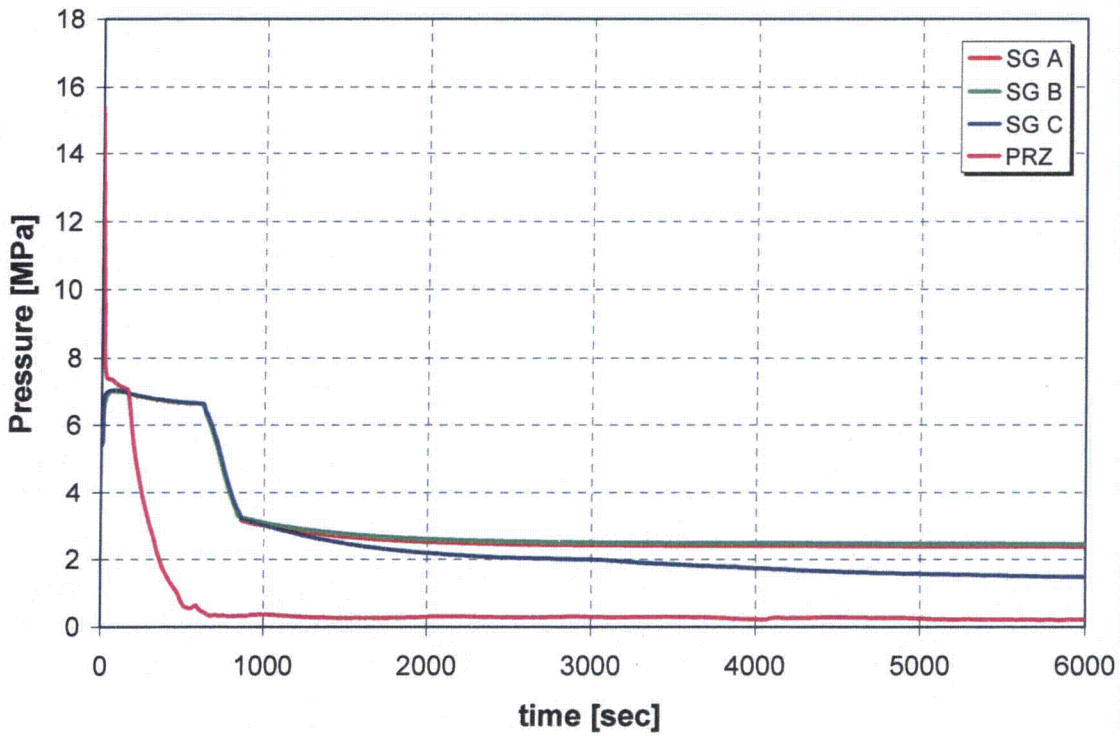

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
time [sec]

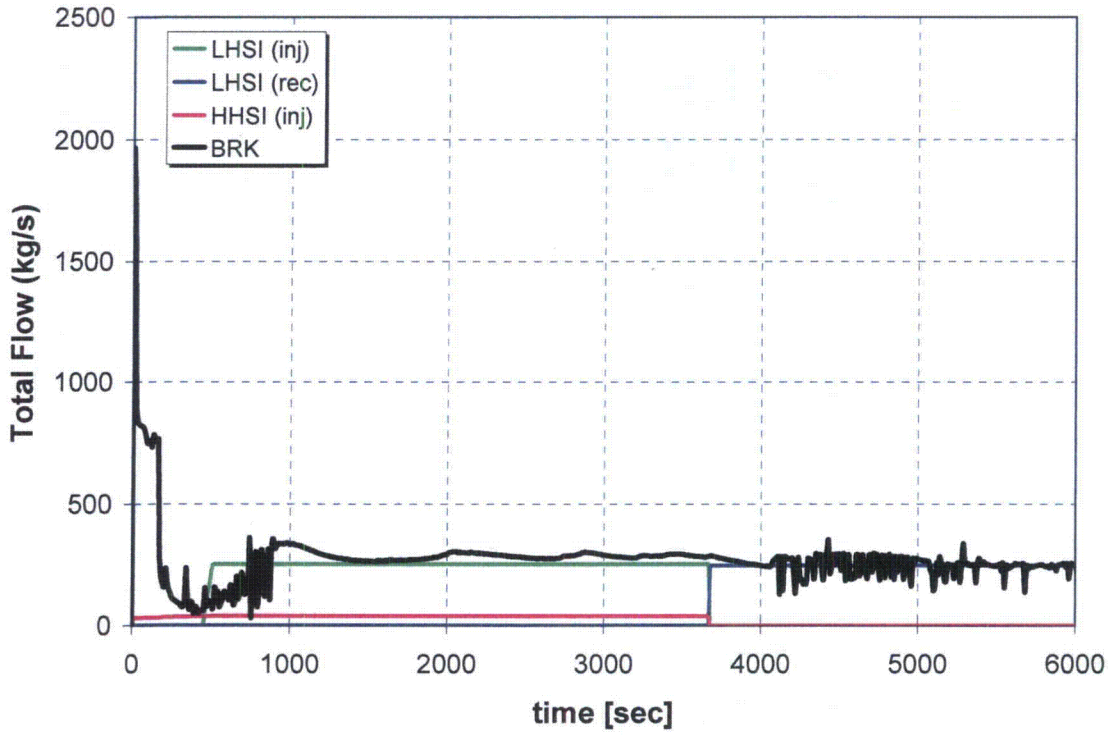

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
time [sec]

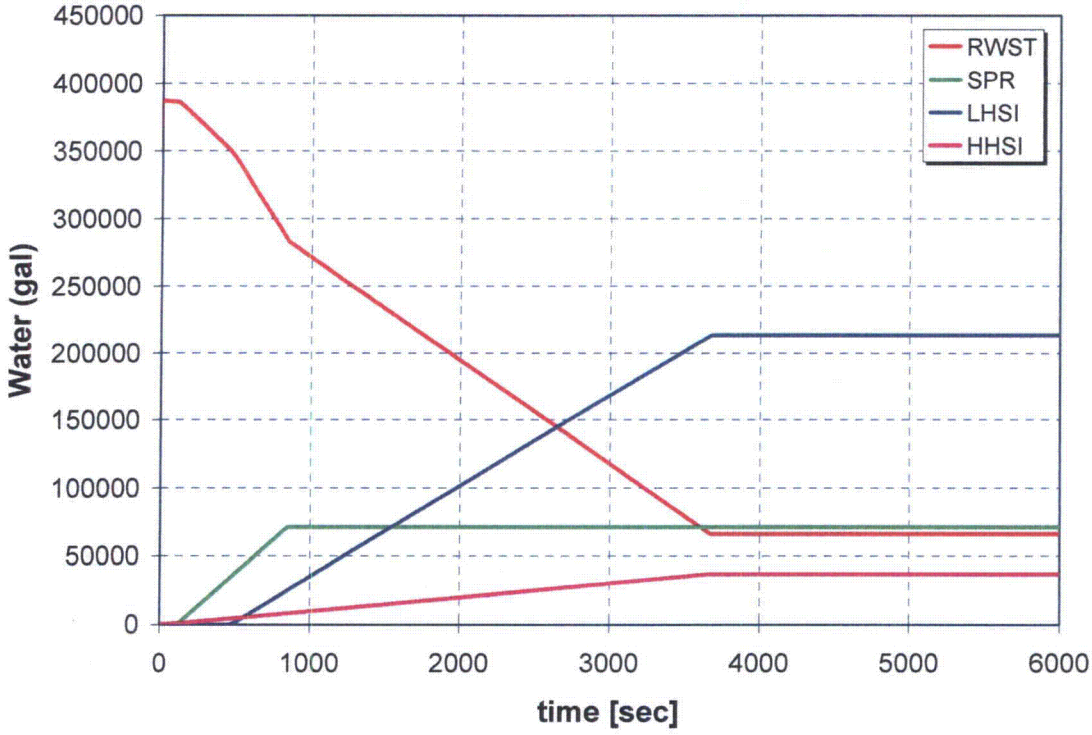

TCL
TFU
2200 F
Maximum Core Temperature [K]
2800
2300
1800
1300
800
300
0
500
1000
1500
2000
2500
3000
time [sec]

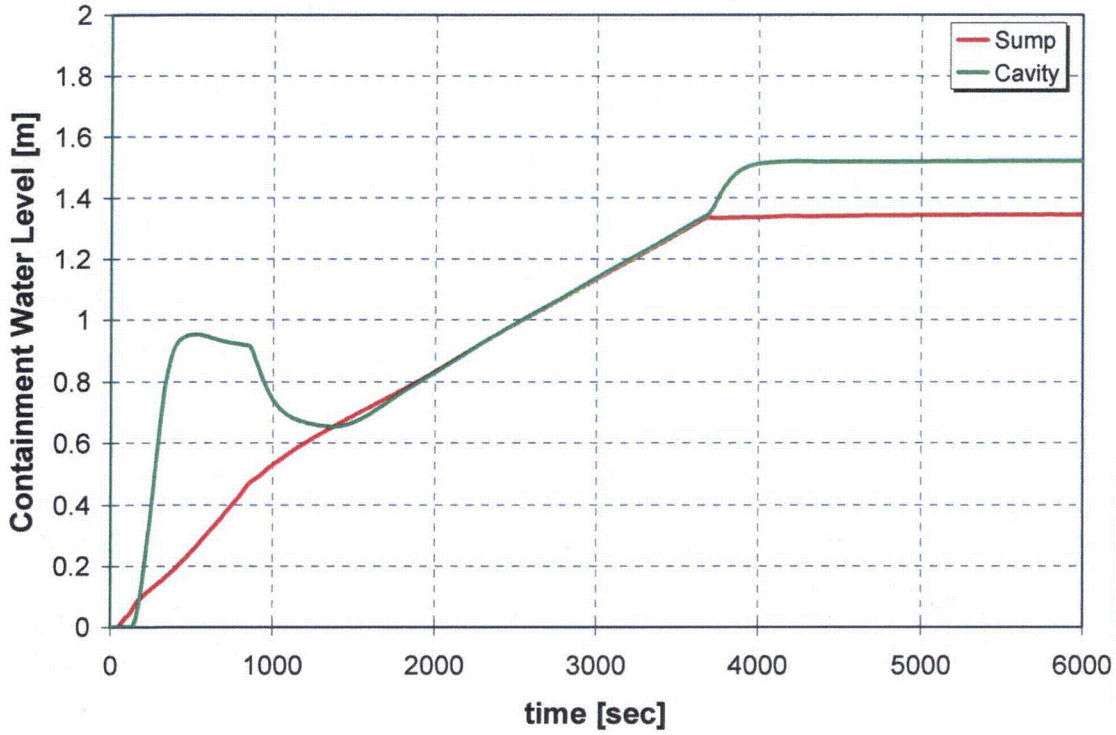
A.6.16 Case 16: 6-Inch Break LOCA, One HHSI, One LHSI, and No ACC, without Auxiliary Feedwater

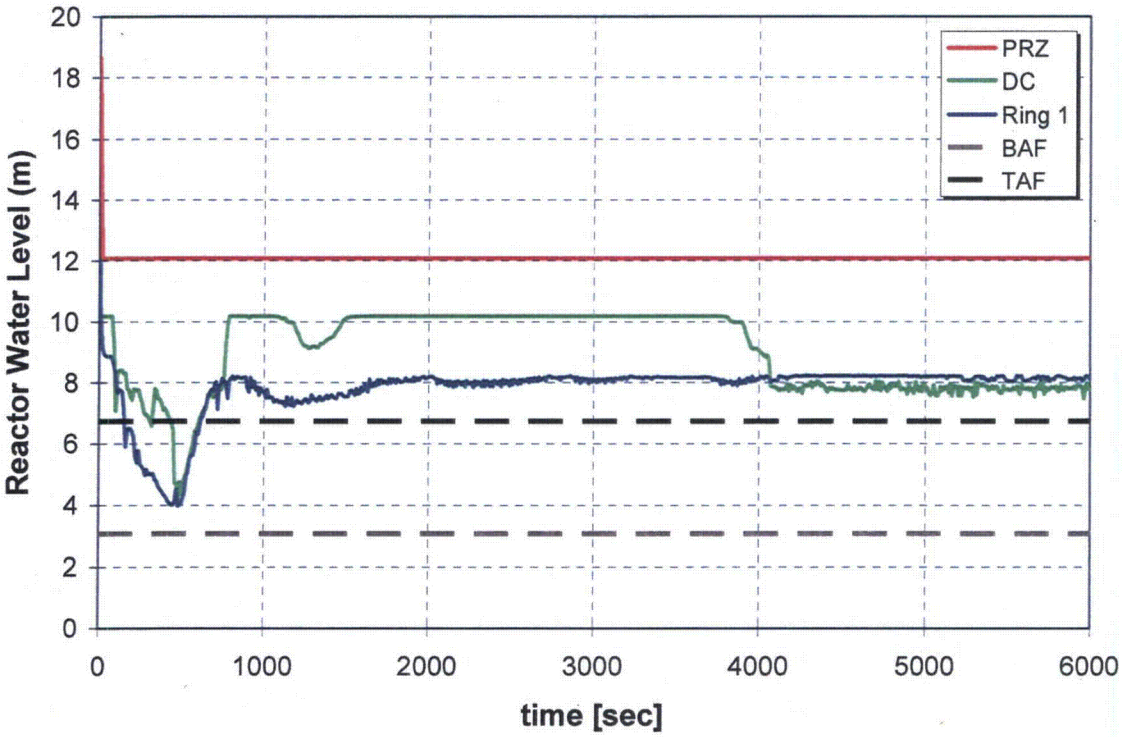


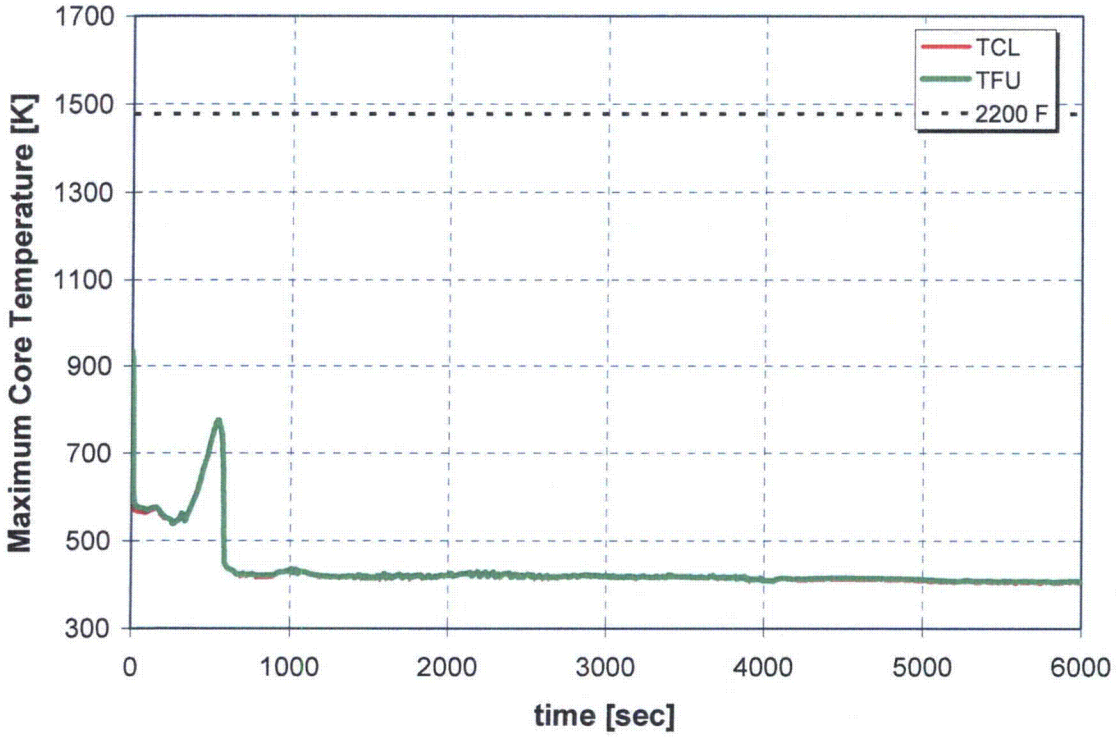



LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
6000
time [sec]

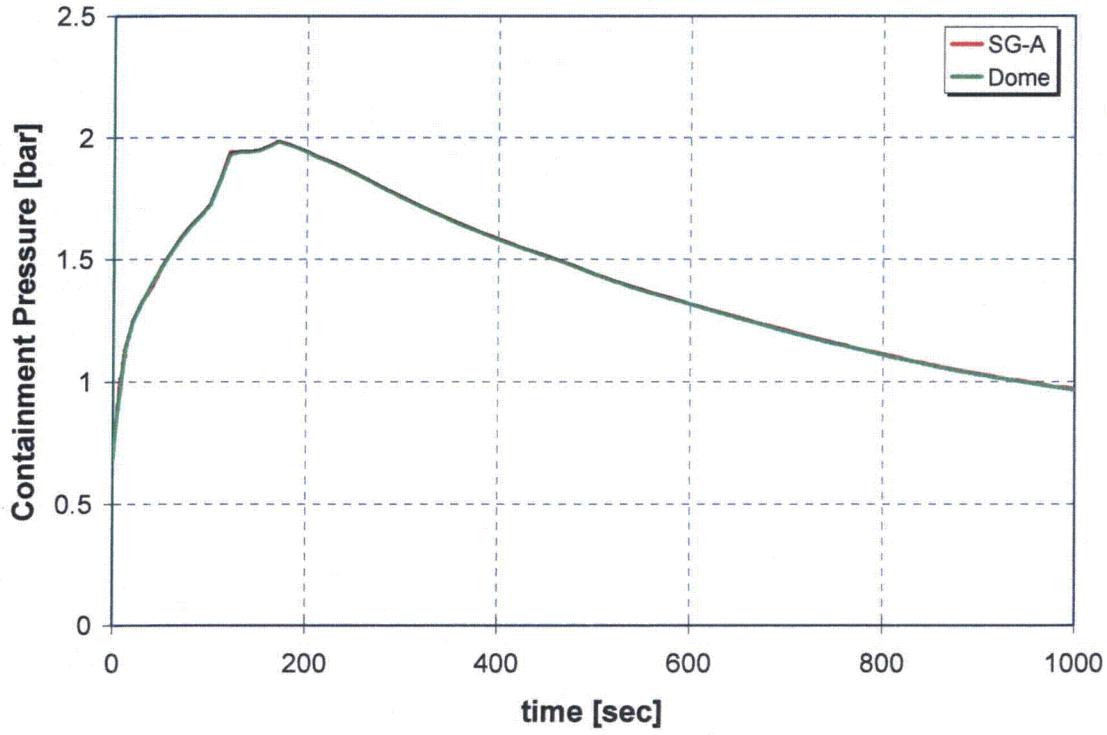

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
1000
2000
3000
4000
5000
6000
time [sec]

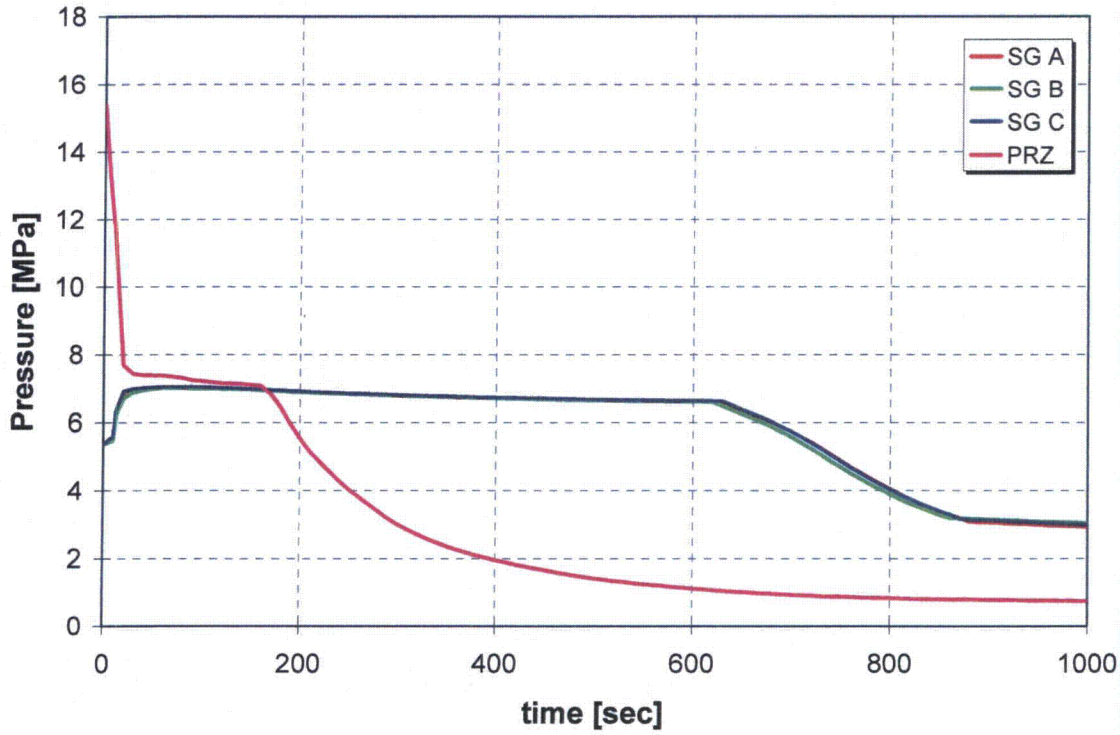

Containment Water Level [m]
time [sec]
Sump
Cavity
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
1000
2000
3000
4000
5000
6000

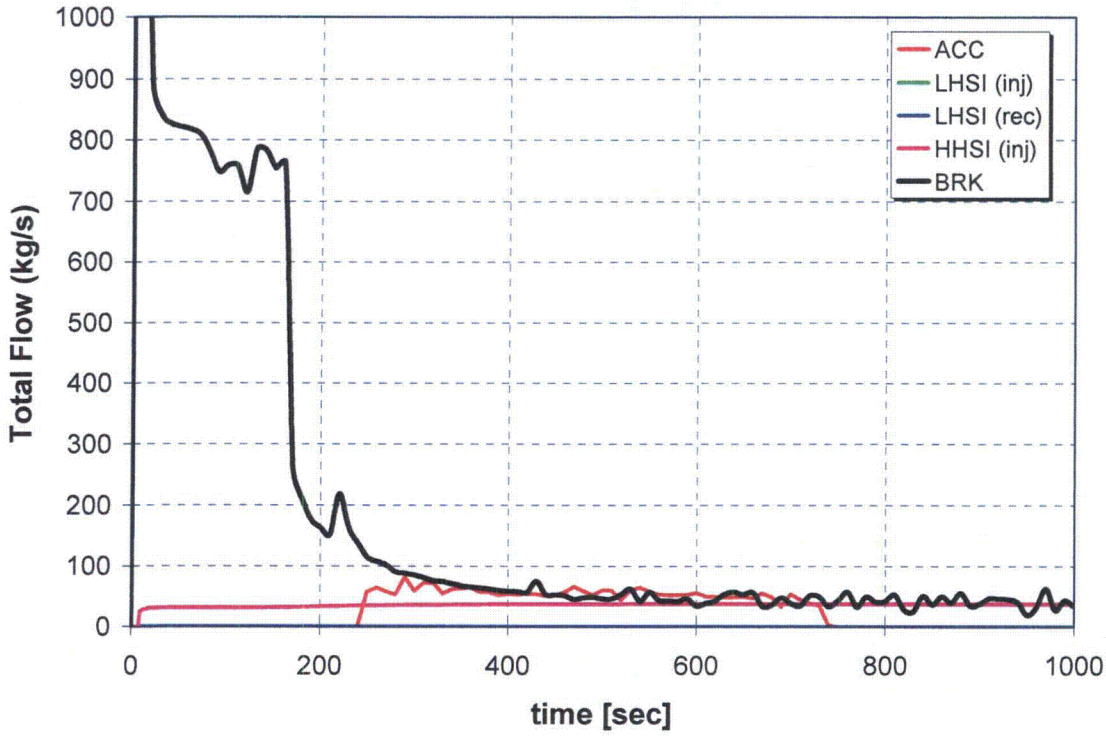

Reactor Water Level (m)
time [sec]
PRZ
DC
Ring 1
BAF
TAF
0
2
4
6
8
10
12
14
16
18
20
0
1000
2000
3000
4000
5000
6000

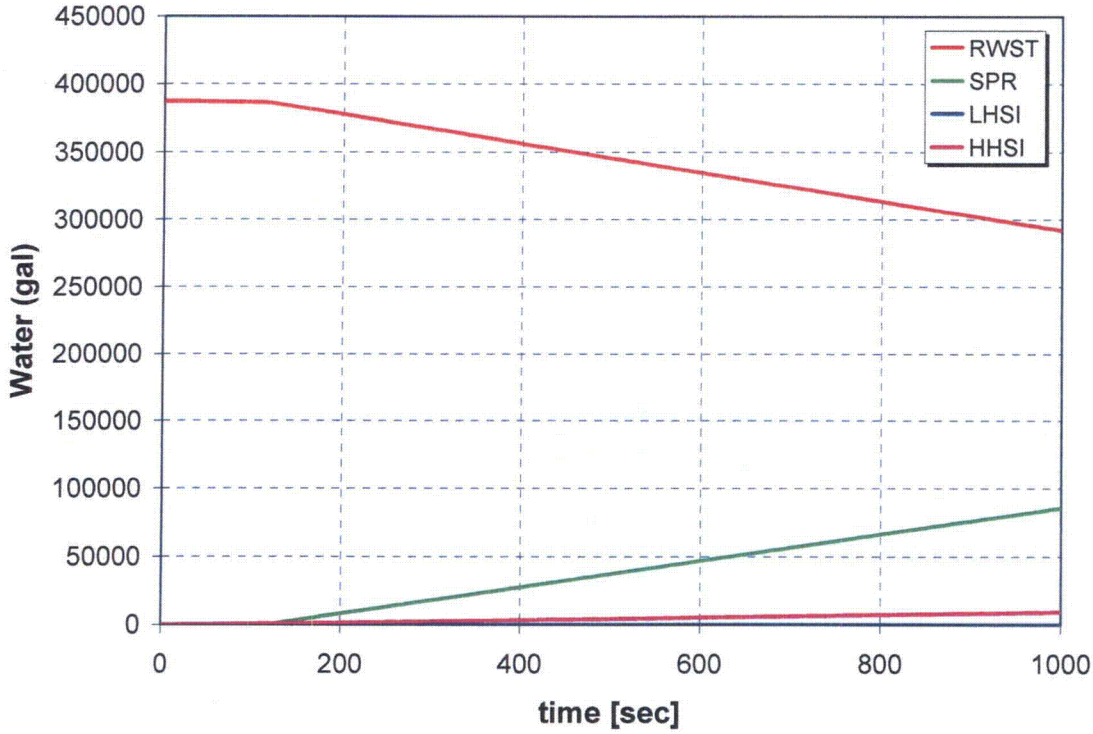

1700
1500
1300
1100
900
700
500
300
Maximum Core Temperature [K]
0
1000
2000
3000
4000
5000
6000
time [sec]
TCL
TFU
2200 F

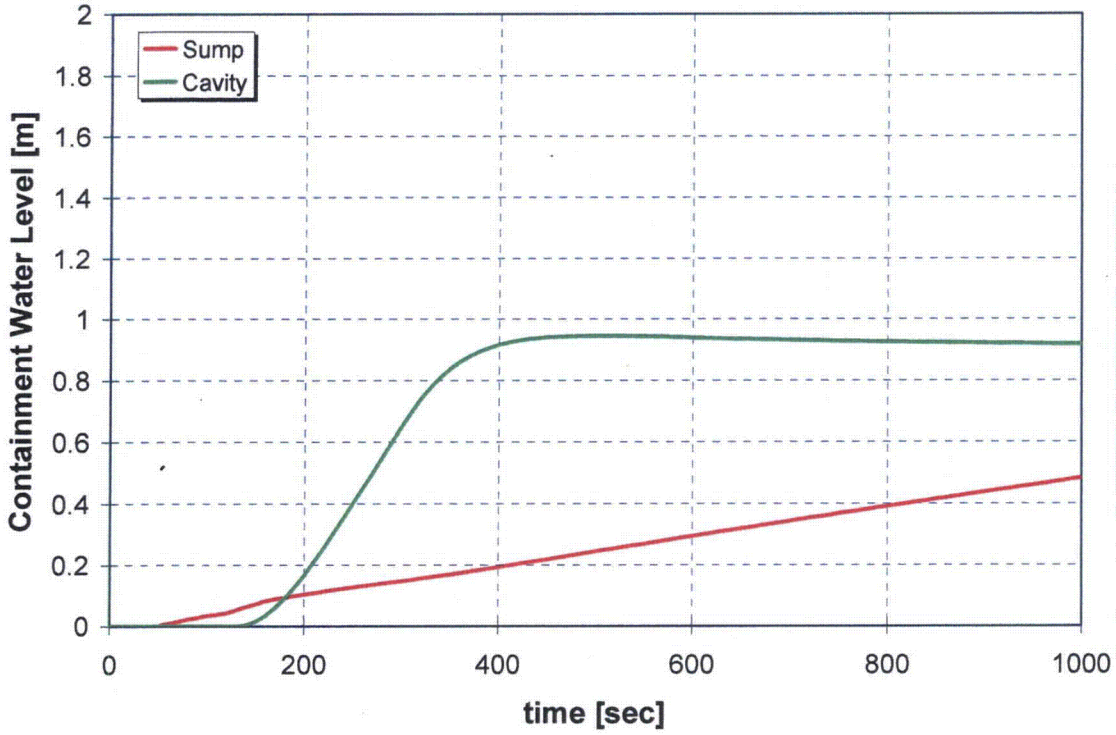
A.6.17 Case 17: 6-Inch Break LOCA, One HHSI, No LHSI, and One ACC, without Auxiliary Feedwater

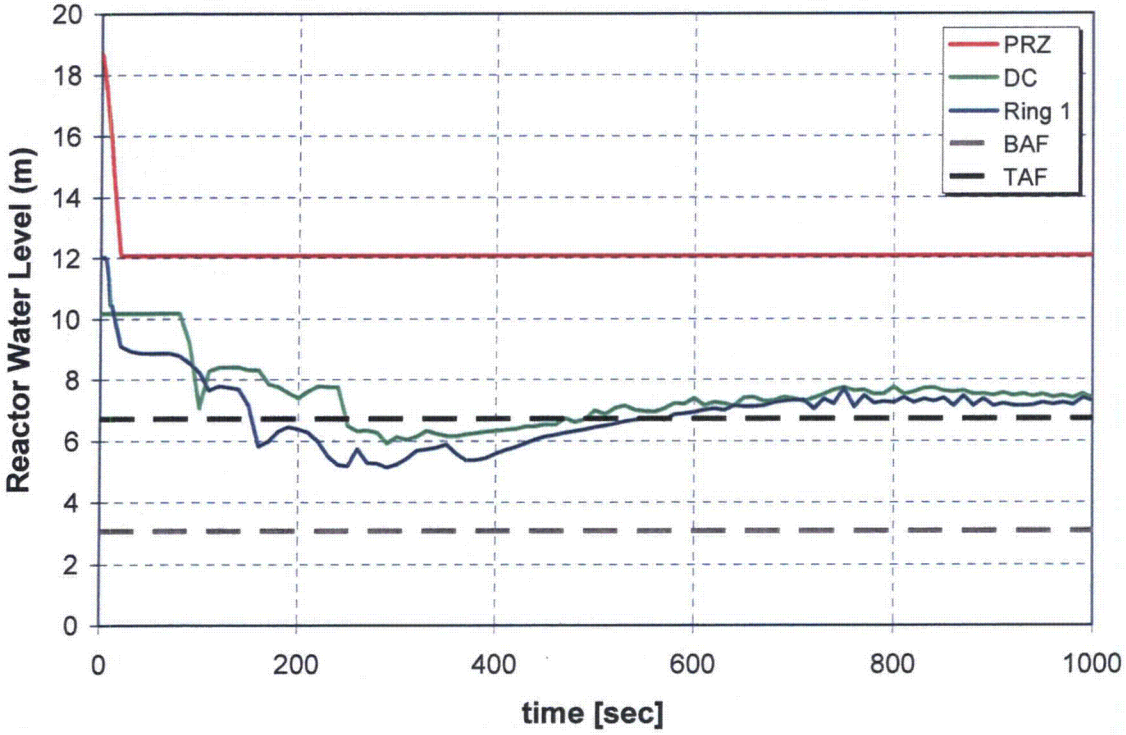


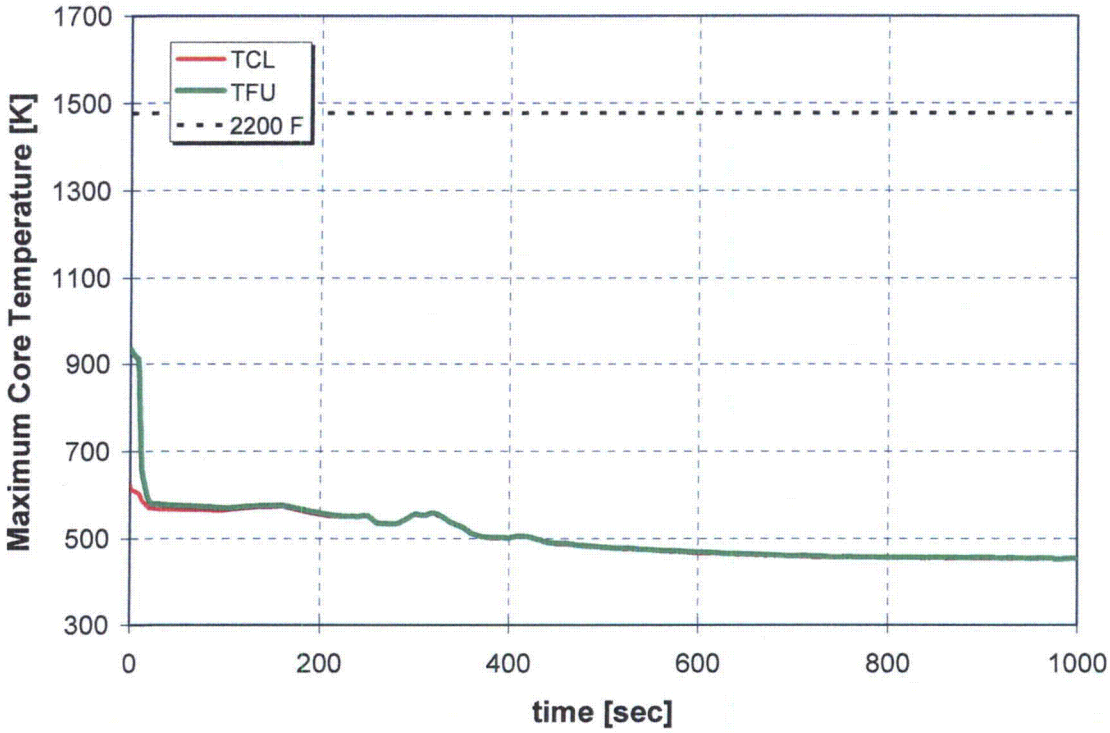



Total Flow (kg/s)
1000
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
time [sec]
ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK

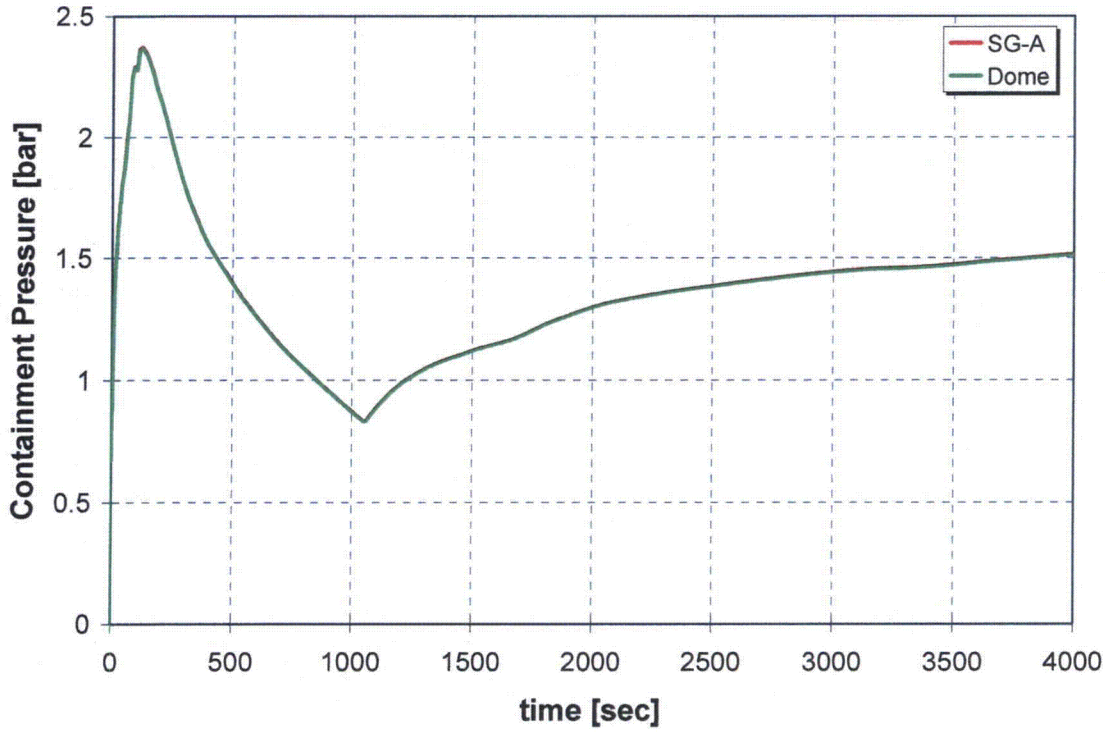

Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
200
400
600
800
1000
time [sec]
RWST
SPR
LHSI
HHSI

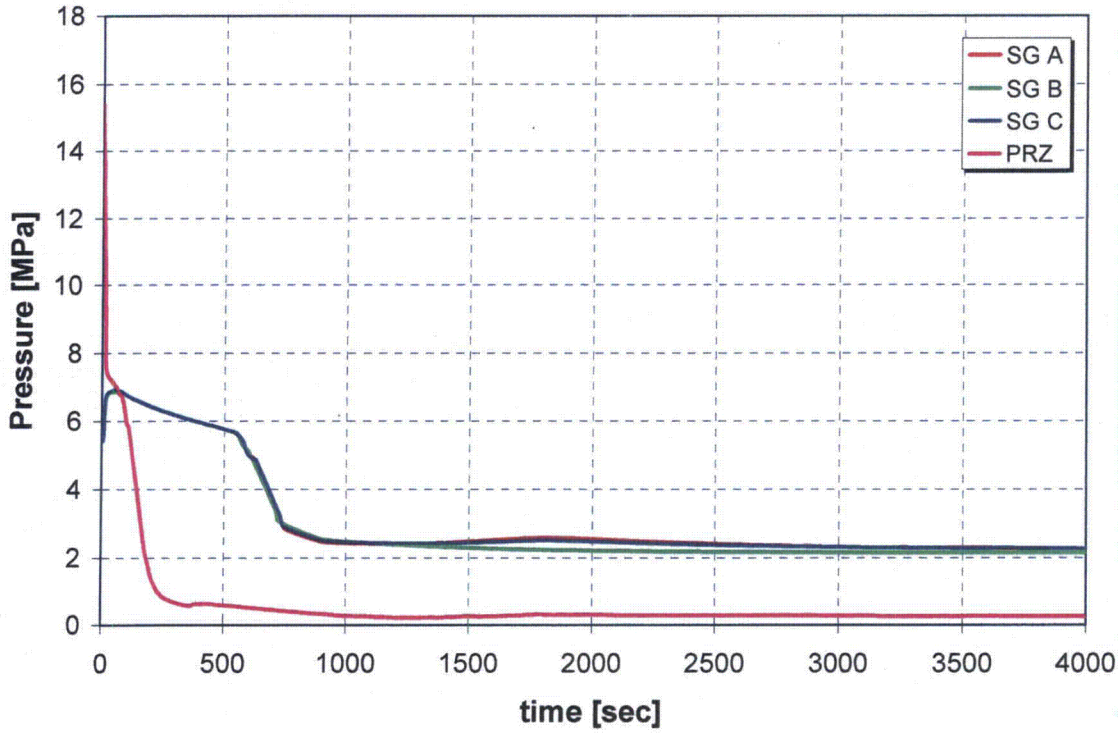

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
200
400
600
800
1000
time [sec]

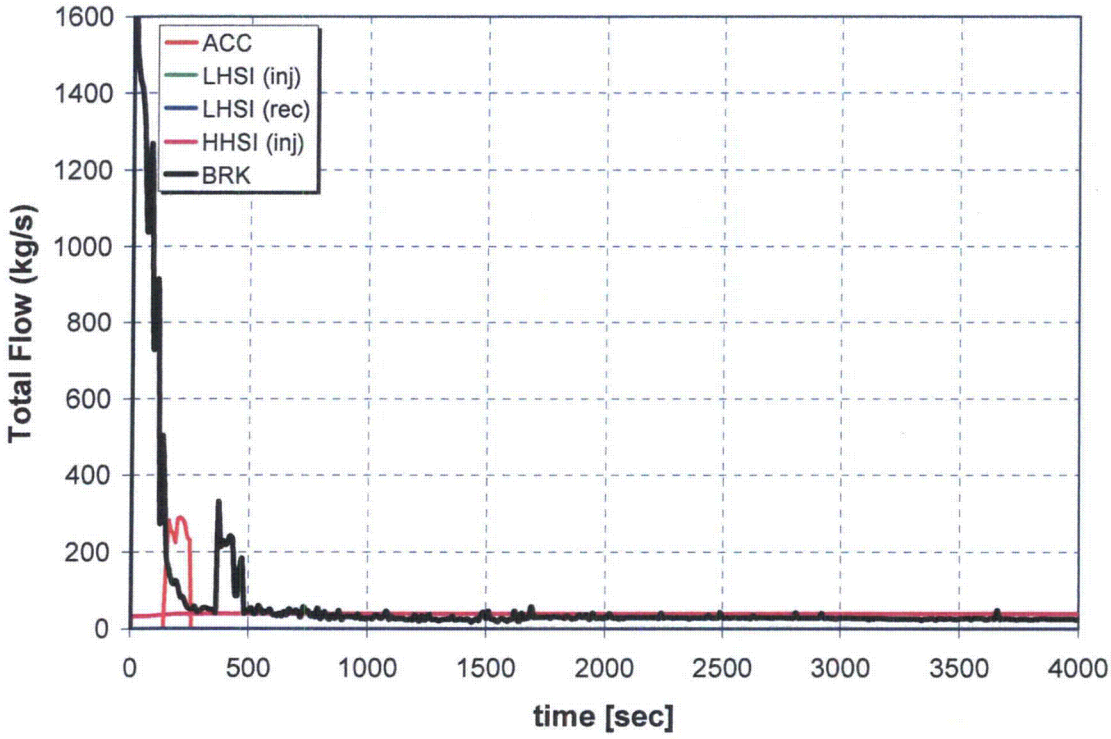

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
200
400
600
800
1000
time [sec]

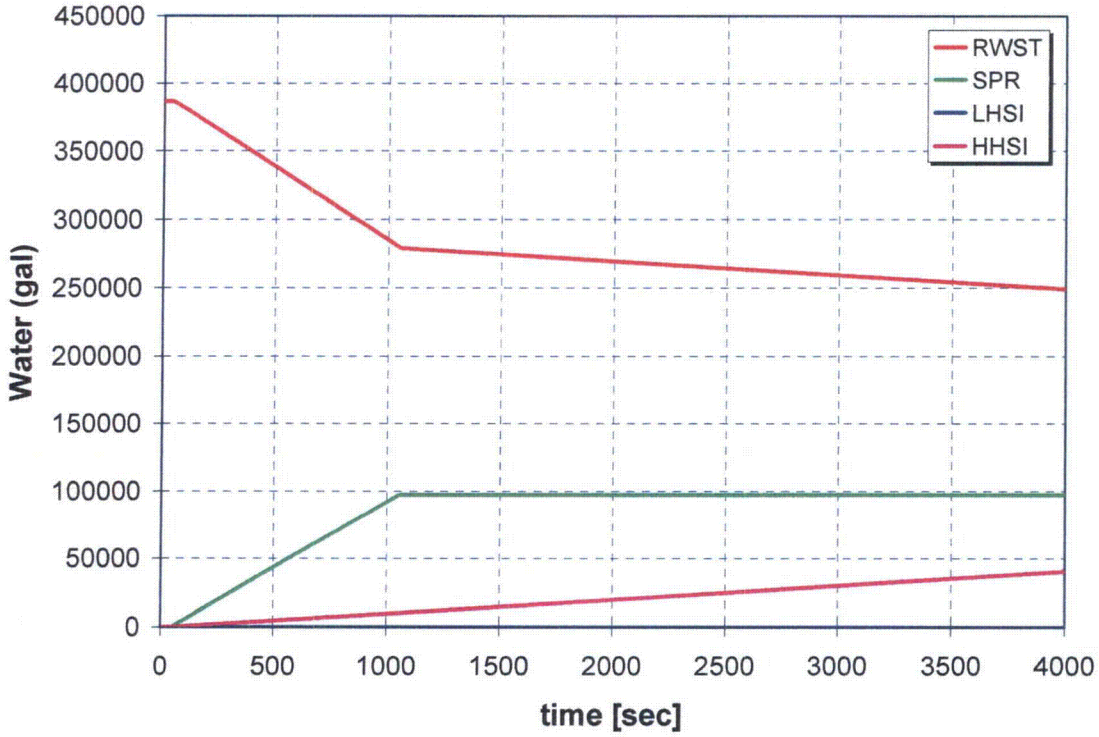

1700
1500
1300
1100
900
700
500
300
Maximum Core Temperature [K]
TCL
TFU
2200 F
0
200
400
600
800
1000
time [sec]

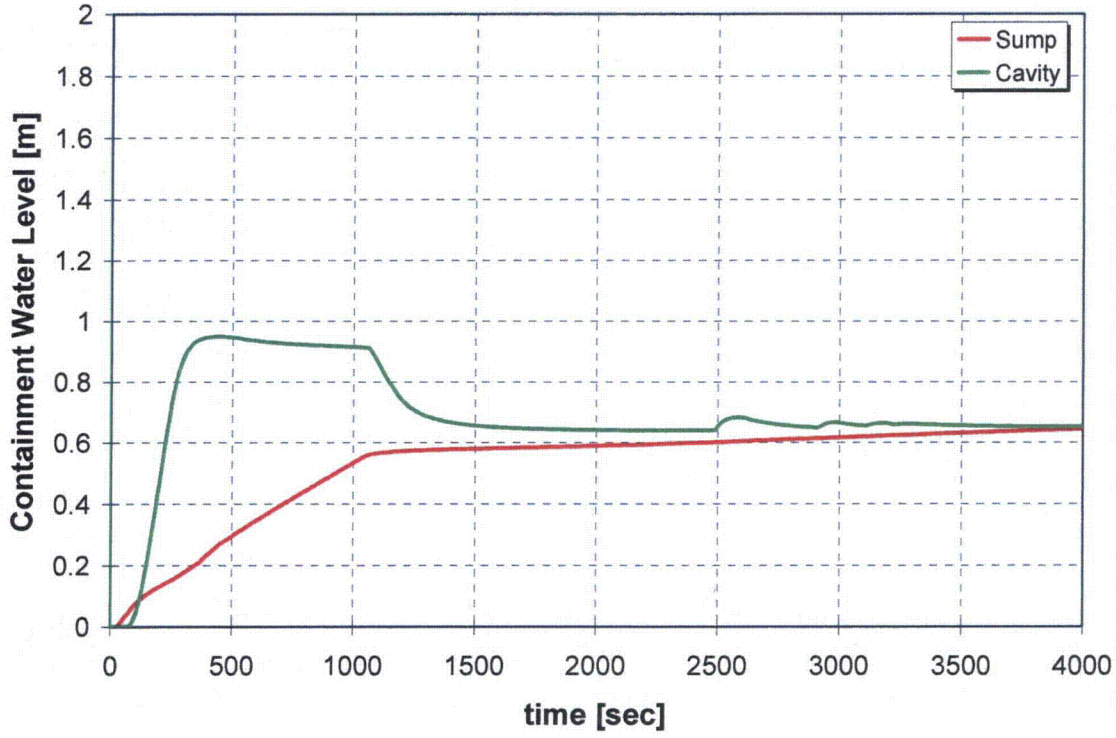
A.6.18 Case 18: 8-Inch Break LOCA, One HHSI, No LHSI, and One ACC

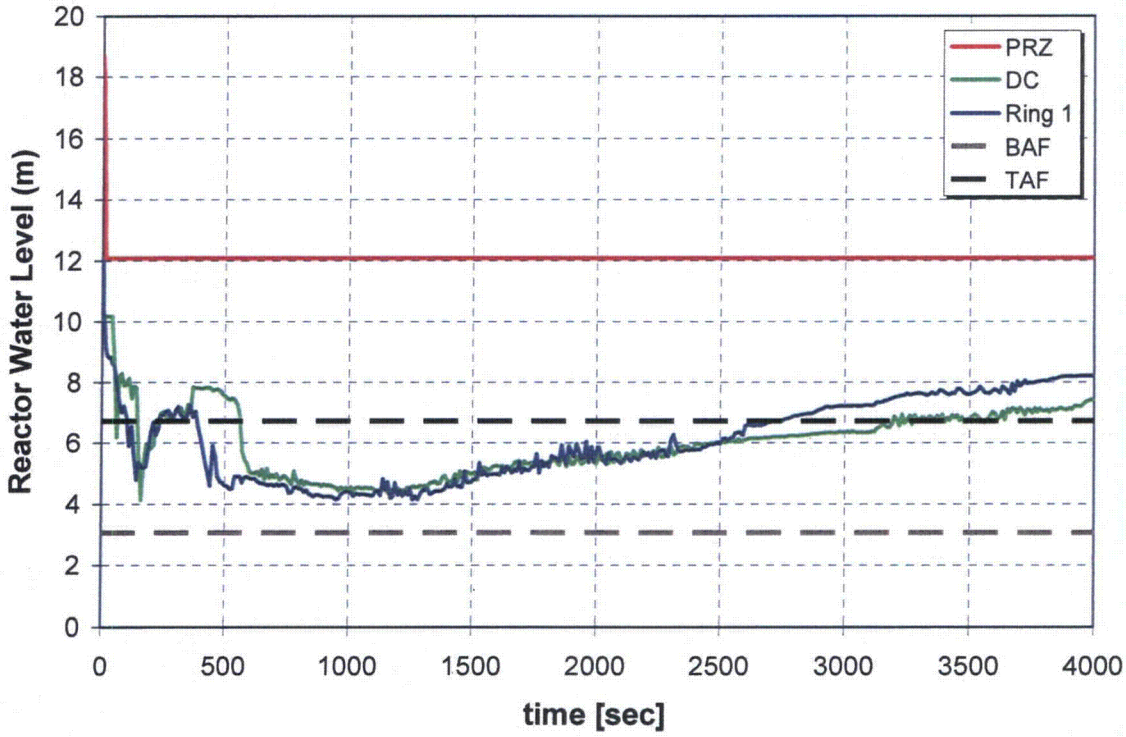


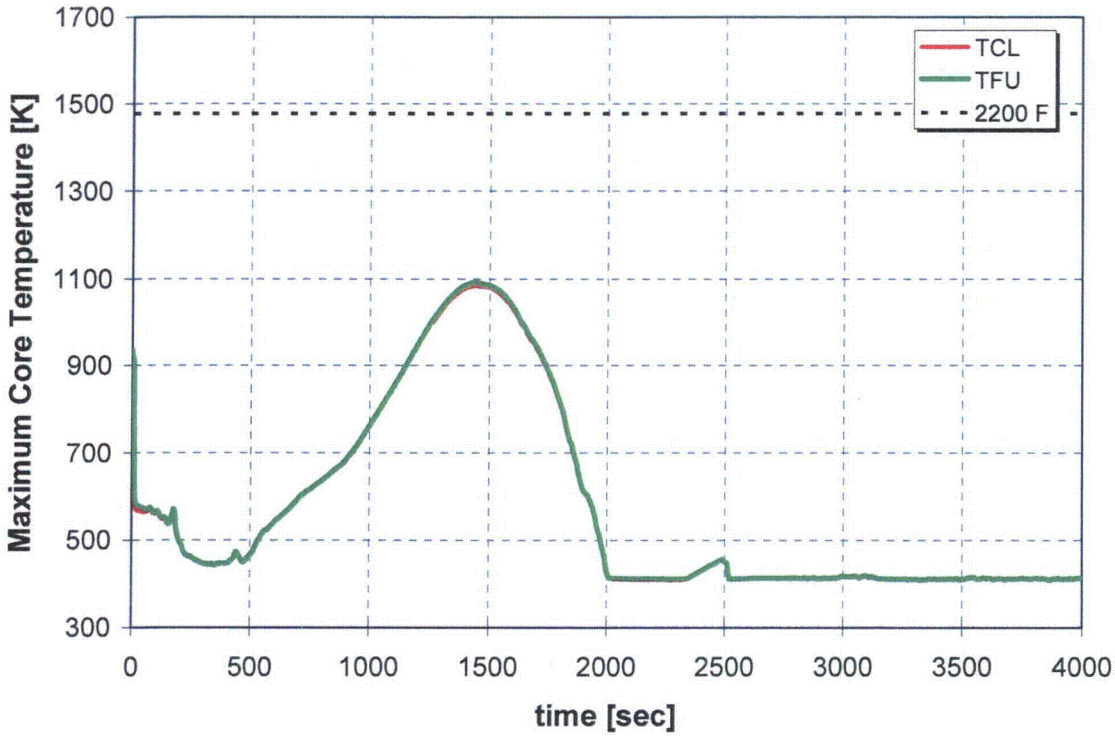



ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

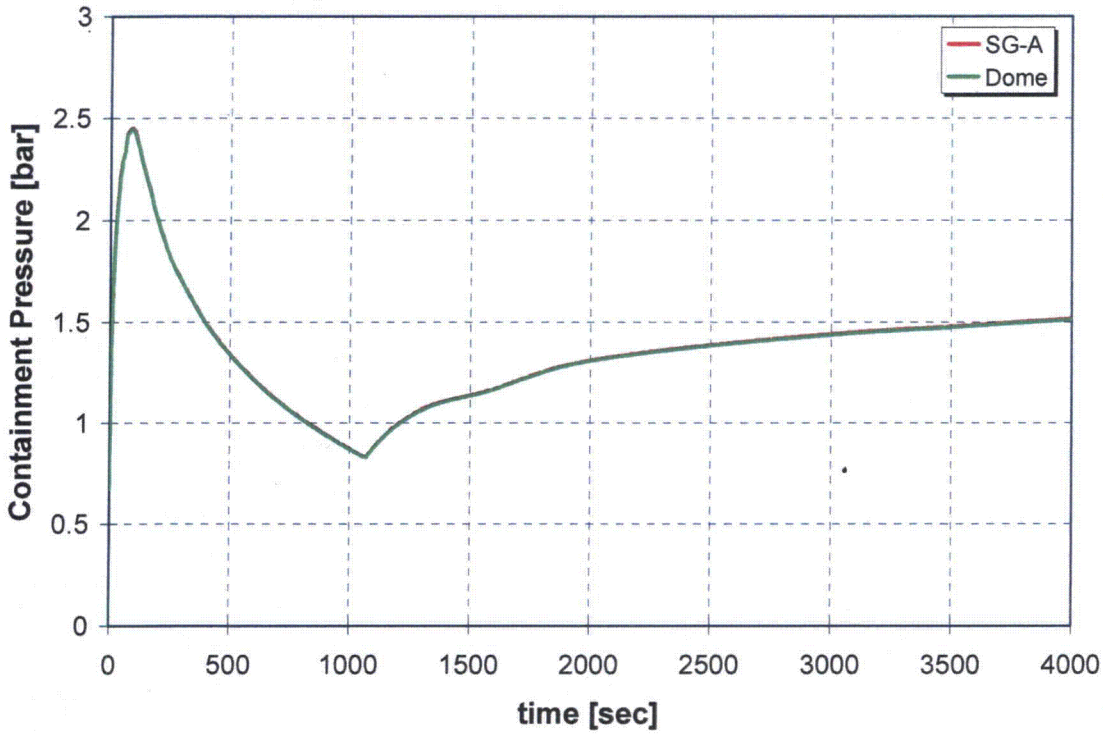

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

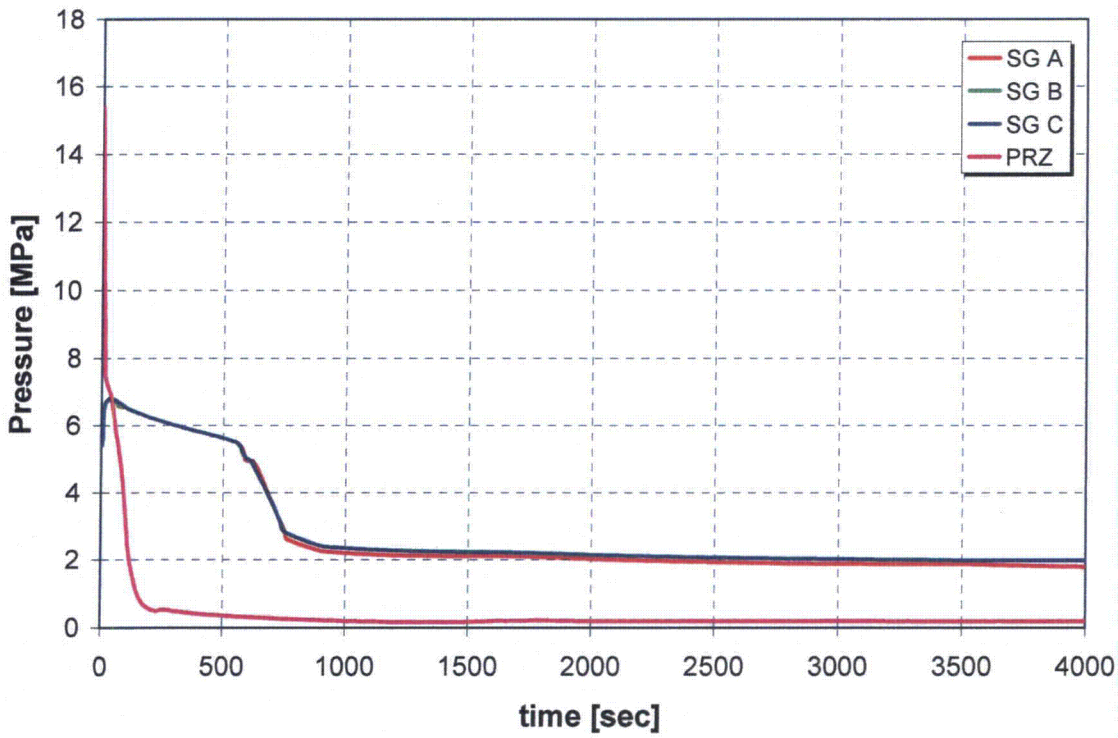

Containment Water Level [m]
time [sec]
Sump
Cavity
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
500
1000
1500
2000
2500
3000
3500
4000

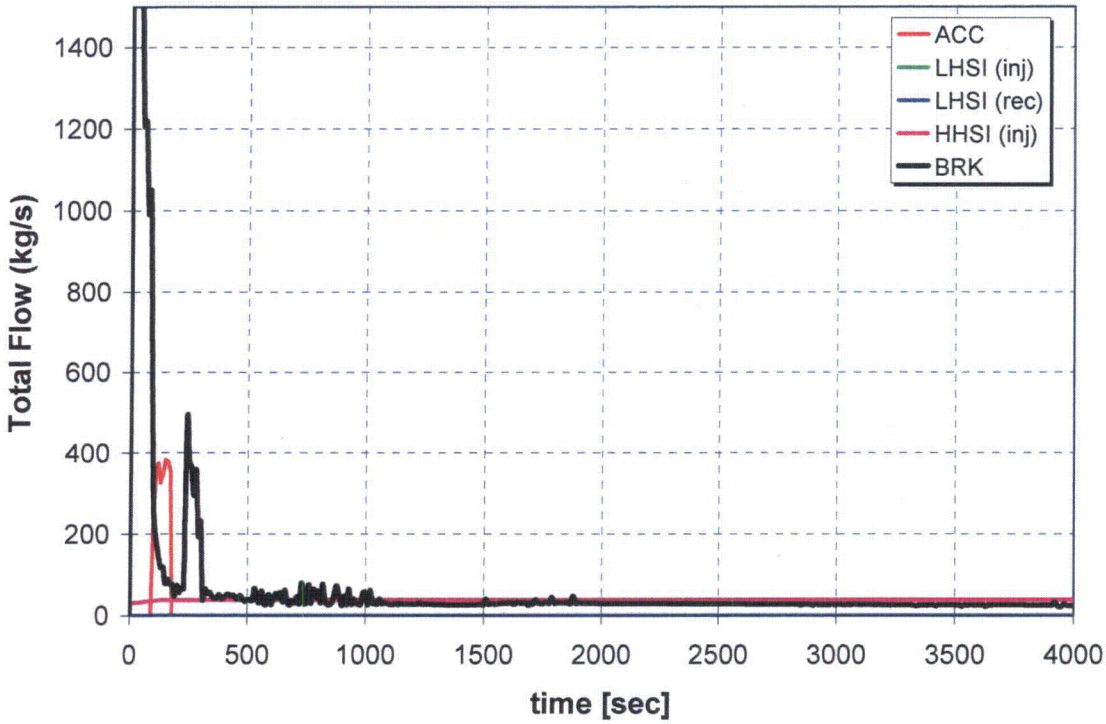

Reactor Water Level (m)
time [sec]
PRZ
DC
Ring 1
BAF
TAF
0
2
4
6
8
10
12
14
16
18
20
0
500
1000
1500
2000
2500
3000
3500
4000

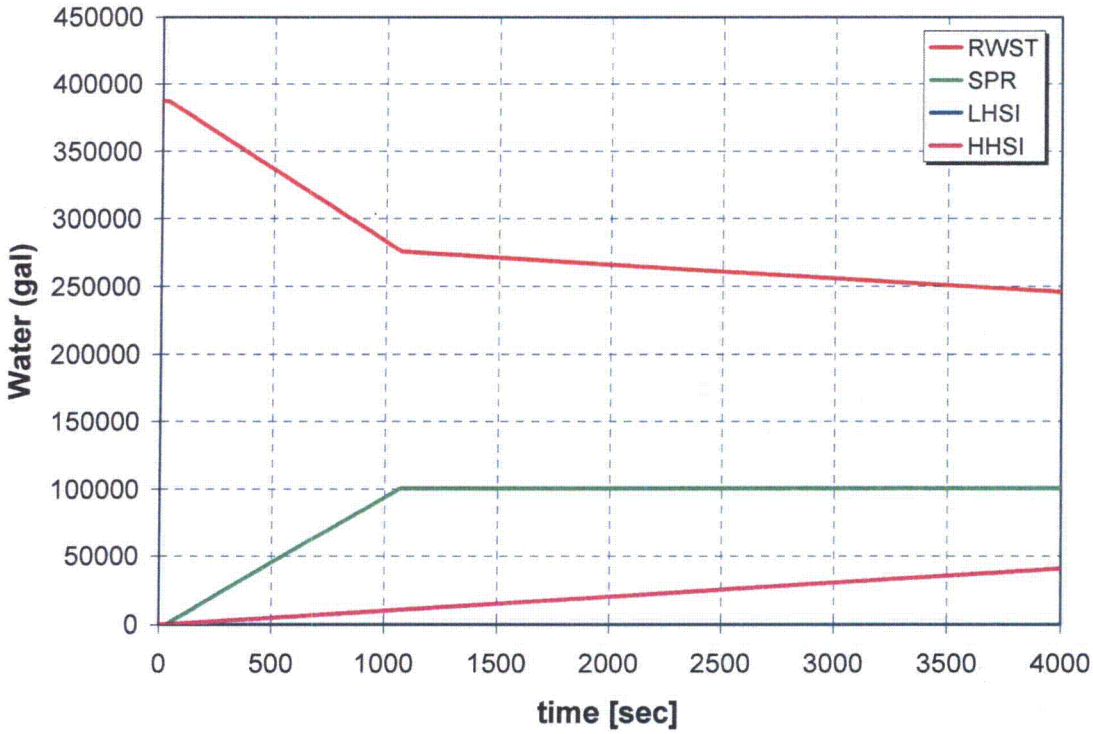

Maximum Core Temperature [K]
1700
1500
1300
1100
900
700
500
300
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
TCL
TFU
2200 F

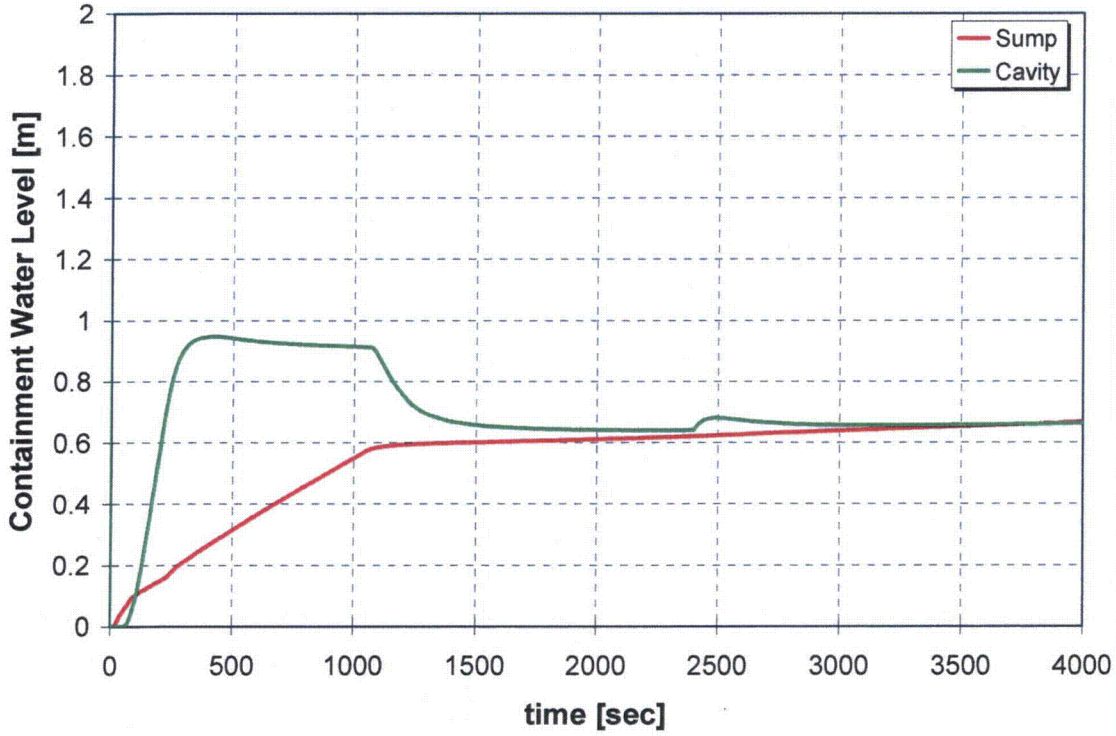
A.6.19 Case 19: 10-Inch Break LOCA, One HHSI, No LHSI, and One ACC

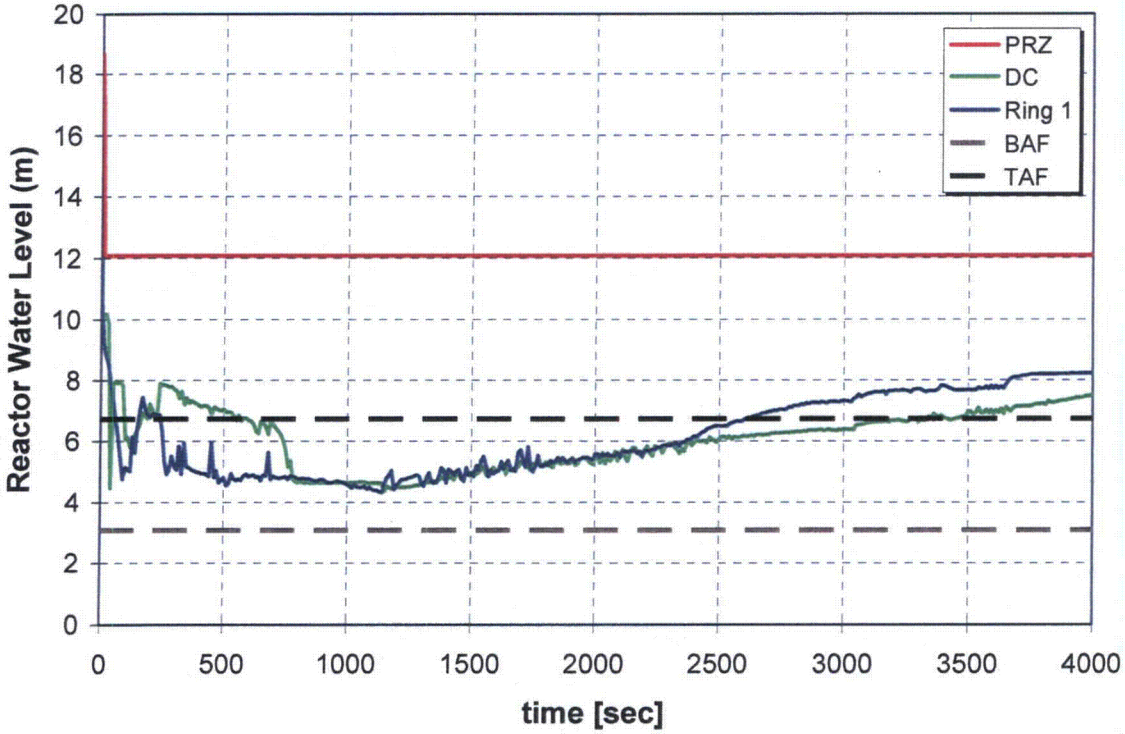


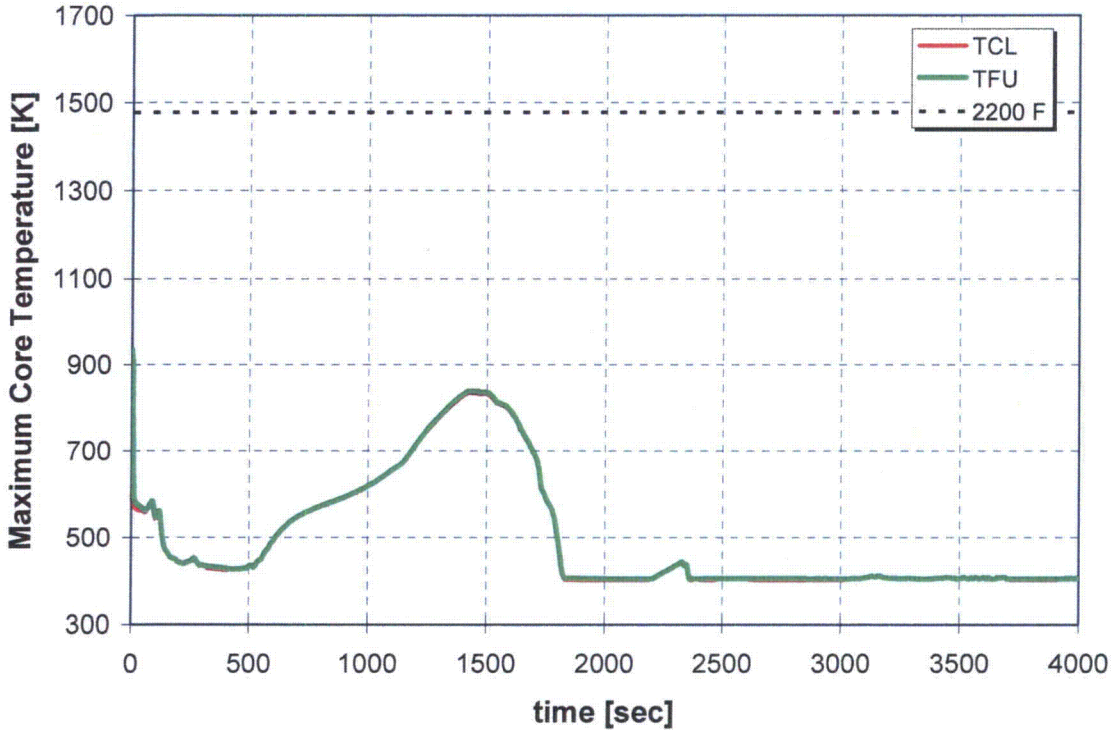



ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

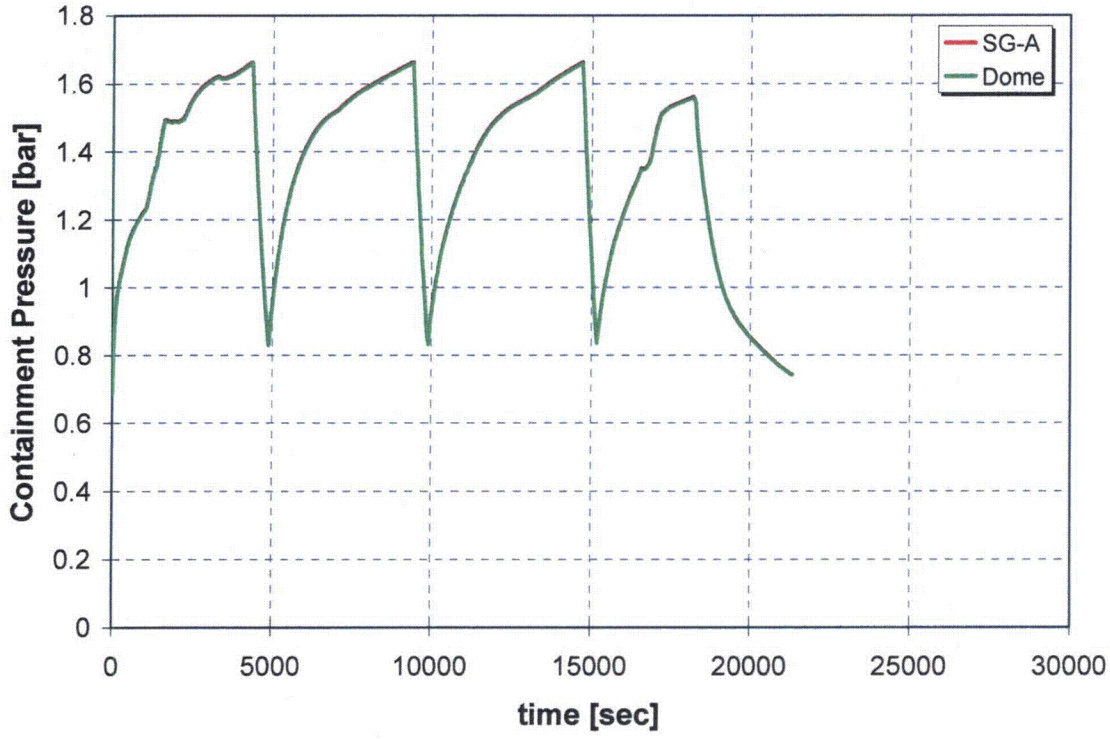

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

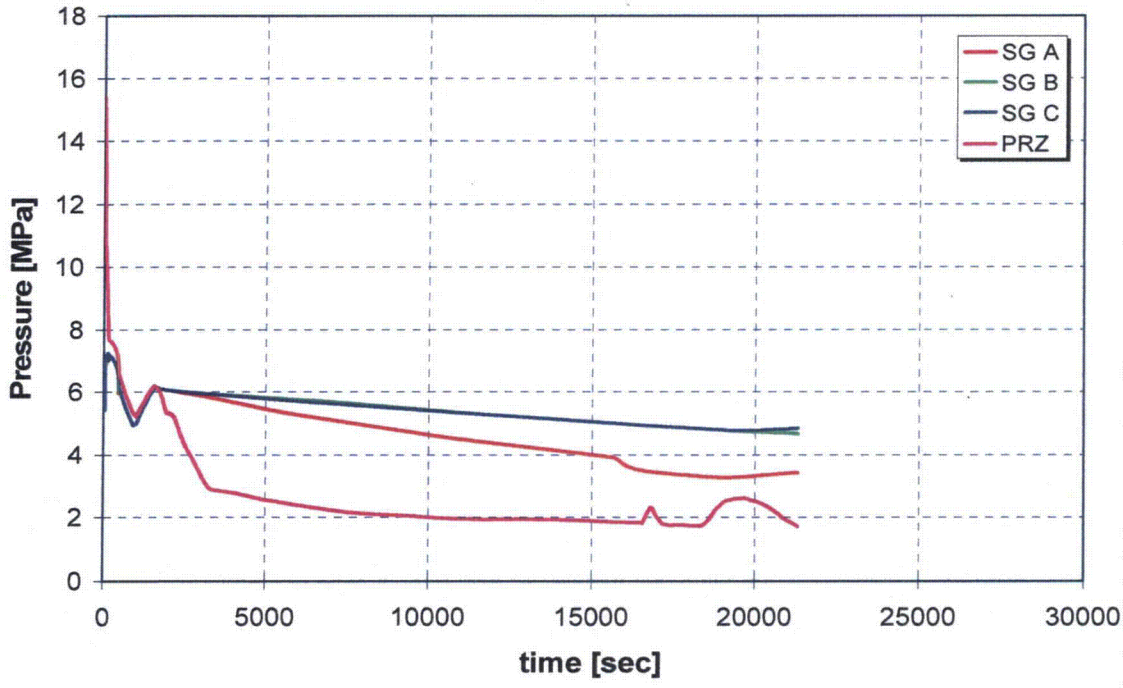

Containment Water Level [m]
time [sec]
Sump
Cavity
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
500
1000
1500
2000
2500
3000
3500
4000

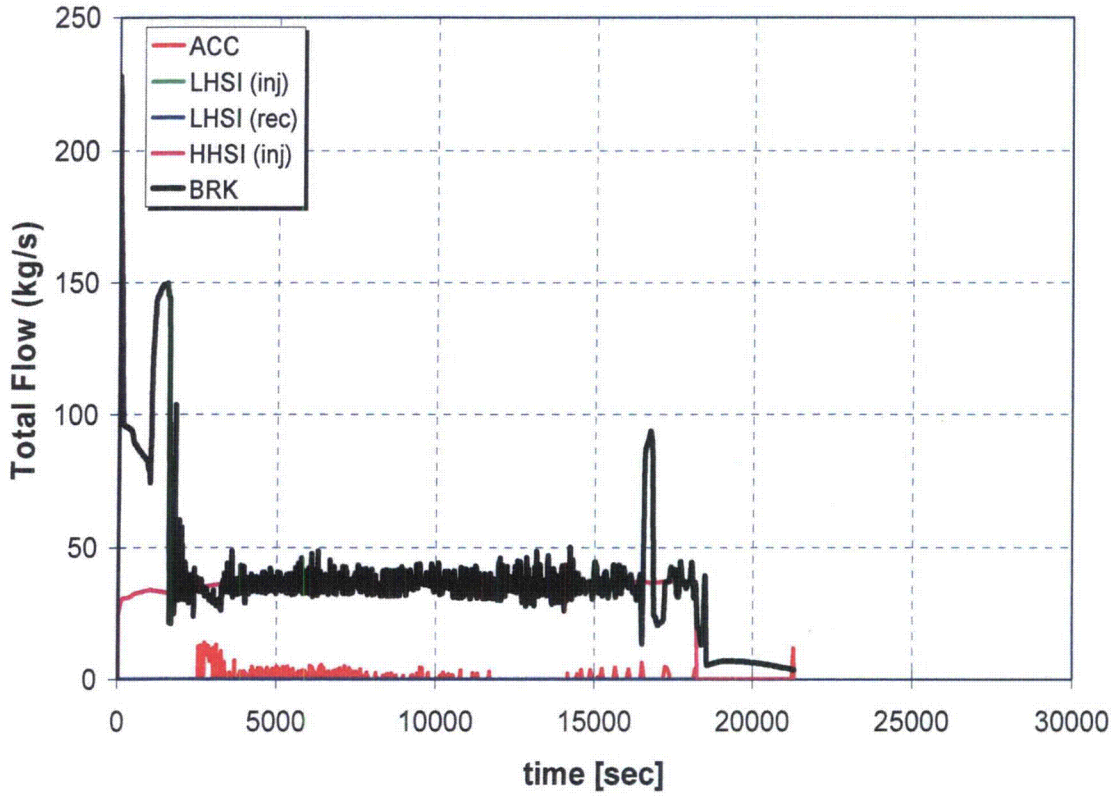

Reactor Water Level (m)
time [sec]
PRZ
DC
Ring 1
BAF
TAF
0
2
4
6
8
10
12
14
16
18
20
0
500
1000
1500
2000
2500
3000
3500
4000

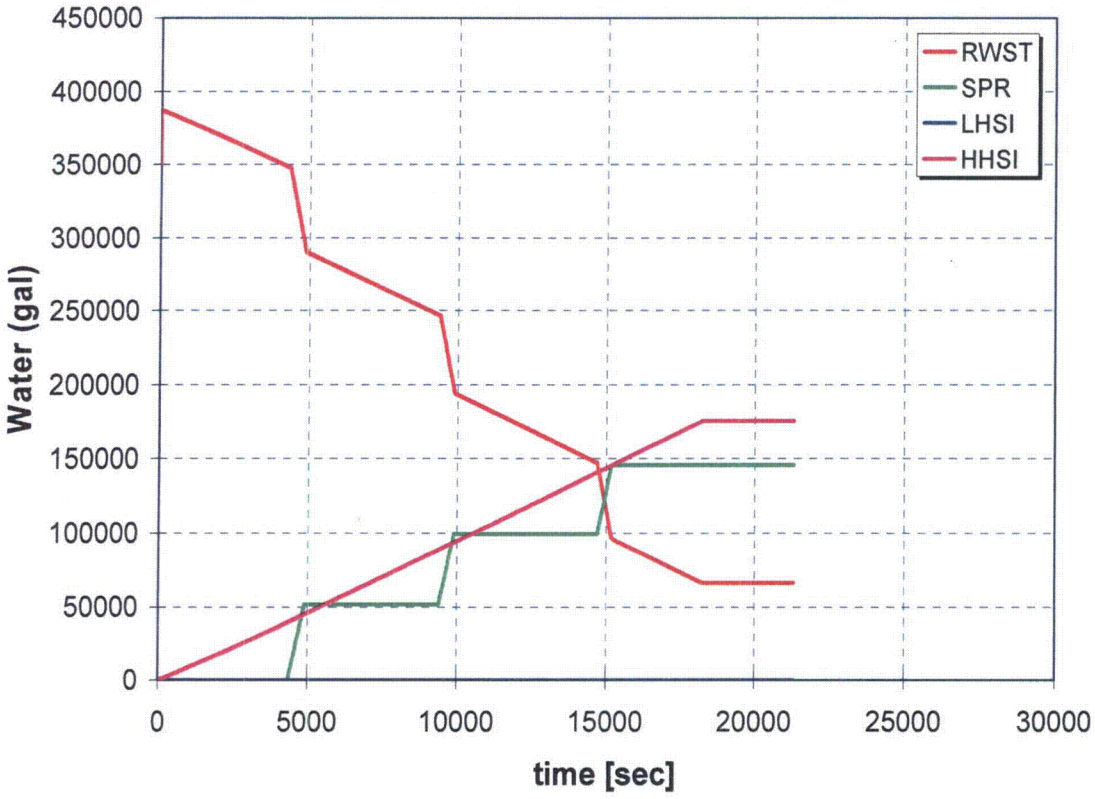

1700
1500
1300
1100
900
700
500
300
Maximum Core Temperature [K]
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
TCL
TFU
2200 F

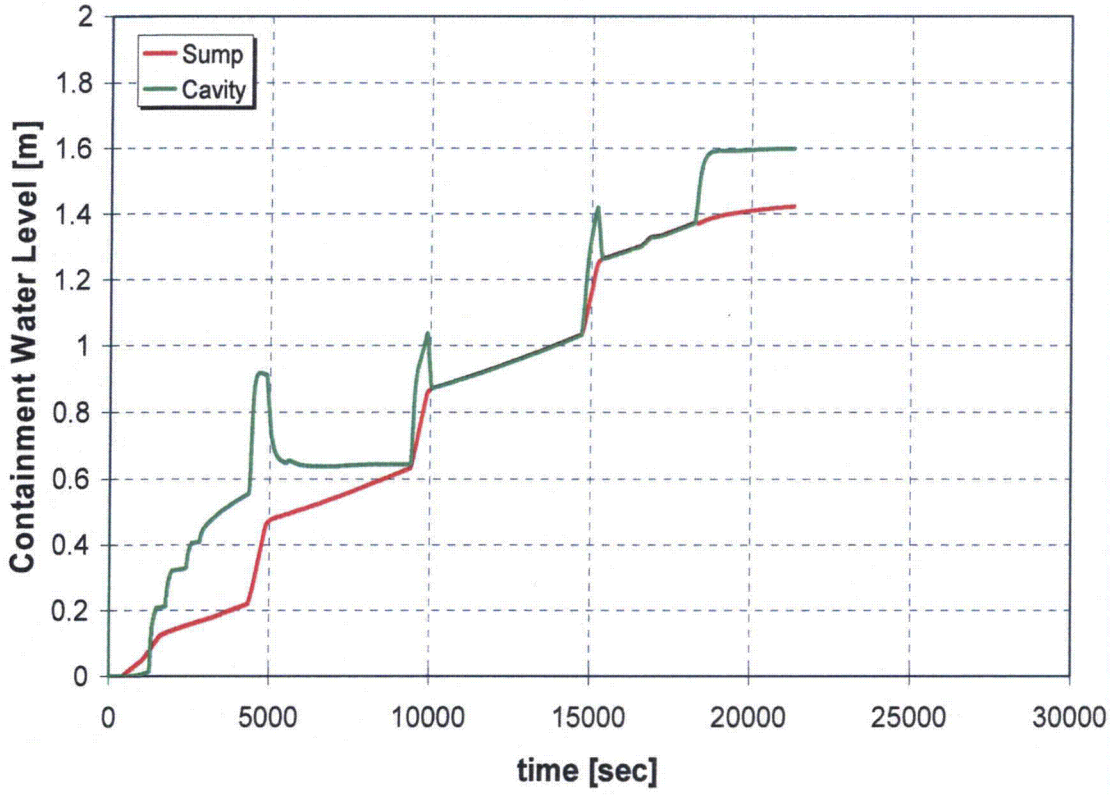
A.6.20 Case 20: 2-Inch Break LOCA, One HHSI, No LHSI, and One ACC

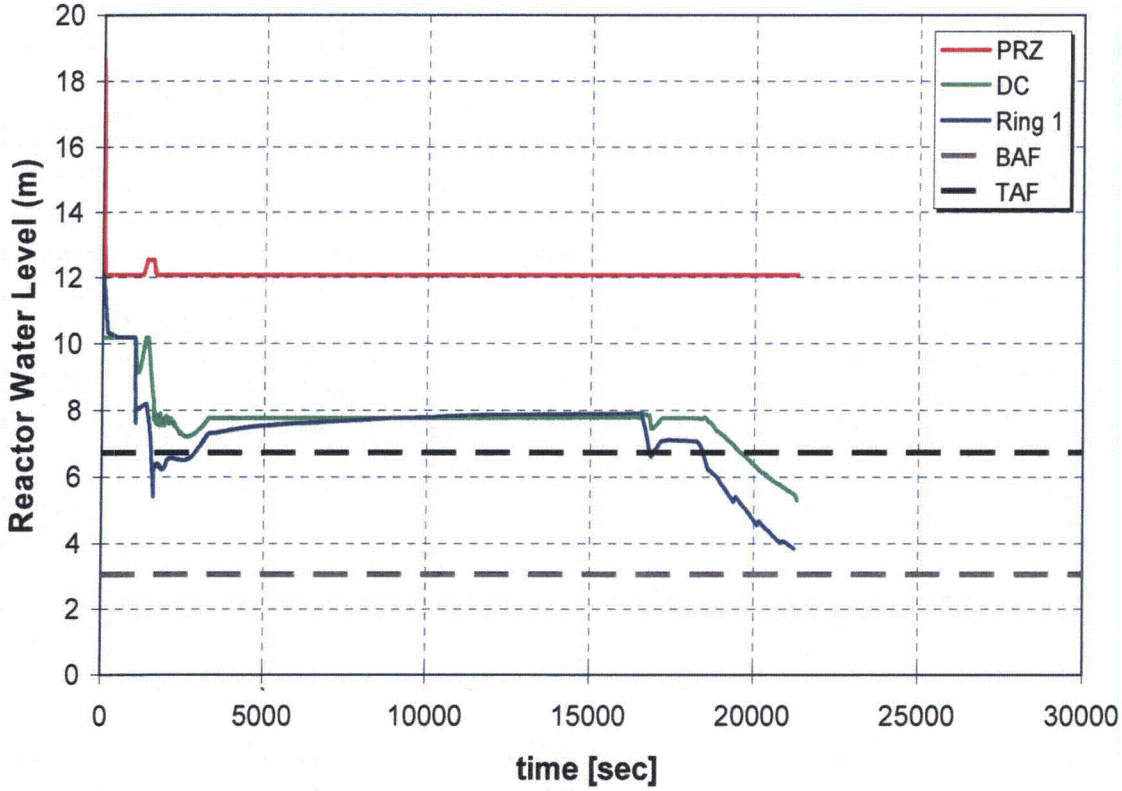


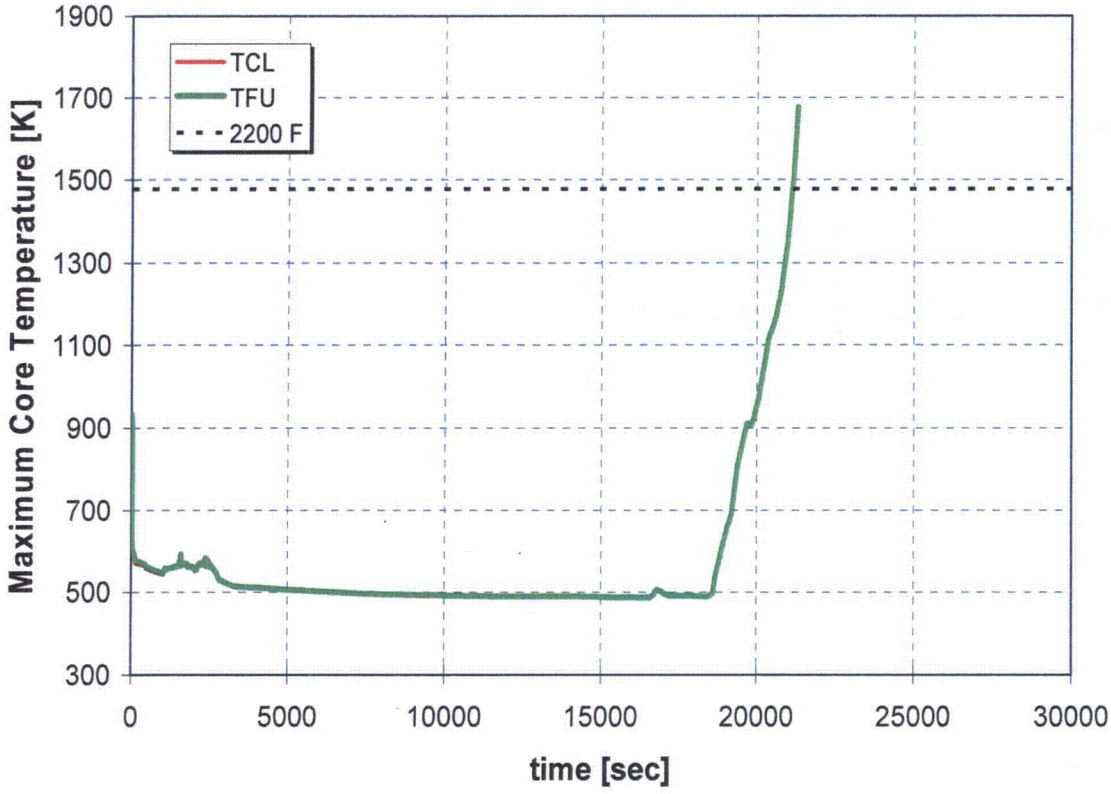



ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
30000
time [sec]

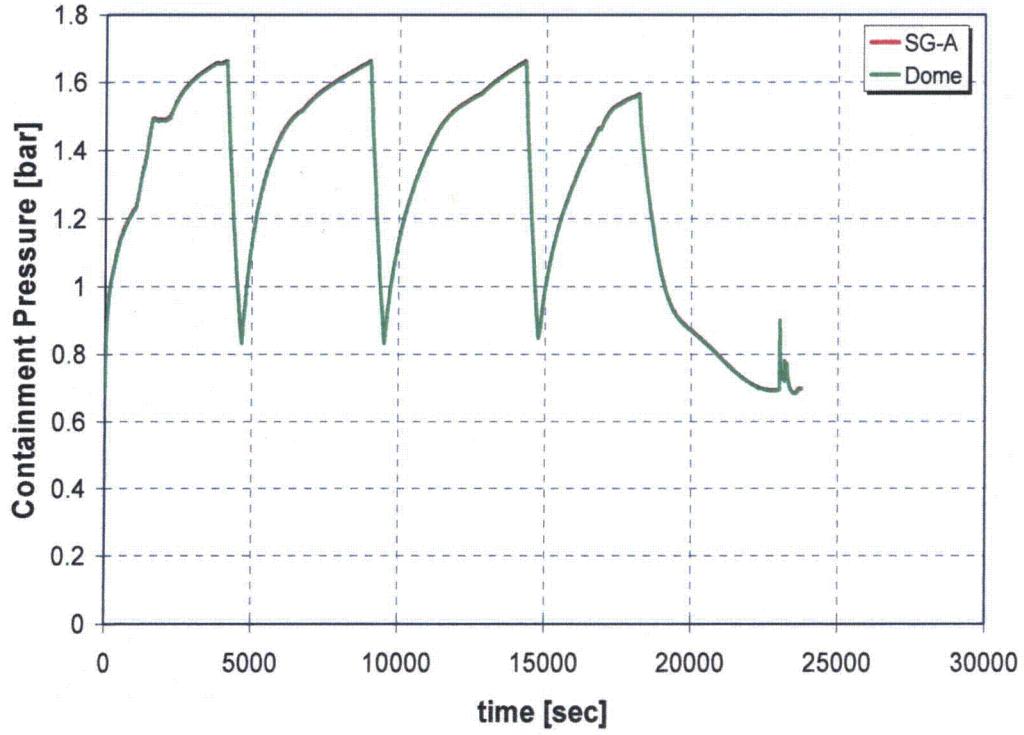

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
5000
10000
15000
20000
25000
30000
time [sec]

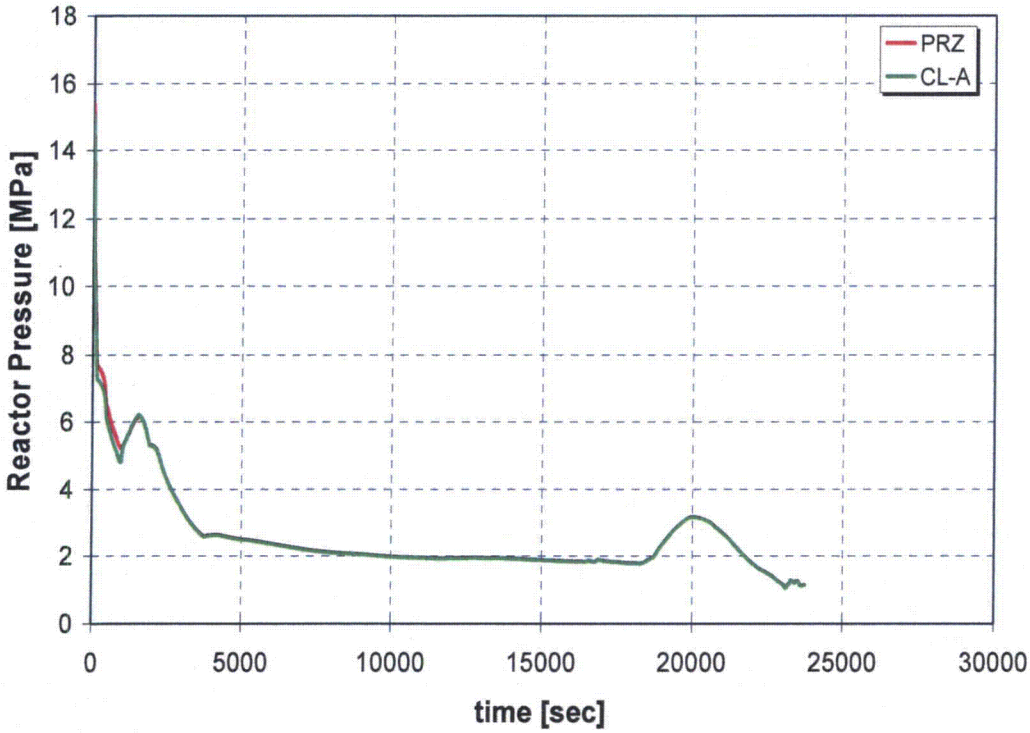

Sump
Cavity
Containment Water Level [m]
time [sec]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
5000
10000
15000
20000
25000
30000

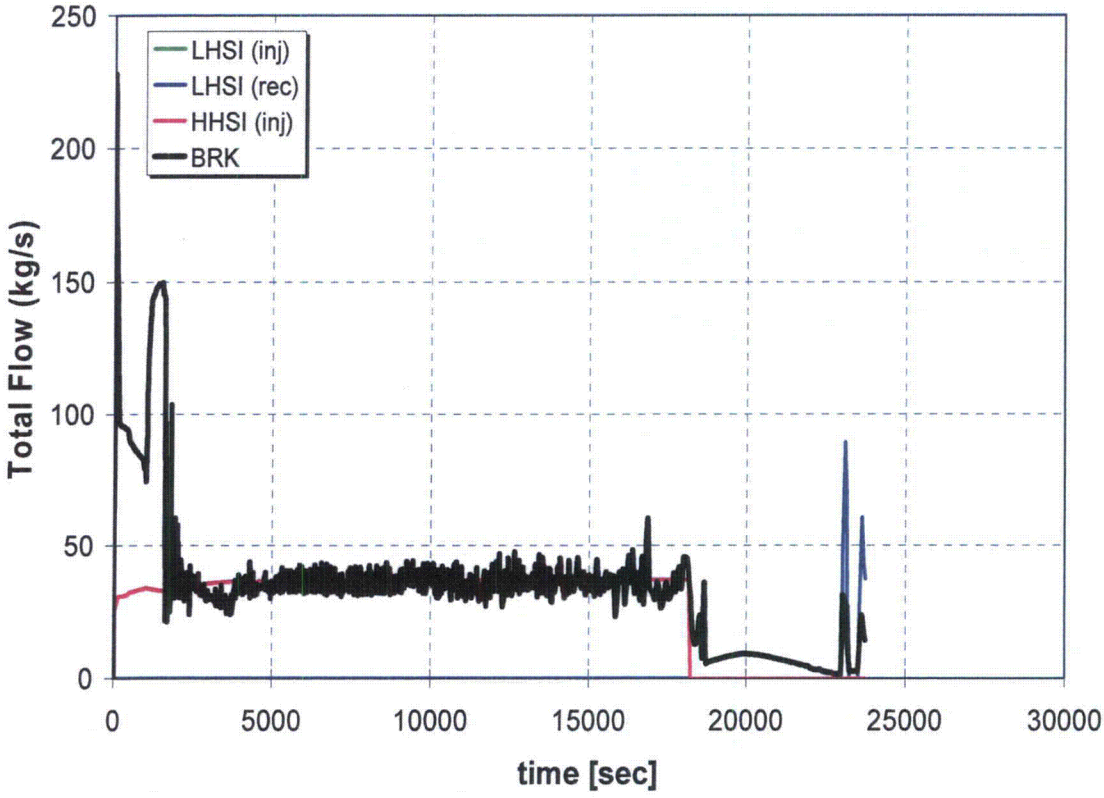

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
time [sec]
0
2
4
6
8
10
12
14
16
18
20
0
5000
10000
15000
20000
25000
30000

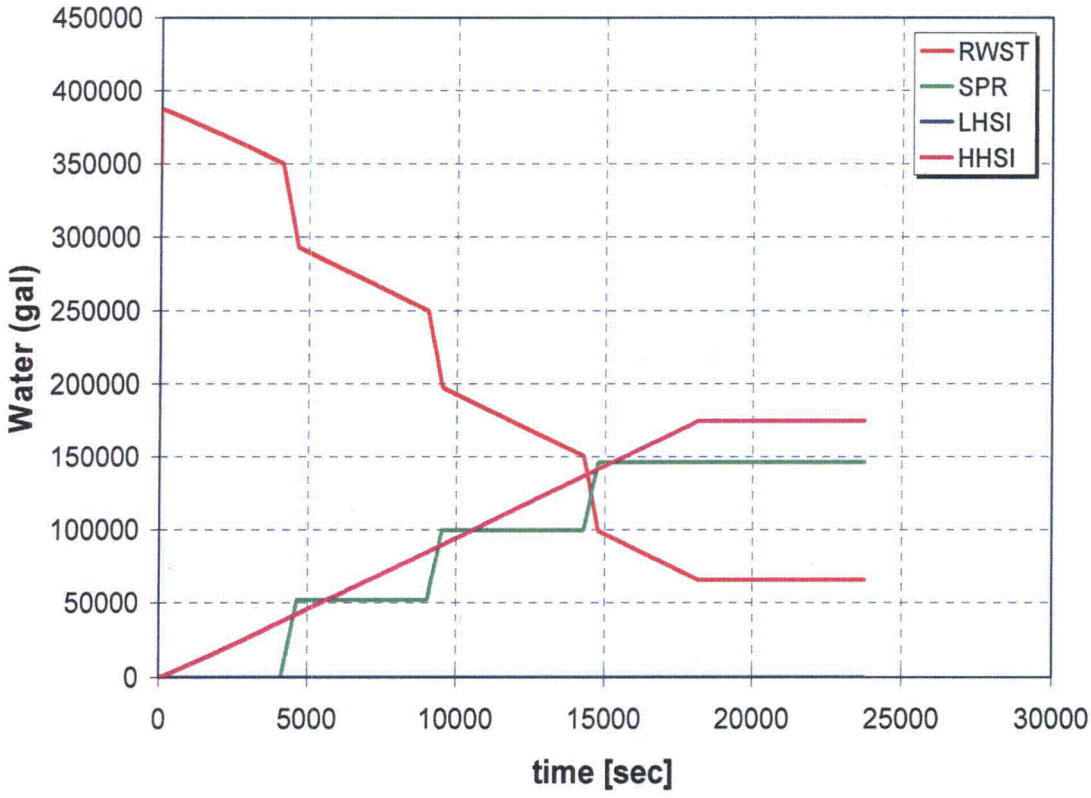

1900
1700
1500
1300
1100
900
700
500
300
Maximum Core Temperature [K]
TCL
TFU
2200 F
0
5000
10000
15000
20000
25000
30000
time [sec]

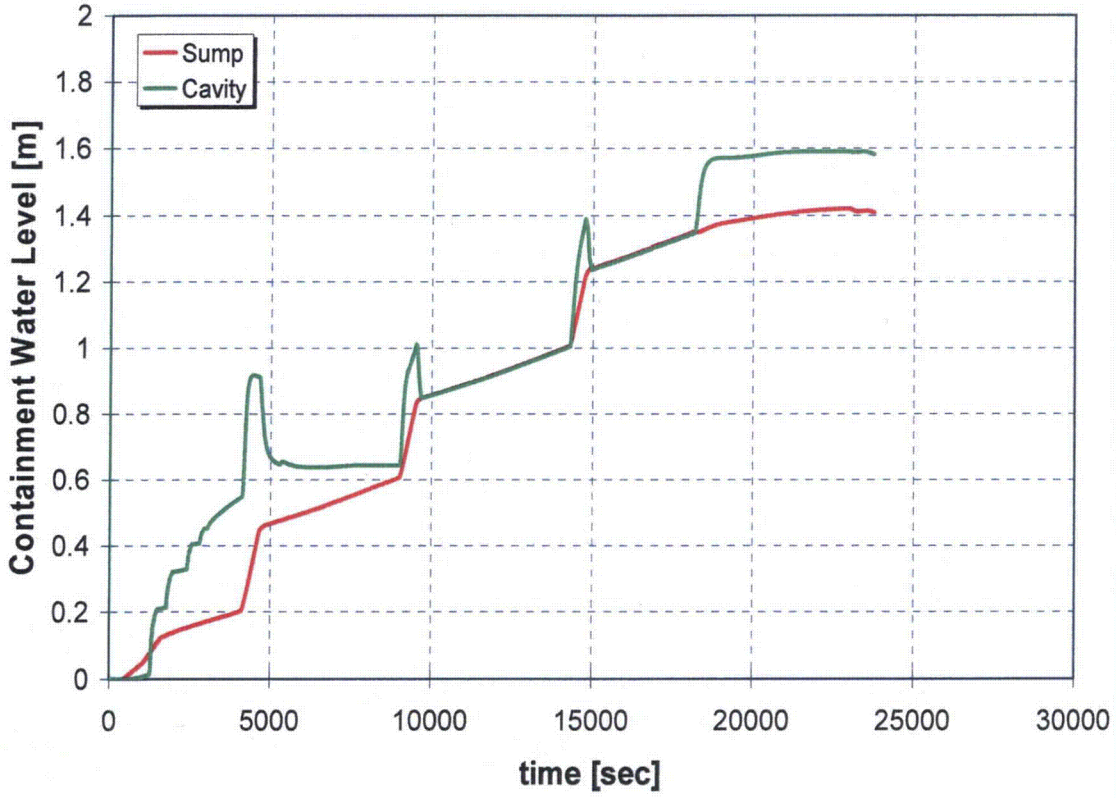
A.6.21 Case 21: 2-Inch Break LOCA, One HHSI, One LHSI, and No ACC

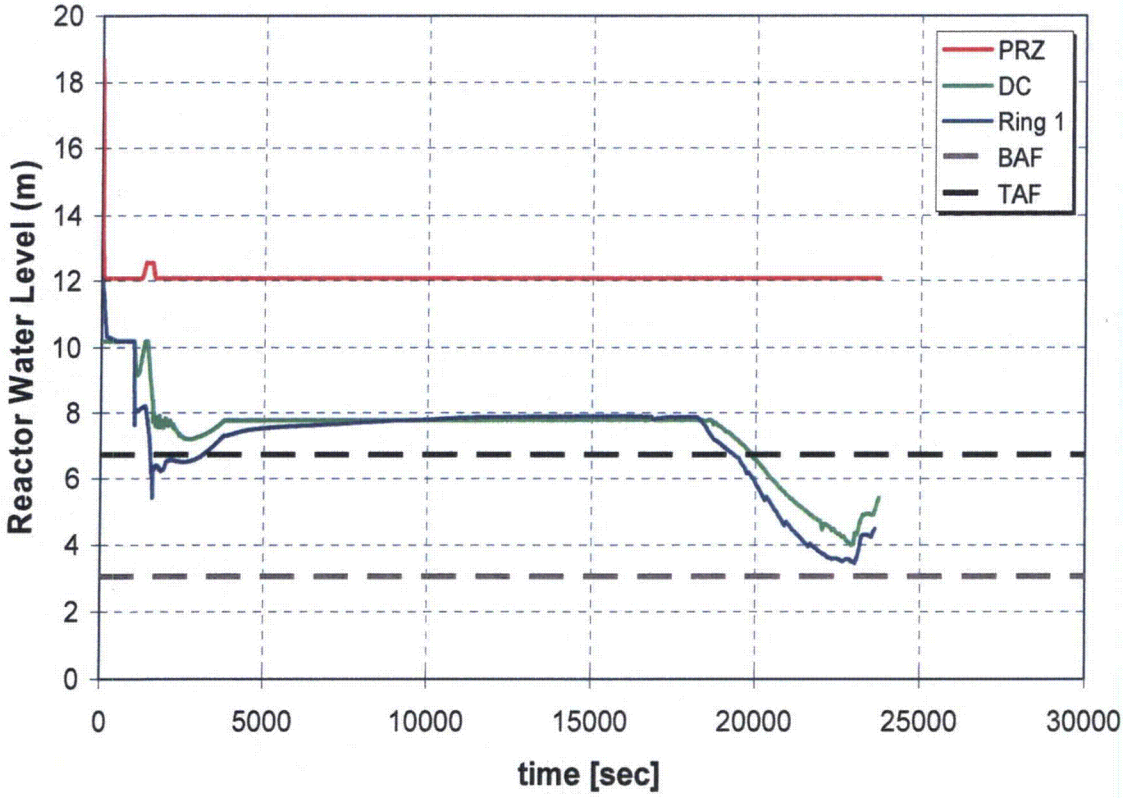


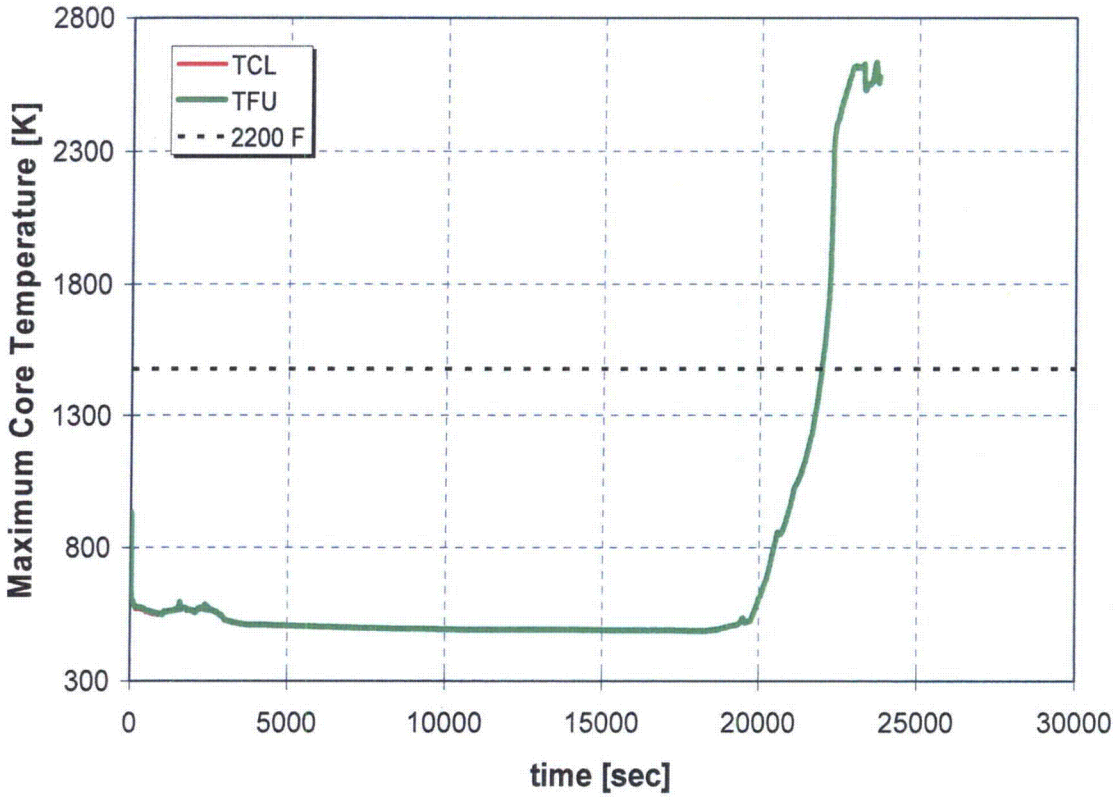



LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
30000
time [sec]

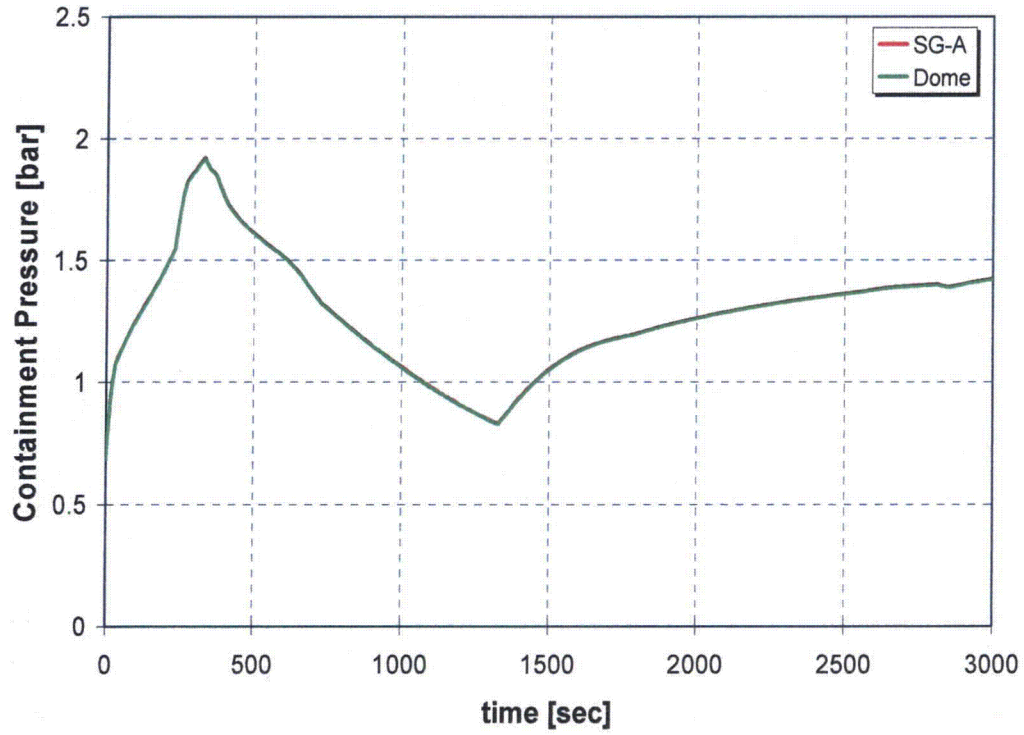

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
5000
10000
15000
20000
25000
30000
time [sec]

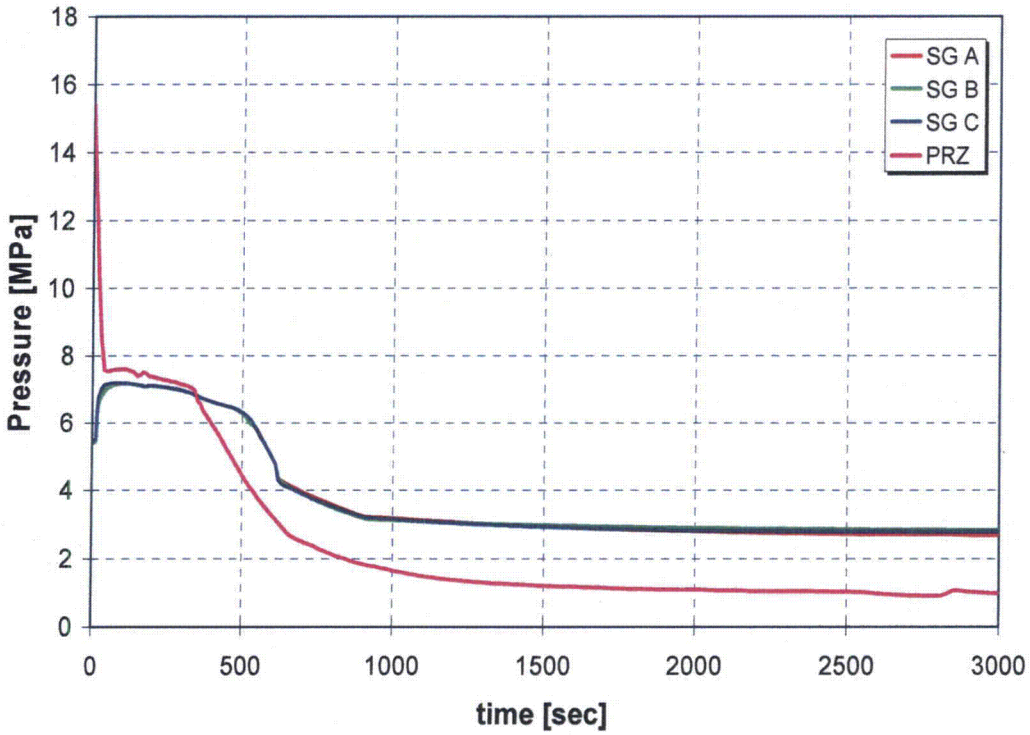

Sump
Cavity
Containment Water Level [m]
time [sec]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
5000
10000
15000
20000
25000
30000

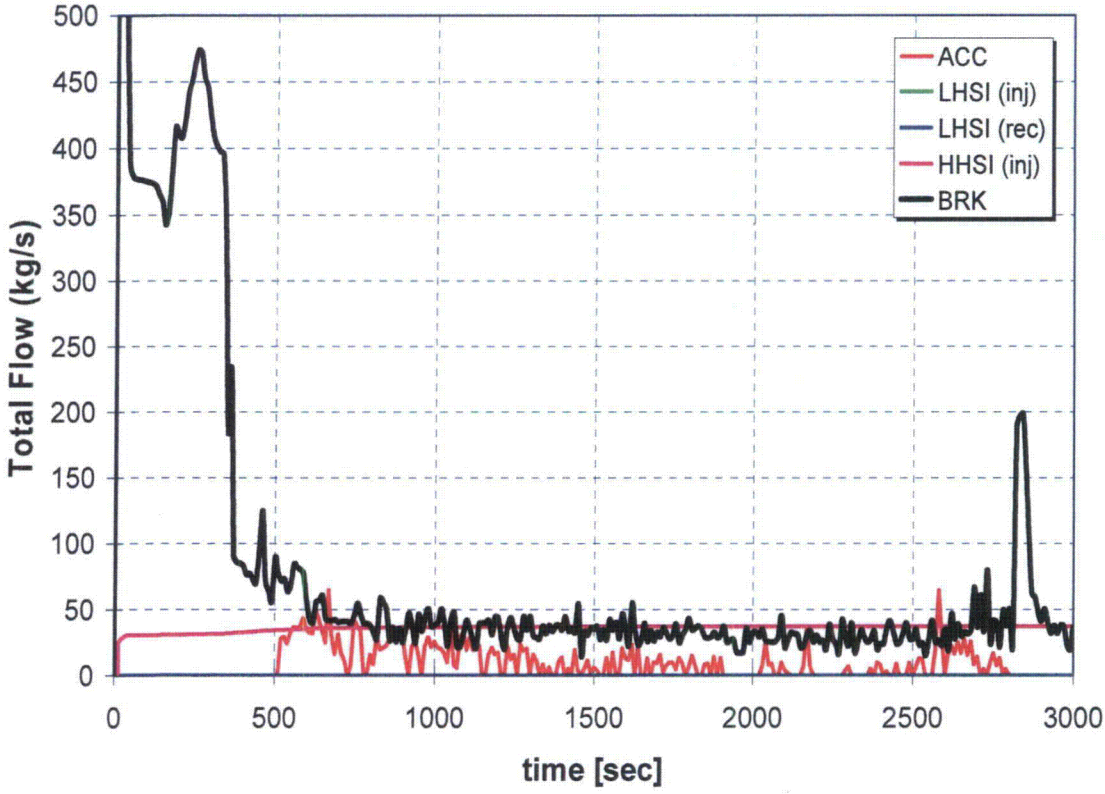

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
time [sec]
0
2
4
6
8
10
12
14
16
18
20
0
5000
10000
15000
20000
25000
30000

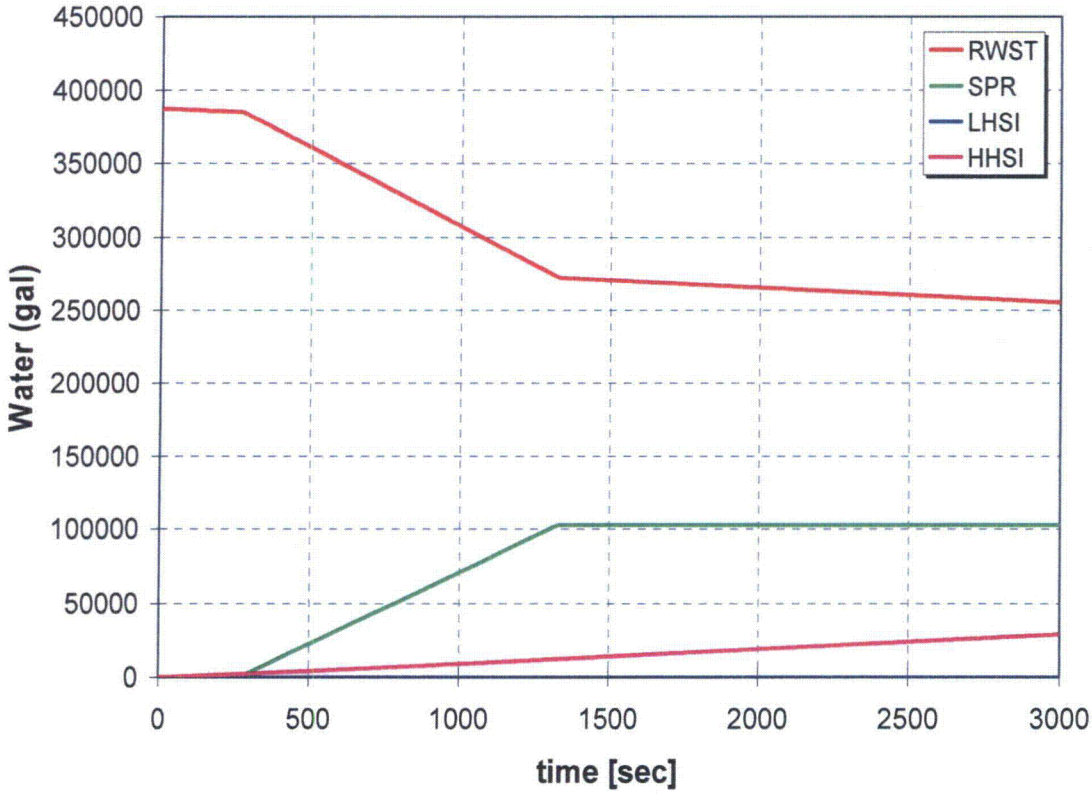

TCL
TFU
2200 F
Maximum Core Temperature [K]
2800
2300
1800
1300
800
300
0
5000
10000
15000
20000
25000
30000
time [sec]

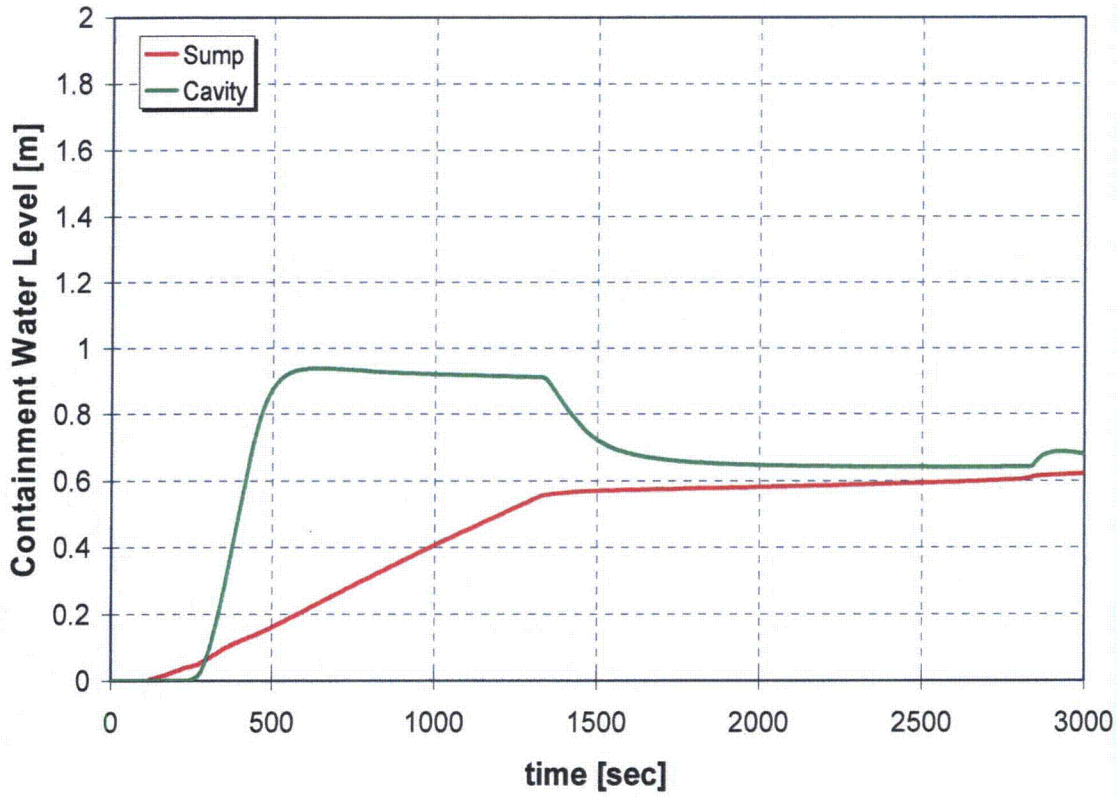
A.6.22 Case 22: 4-Inch Break LOCA, One HHSI, No LHSI, and One ACC

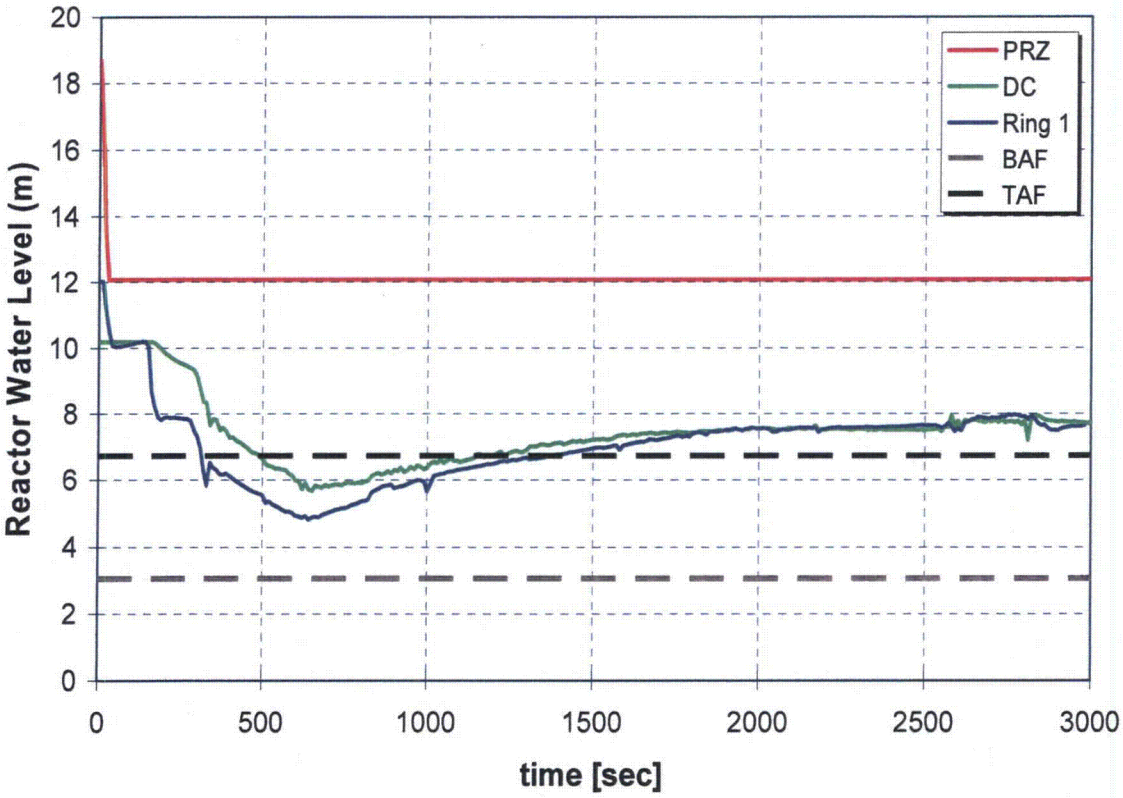


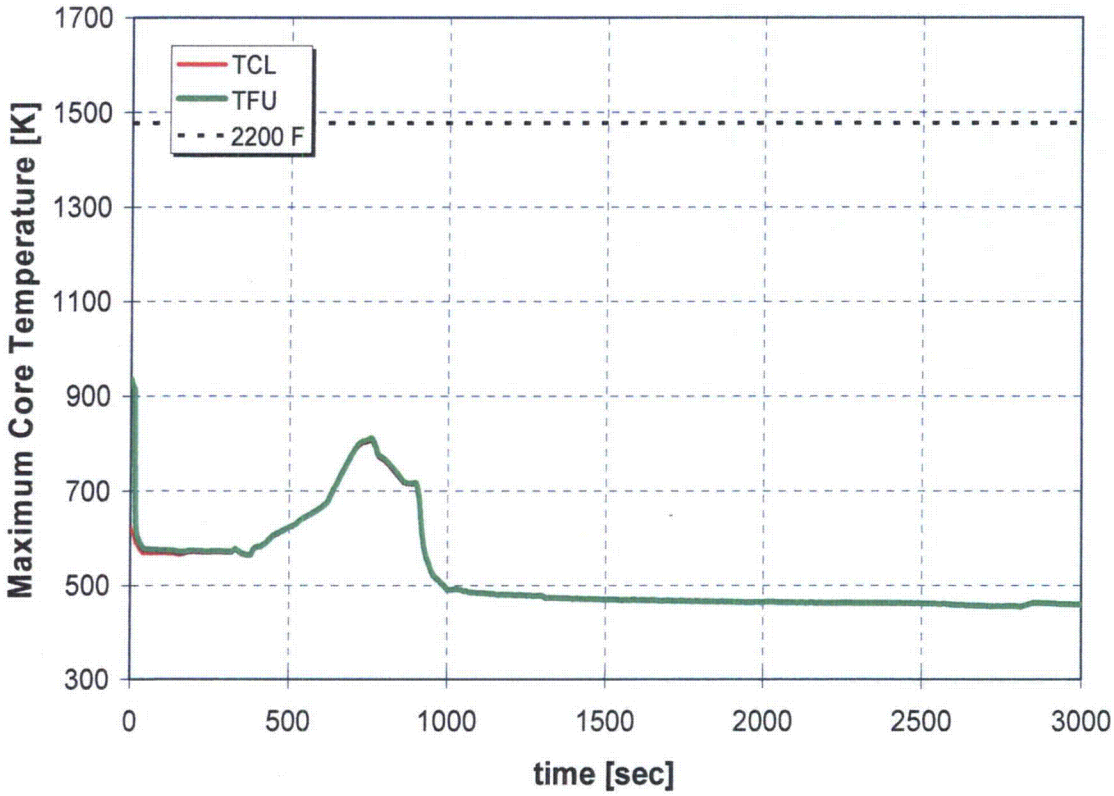



Total Flow (kg/s)
500
450
400
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
3000
time [sec]
ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK

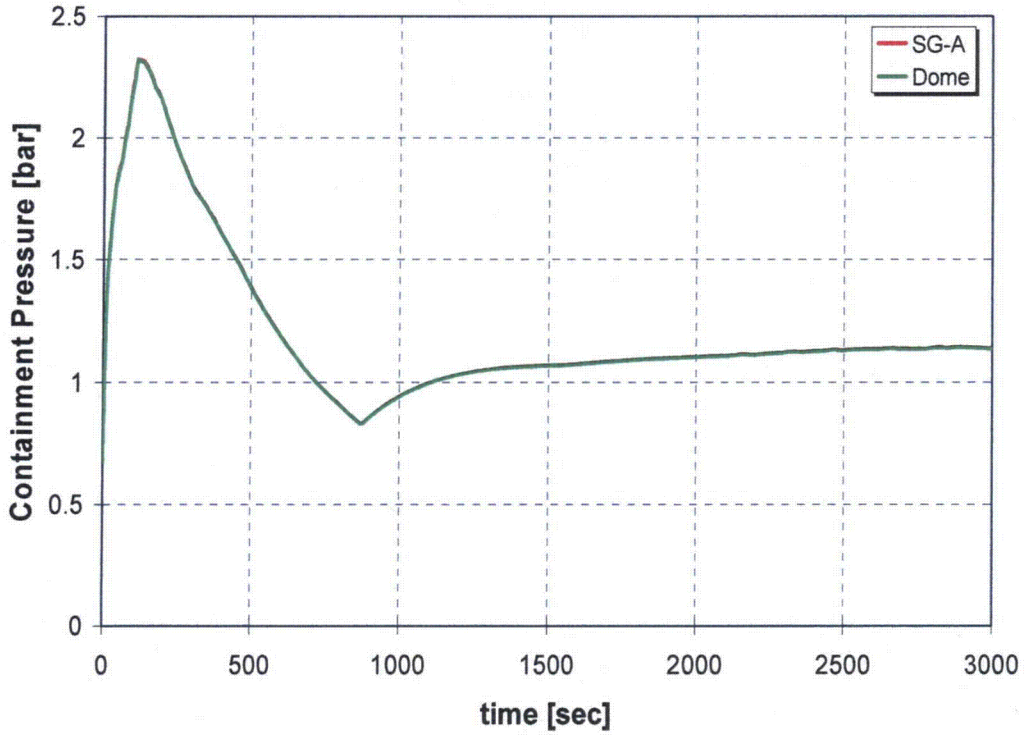

Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
500
1000
1500
2000
2500
3000
time [sec]
RWST
SPR
LHSI
HHSI

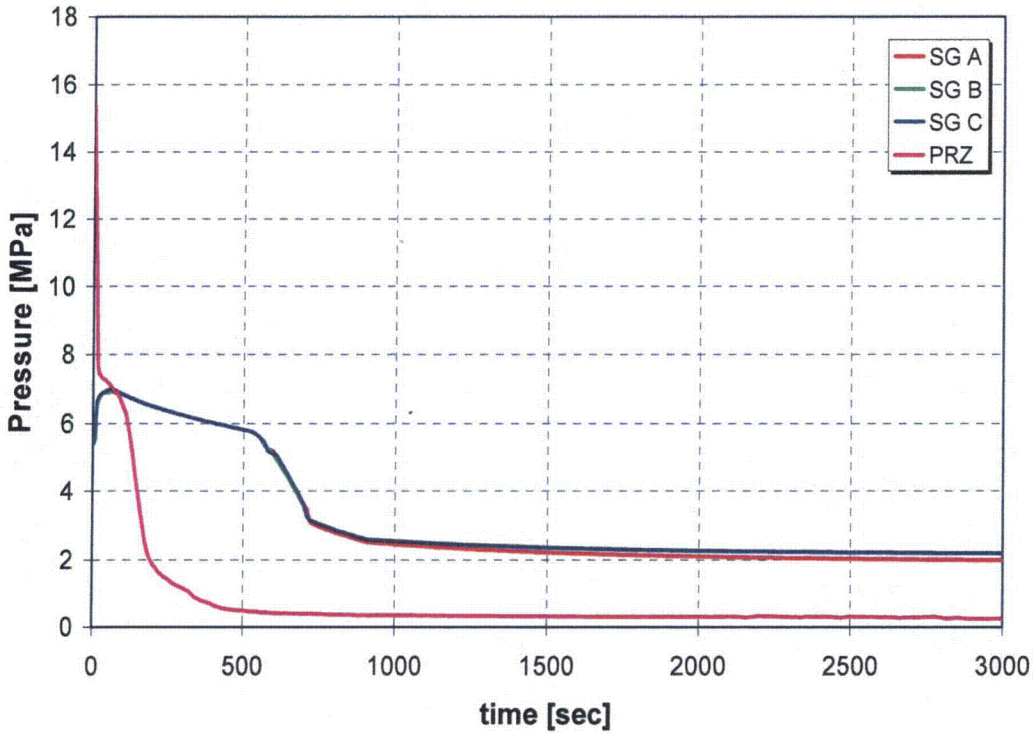

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
time [sec]

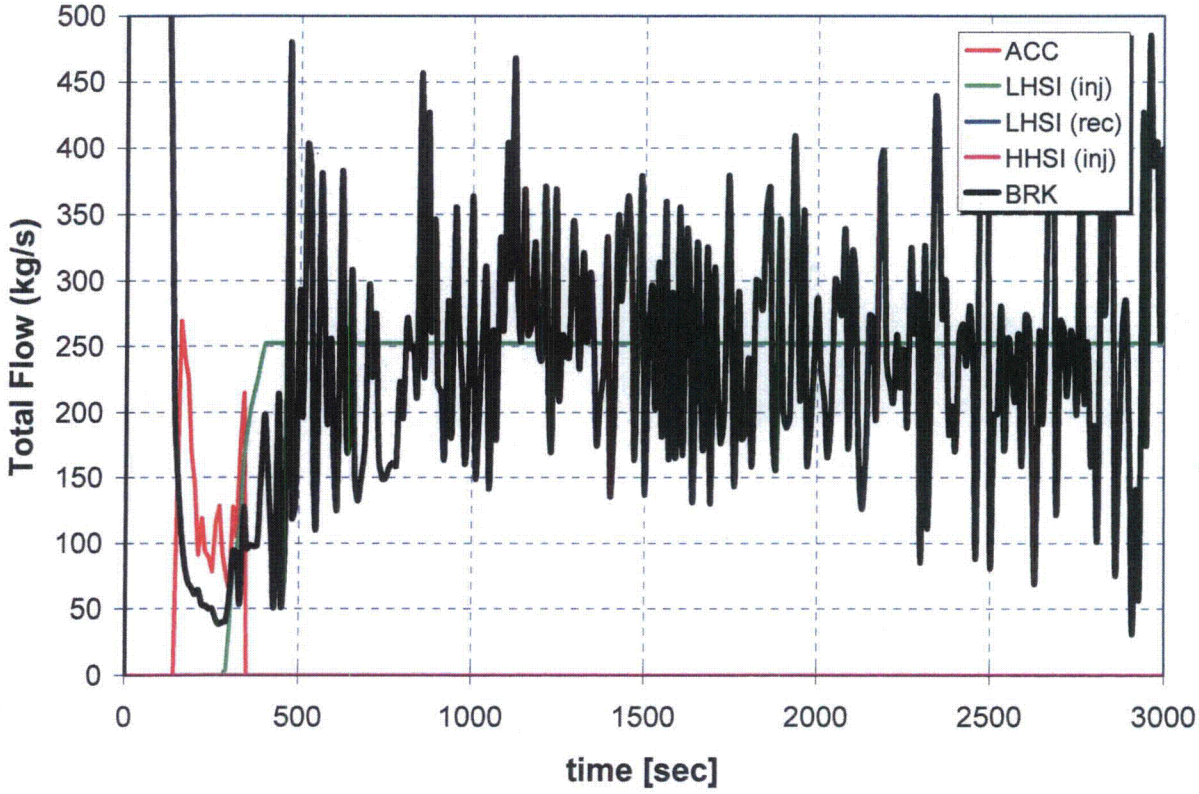

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
time [sec]

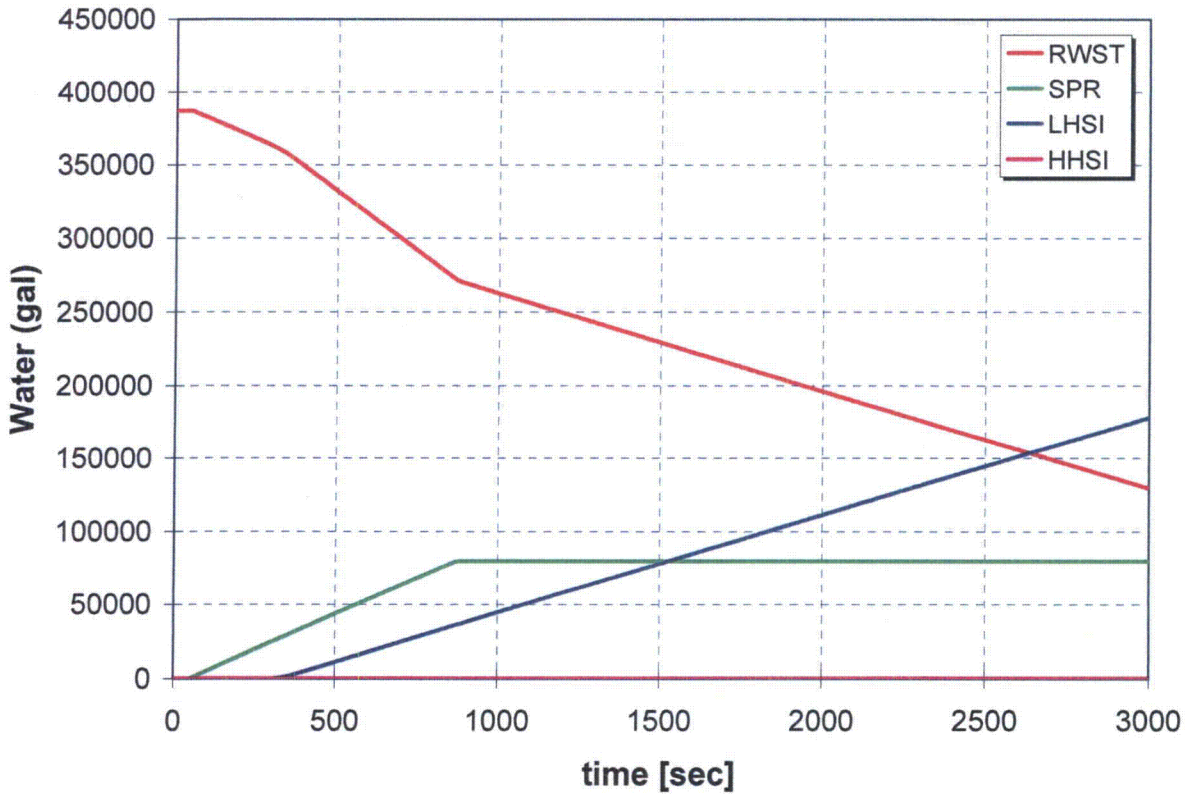

TCL
TFU
2200 F
Maximum Core Temperature [K]
1700
1500
1300
1100
900
700
500
300
0
500
1000
1500
2000
2500
3000
time [sec]

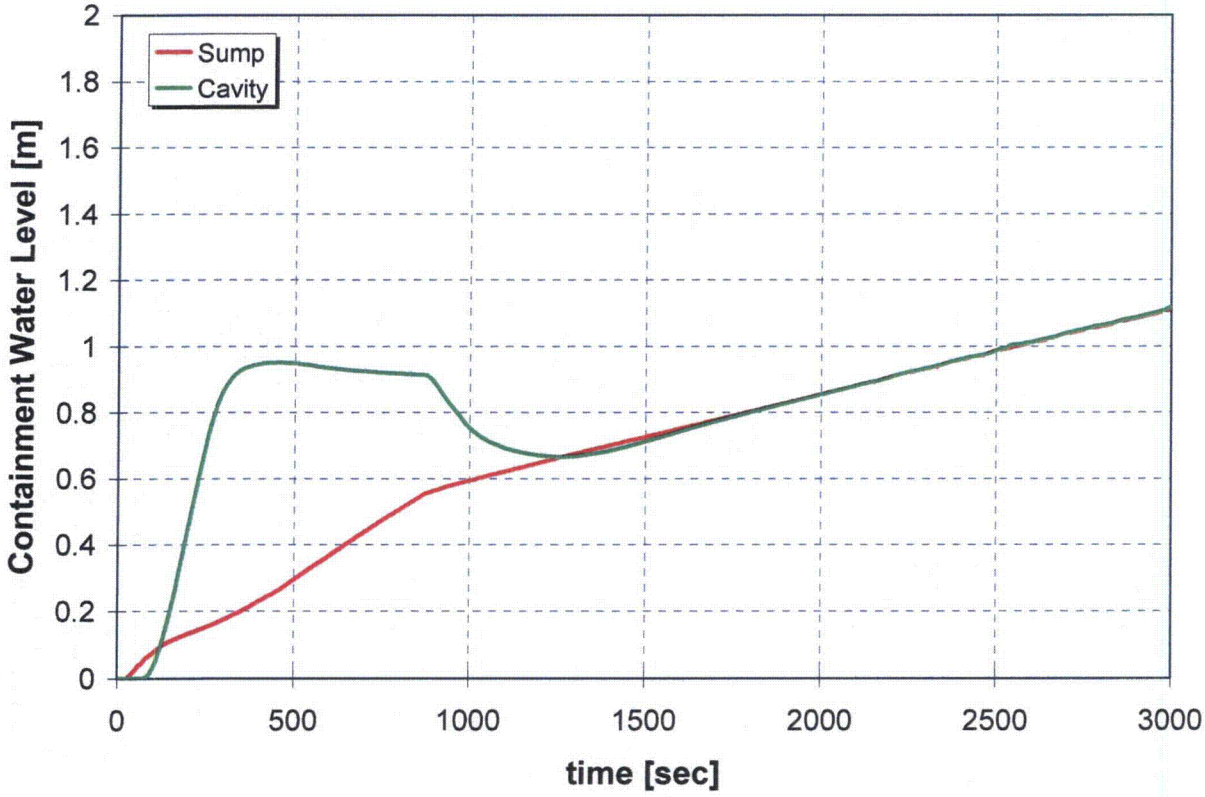
A.6.23 Case 23: 8-Inch Break LOCA, No HHSI, One LHSI, and One ACC

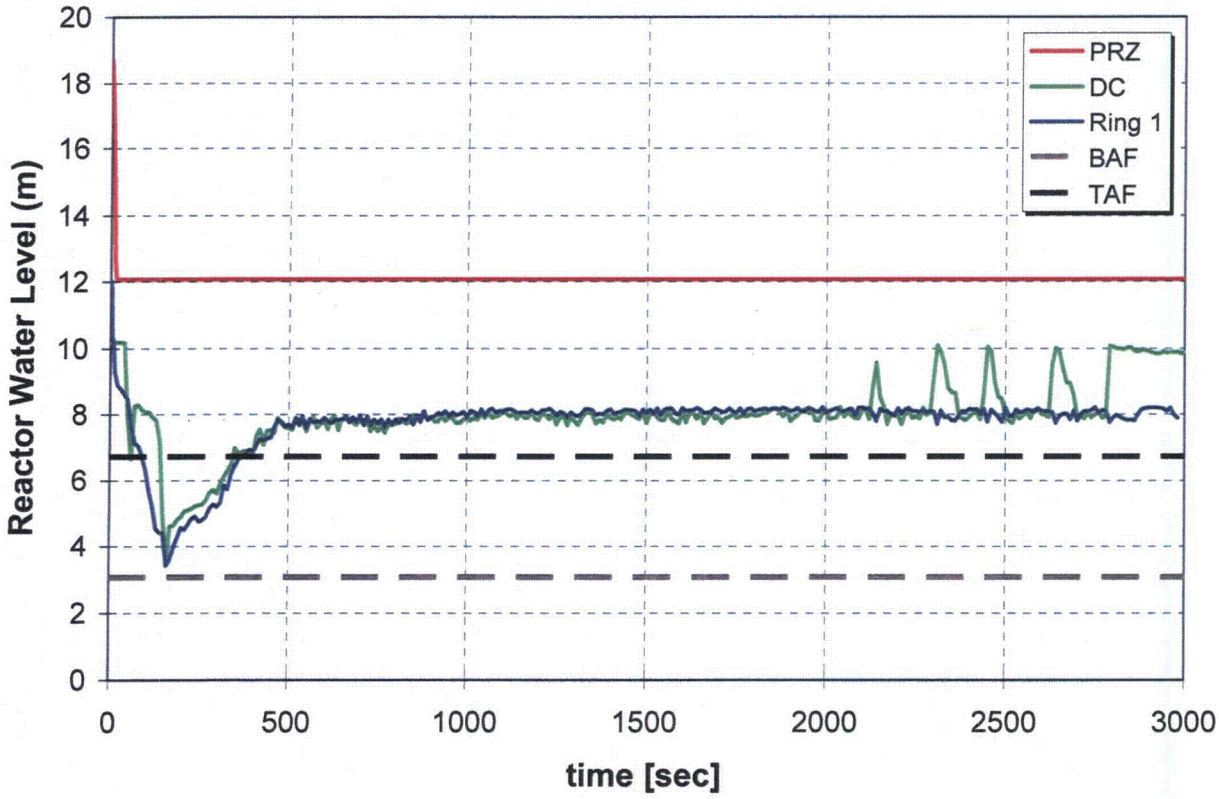


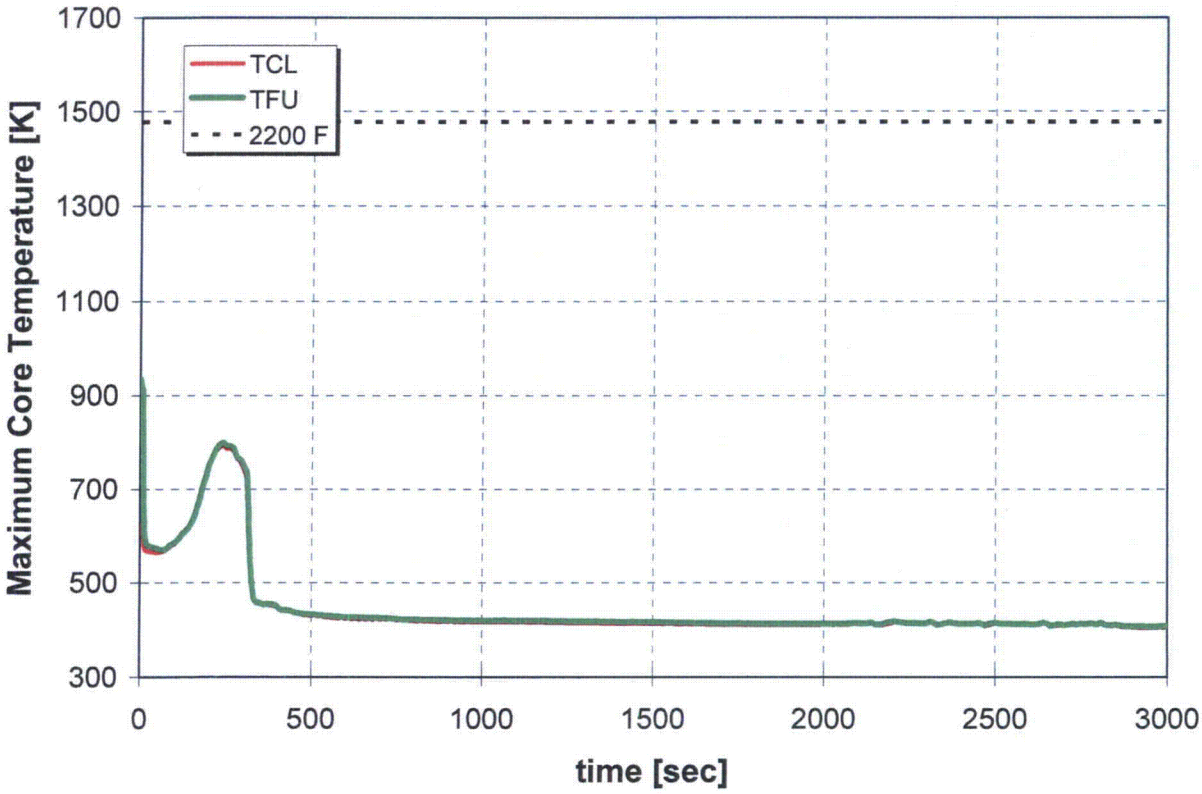



Total Flow (kg/s)
time [sec]
ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
0
50
100
150
200
250
300
350
400
450
500
0
500
1000
1500
2000
2500
3000

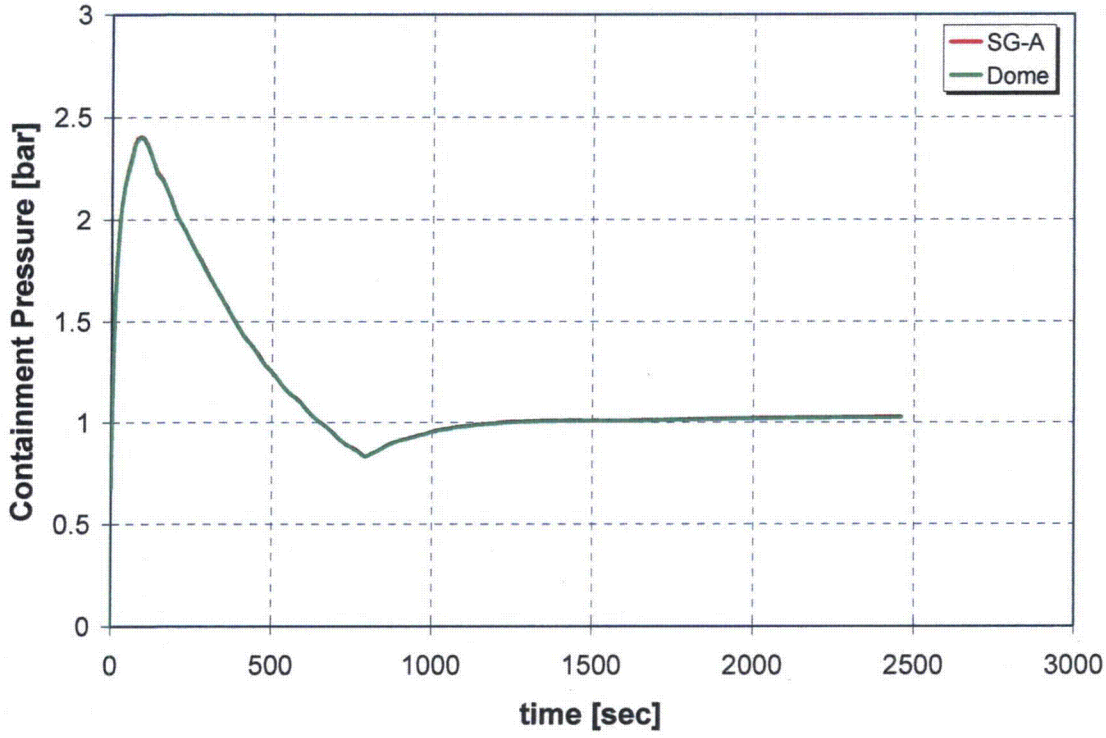

Water (gal)
time [sec]
RWST
SPR
LHSI
HHSI
0
50000
100000
150000
200000
250000
300000
350000
400000
450000
0
500
1000
1500
2000
2500
3000

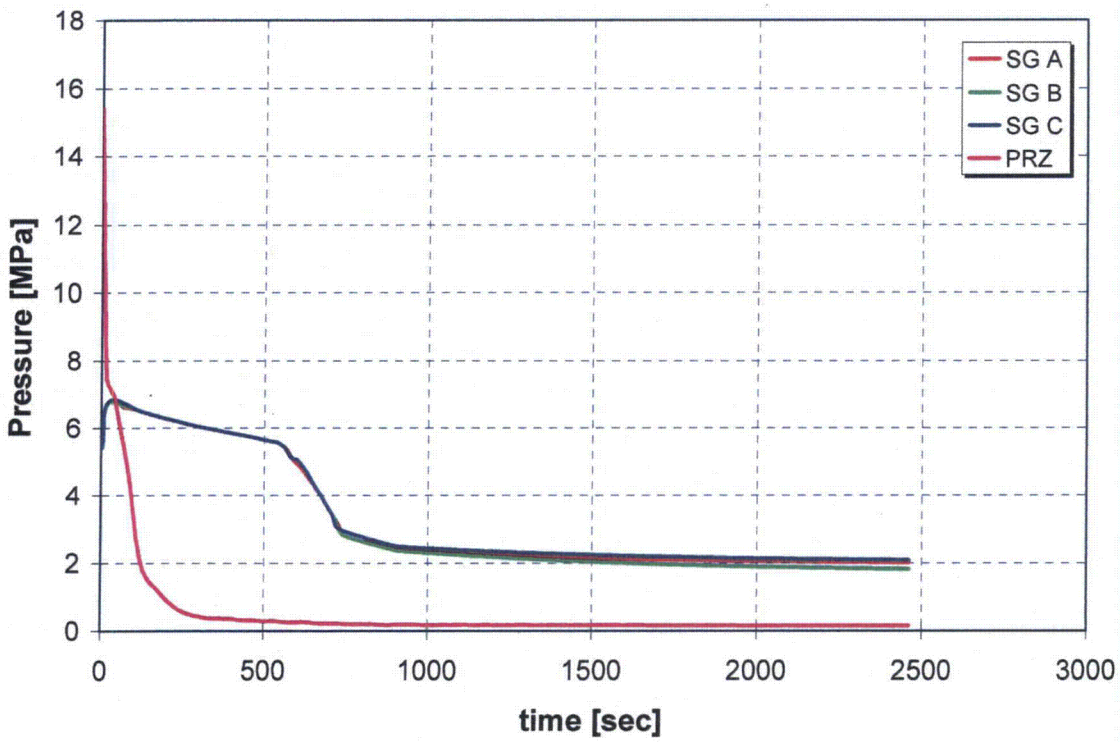

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
time [sec]

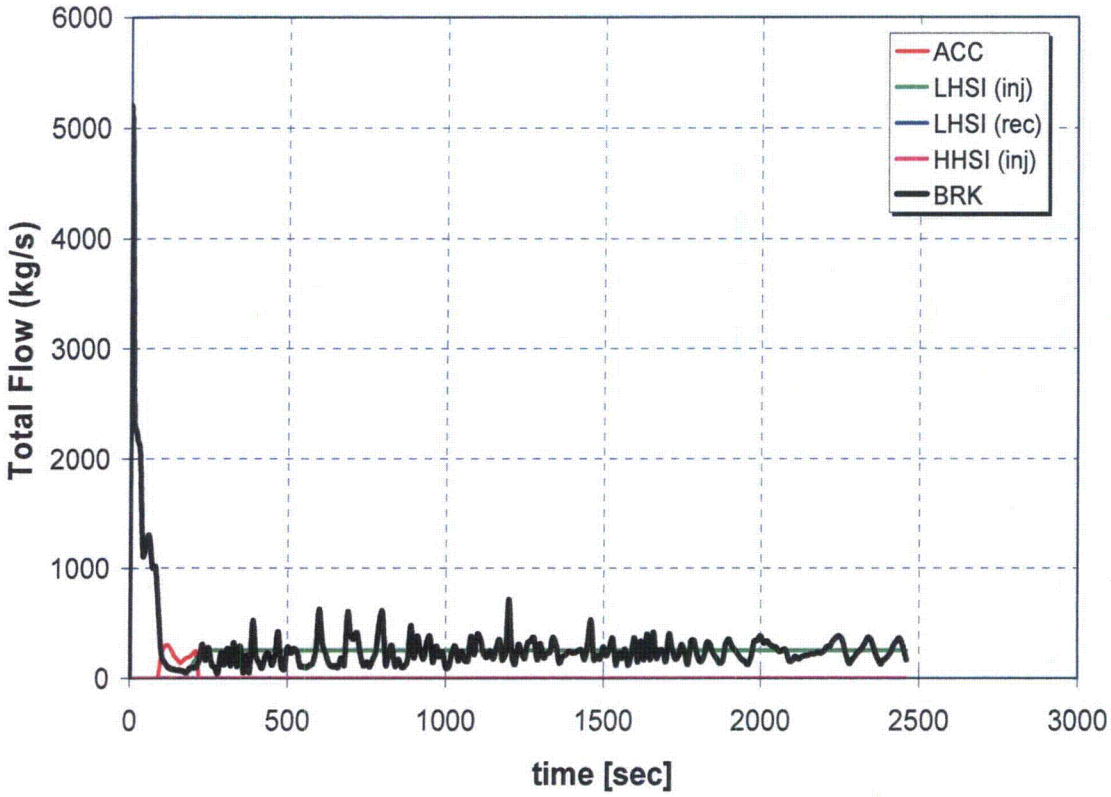

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
time [sec]

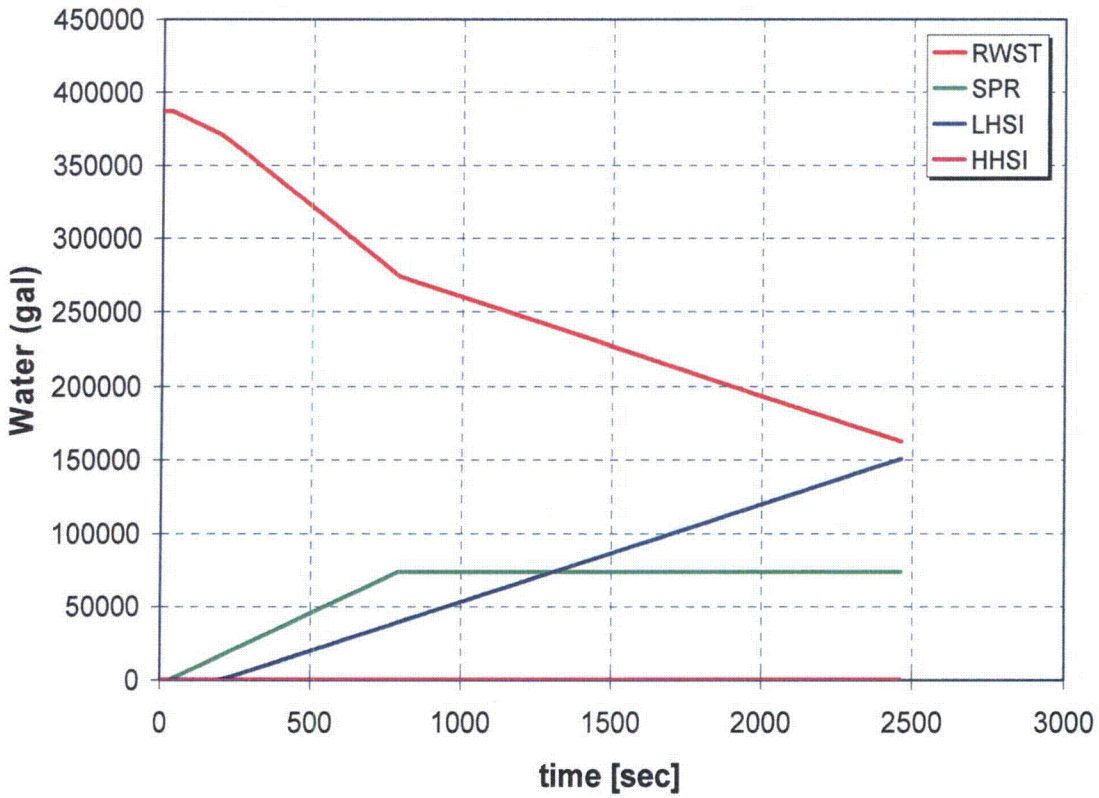

1700
1500
1300
1100
900
700
500
300
Maximum Core Temperature [K]
TCL
TFU
2200 F
0
500
1000
1500
2000
2500
3000
time [sec]

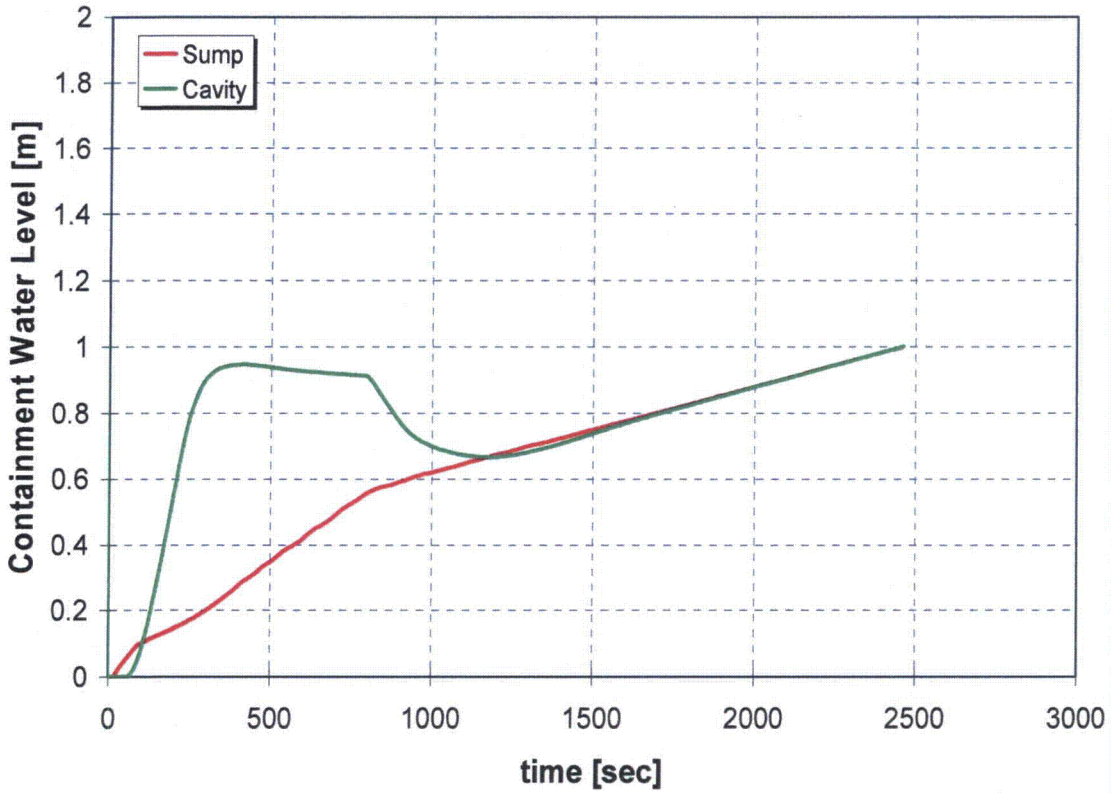
A.6.24 Case 24: 10-Inch Break LOCA, No HHSI, One LHSI, and One ACC

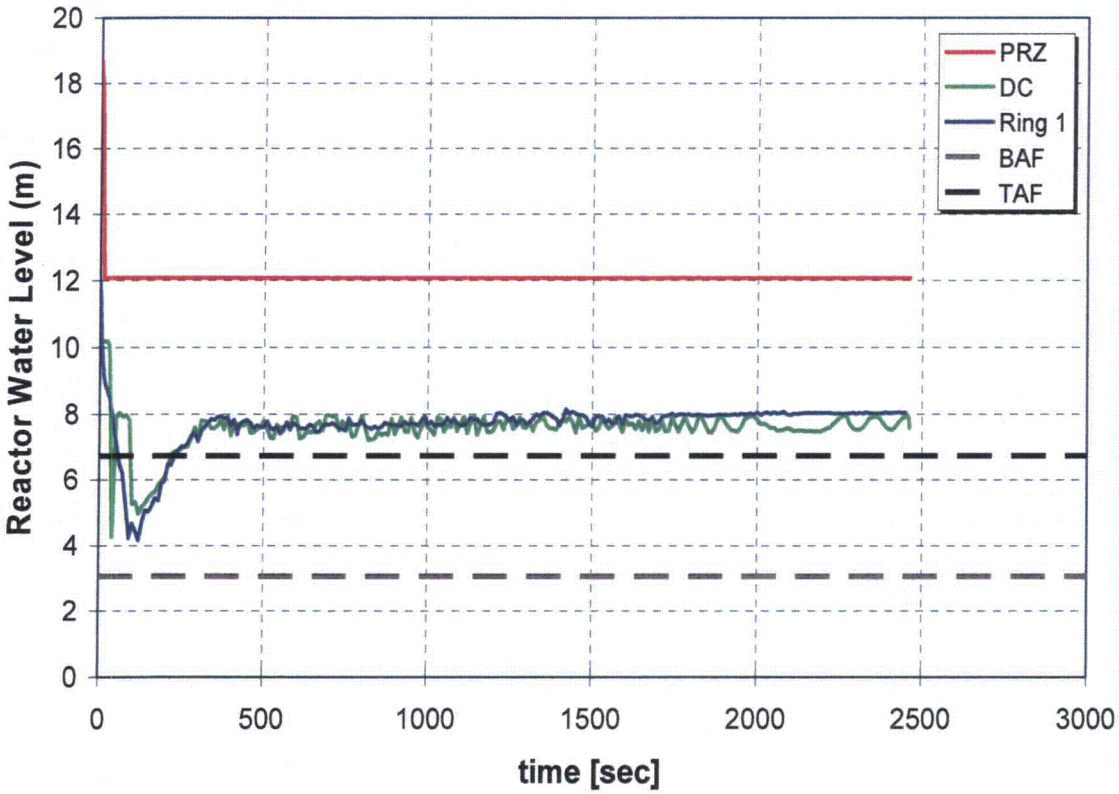


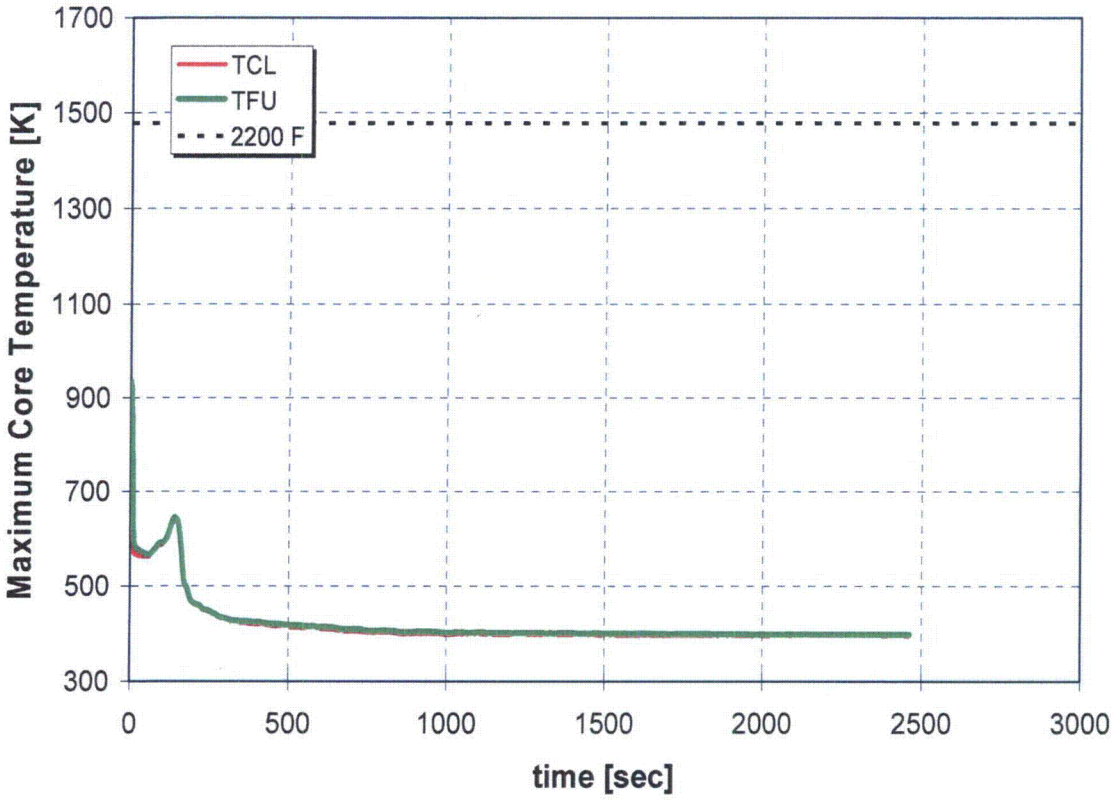



6000
5000
4000
3000
2000
1000
0
Total Flow (kg/s)
0
500
1000
1500
2000
2500
3000
time [sec]
ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK

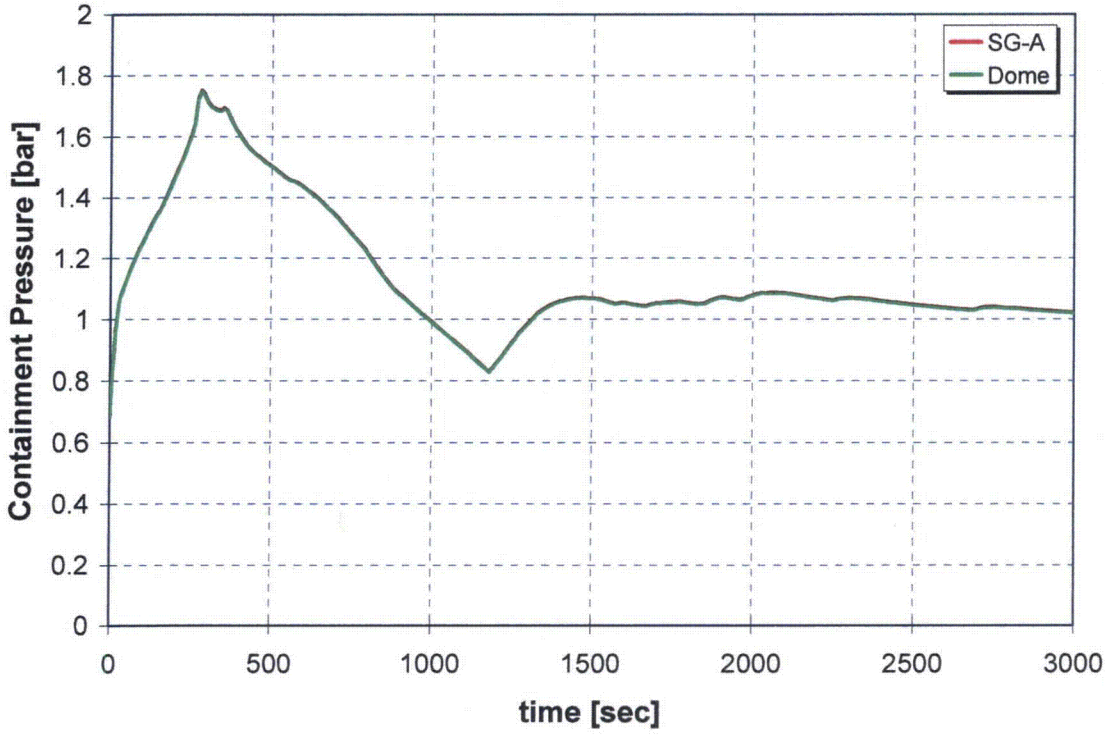

450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Water (gal)
0
500
1000
1500
2000
2500
3000
time [sec]
RWST
SPR
LHSI
HHSI

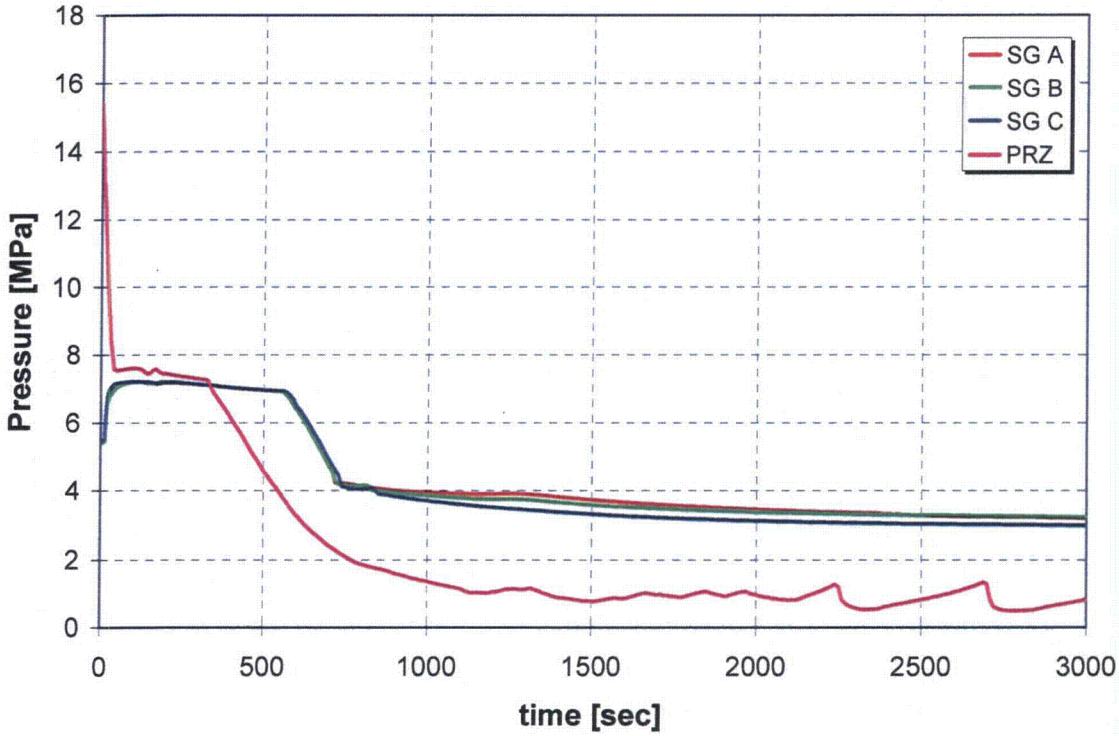

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
time [sec]

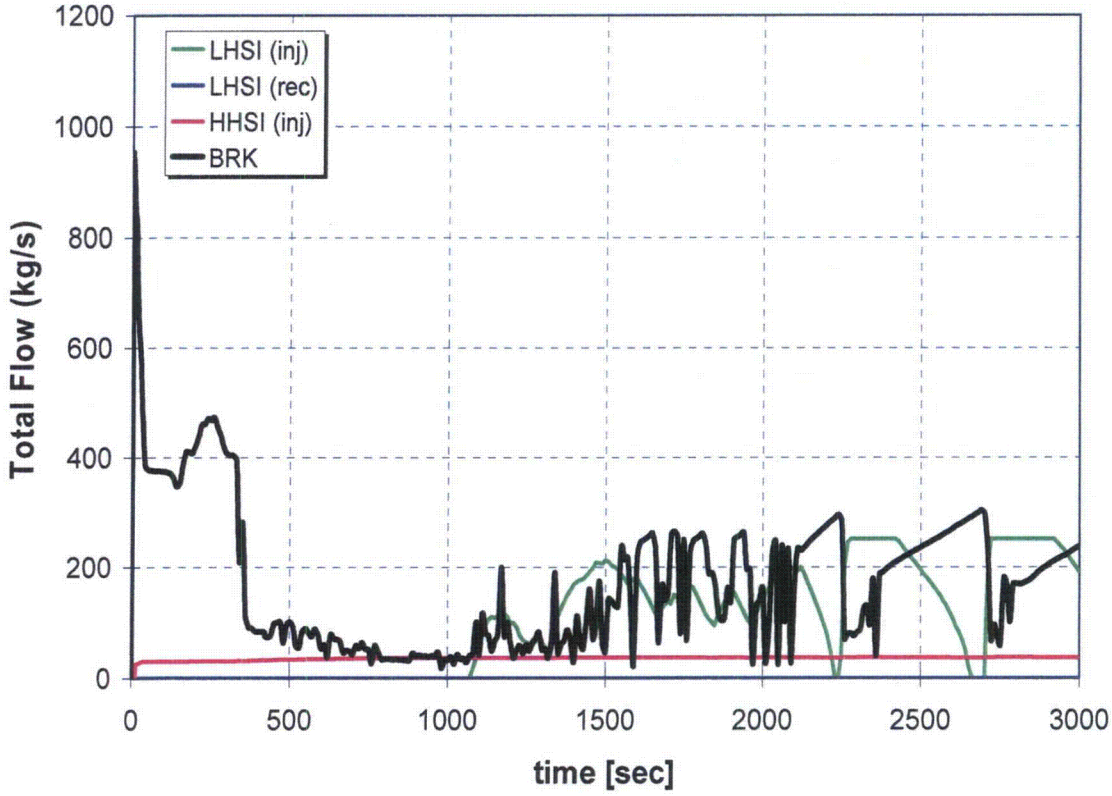

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
time [sec]

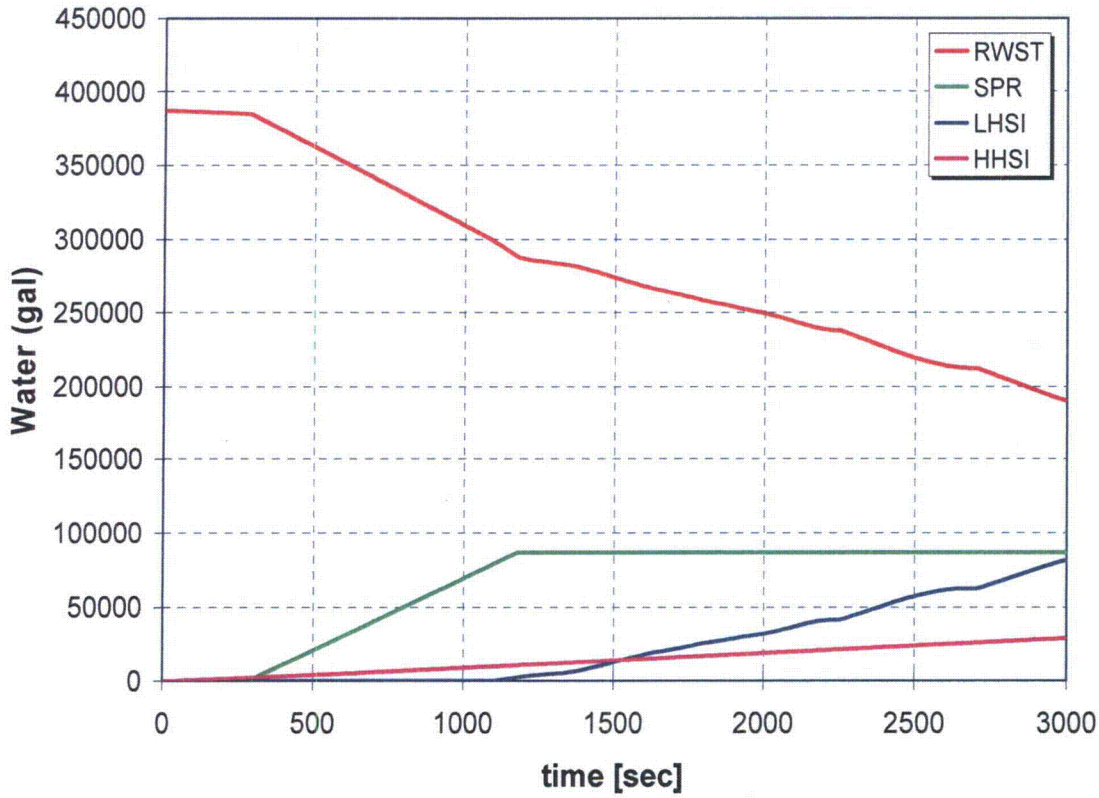

TCL
TFU
2200 F
Maximum Core Temperature [K]
1700
1500
1300
1100
900
700
500
300
0
500
1000
1500
2000
2500
3000
time [sec]

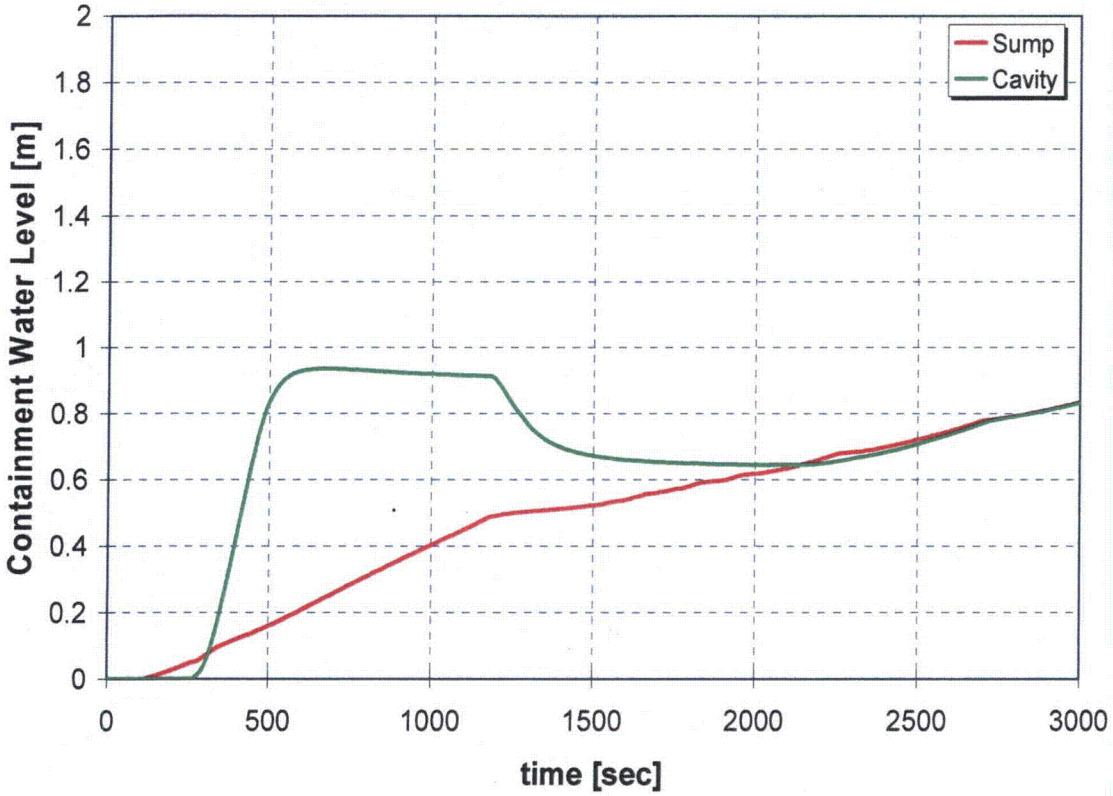
A.6.25 Case 25: 4-Inch Break LOCA, One HHSI, One LHSI, No ACC, without Auxiliary Feedwater

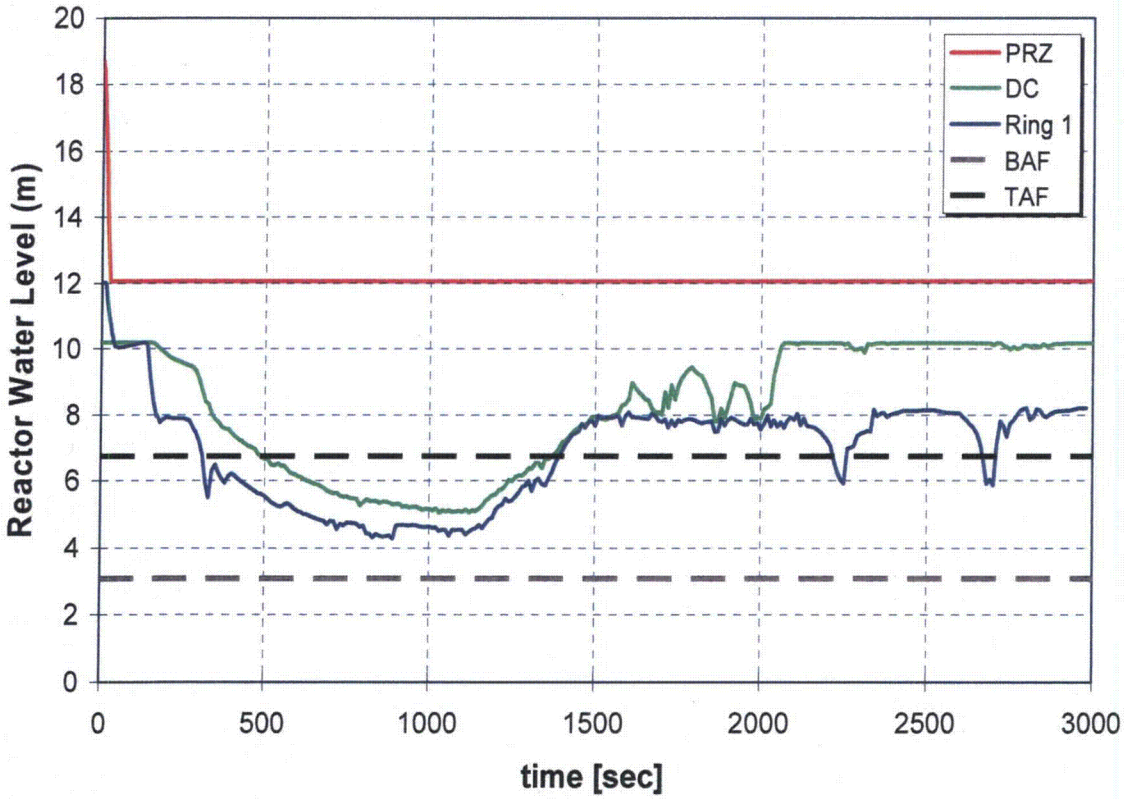


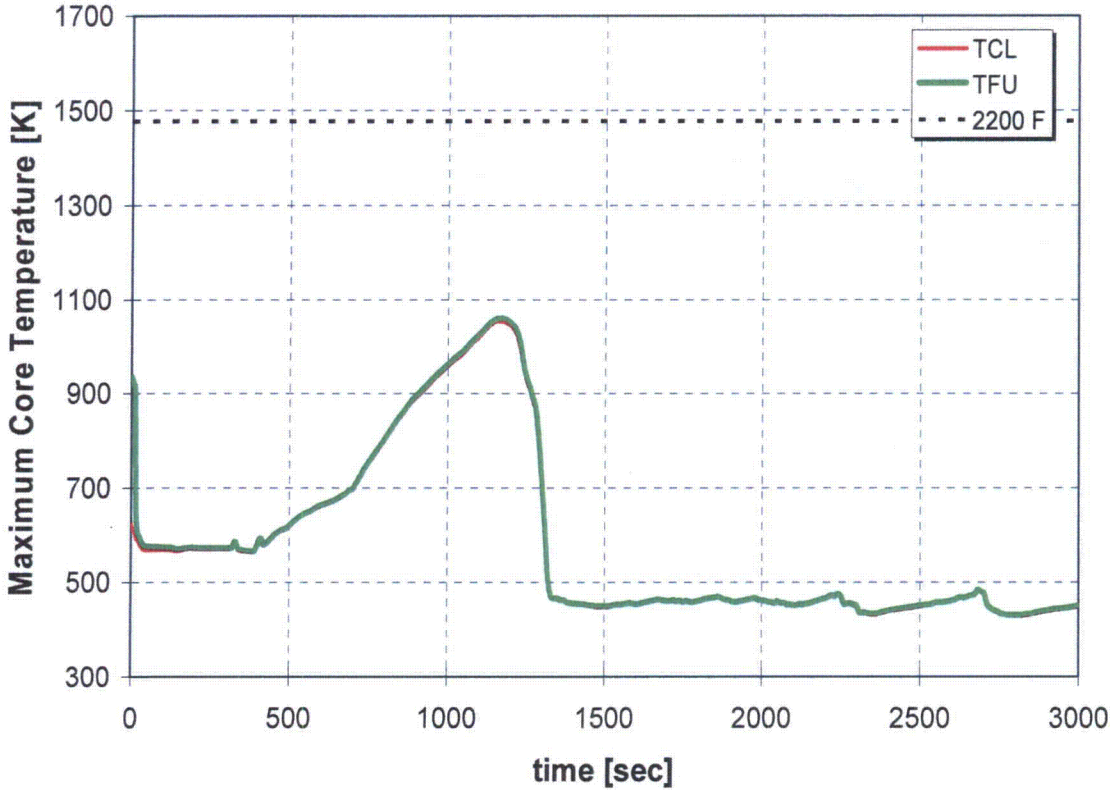



LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
time [sec]

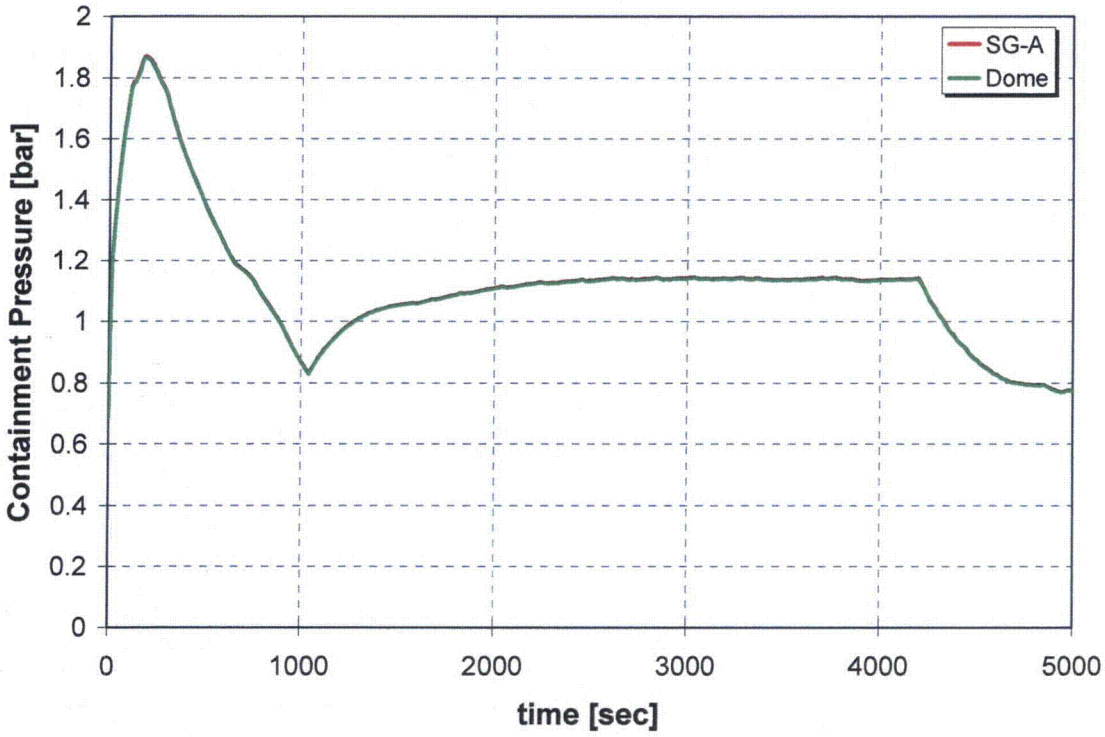

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
500
1000
1500
2000
2500
3000
time [sec]

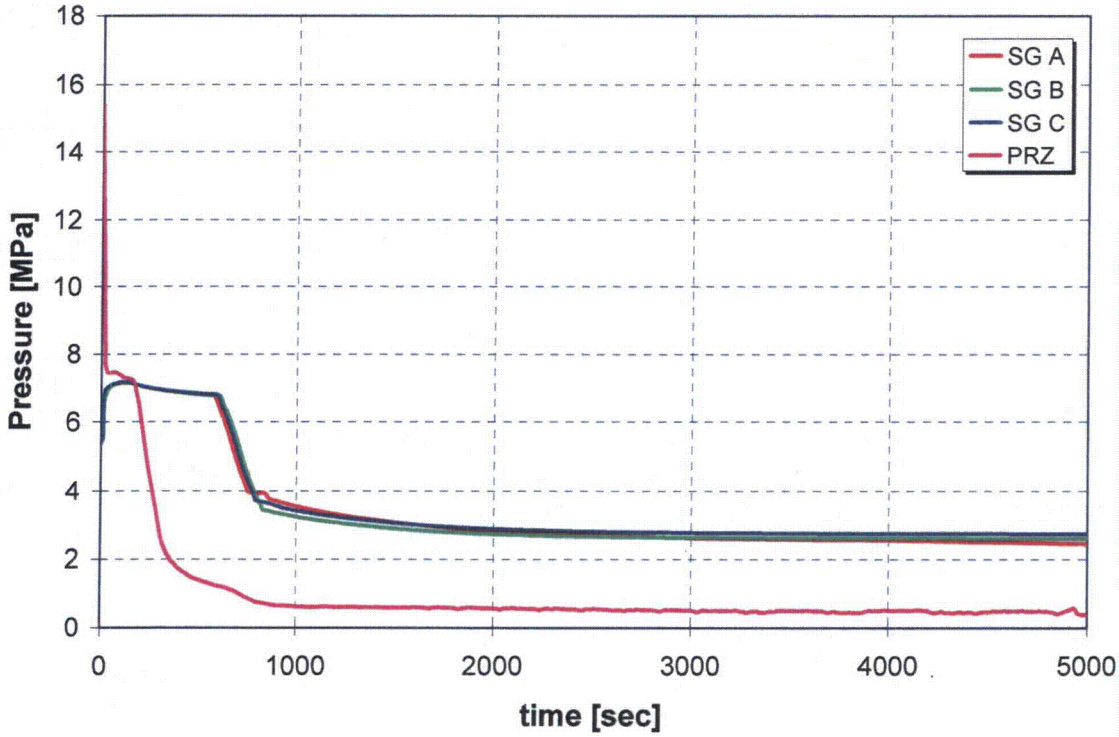

Containment Water Level [m]
time [sec]
Sump
Cavity
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
500
1000
1500
2000
2500
3000

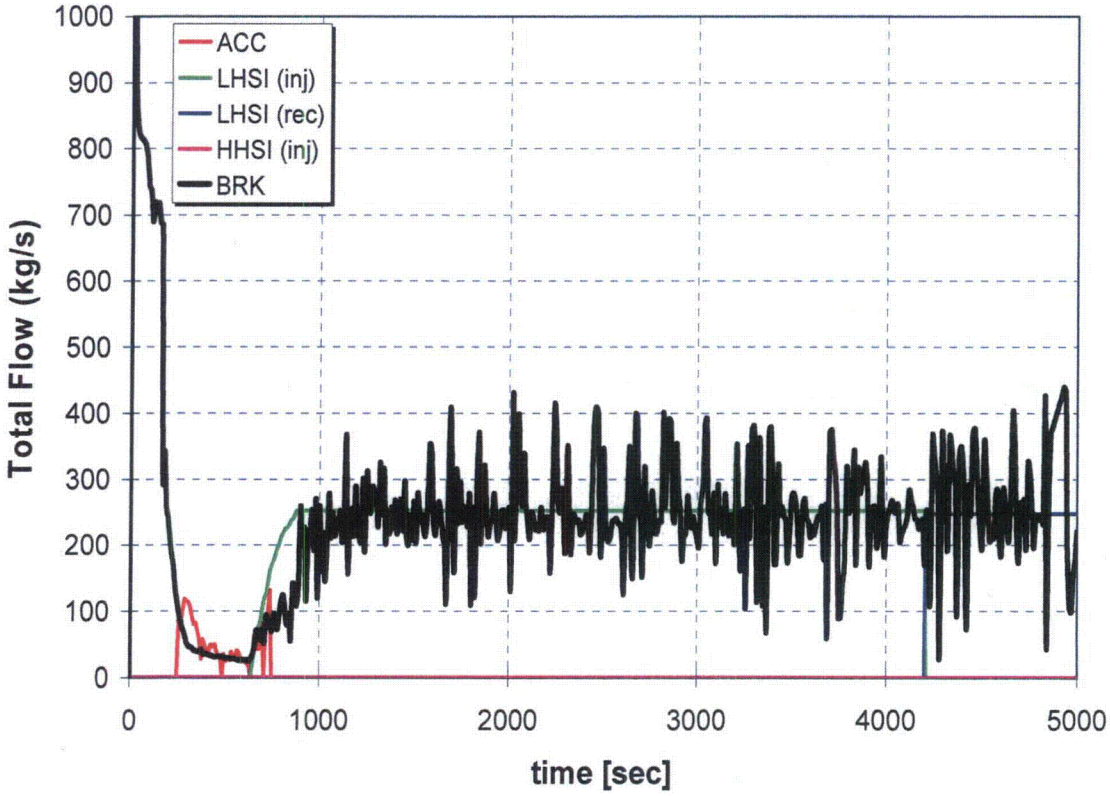

Reactor Water Level (m)
time [sec]
PRZ
DC
Ring 1
BAF
TAF
0
2
4
6
8
10
12
14
16
18
20
0
500
1000
1500
2000
2500
3000

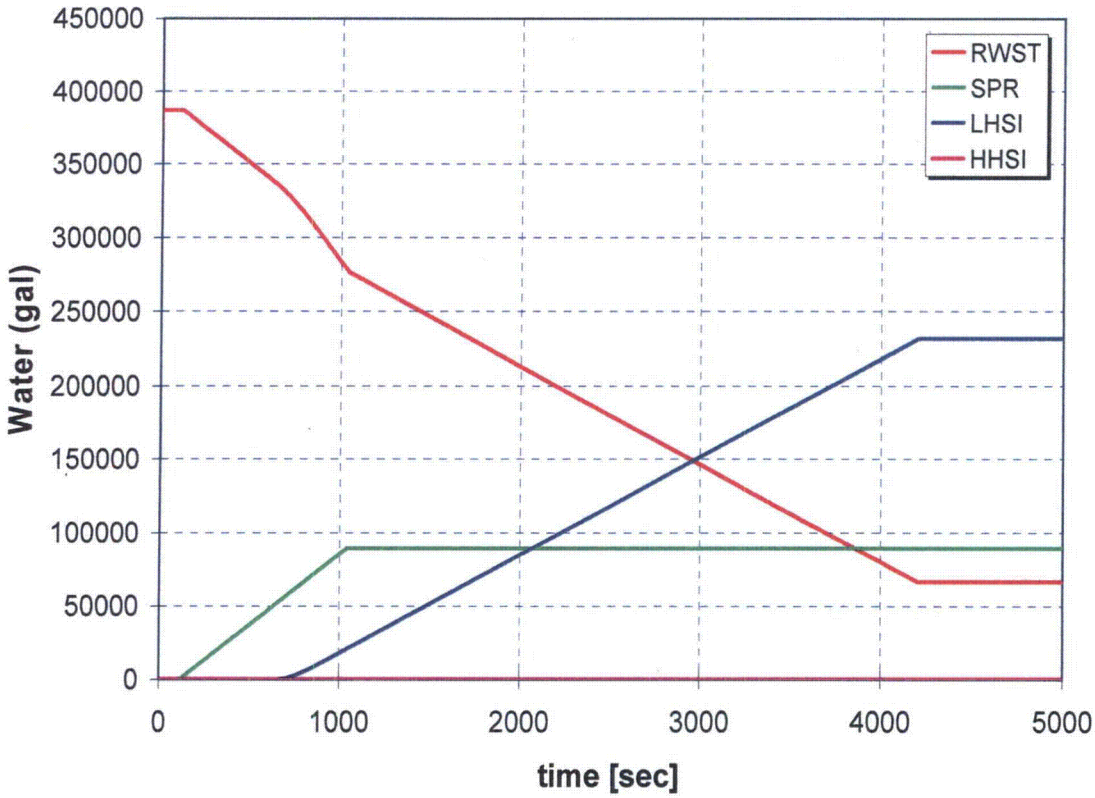

1700
1500
1300
1100
900
700
500
300
Maximum Core Temperature [K]
0
500
1000
1500
2000
2500
3000
time [sec]
TCL
TFU
2200 F

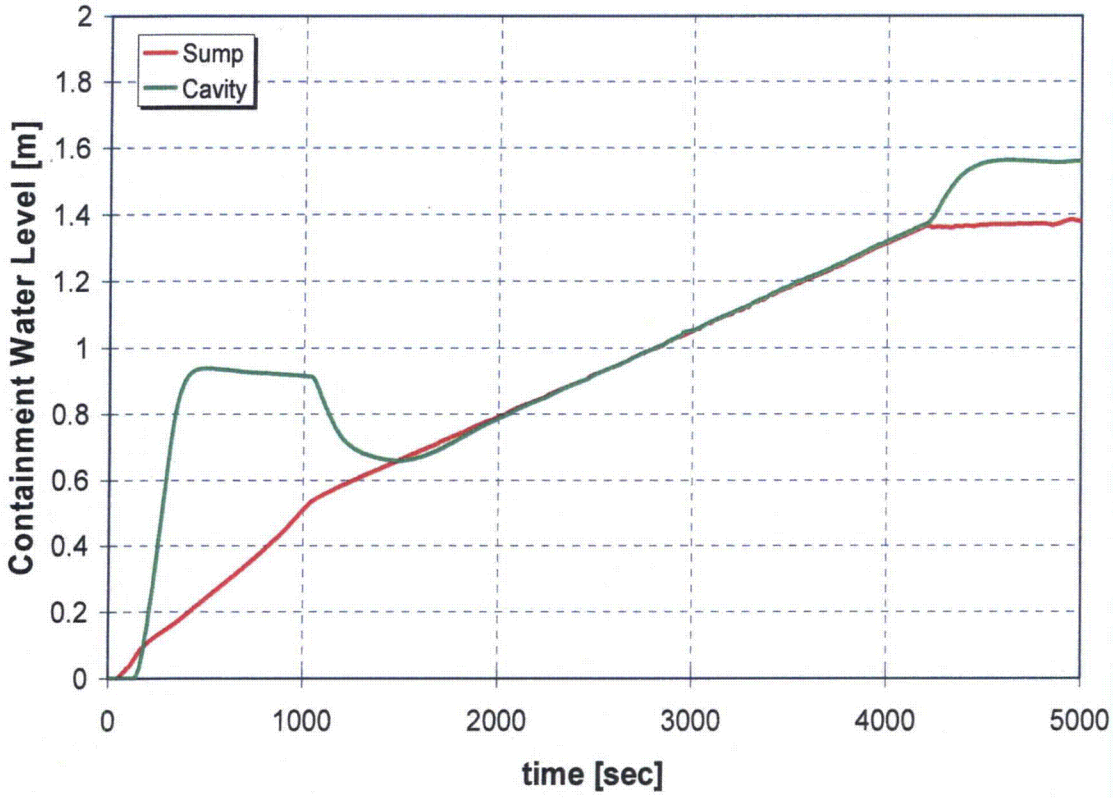
A.6.26 Case 26: 6-Inch Break LOCA, No HHSI, One LHSI, and One ACC, without Auxiliary Feedwater

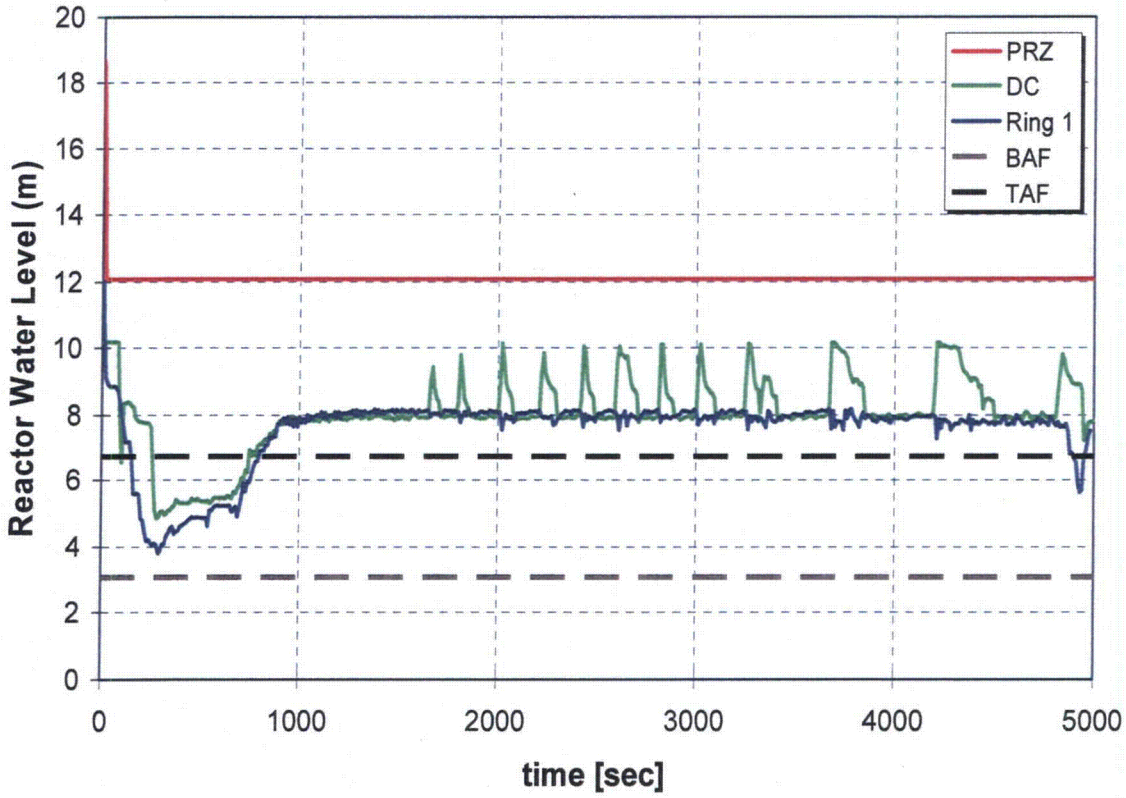


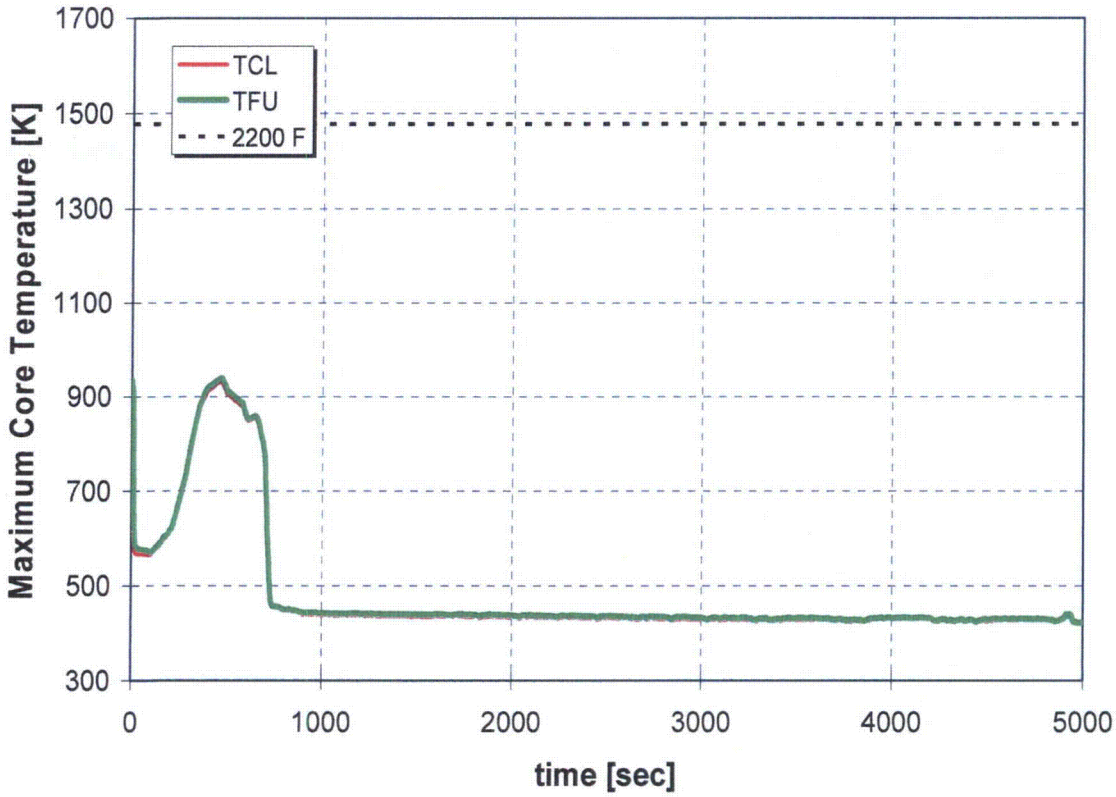



ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
4000
5000
time [sec]

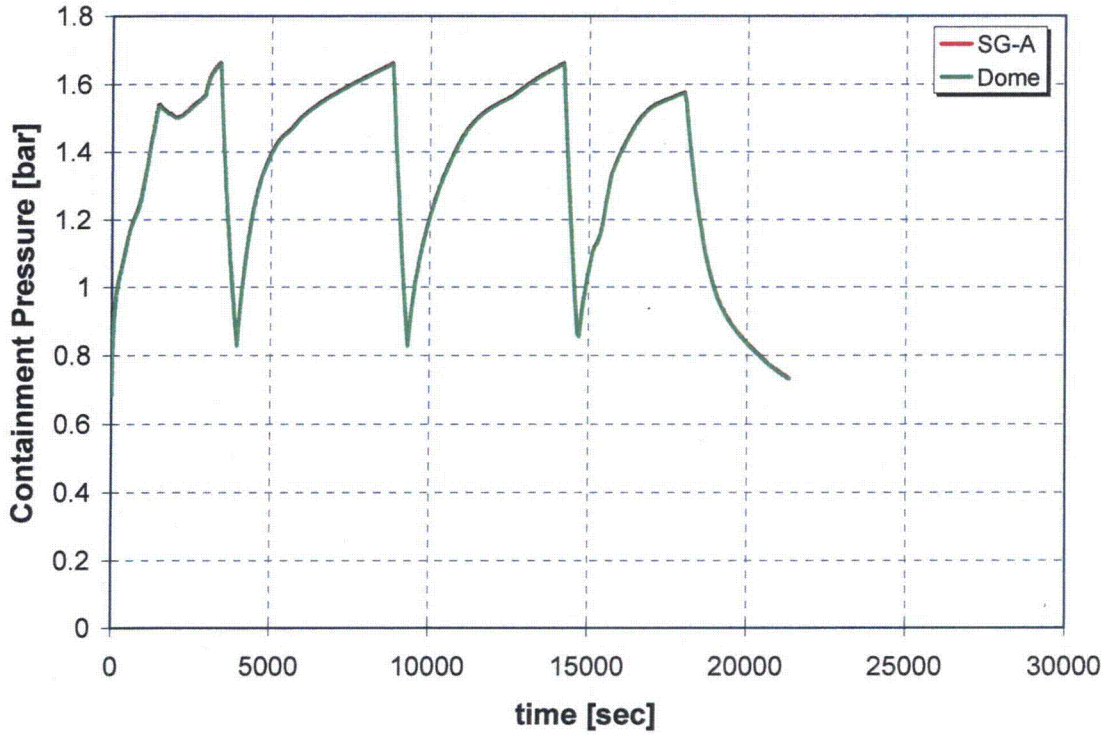

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
1000
2000
3000
4000
5000
time [sec]

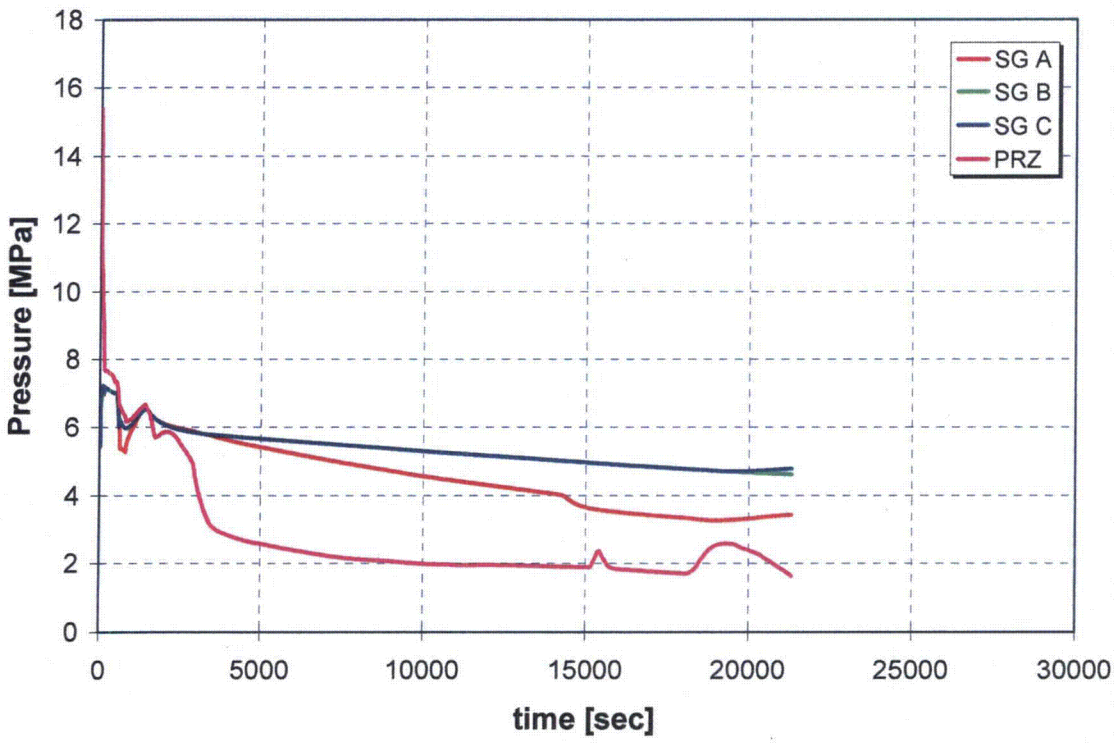

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1000
2000
3000
4000
5000
time [sec]

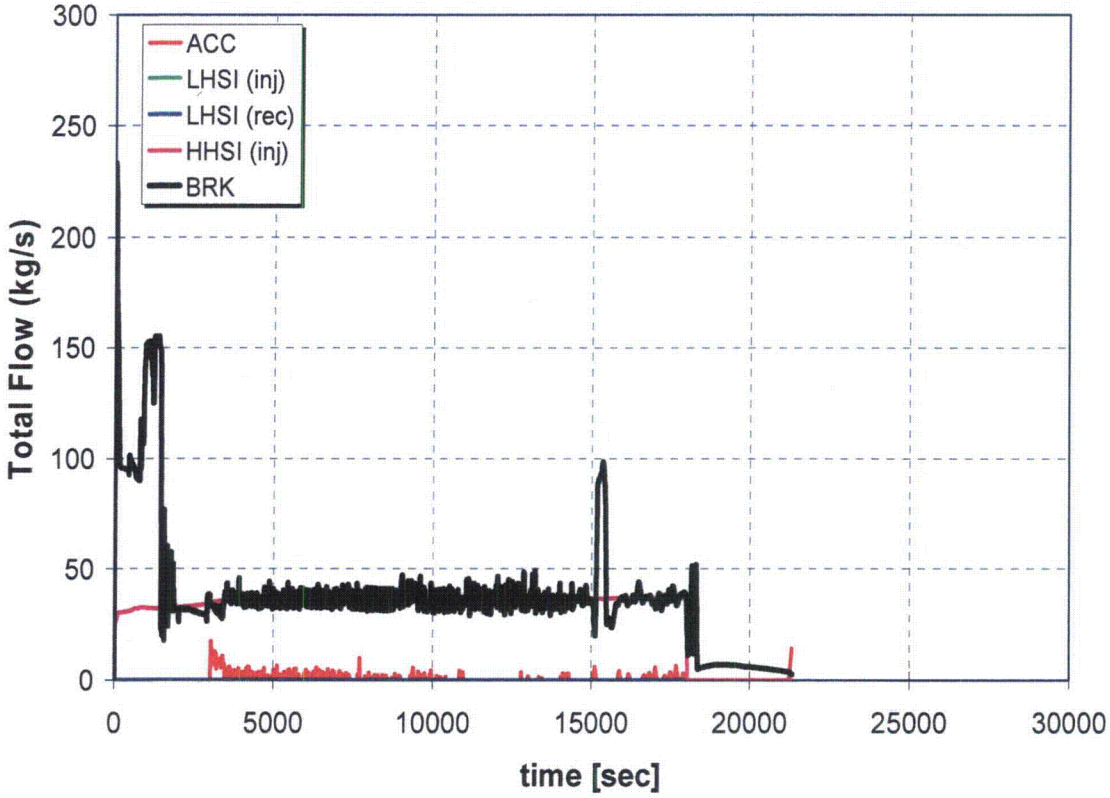

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
1000
2000
3000
4000
5000
time [sec]

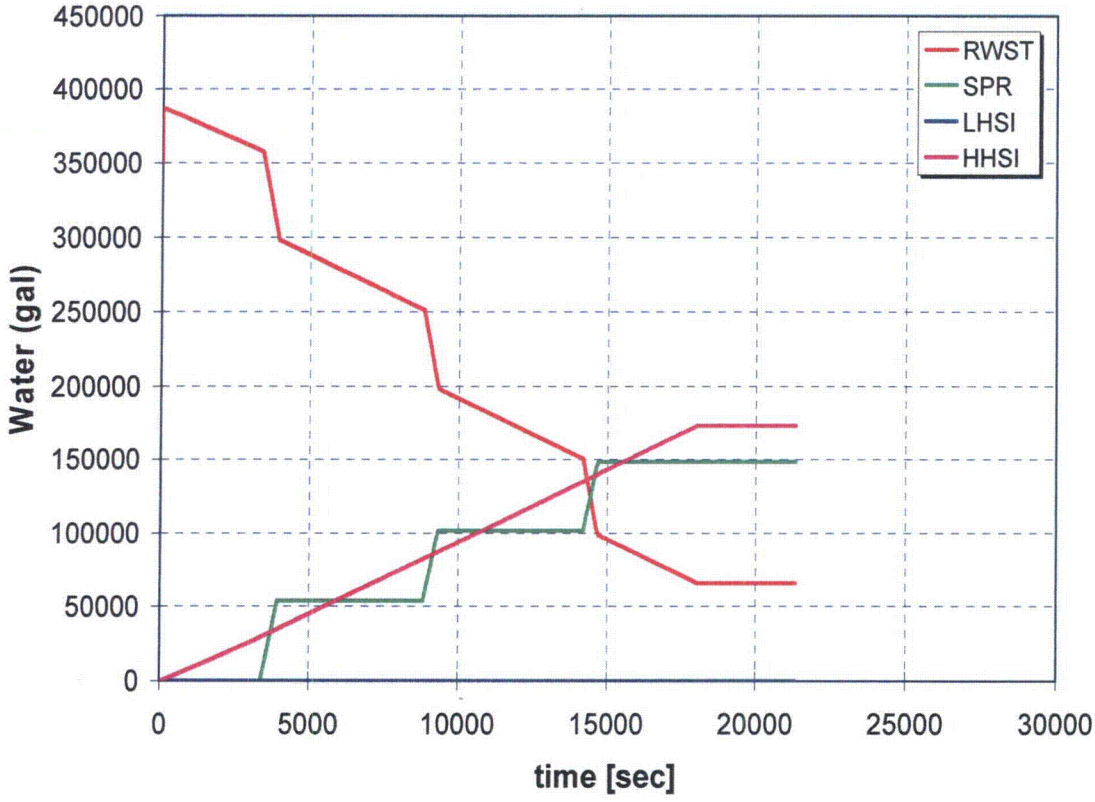

1700
1500
1300
1100
900
700
500
300
0
1000
2000
3000
4000
5000
TCL
TFU
2200 F
Maximum Core Temperature [K]
time [sec]

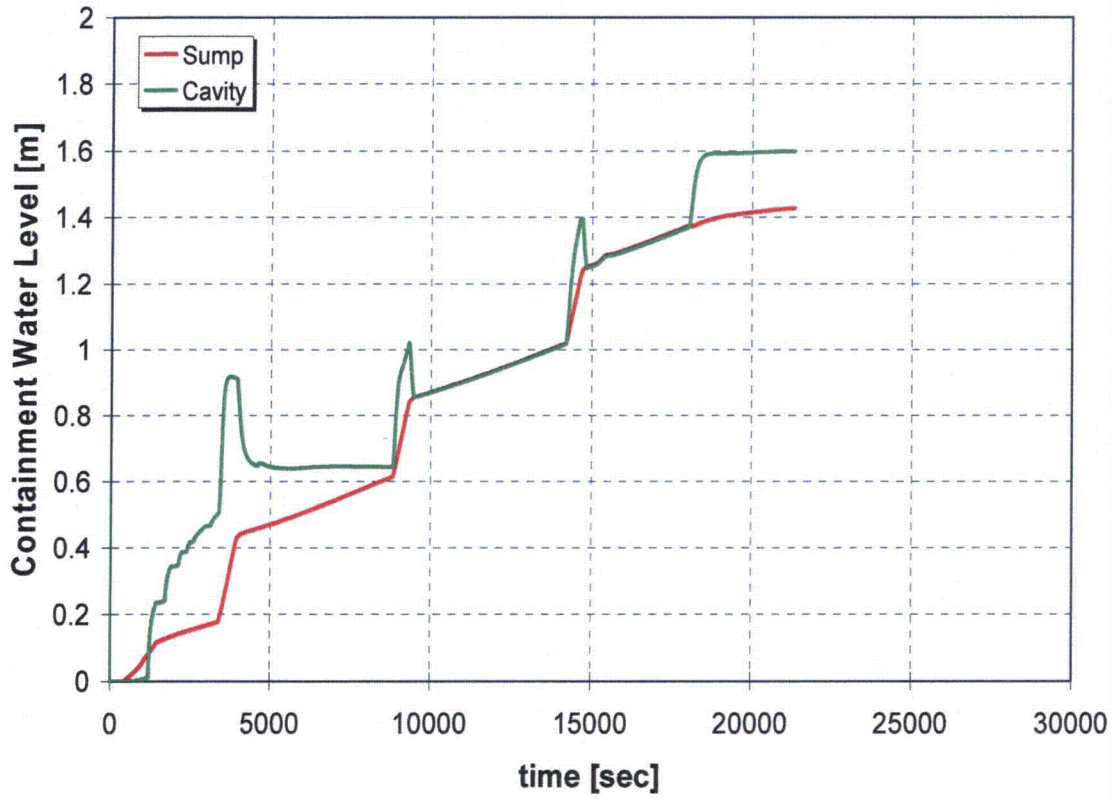
A.6.27 Case 27: 2-Inch Break LOCA, One HHSI, No LHSI, and One ACC, without Auxiliary Feedwater

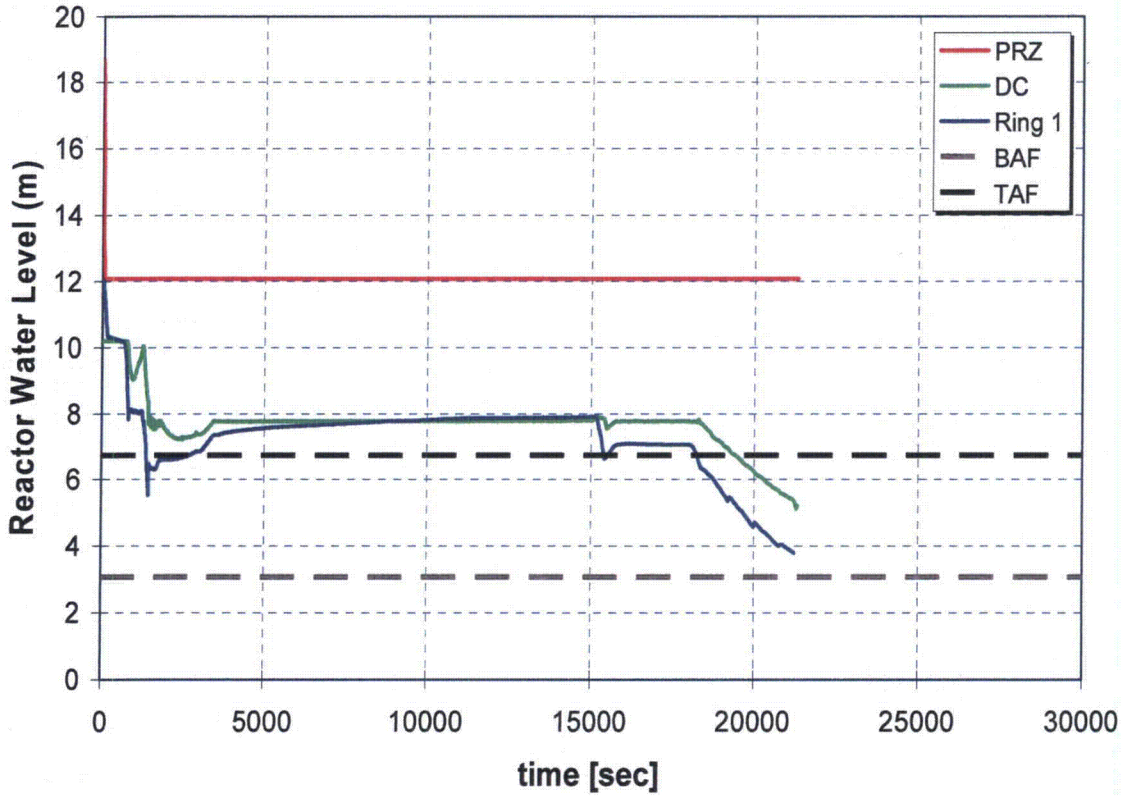


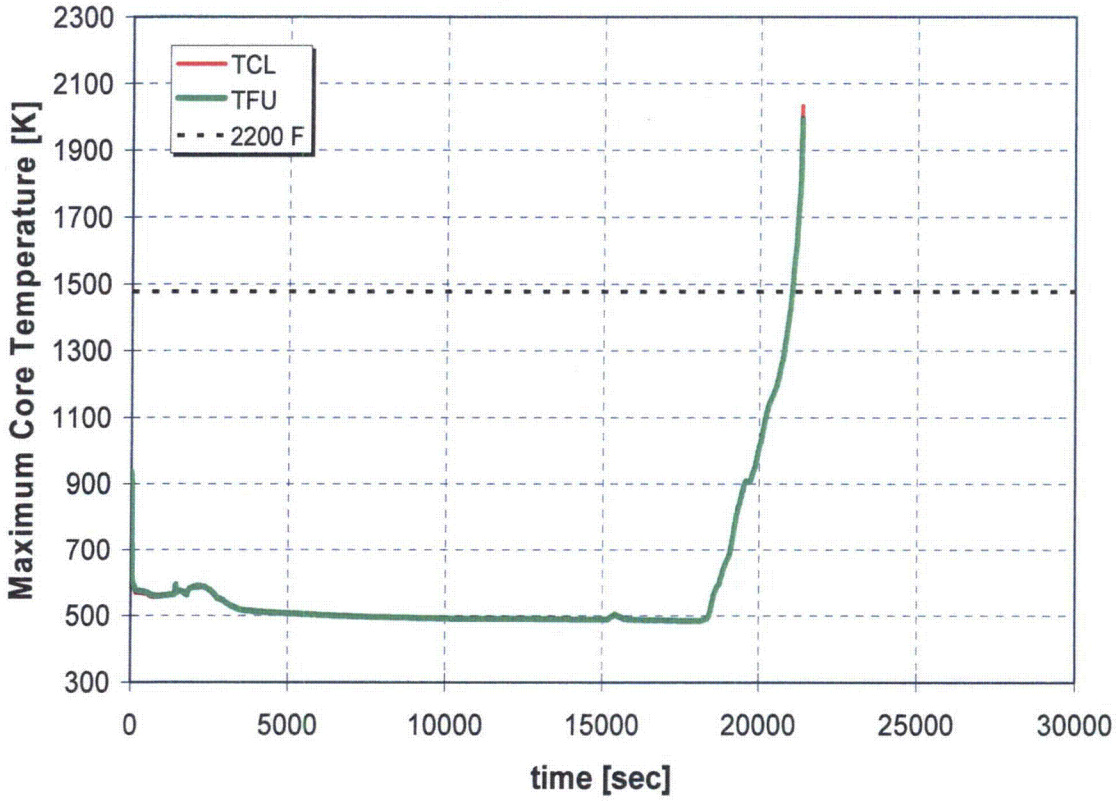



ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
300
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
30000
time [sec]

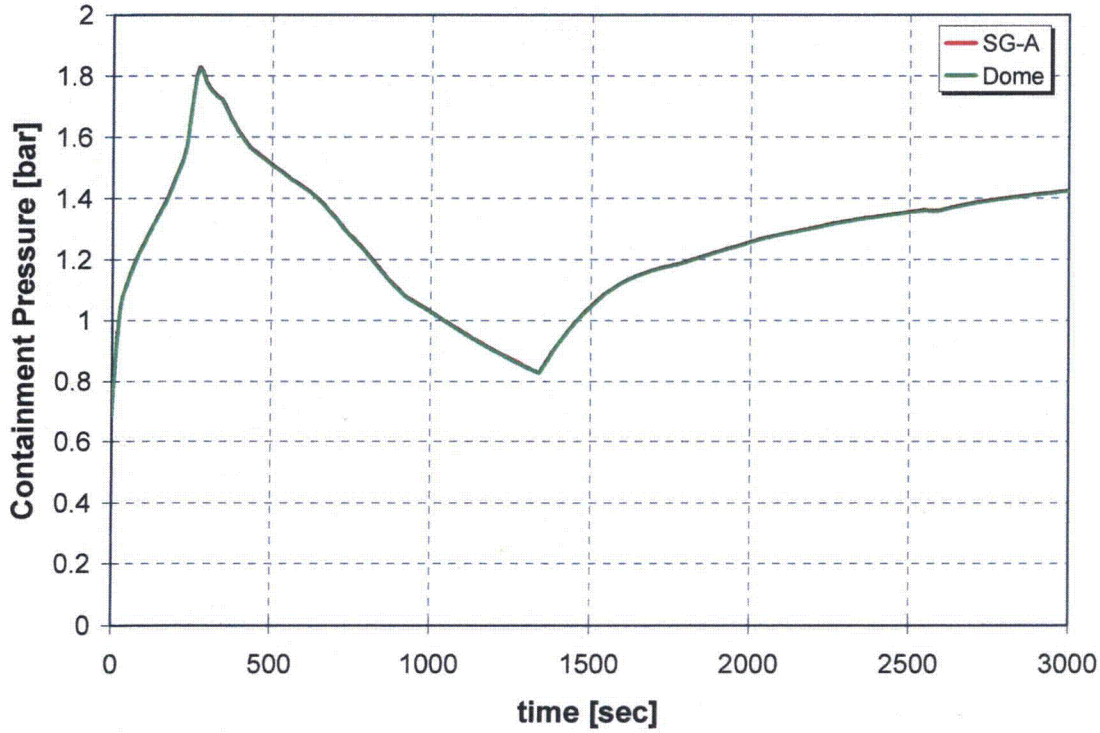

RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
5000
10000
15000
20000
25000
30000
time [sec]

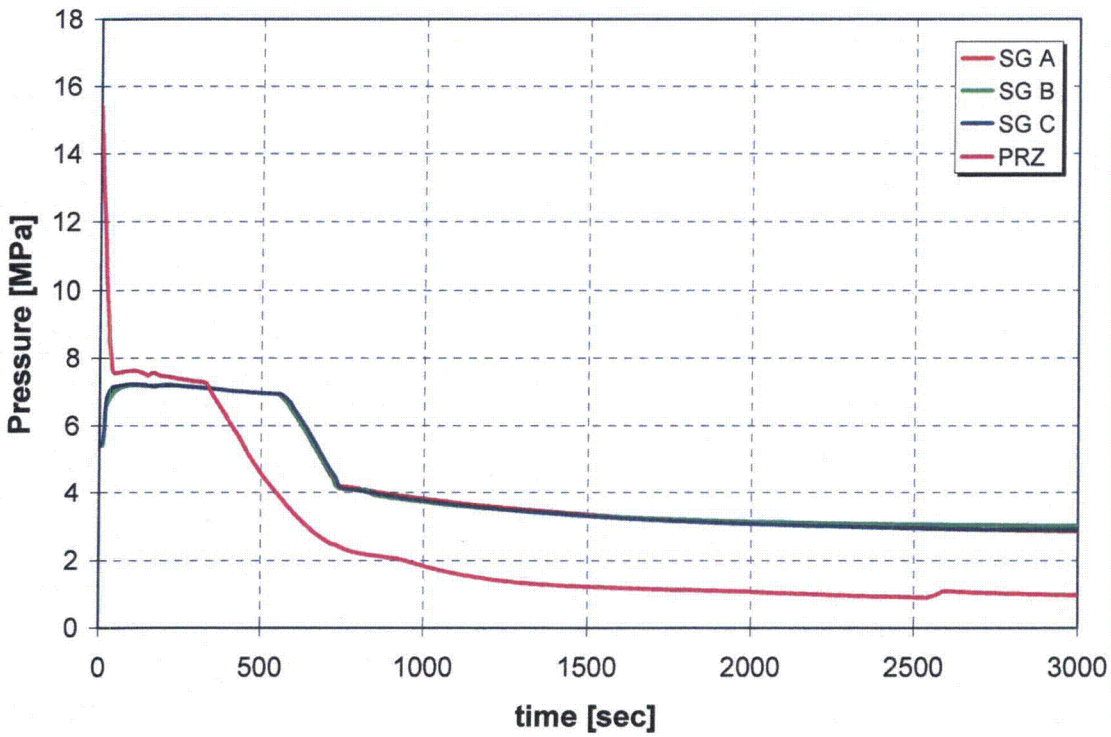

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5000
10000
15000
20000
25000
30000
time [sec]

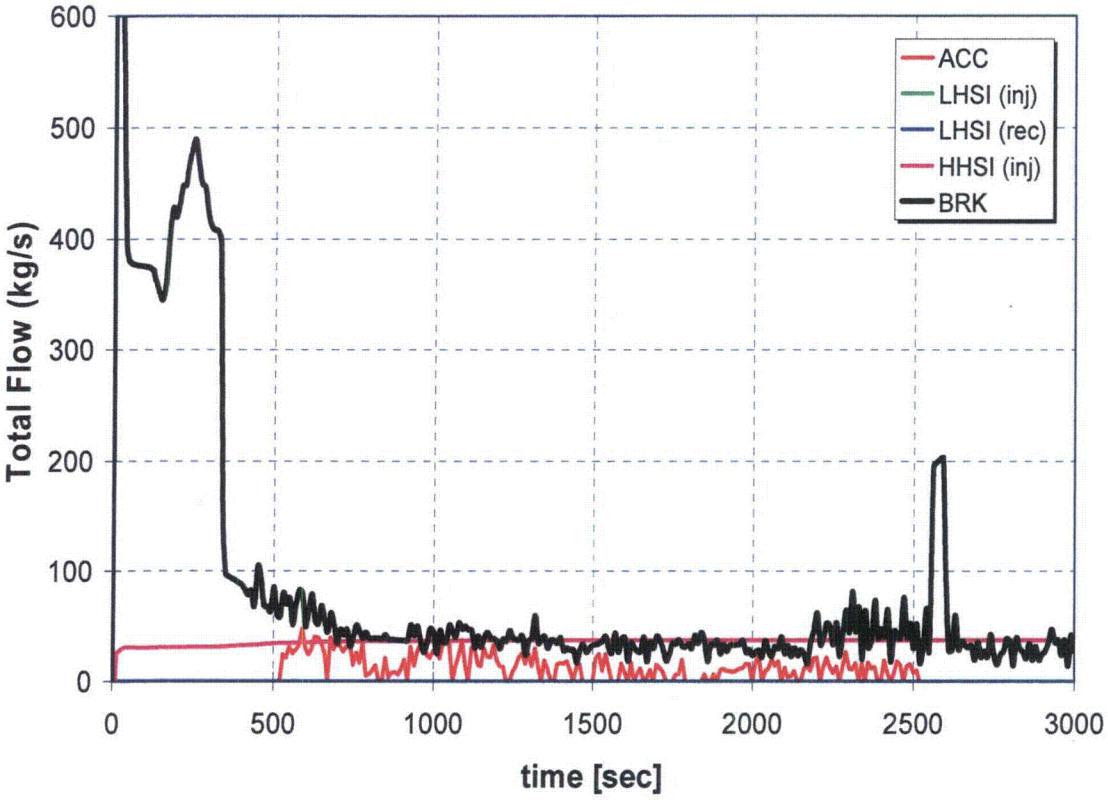

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
5000
10000
15000
20000
25000
30000
time [sec]

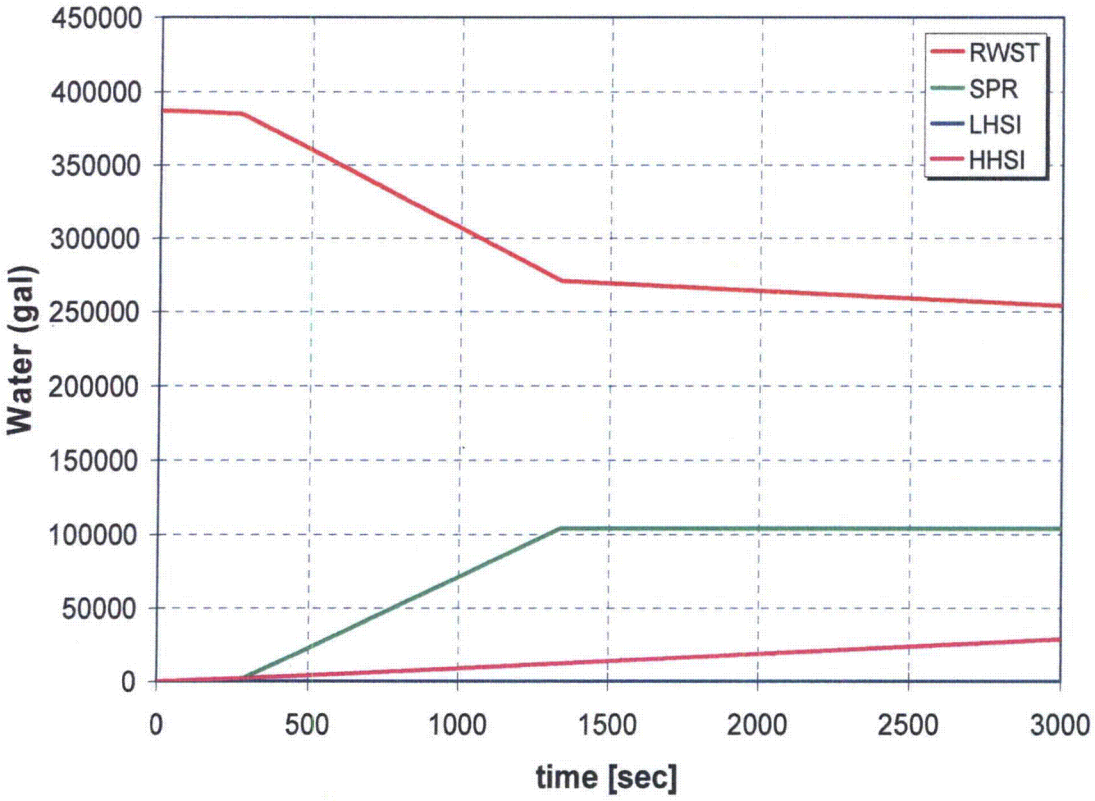

TCL
TFU
2200 F
Maximum Core Temperature [K]
2300
2100
1900
1700
1500
1300
1100
900
700
500
300
0
5000
10000
15000
20000
25000
30000
time [sec]

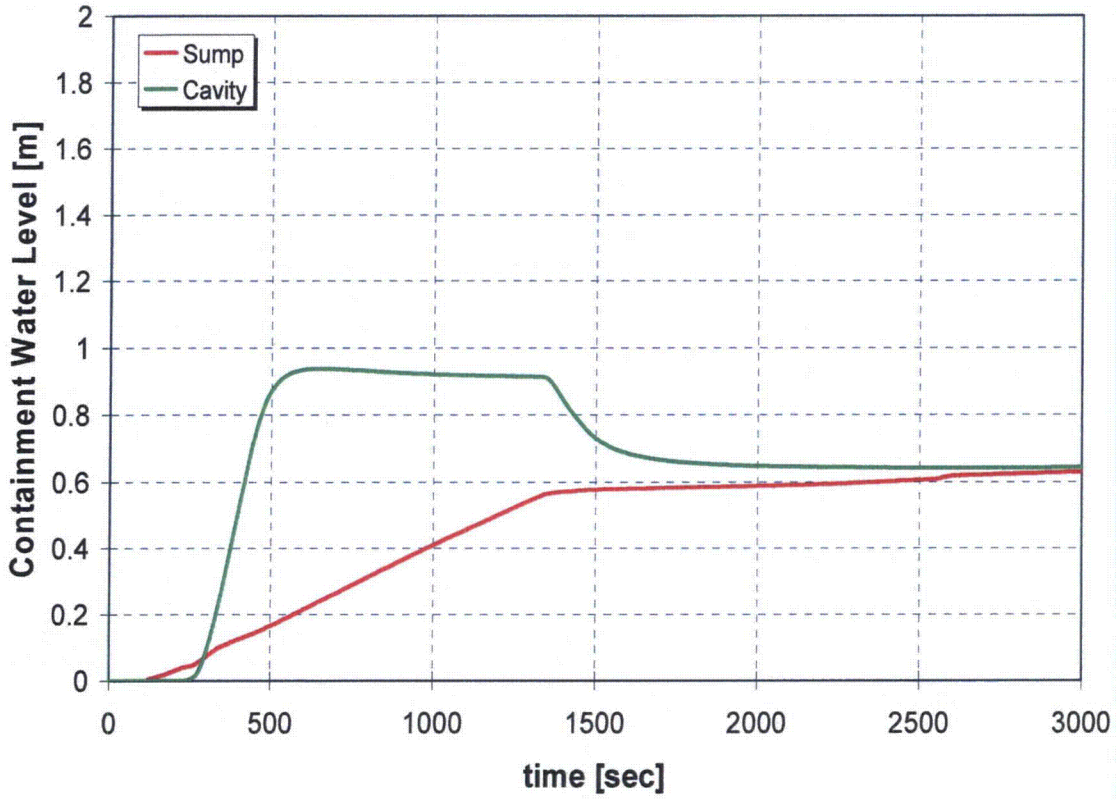
A.6.28 Case 28: 4-Inch Break LOCA, One HHSI, No LHSI, and One ACC, without Auxiliary Feedwater

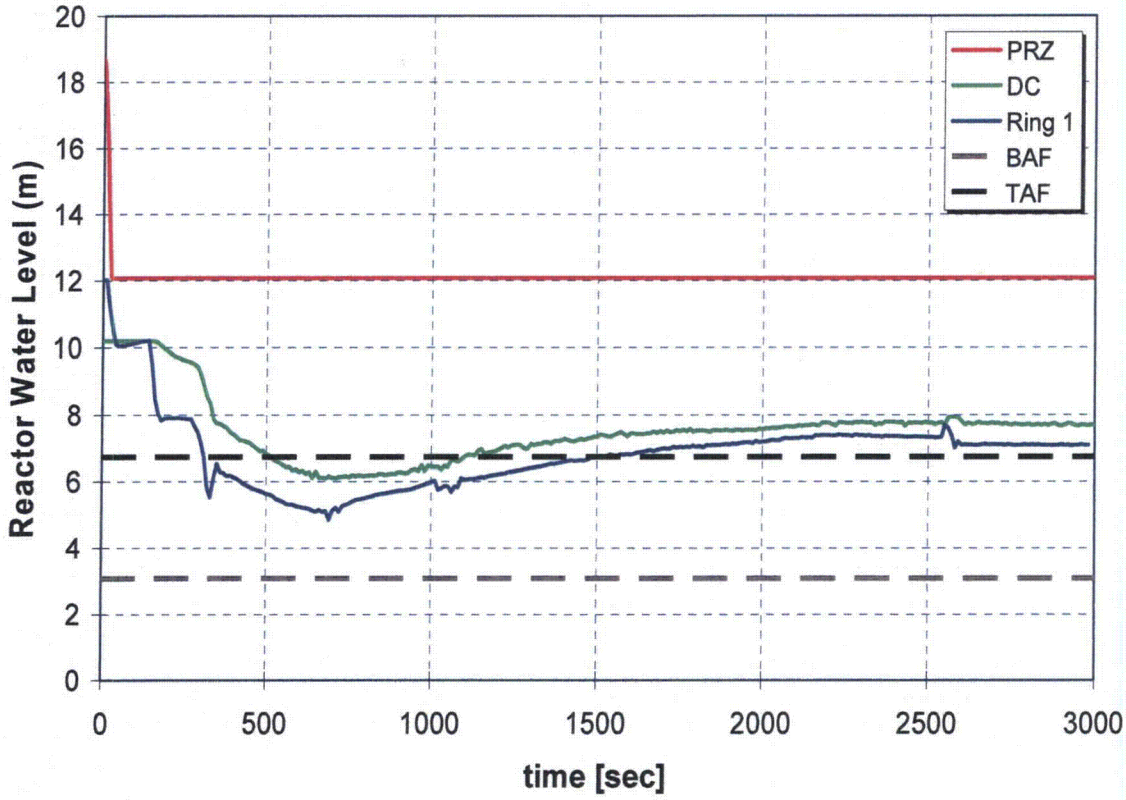


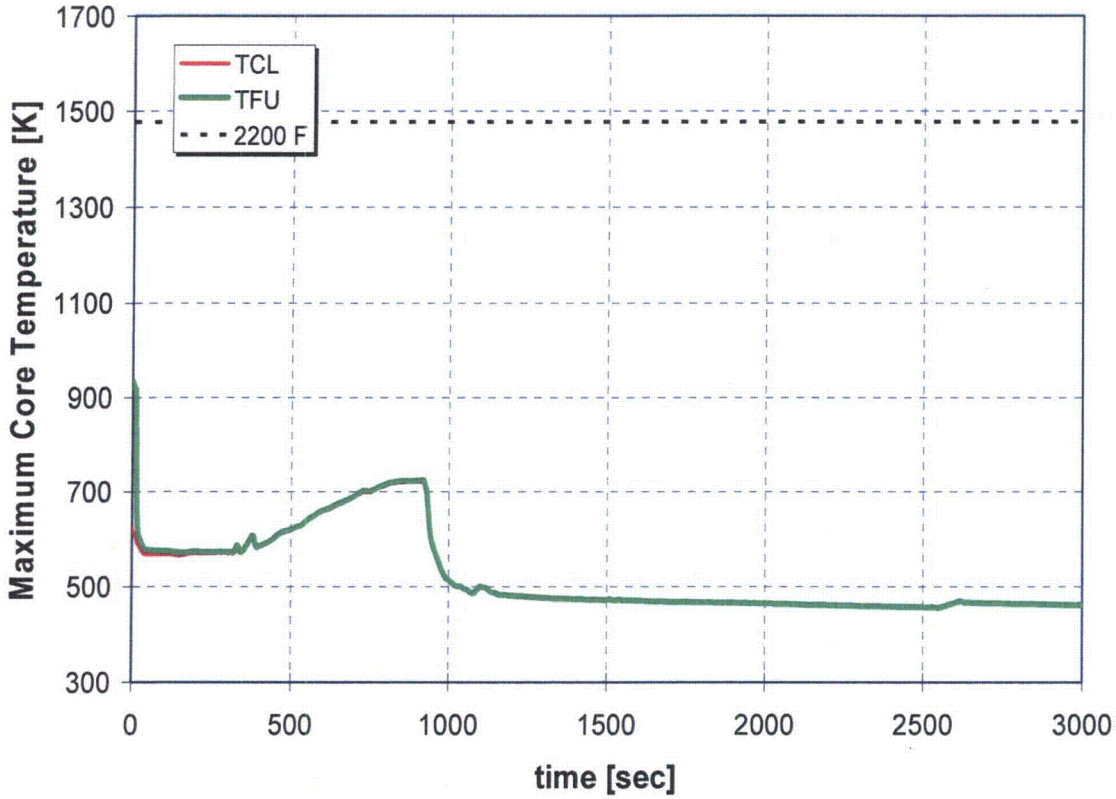



600
500
400
300
200
100
0
Total Flow (kg/s)
0
500
1000
1500
2000
2500
3000
time [sec]
ACC
LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK

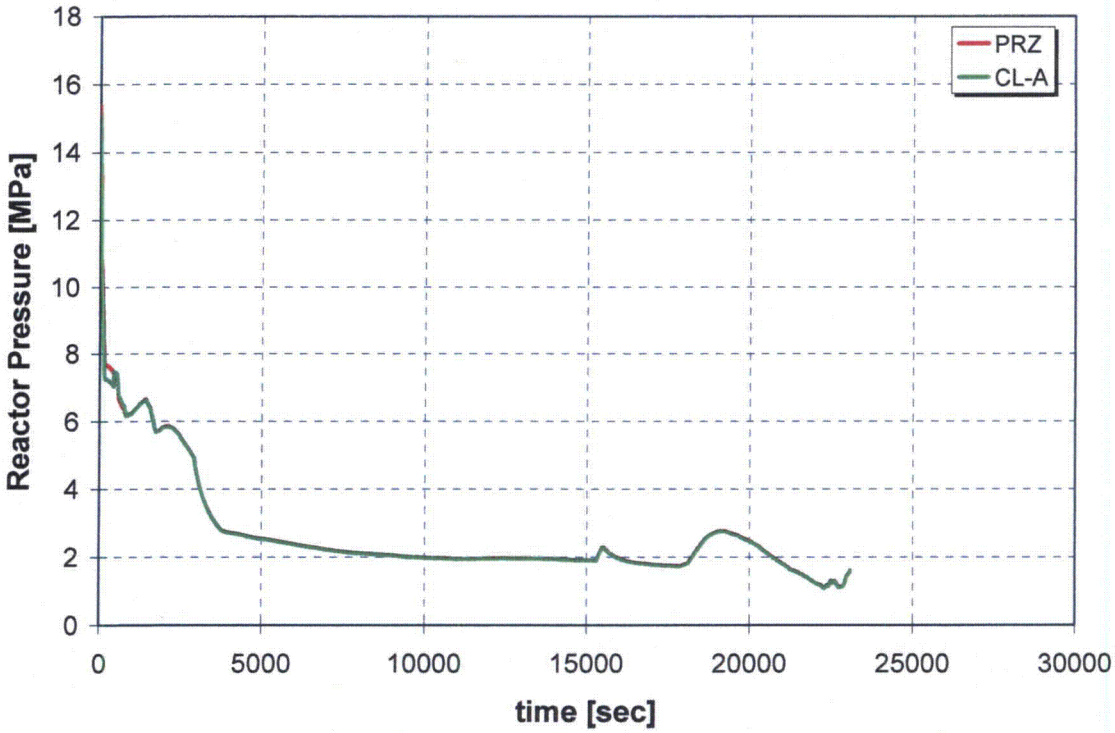

450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Water (gal)
0
500
1000
1500
2000
2500
3000
time [sec]
RWST
SPR
LHSI
HHSI

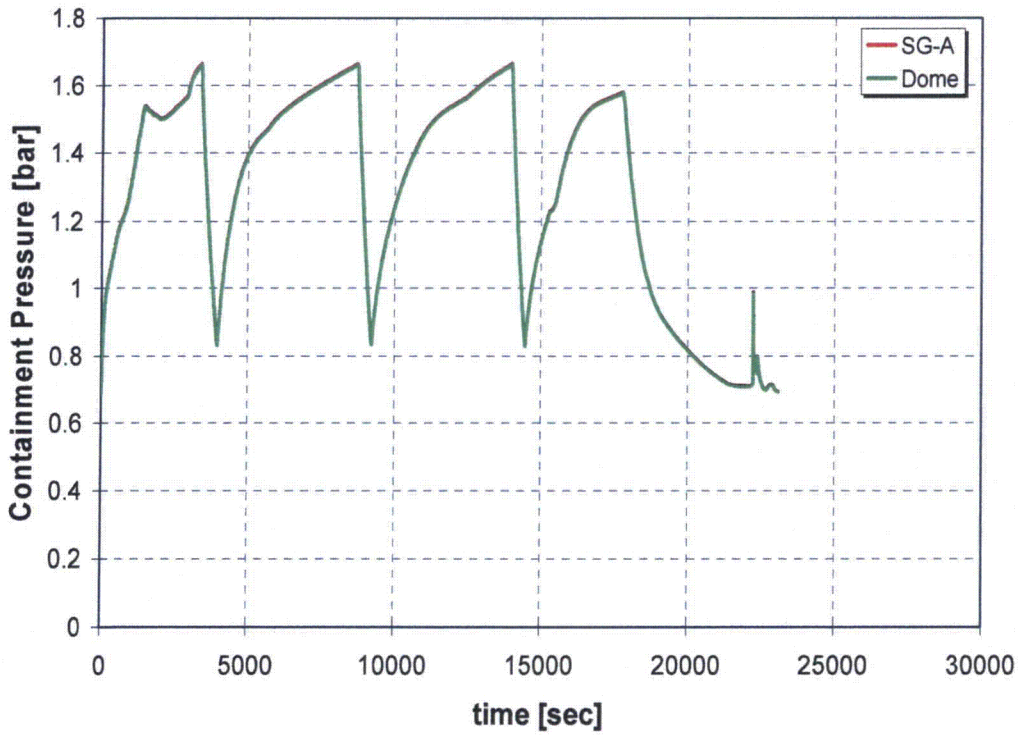

Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
time [sec]

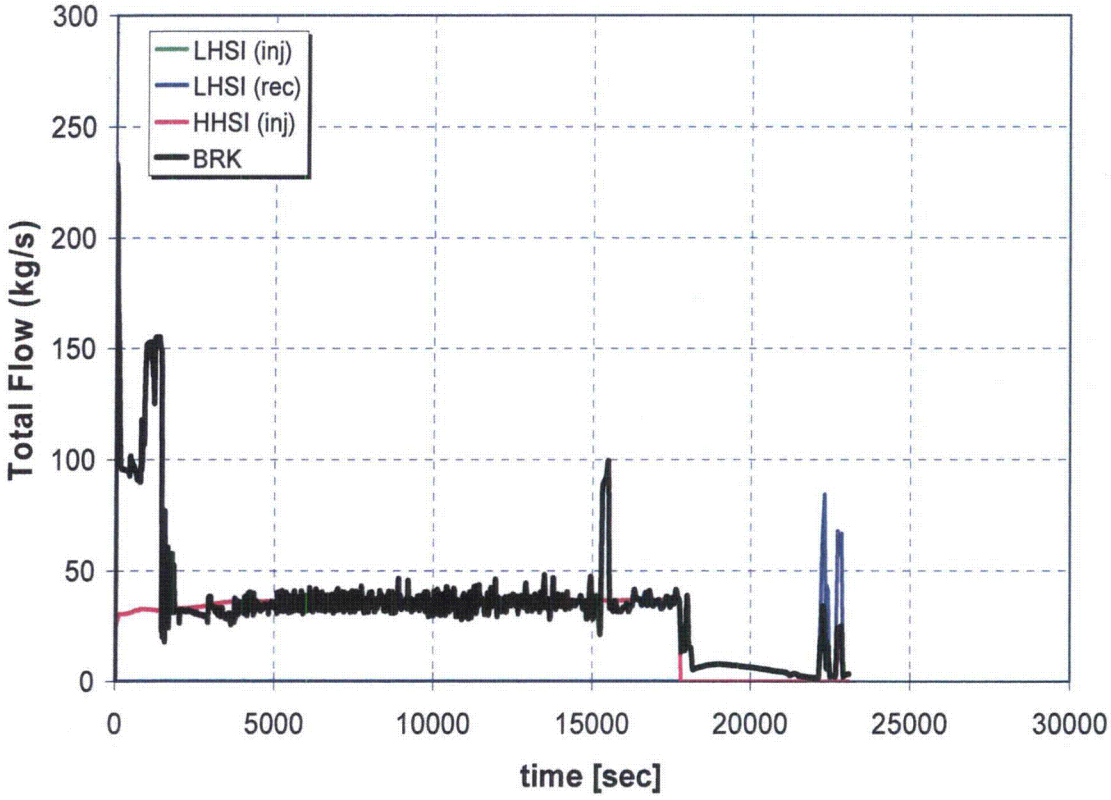

PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
time [sec]

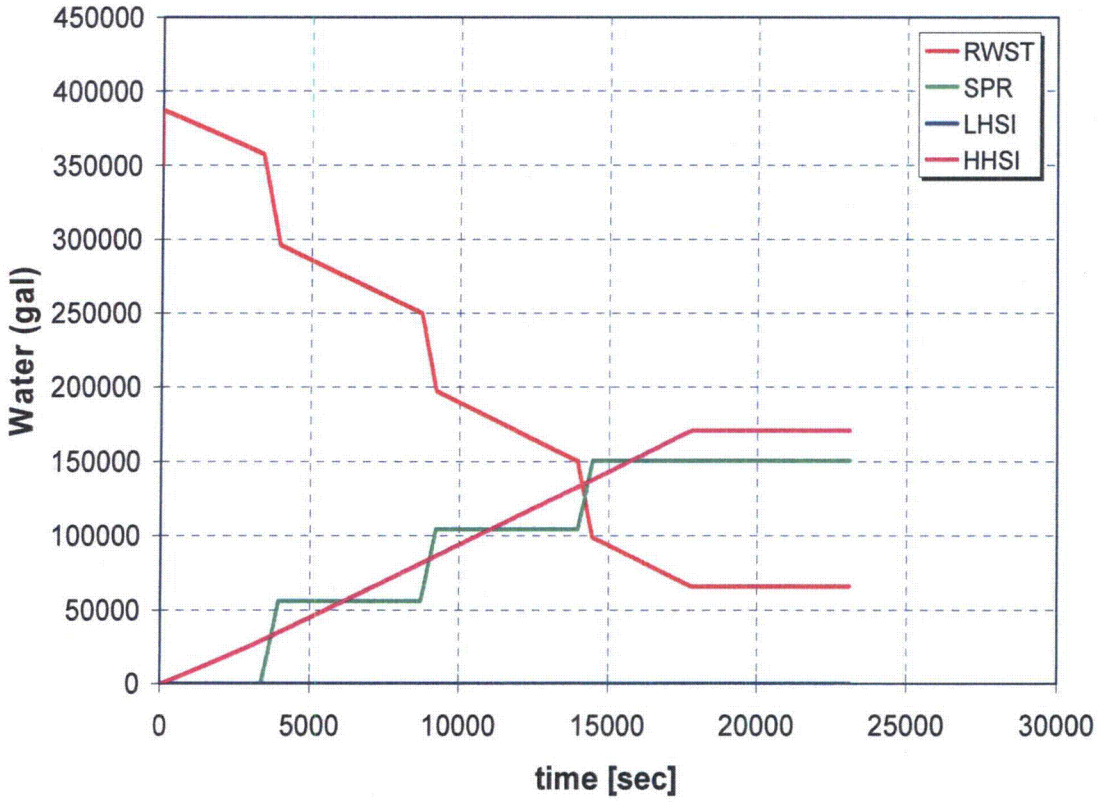

TCL
TFU
2200 F
Maximum Core Temperature [K]
1700
1500
1300
1100
900
700
500
300
0
500
1000
1500
2000
2500
3000
time [sec]

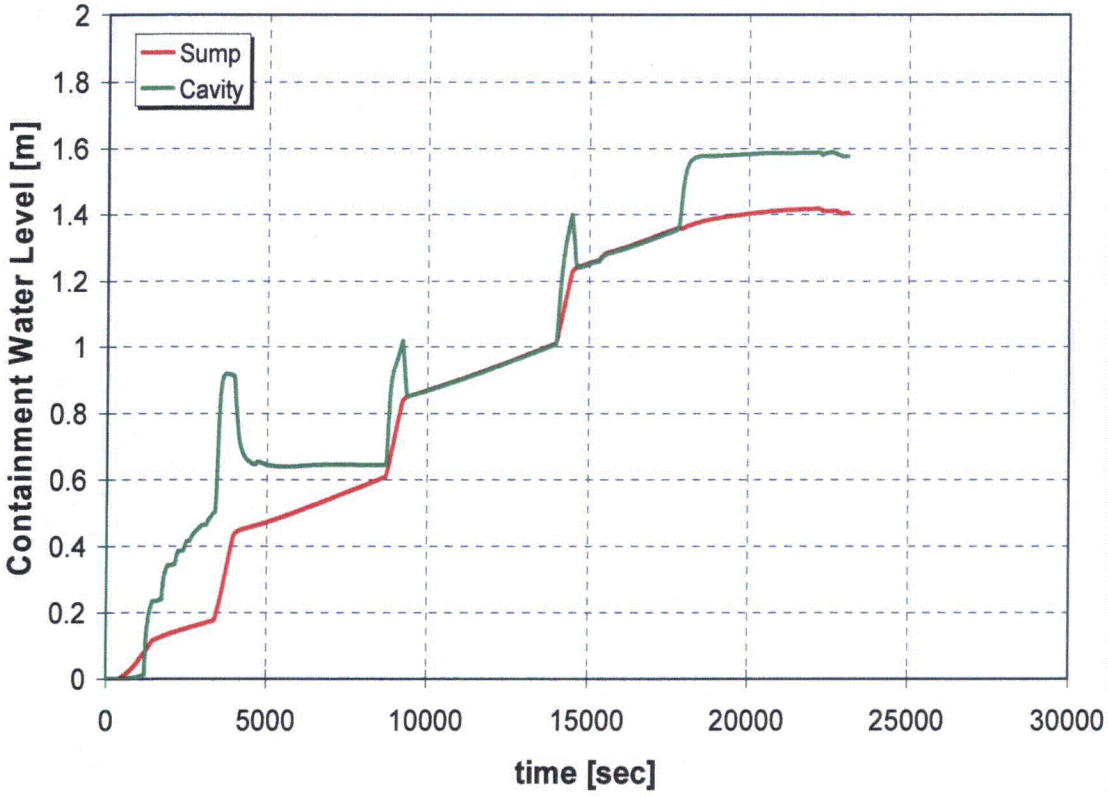
A.6.29 Case 29: 2-Inch Break LOCA, One HHSI, One LHSI, and No ACC, without Auxiliary Feedwater

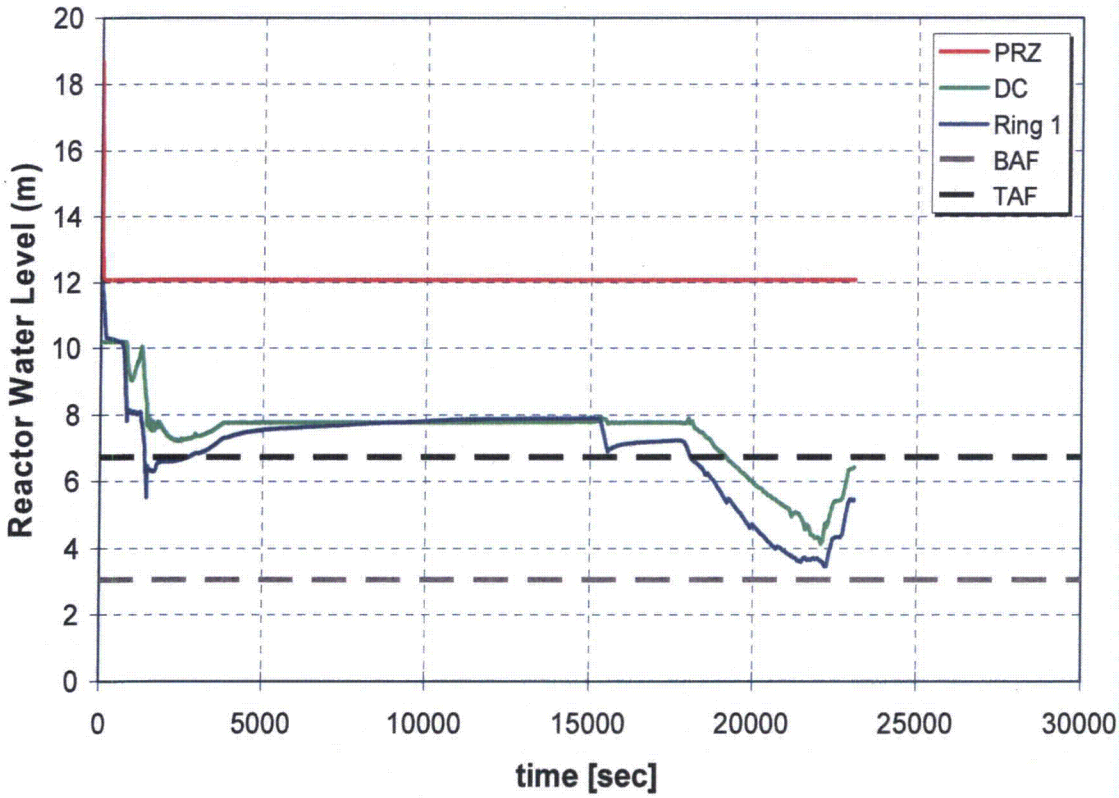


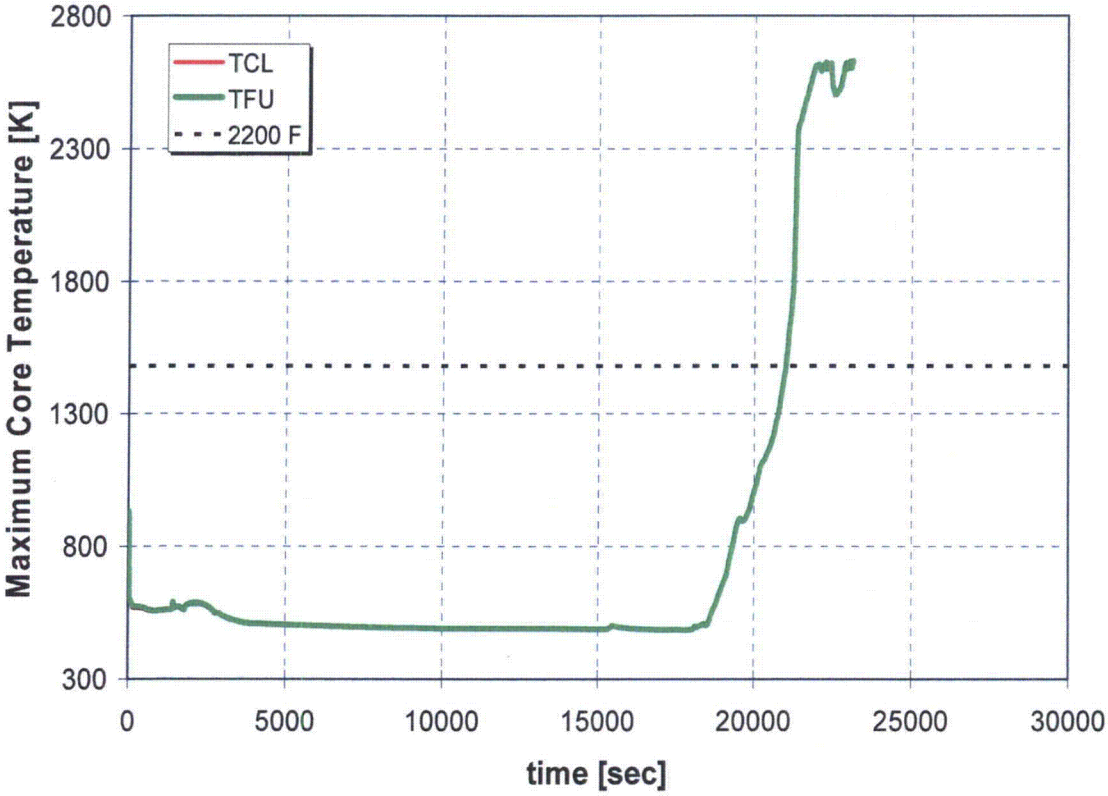



LHSI (inj)
LHSI (rec)
HHSI (inj)
BRK
Total Flow (kg/s)
300
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
30000
time [sec]


RWST
SPR
LHSI
HHSI
Water (gal)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
5000
10000
15000
20000
25000
30000
time [sec]


Sump
Cavity
Containment Water Level [m]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5000
10000
15000
20000
25000
30000
time [sec]


PRZ
DC
Ring 1
BAF
TAF
Reactor Water Level (m)
20
18
16
14
12
10
8
6
4
2
0
0
5000
10000
15000
20000
25000
30000
time [sec]


2800
2300
1800
1300
800
300
Maximum Core Temperature [K]
TCL
TFU
2200 F
0
5000
10000
15000
20000
25000
30000
time [sec]

A.7 REFERENCES

[NRC, 2003] U.S. Nuclear Regulatory Commission, "Virginia Electric and Power Company Docket No. 50-280 Surry Power Station, Unit No. 1 Renewed Facility Operating License," March 2003. Agencywide Documents Access and Management System (ADAMS) Accession No. ML0529103580.

APPENDIX B

PEACH BOTTOM MELCOR ANALYSES

TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

ac	alternating current
ADS	automatic depressurization system
BAF	bottom of active fuel
C	Celsius
CRD	control rod drive injection
CST	condensate storage tank
dc	direct current
DC	downcomer
DW	drywell
F	Fahrenheit
ft	feet
FW	feedwater
HCTL	heat capacity temperature limit
HPCI	high-pressure core injection
hr	hour
JP	jet pump
K	Kelvin
kg/s	kilograms per second
LPCI	low-pressure core injection
LPCS	low-pressure core spray
m	meter
min	minute
MPa	megapascal
MSIV	main steam isolation valve
NPSH	net positive suction head
psig	pounds per square inch gage
RCIC	reactor core isolation cooling
RPV	reactor pressure vessel
sec	seconds
SP	suppression pool
SPC	suppression pool cooling
SRV	safety relief valve
SV	safety valve
TAF	top of active fuel
TCL	cladding temperature
TFU	fuel temperature
TLIQ	liquid temperature
TSAT	saturation temperature
TVAP	vapor temperature
WW	wetwell

B.1 Inadvertent Open Relief Valve Success Criteria

Analysis Summary

Table 1 and Table 2 below provide results for this portion of the analysis.

Table 1 Peach Bottom Inadvertent Open SRV Results

Case	RCIC	HPCI	CRD	LPCI	LPCS	ac/dc	FW, SPC, ADS	Core Uncovery (hr)	Core Damage (hr)
1	Yes	No	No	Yes	No	ac/dc	No	No	No
2	No	Yes						No	No
3		No	1 at t = 0 and 2 at t = 10 min					0.41	No
4			1 at t = 0 and 2 at t = 20 min					0.37	No
4a[1]								0.29	No
5			No					0.32	No

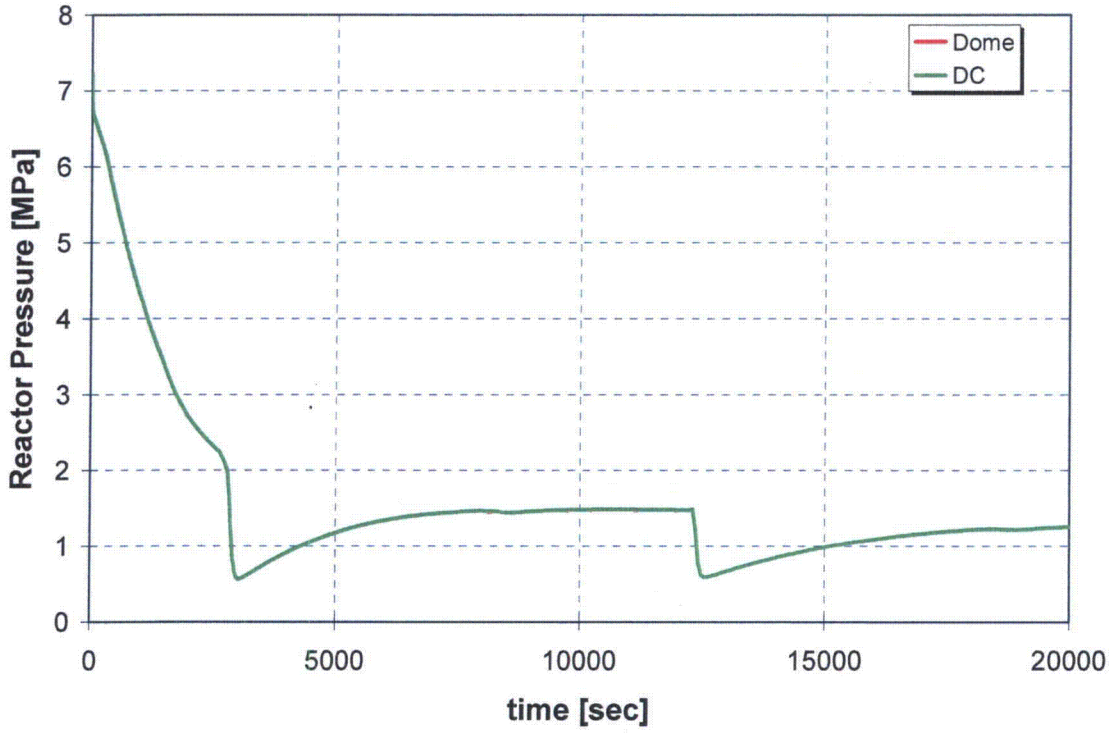
[1] For this case, the reactor was allowed to scram based on a reactor protection system trip signal, rather than at time t = 0.

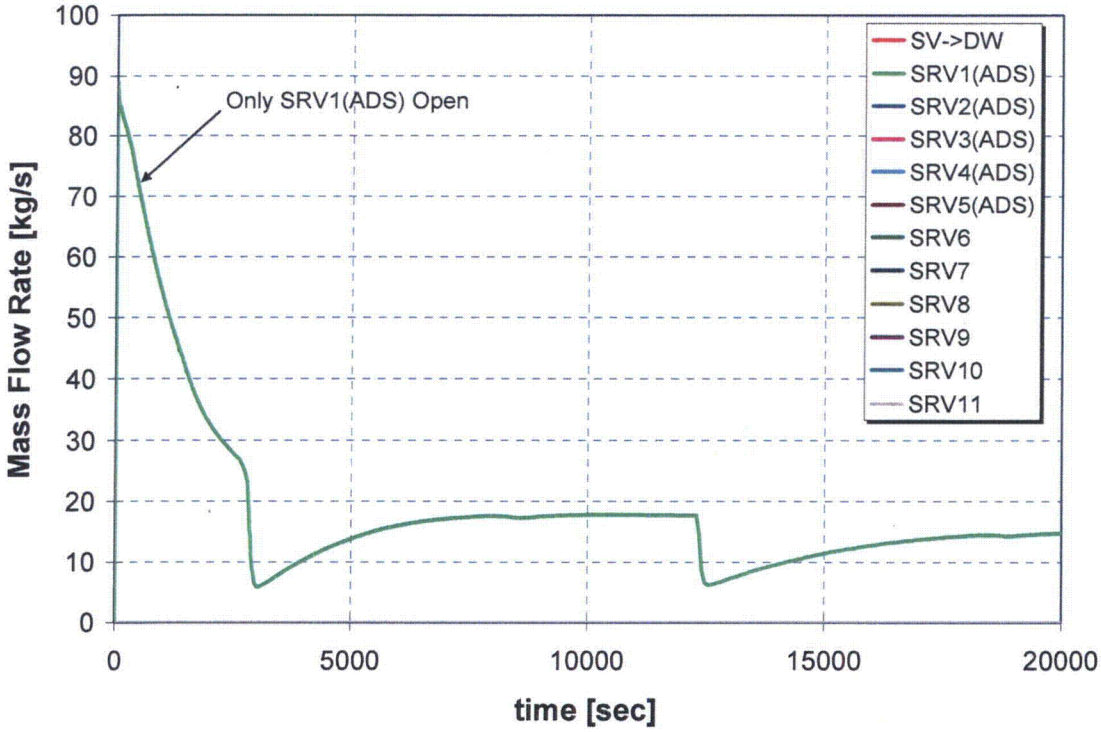
Table 2 Peach Bottom Inadvertent Open SRV Key Timings (Cases 1–5)

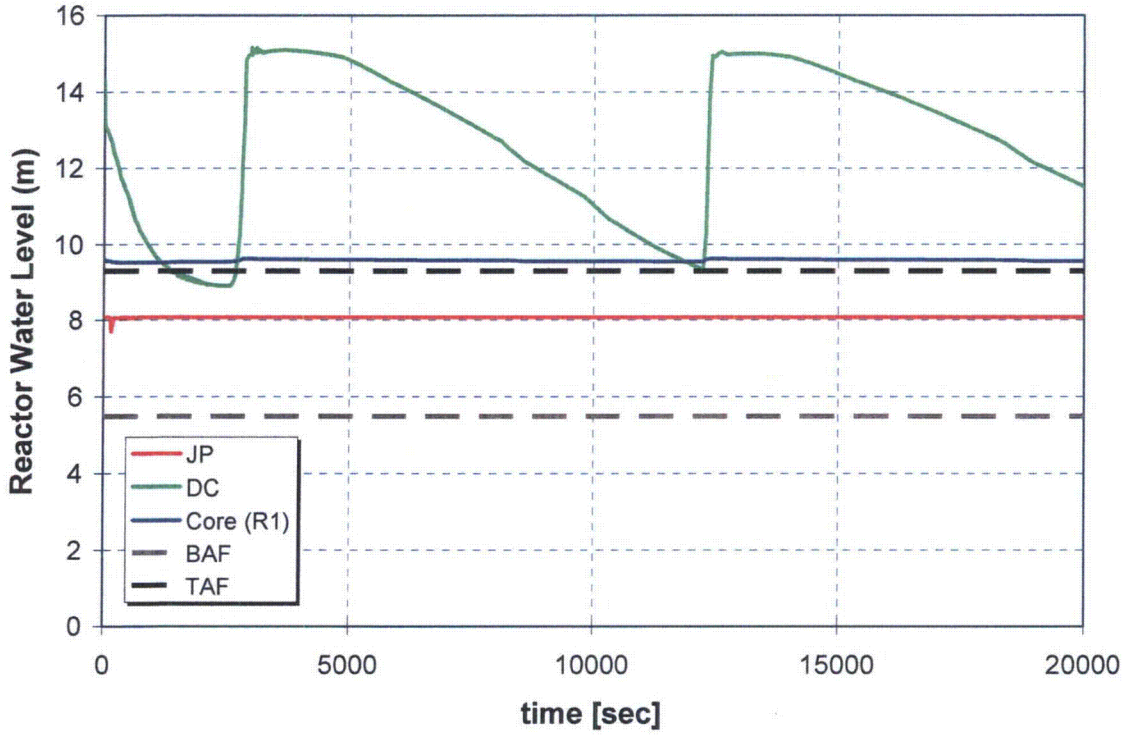
Event	Case 1 (hr)	Case 2 (hr)	Case 3 (hr)	Case 4 (hr)	Case 4a (hr)	Case 5 (hr)
SRV 1 open	0	0	0	0	0	0
Reactor trip	0	0	0	0	< 0.01[1]	0
Downcomer level first reaches L2	0.07	0.07	0.07	0.07	0.03	0.07
RCIC/HPCI first started (CST injection mode)	0.08	0.08	-	-	-	-
2nd CRD pump started	-	-	0.17	0.33	0.33	-
Downcomer level reaches L1	0.37	8.93	0.32	0.32	0.24	0.26
Downcomer level below TAF	0.37	8.93	0.35	0.33	0.25	0.28
LPCI first started	0.51	8.93	0.59	0.58	0.53	0.57
RCIC/HPCI pump isolation: low steamline pressure < 0.52 MPa (75 psig)	0.82	5.59	-	-	-	-
Maximum cladding temperature timing (max temperature)	No heatup	No heatup	0.78 (786 K)	0.76 (830 K)	0.67 (941 K)	0.75 (1,212 K)

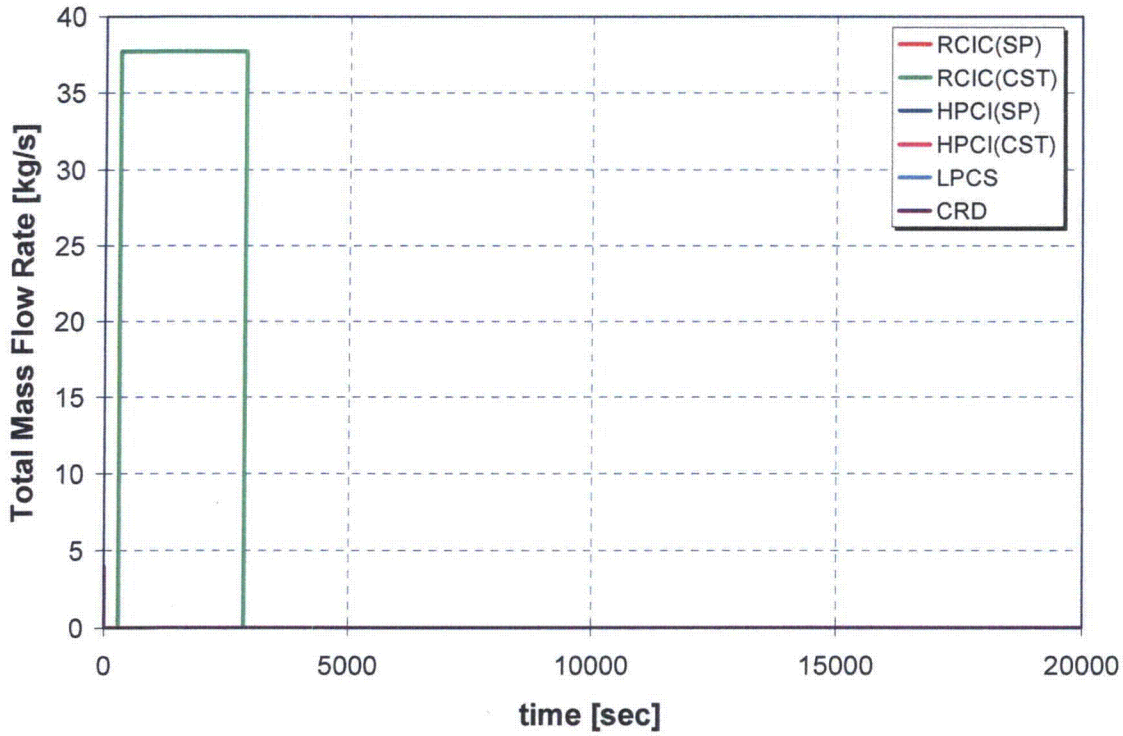
[1] Reactor trips at 8 seconds on low RPV level.

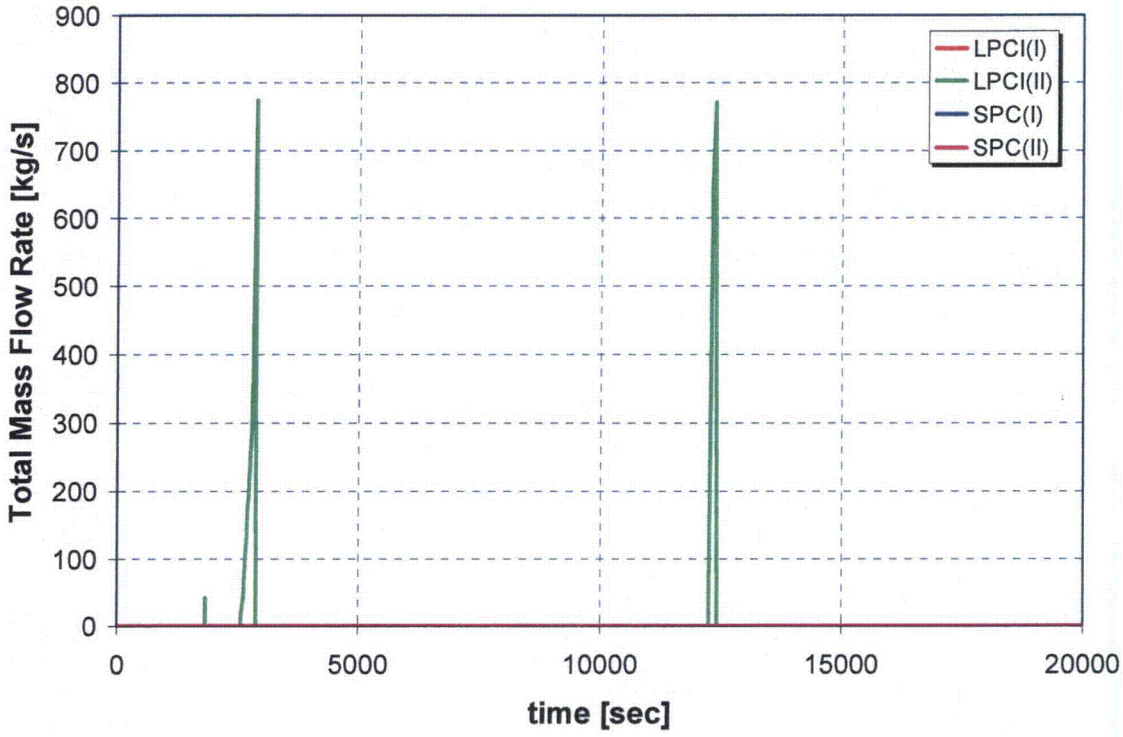
B.1.1 Case 1: Safety Relief Valve Opening and Reactor Core Isolation Cooling

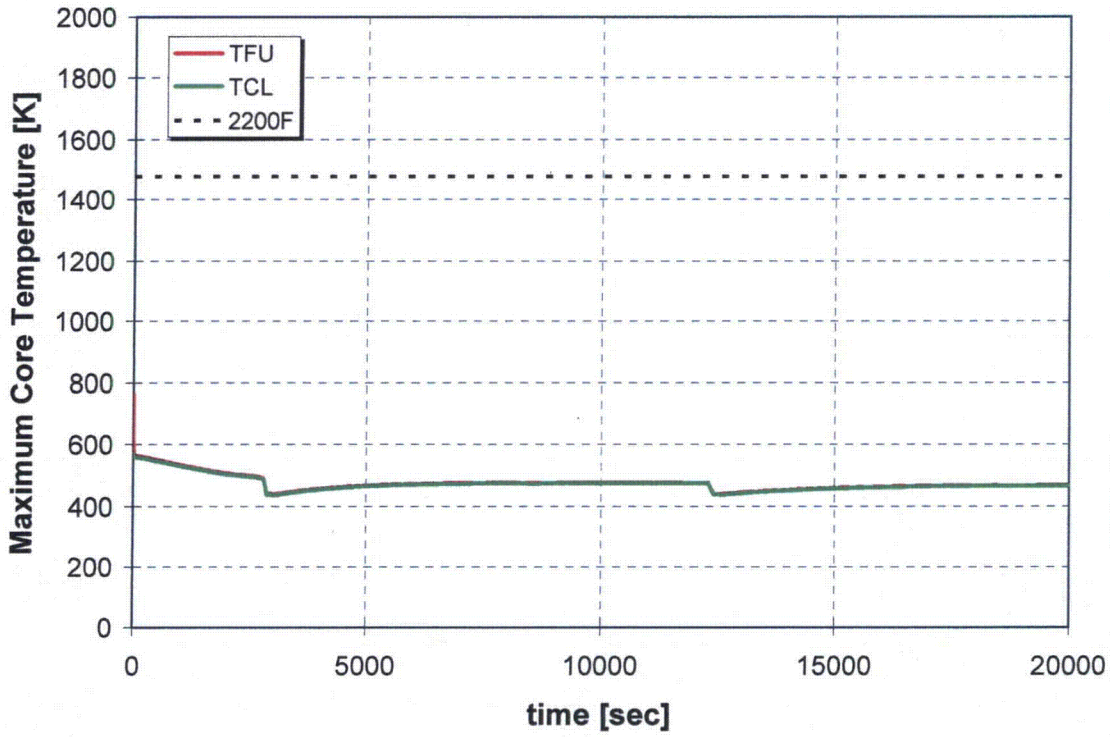


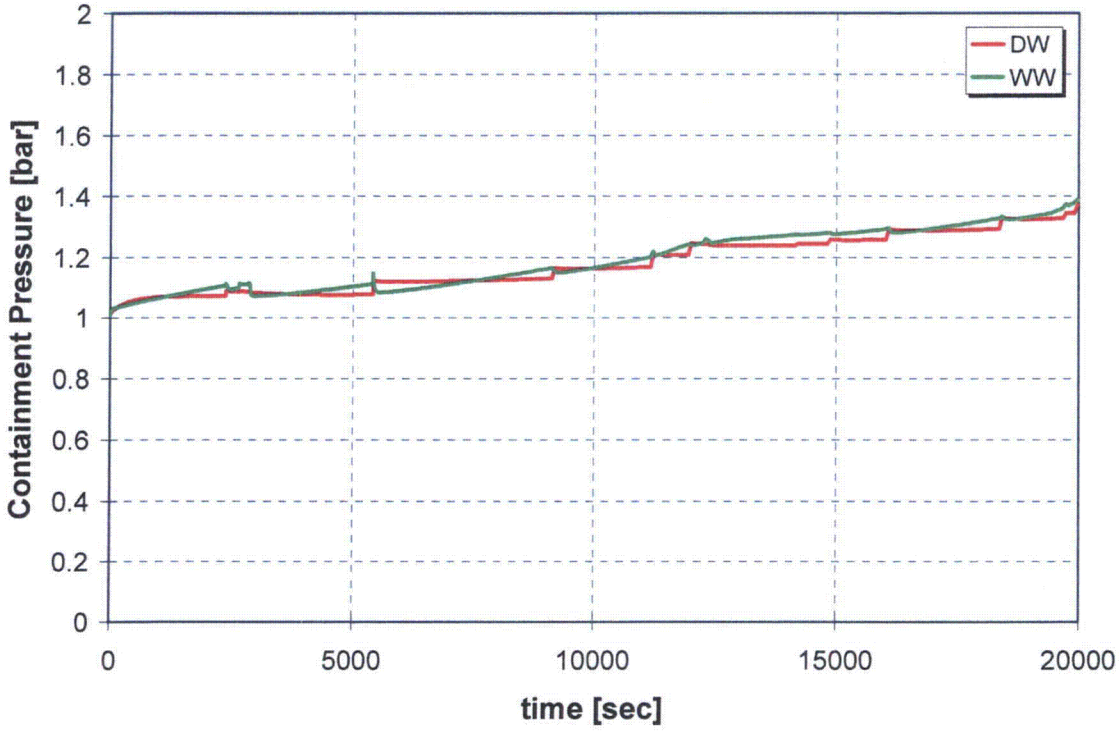


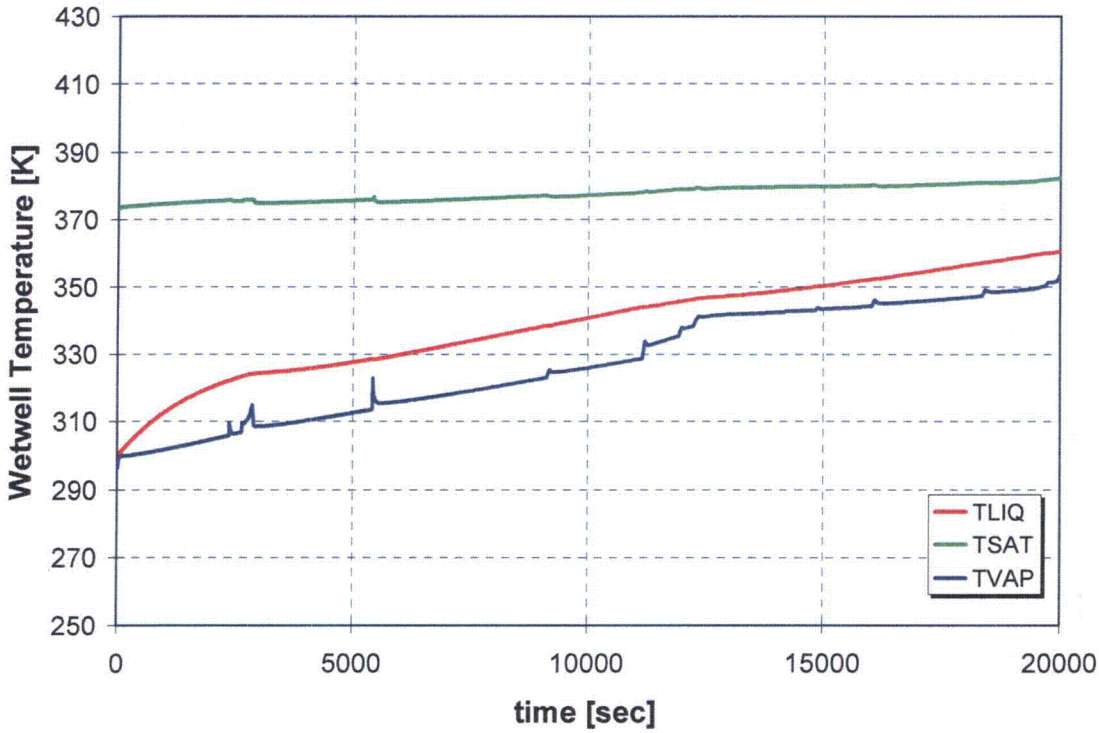

Reactor Water Level (m)
16
14
12
10
8
6
4
2
0
0
5000
10000
15000
20000
time [sec]
JP
DC
Core (R1)
BAF
TAF

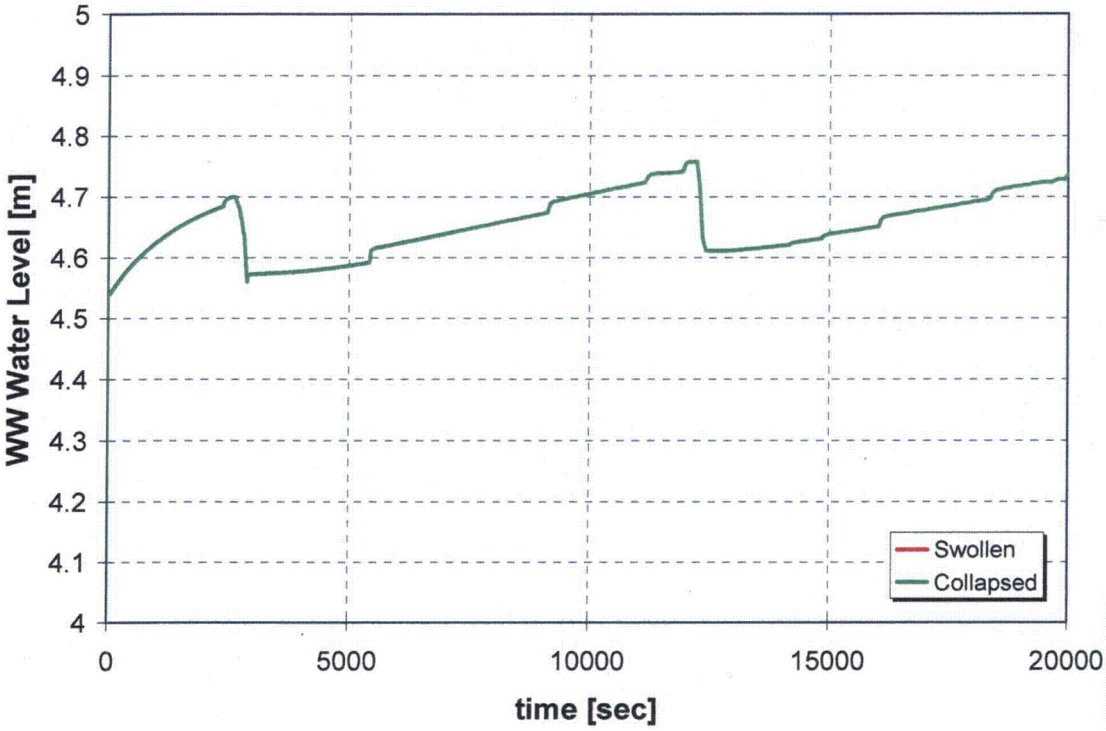

Total Mass Flow Rate [kg/s]
40
35
30
25
20
15
10
5
0
0
5000
10000
15000
20000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
900
800
700
600
500
400
300
200
100
0
0
5000
10000
15000
20000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)

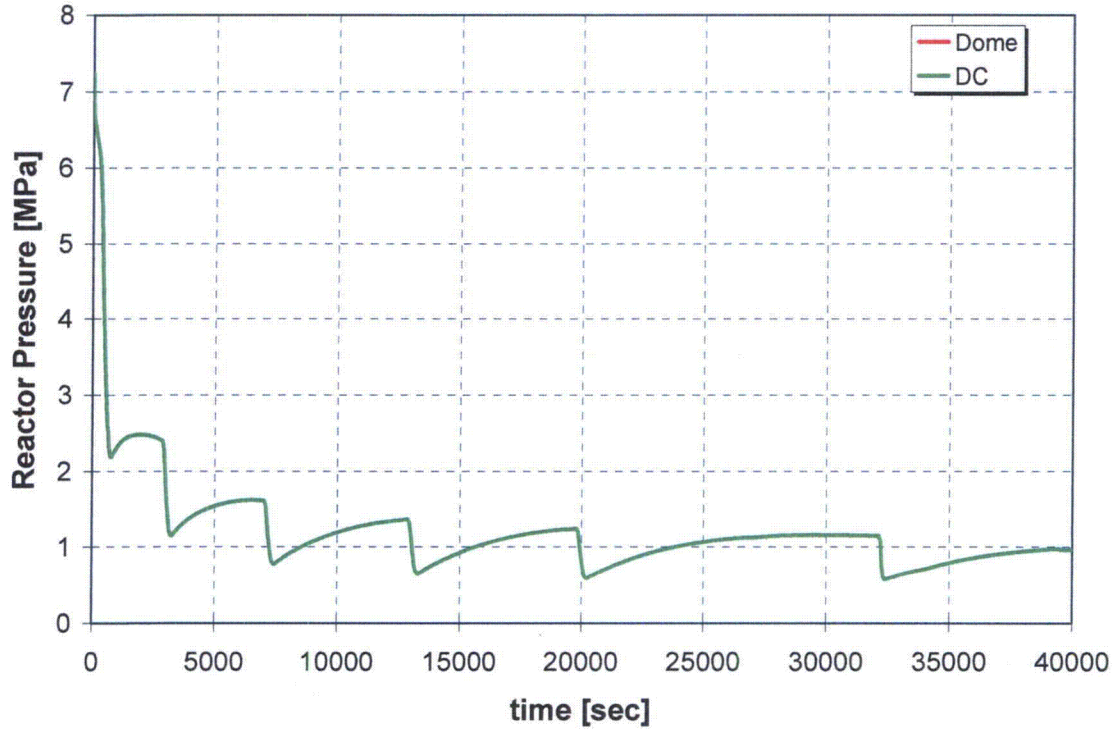

Maximum Core Temperature [K]
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
5000
10000
15000
20000
time [sec]
TFU
TCL
2200F

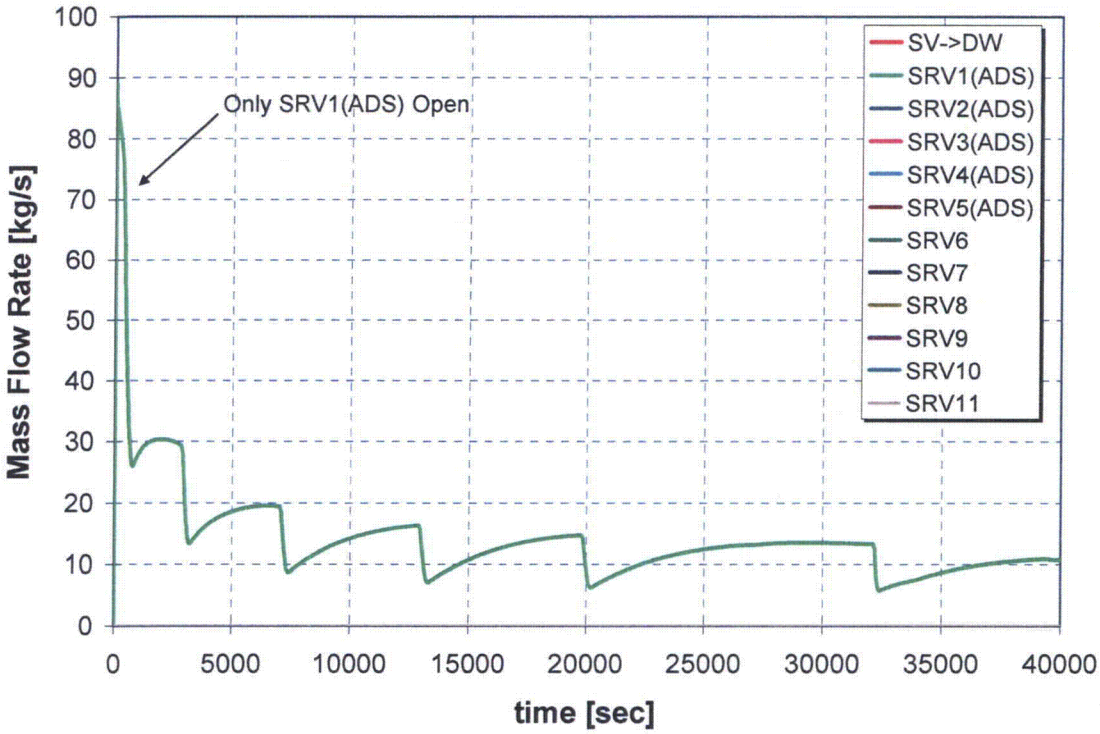

Containment Pressure [bar]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5000
10000
15000
20000
time [sec]
DW
WW

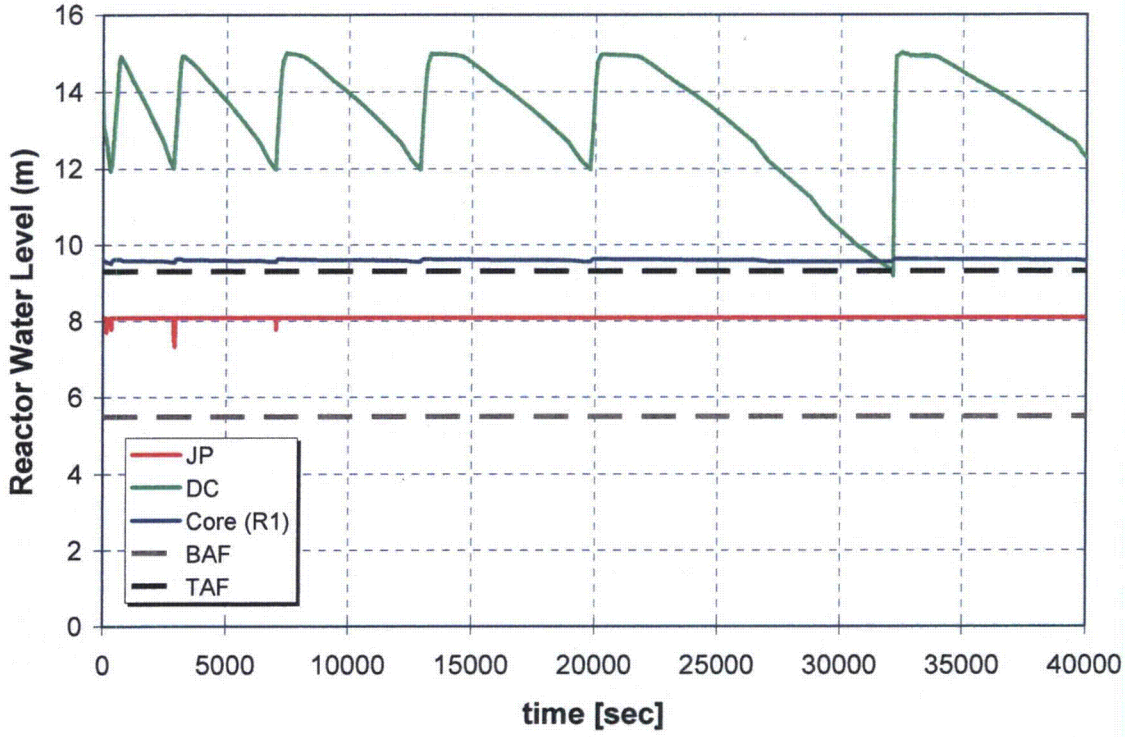

Wetwell Temperature [K]
430
410
390
370
350
330
310
290
270
250
0
5000
10000
15000
20000
time [sec]
TLIQ
TSAT
TVAP

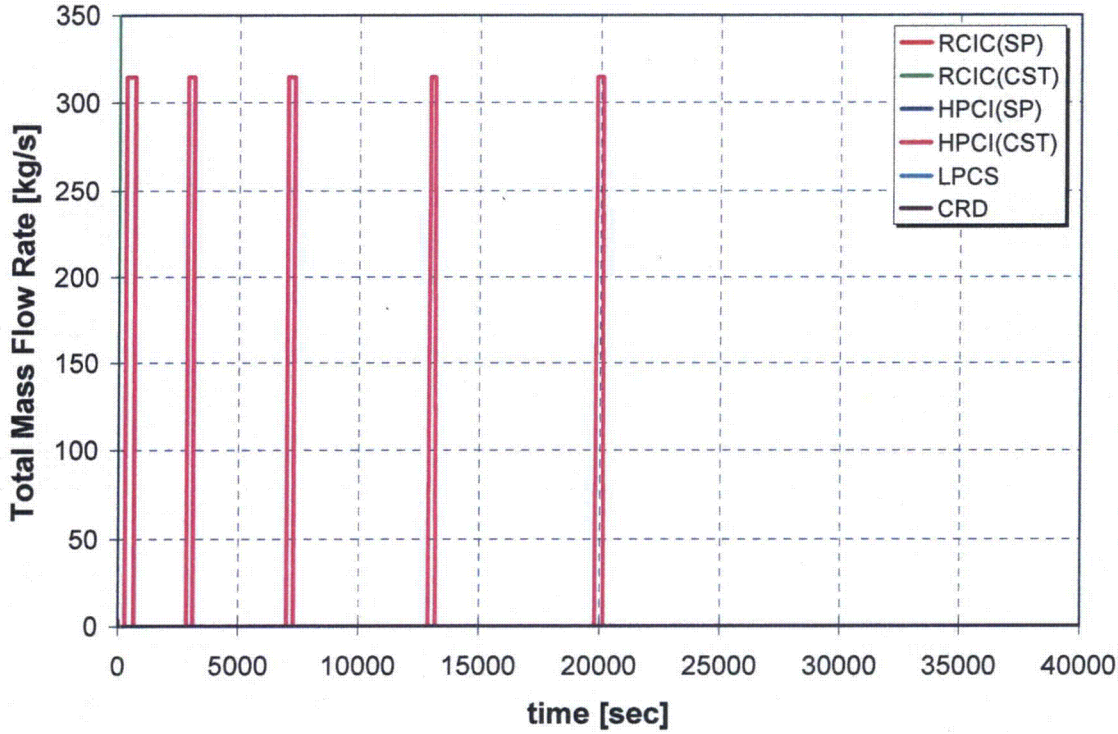

5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
WW Water Level [m]
0
5000
10000
15000
20000
time [sec]
Swollen
Collapsed

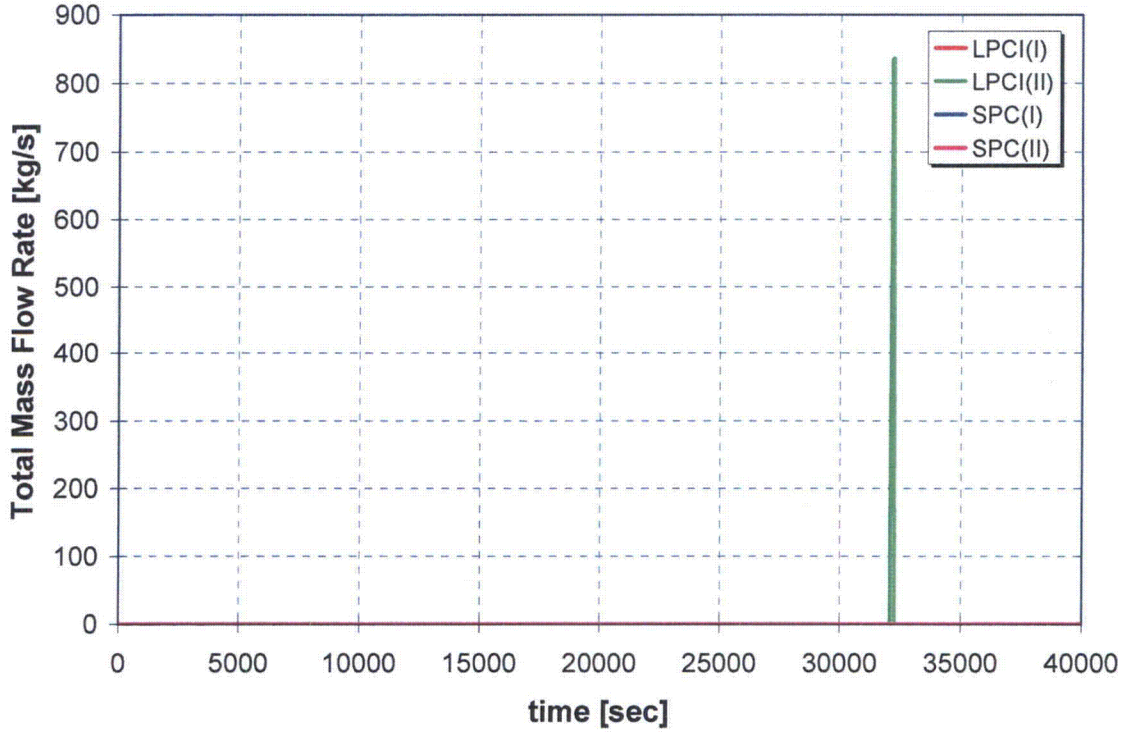
B.1.2 Case 2: Safety Relief Valve Opening and High-Pressure Core Injection

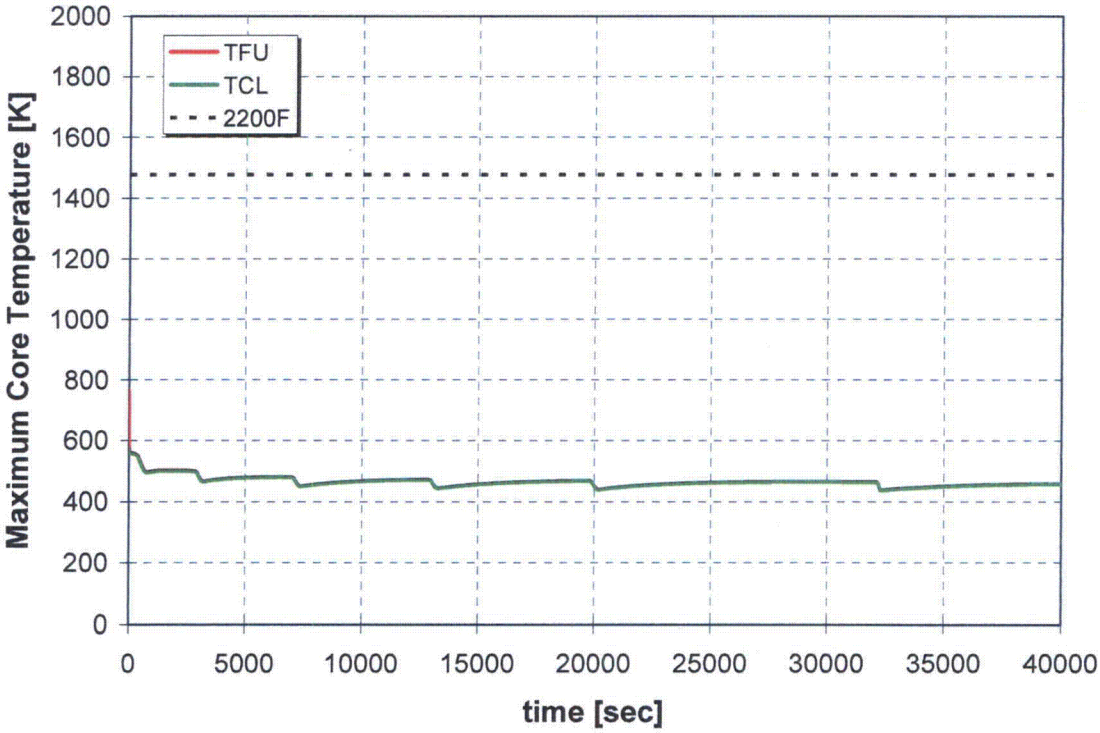


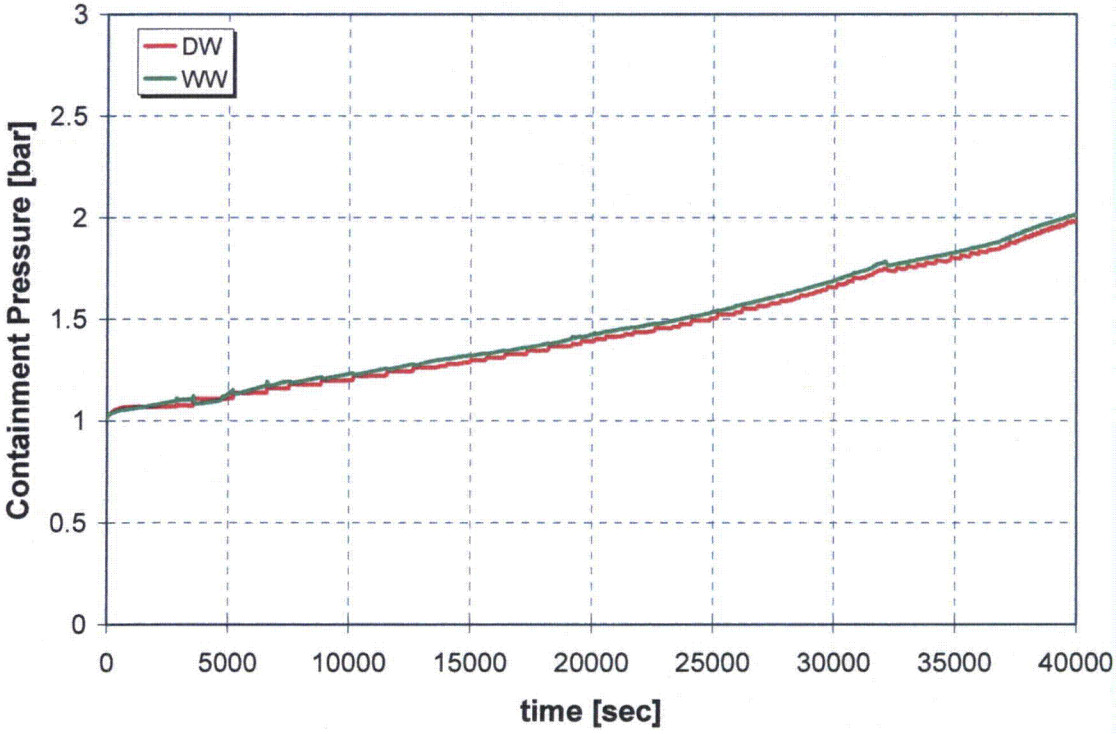


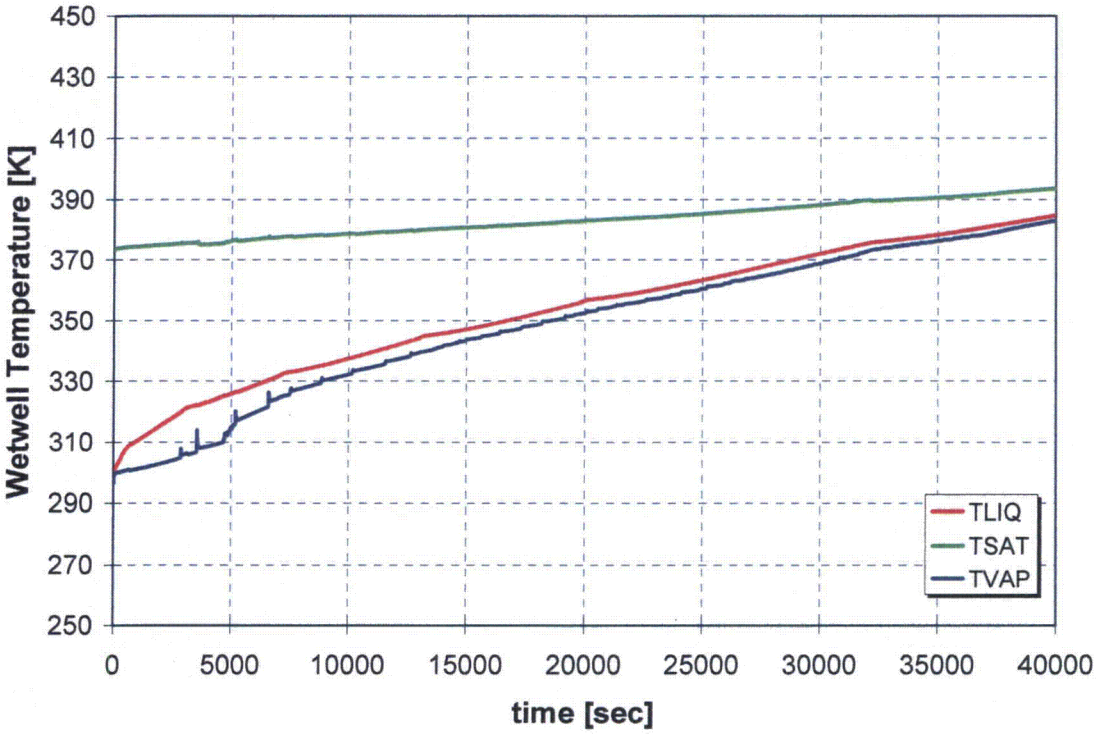

Reactor Water Level (m)
16
14
12
10
8
6
4
2
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
JP
DC
Core (R1)
BAF
TAF

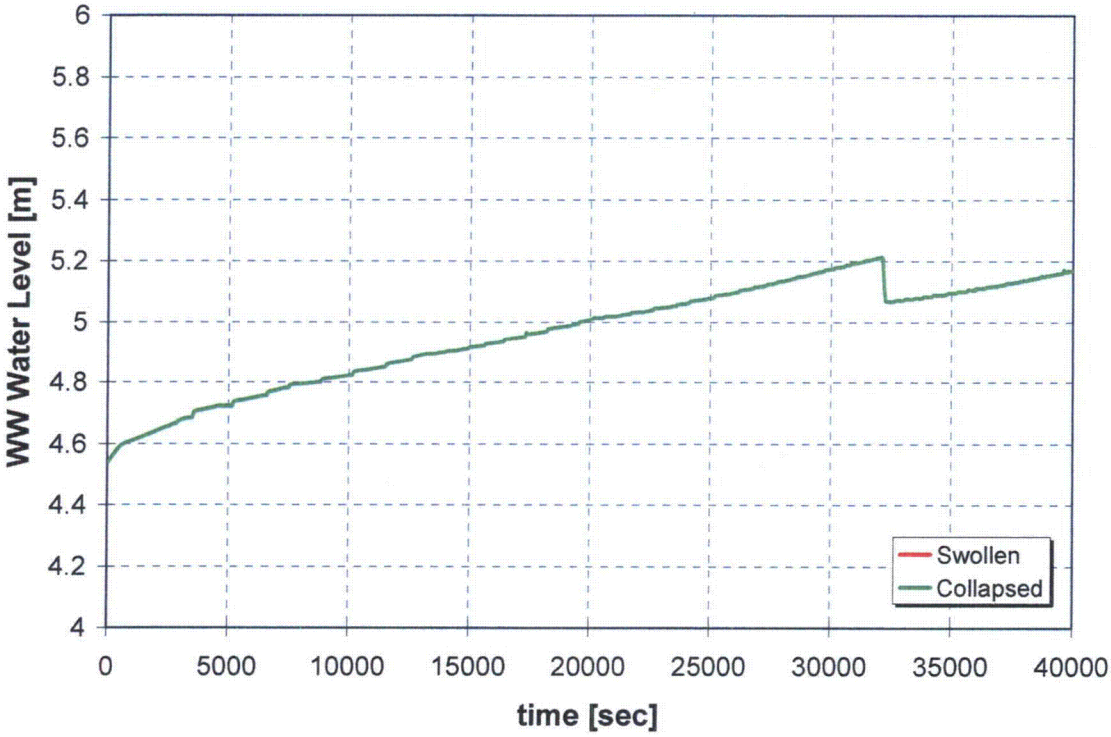

Total Mass Flow Rate [kg/s]
350
300
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
900
800
700
600
500
400
300
200
100
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)

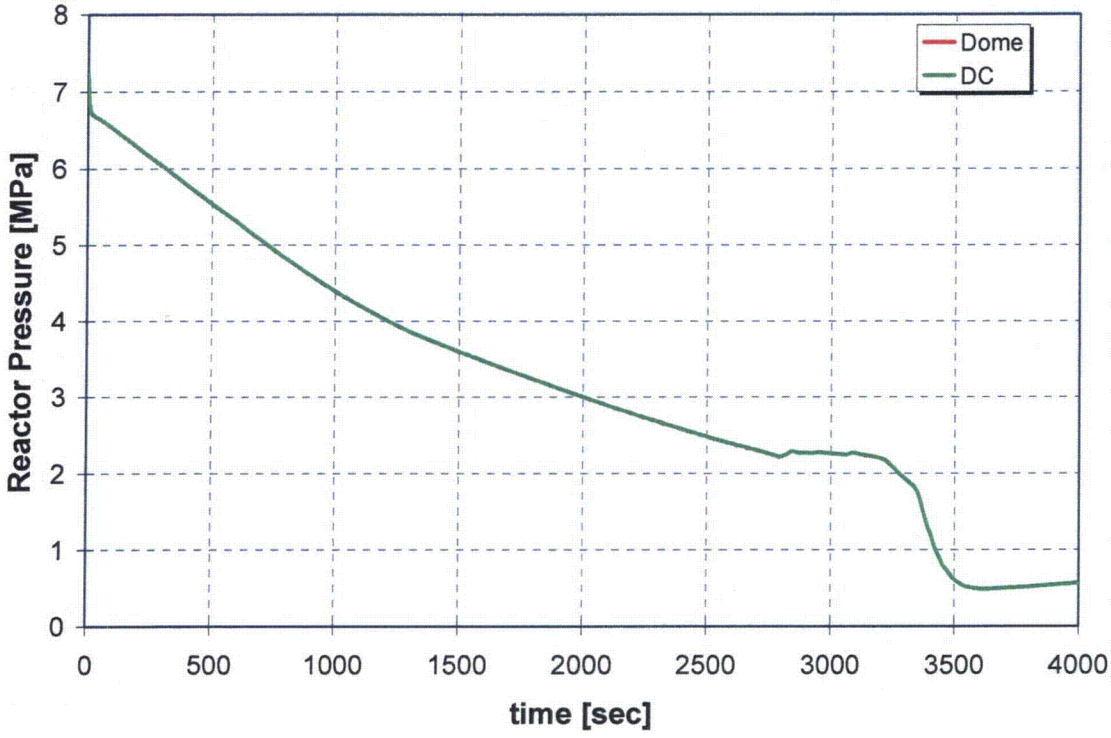

Maximum Core Temperature [K]
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
TFU
TCL
2200F

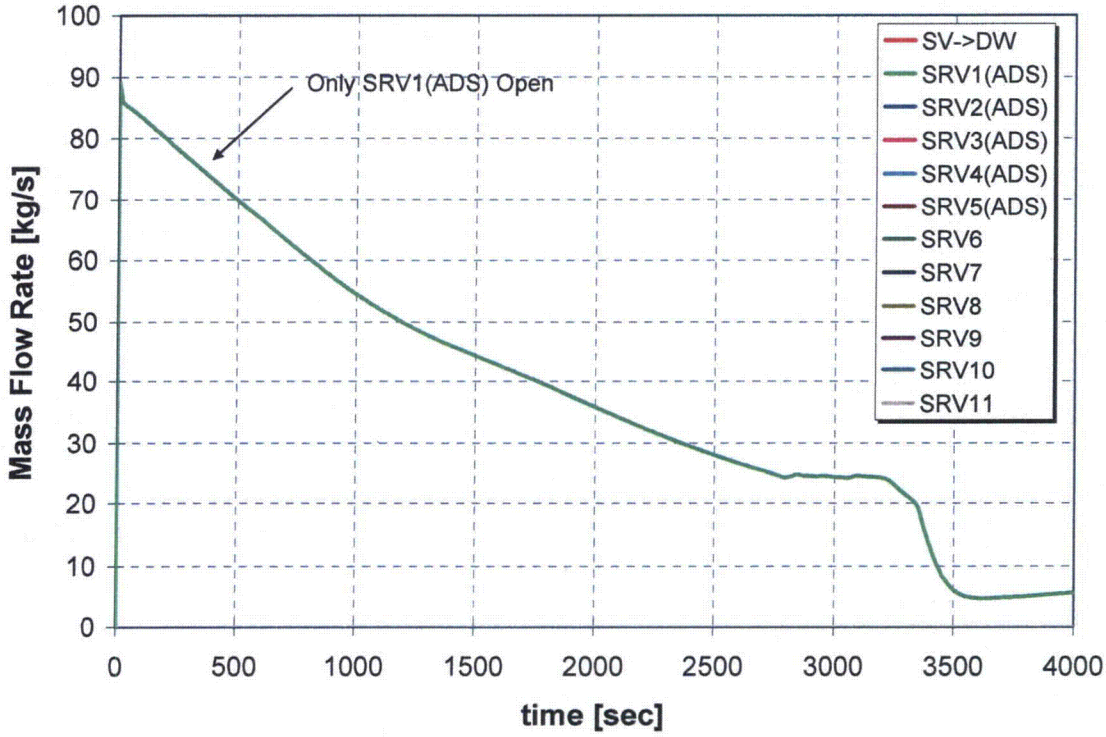

DW
WW
Containment Pressure [bar]
3
2.5
2
1.5
1
0.5
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]

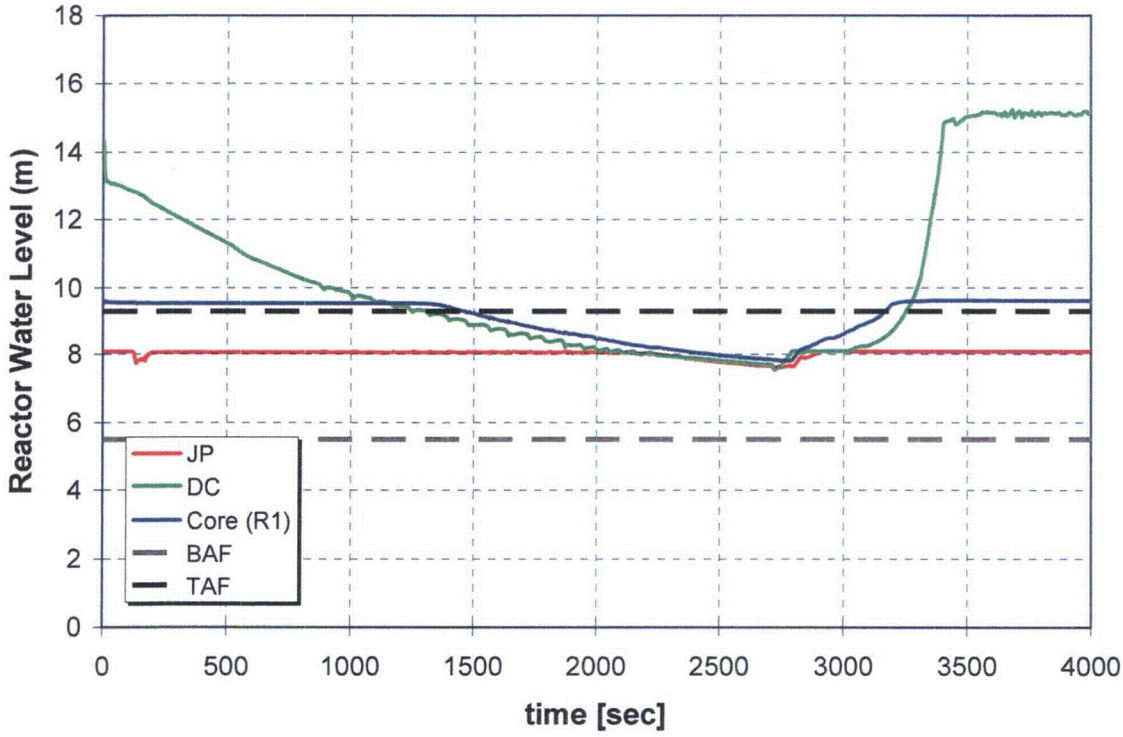

Wetwell Temperature [K]
450
430
410
390
370
350
330
310
290
270
250
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
TLIQ
TSAT
TVAP

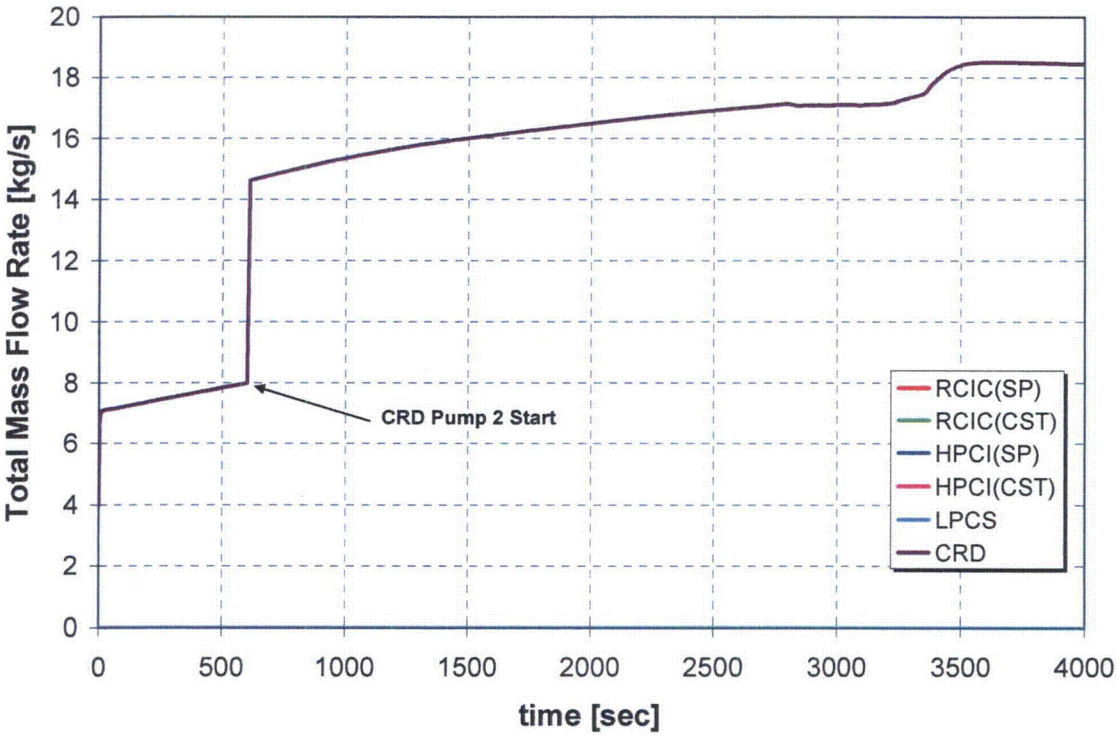

WW Water Level [m]
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
Swollen
Collapsed

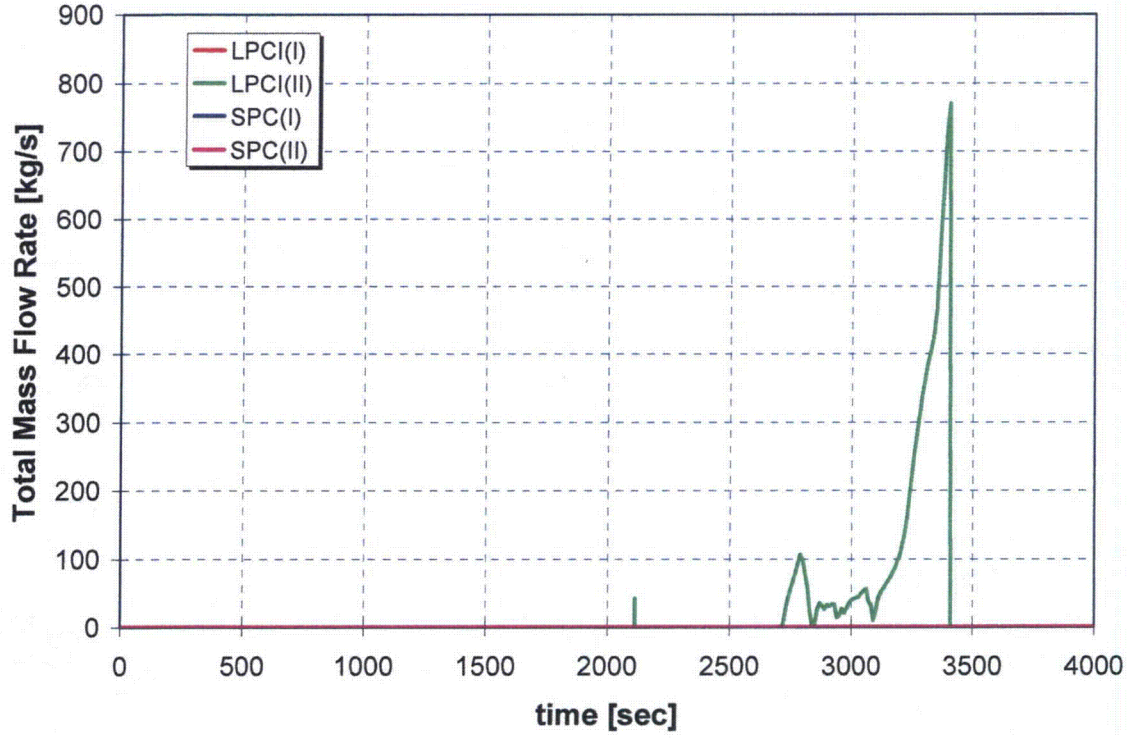
B.1.3 Case 3: Safety Relief Valve Opening and CRD 2 at 10 Minutes

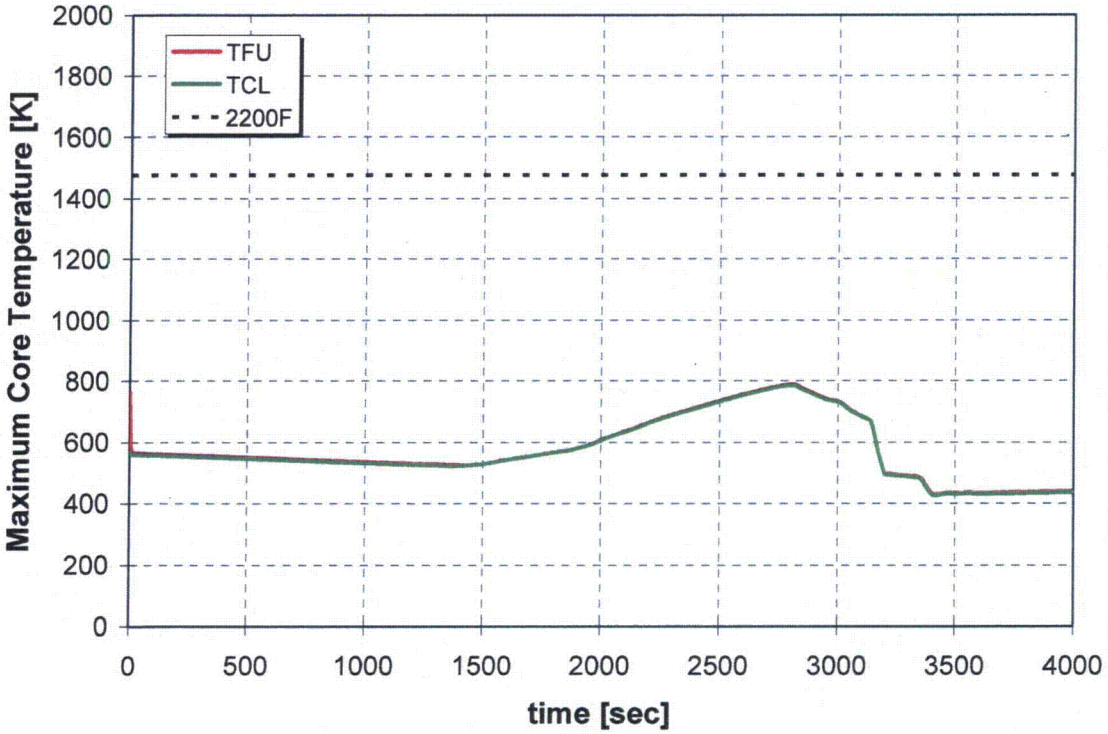


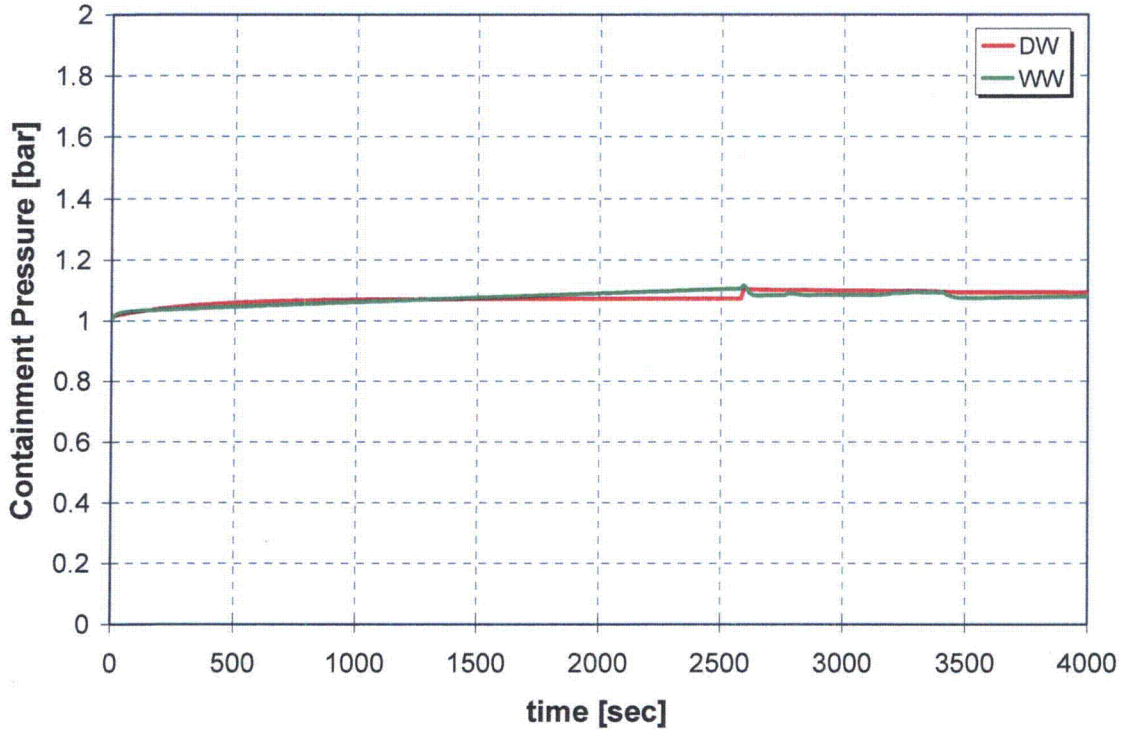


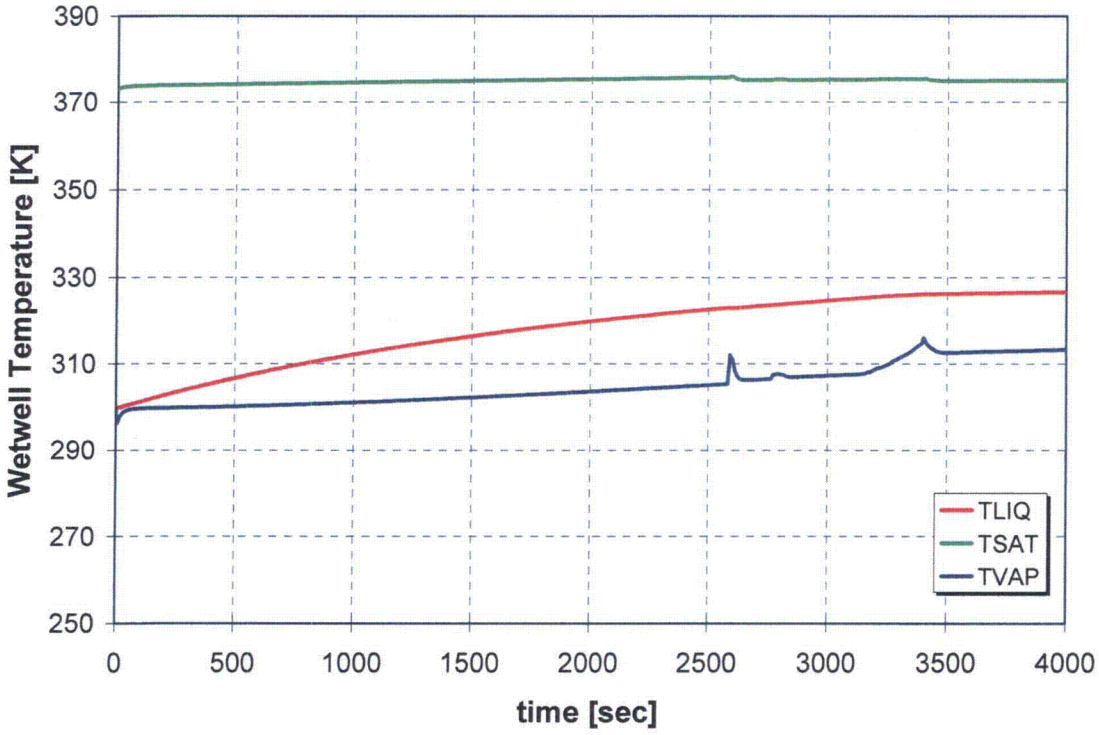

Reactor Water Level (m)
time [sec]
JP
DC
Core (R1)
BAF
TAF
0
2
4
6
8
10
12
14
16
18
0
500
1000
1500
2000
2500
3000
3500
4000

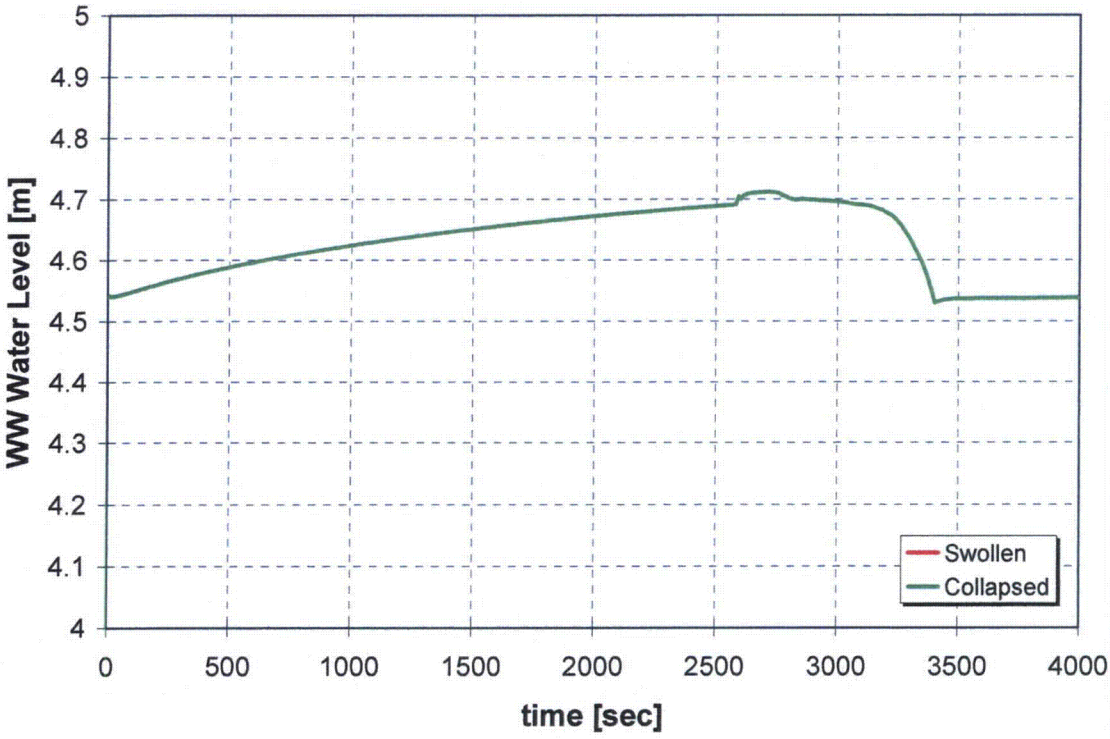

Total Mass Flow Rate [kg/s]
time [sec]
CRD Pump 2 Start
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD
0
2
4
6
8
10
12
14
16
18
20
0
500
1000
1500
2000
2500
3000
3500
4000


LPCI(I)
LPCI(II)
SPC(I)
SPC(II)
Total Mass Flow Rate [kg/s]
900
800
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

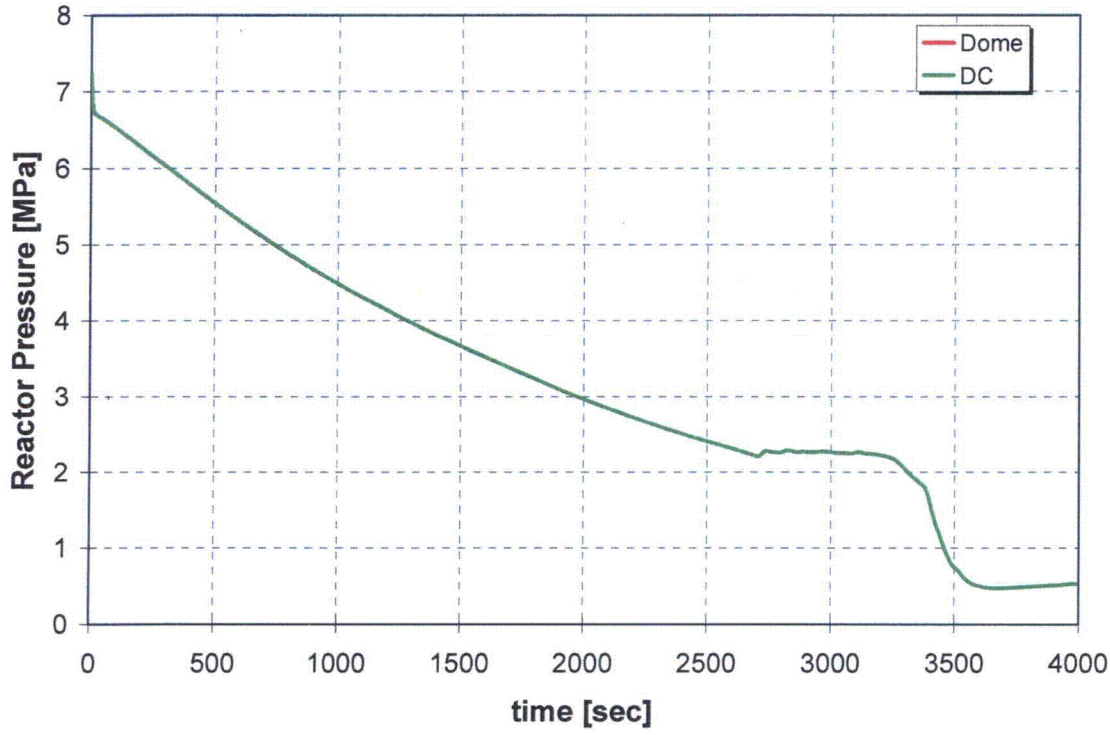

TFU
TCL
2200F
Maximum Core Temperature [K]
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

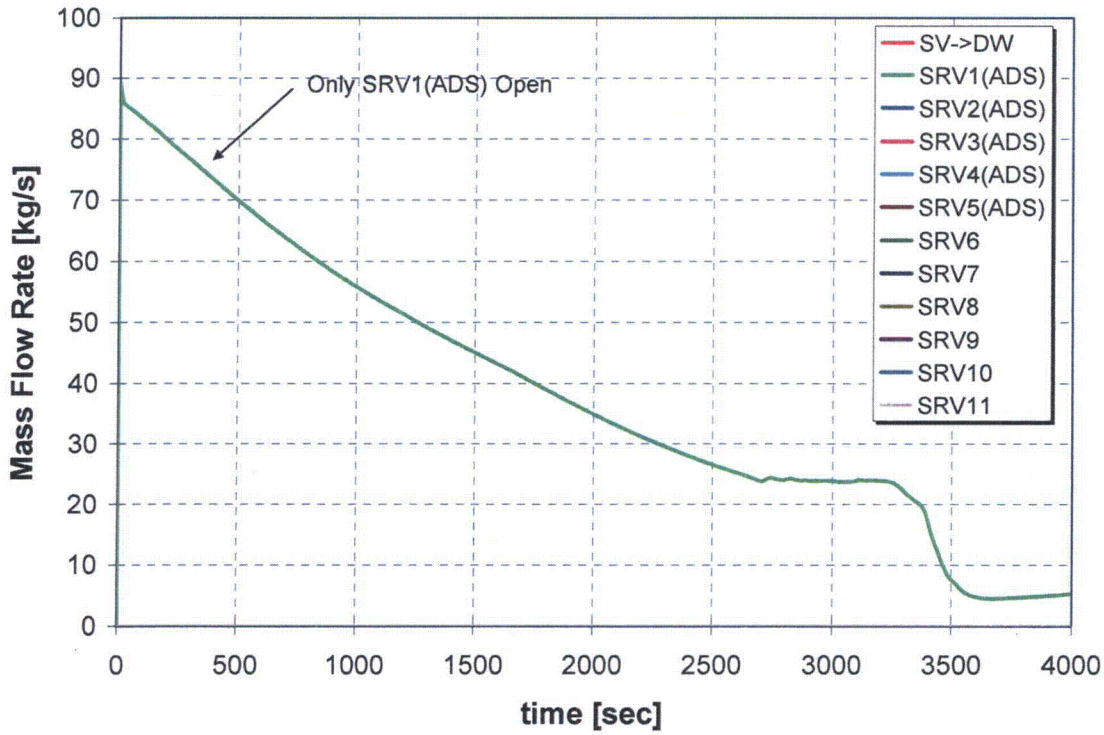

Containment Pressure [bar]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
DW
WW

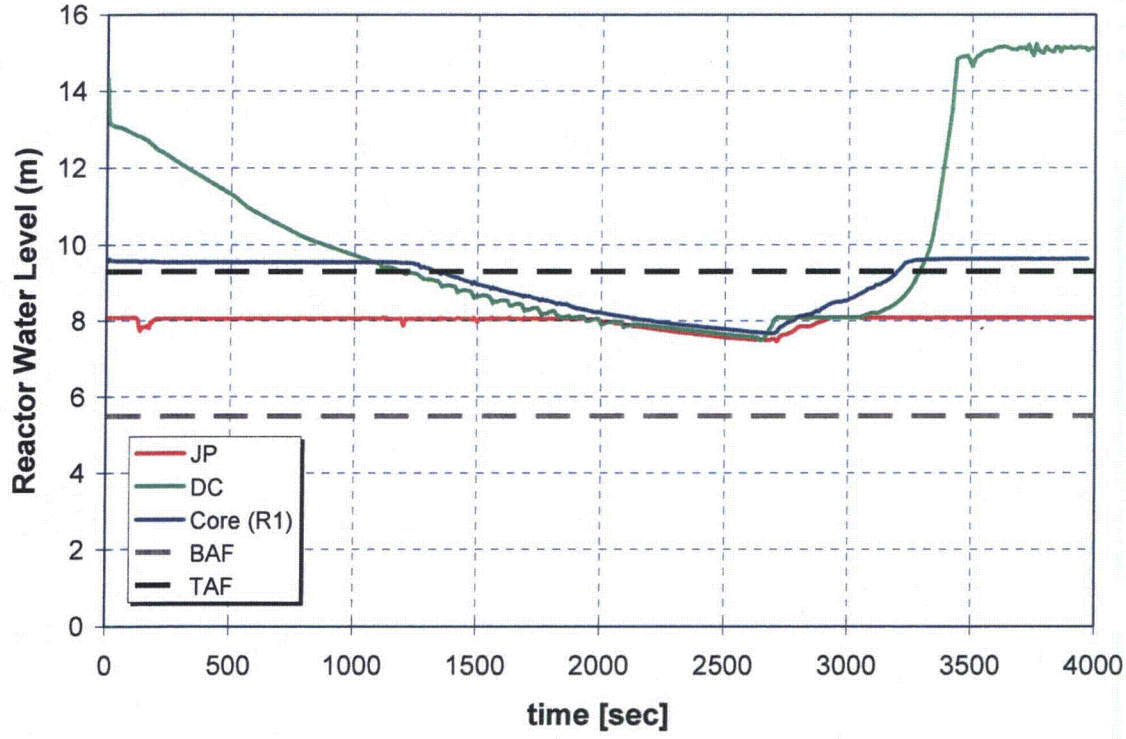

Wetwell Temperature [K]
390
370
350
330
310
290
270
250
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
TLIQ
TSAT
TVAP

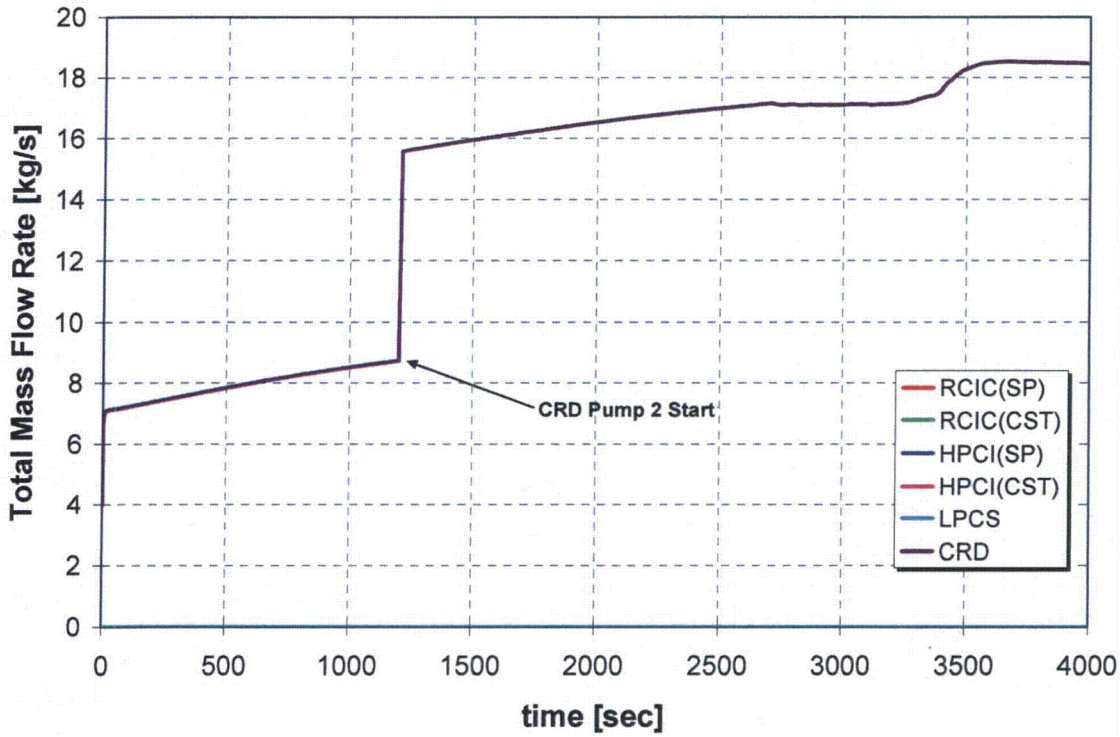

5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
WW Water Level [m]
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
Swollen
Collapsed

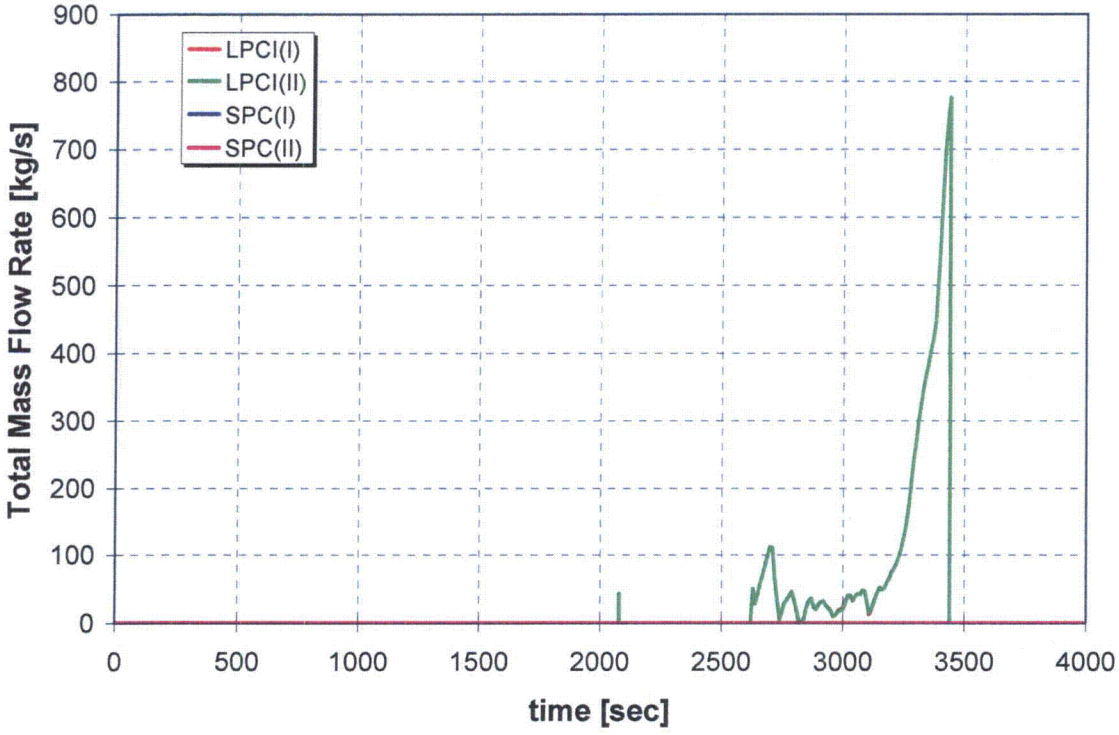
B.1.4 Case 4: Safety Relief Valve Opening and CRD 2 at 20 Minutes

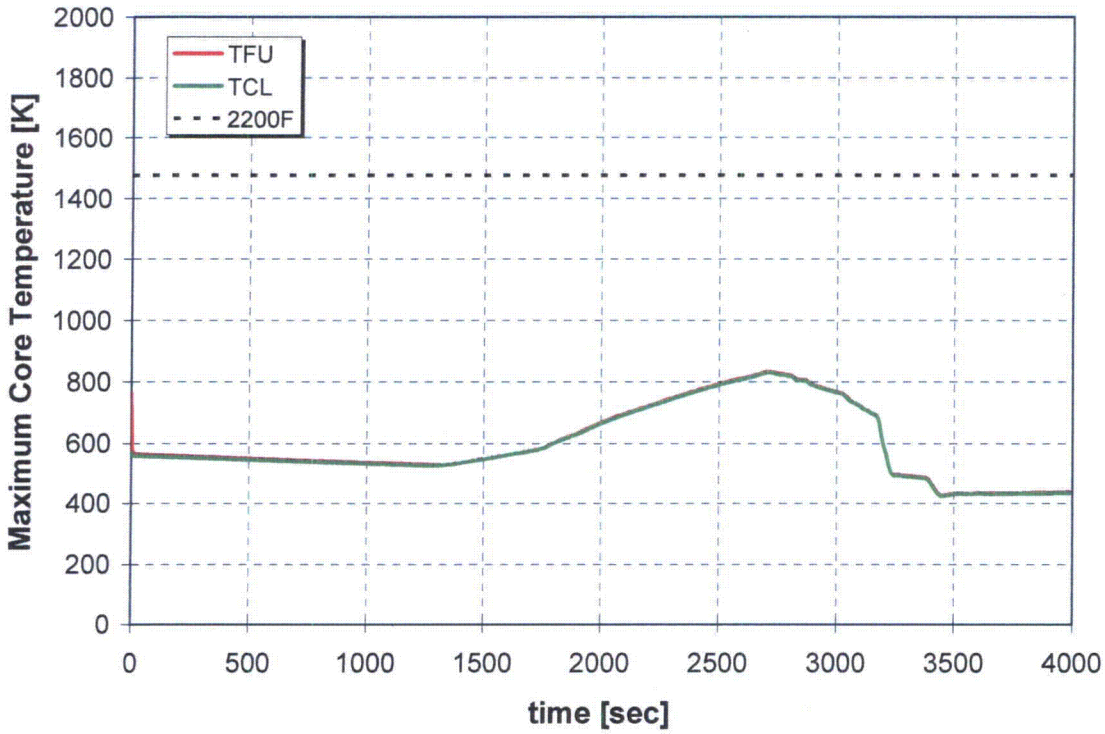


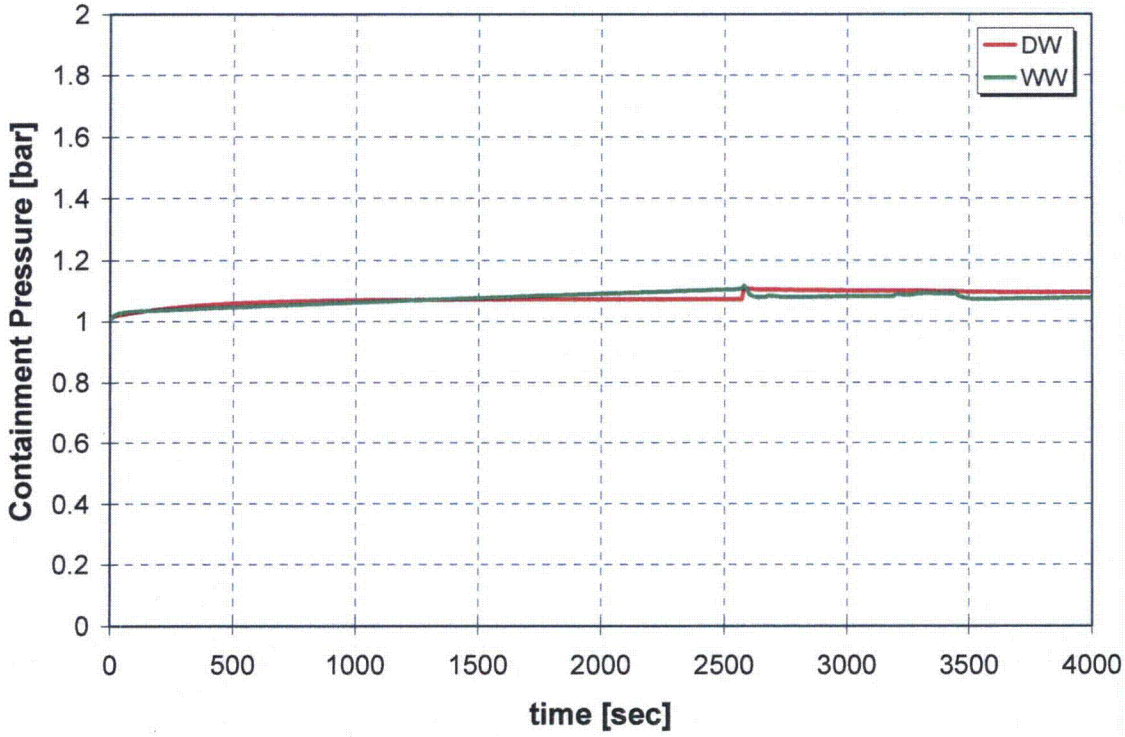


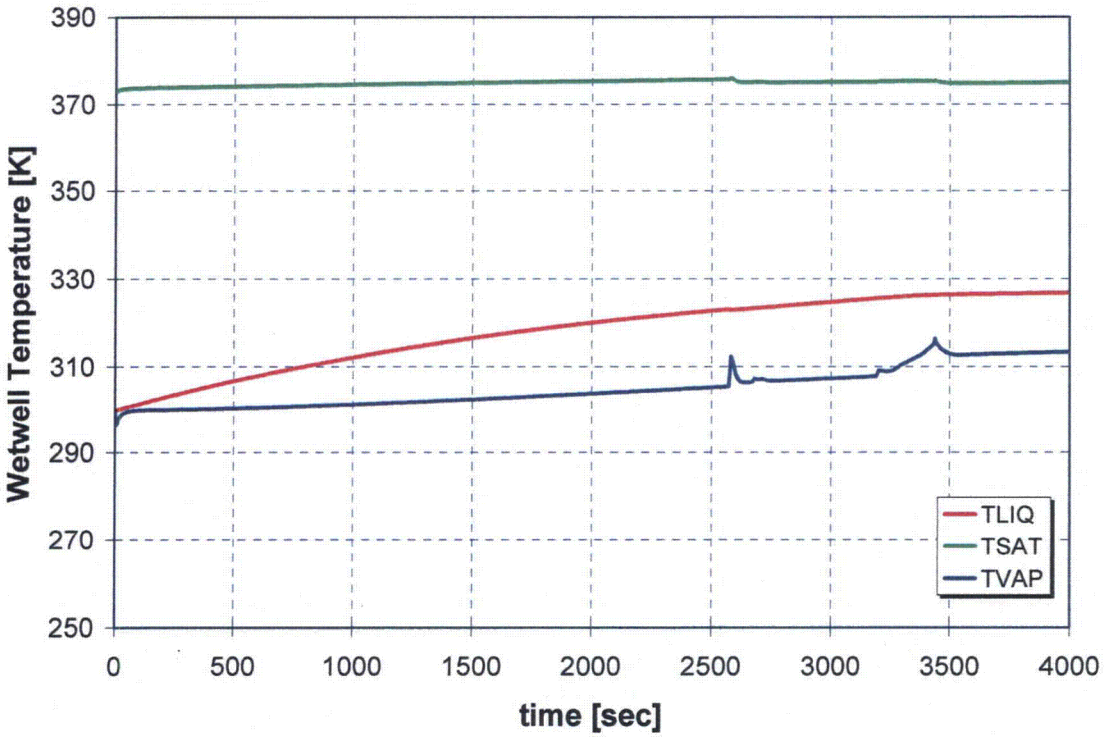

Reactor Water Level (m)
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
JP
DC
Core (R1)
BAF
TAF

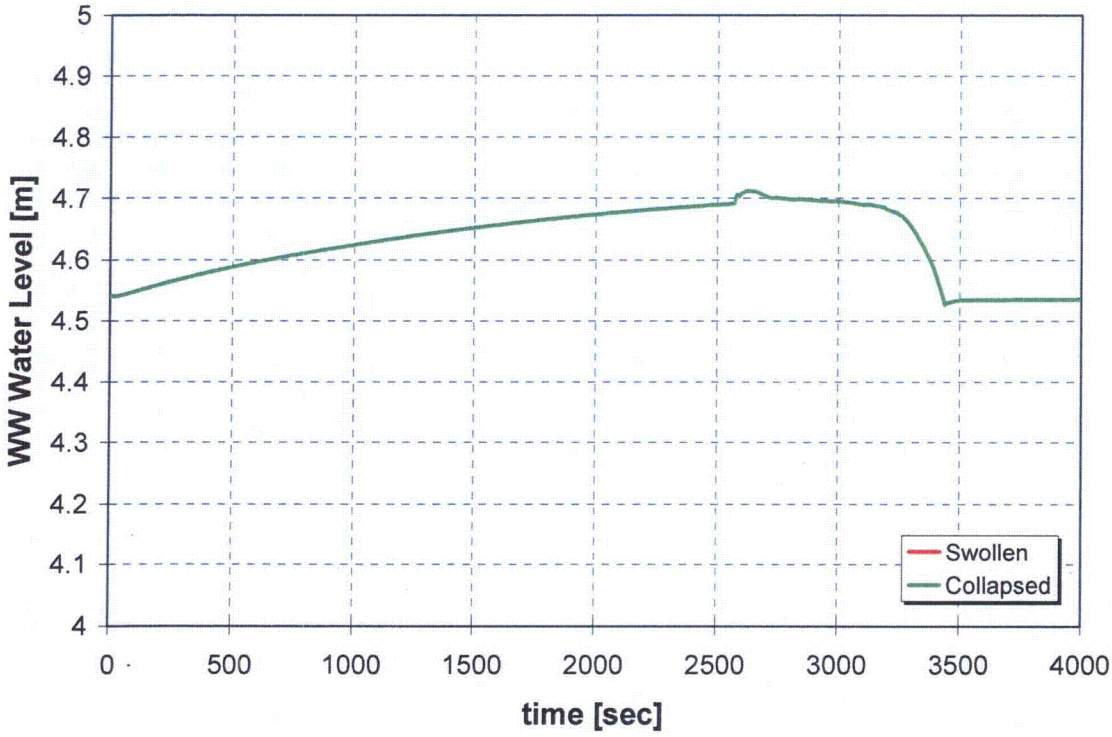

Total Mass Flow Rate [kg/s]
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
CRD Pump 2 Start
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


LPCI(I)
LPCI(II)
SPC(I)
SPC(II)
Total Mass Flow Rate [kg/s]
900
800
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

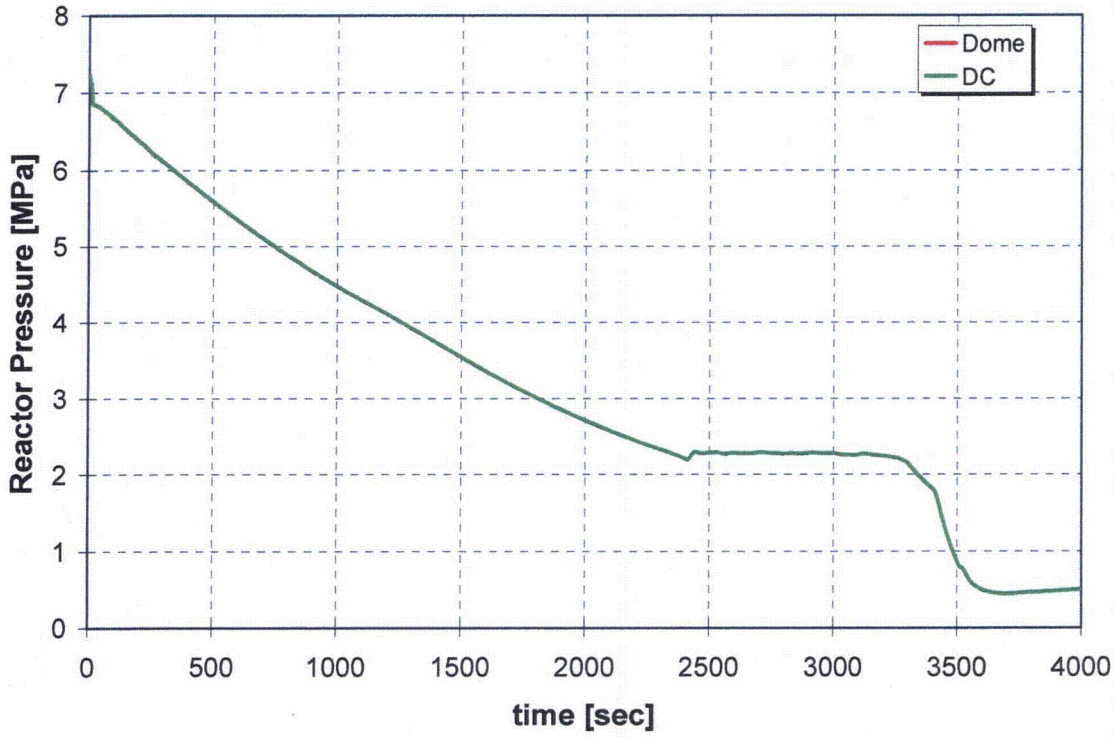

TFU
TCL
2200F
Maximum Core Temperature [K]
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

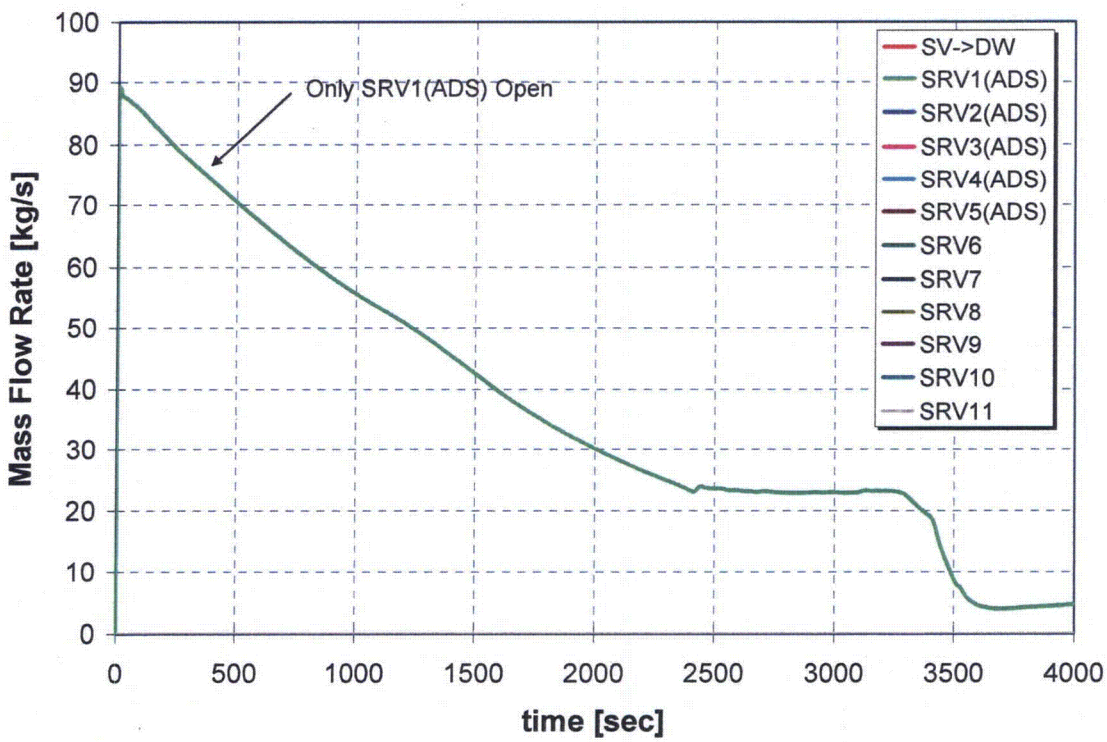

Containment Pressure [bar]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
DW
WW

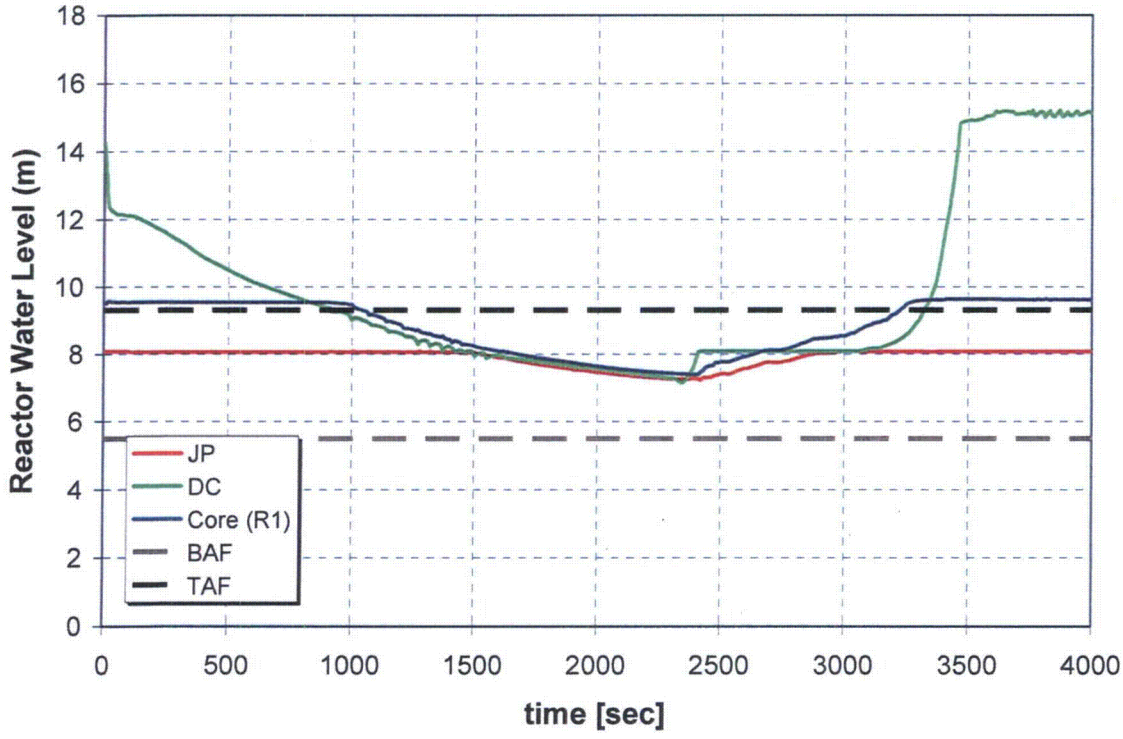

Wetwell Temperature [K]
390
370
350
330
310
290
270
250
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
TLIQ
TSAT
TVAP

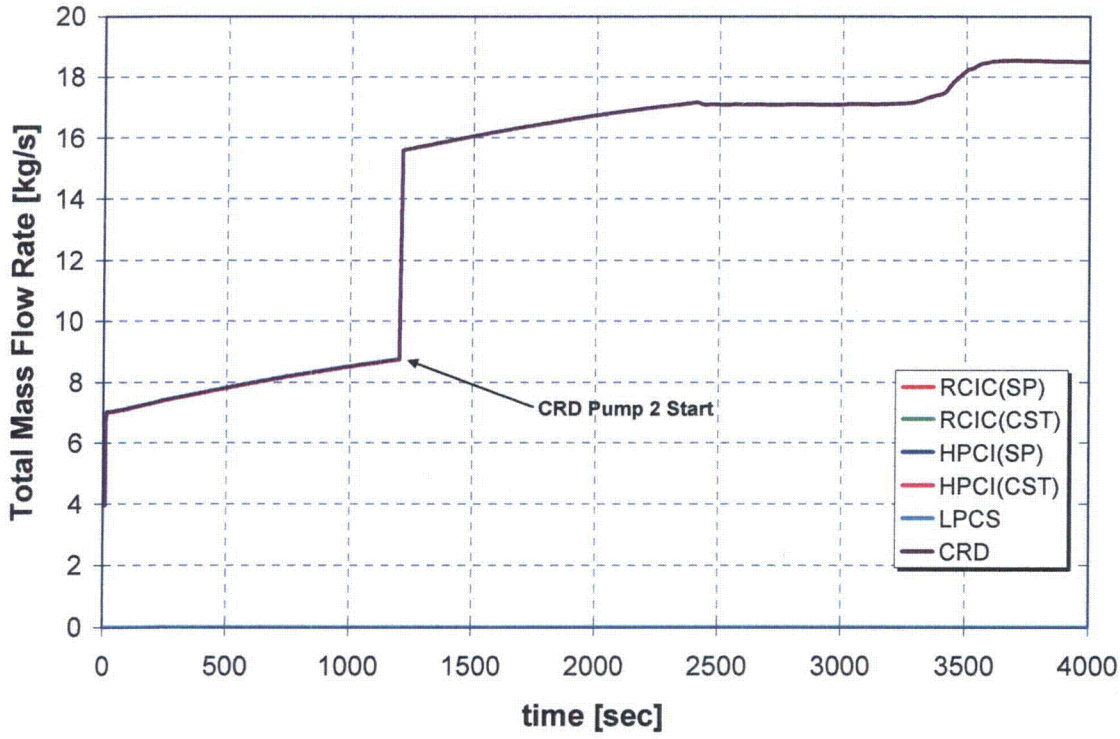

5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
WW Water Level [m]
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
Swollen
Collapsed

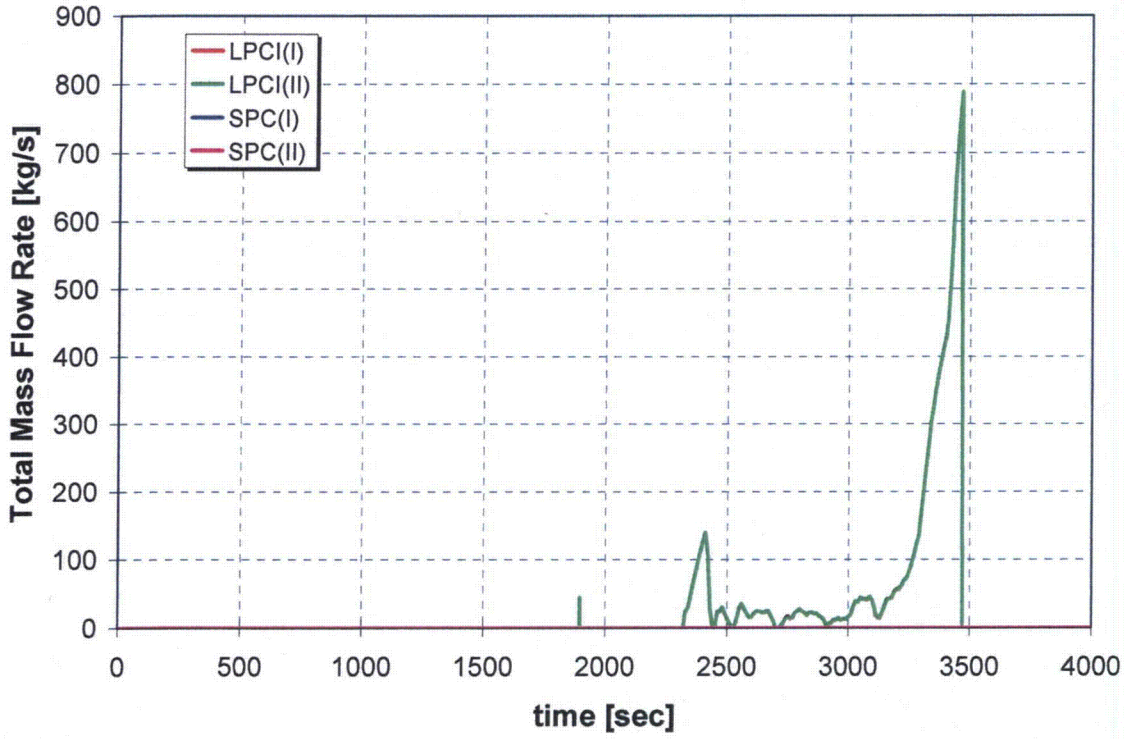
B.1.4.1 Case 4a: Safety Relief Valve Opening, CRD 2 at 20 Minutes, and No Reactor Trip at t = 0

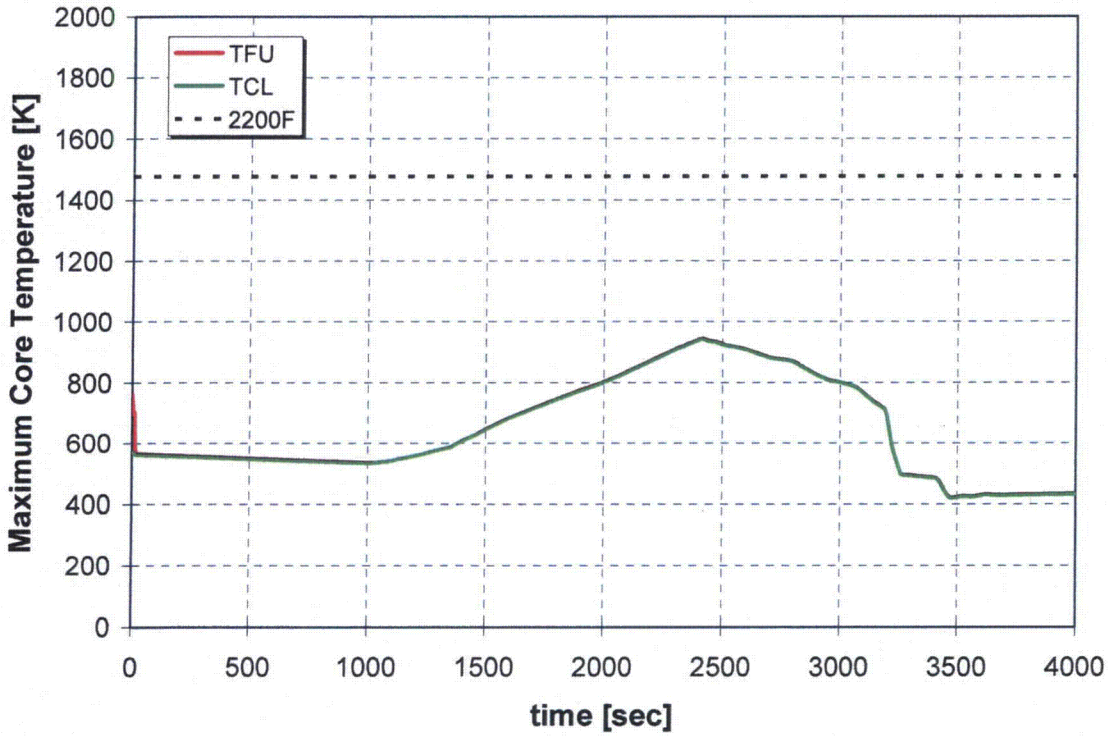


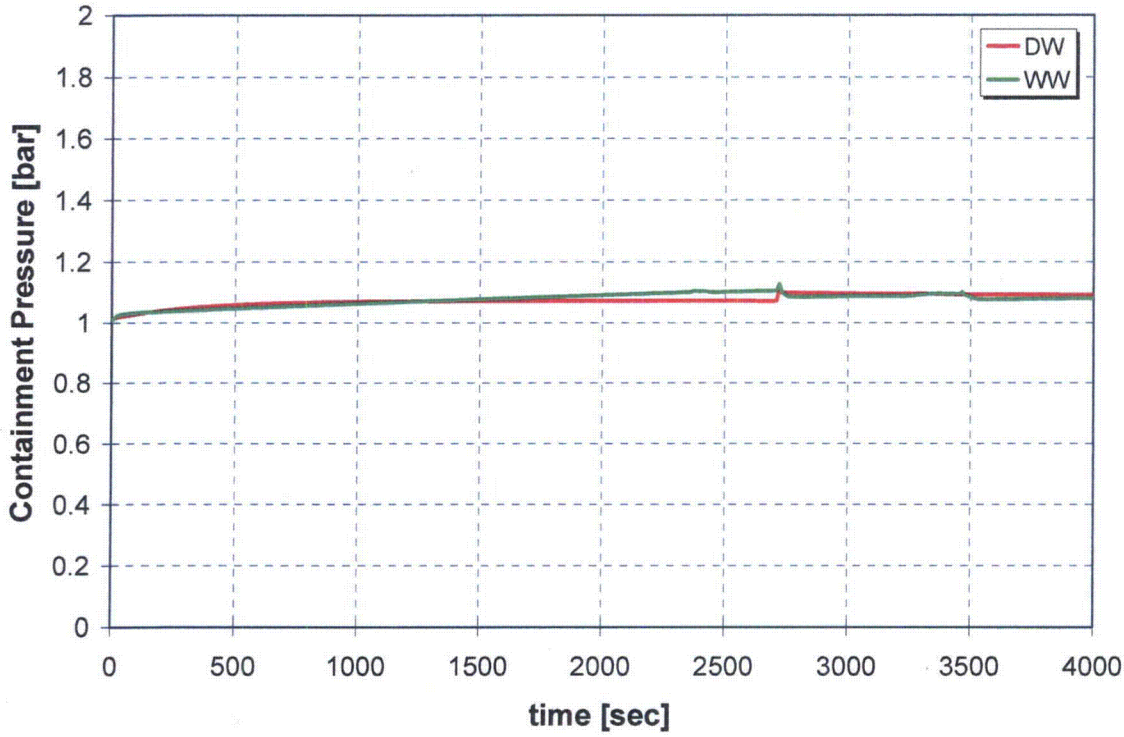


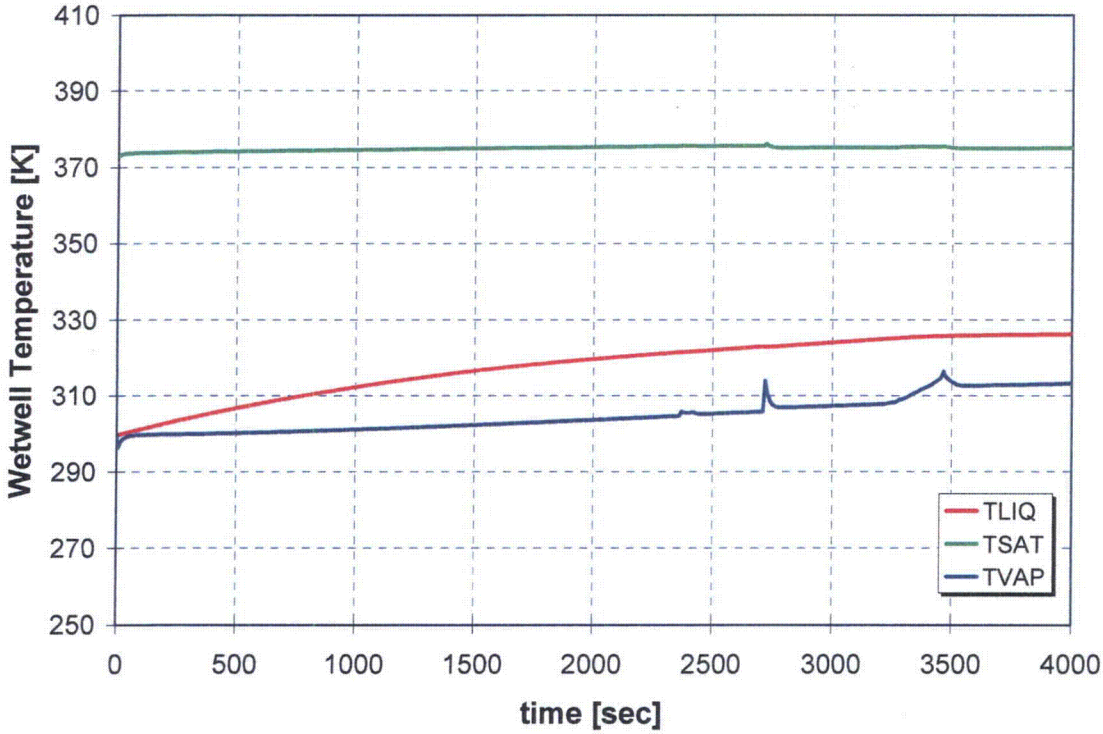

Reactor Water Level (m)
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
JP
DC
Core (R1)
BAF
TAF

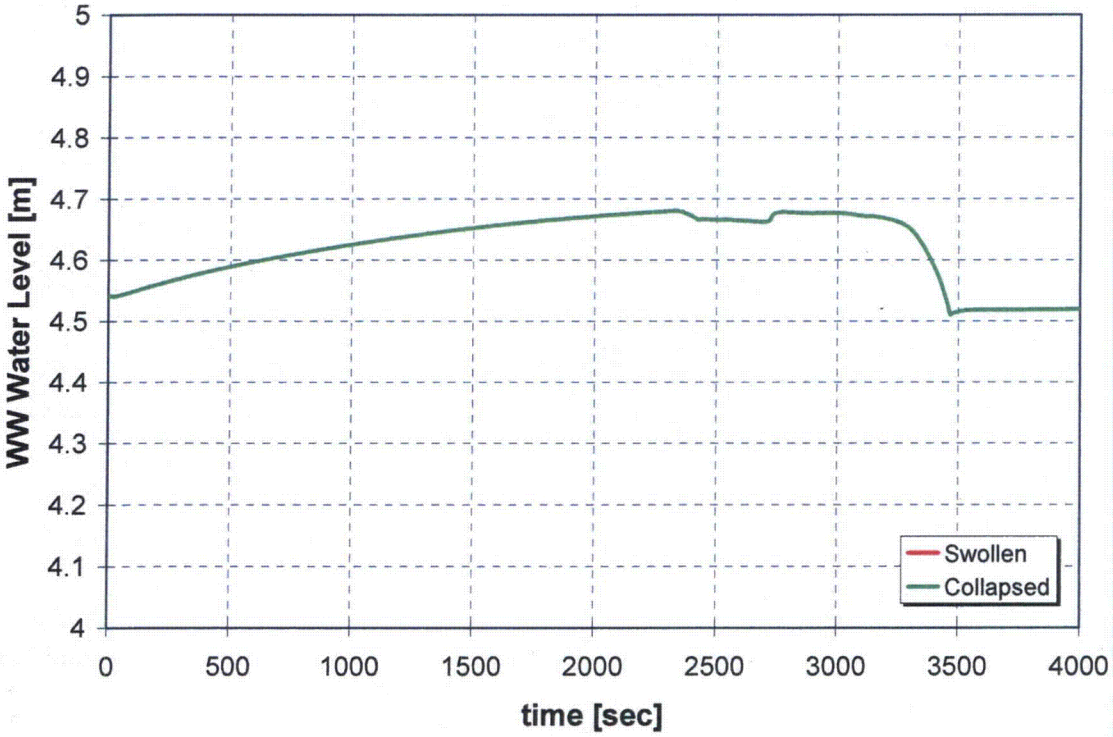

Total Mass Flow Rate [kg/s]
20
18
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
CRD Pump 2 Start
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


LPCI(I)
LPCI(II)
SPC(I)
SPC(II)
Total Mass Flow Rate [kg/s]
900
800
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

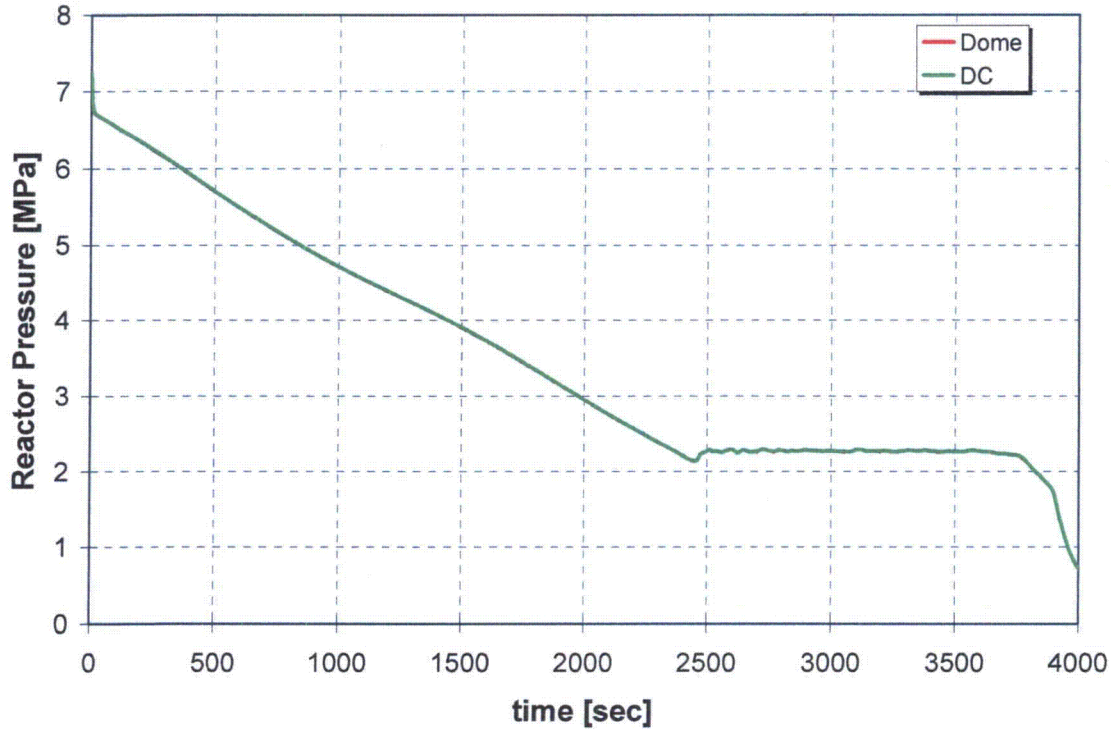

TFU
TCL
2200F
Maximum Core Temperature [K]
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]

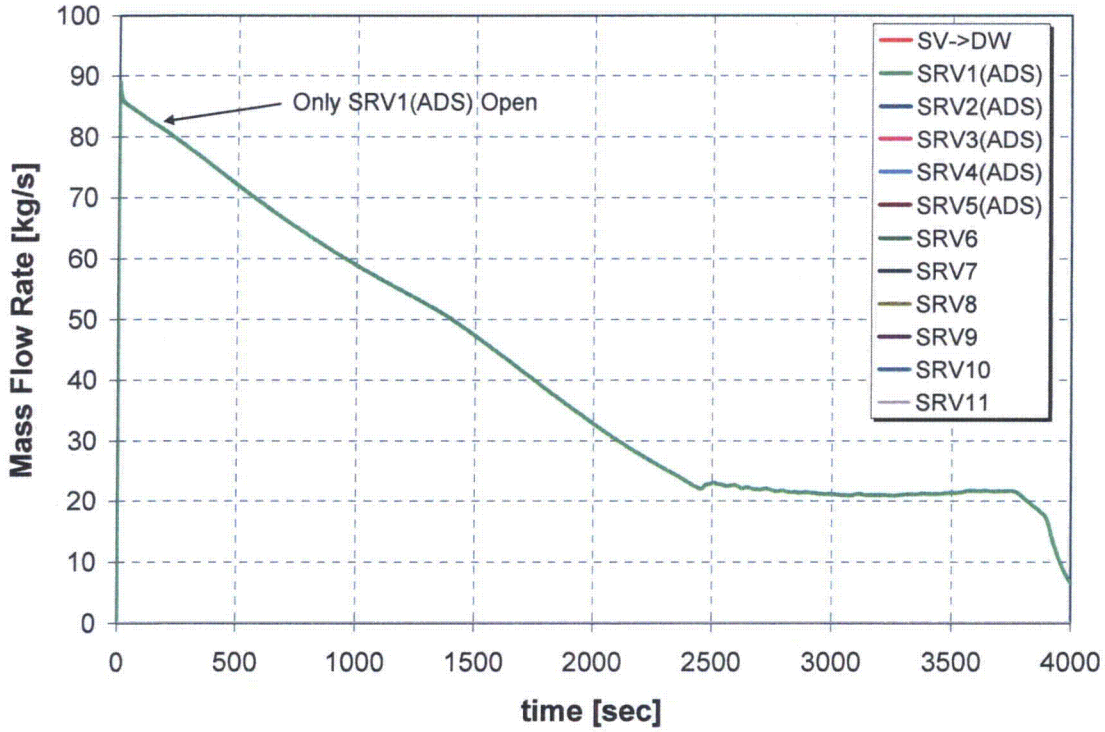

Containment Pressure [bar]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
DW
WW

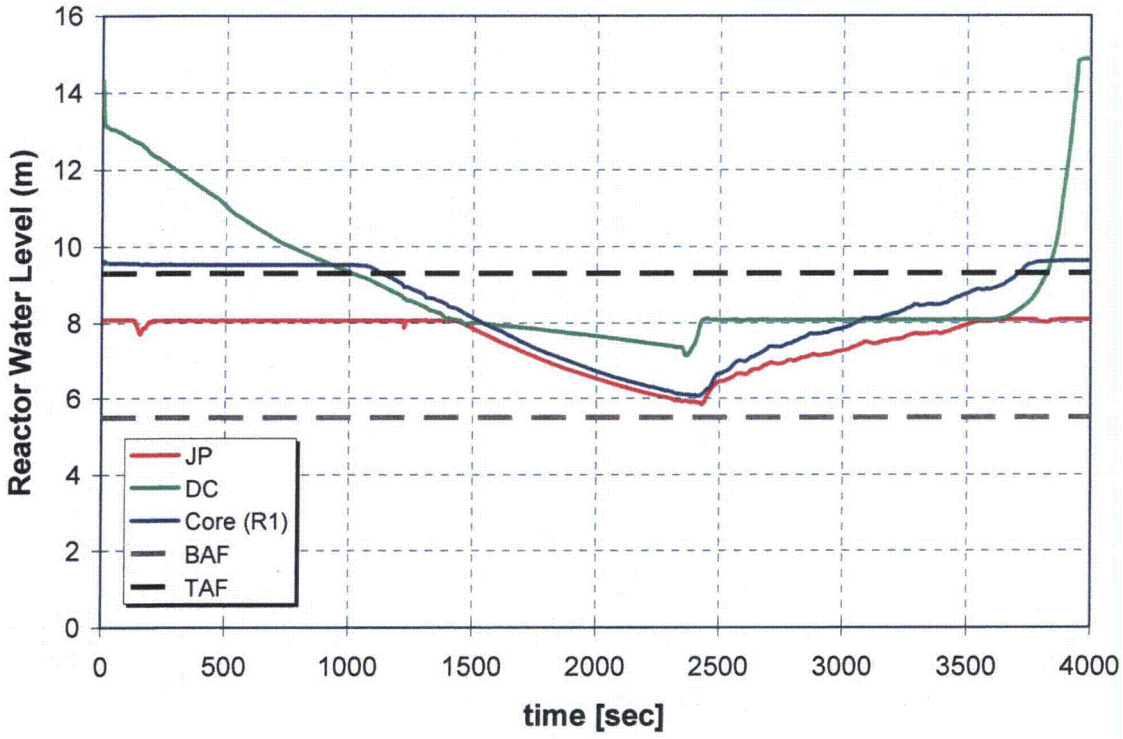

Wetwell Temperature [K]
410
390
370
350
330
310
290
270
250
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
TLIQ
TSAT
TVAP

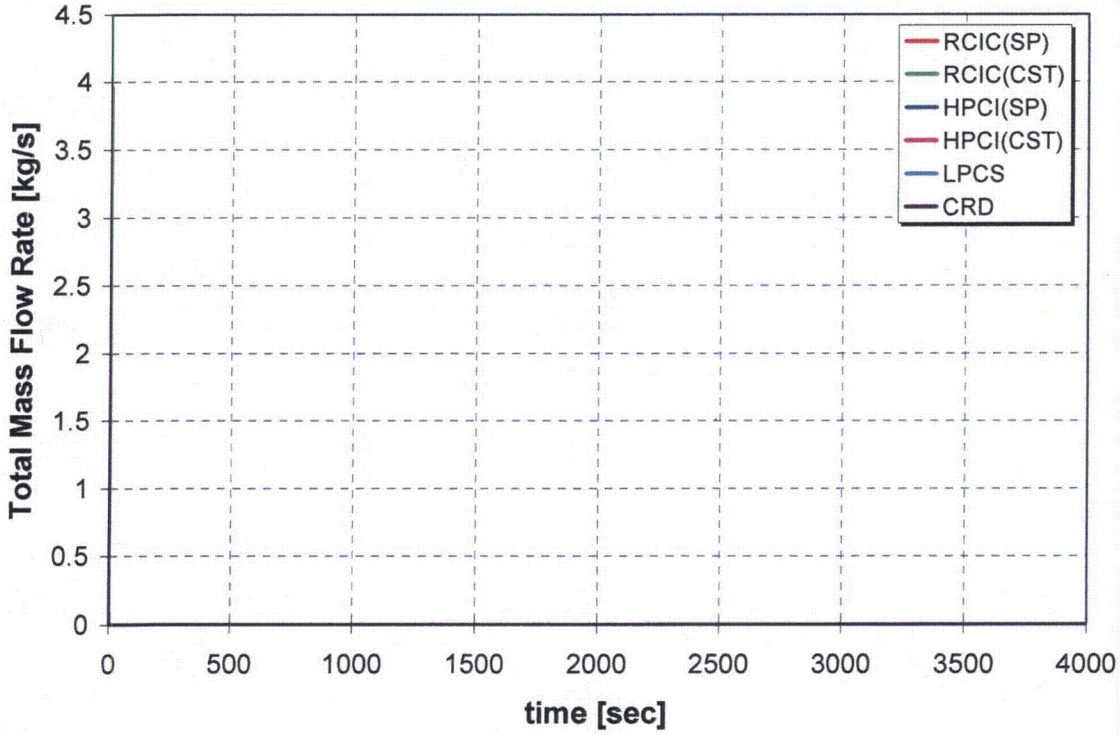

5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
WW Water Level [m]
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
Swollen
Collapsed

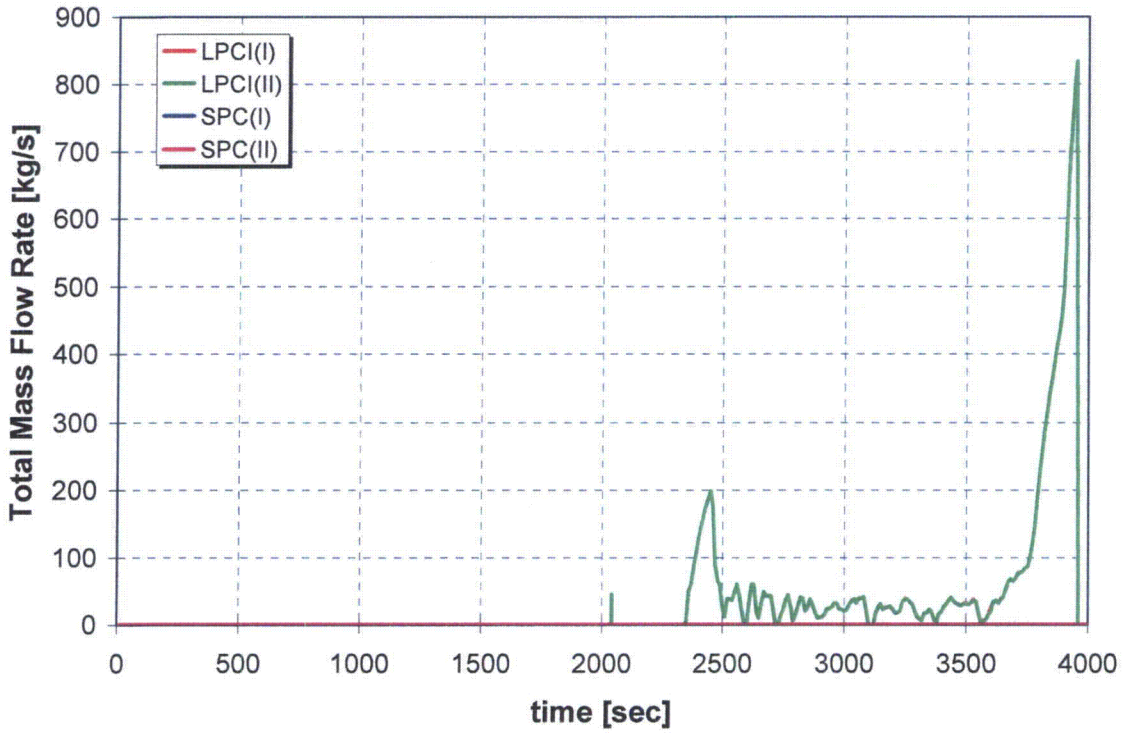
B.1.5 Case 5: Safety Relief Valve Opening

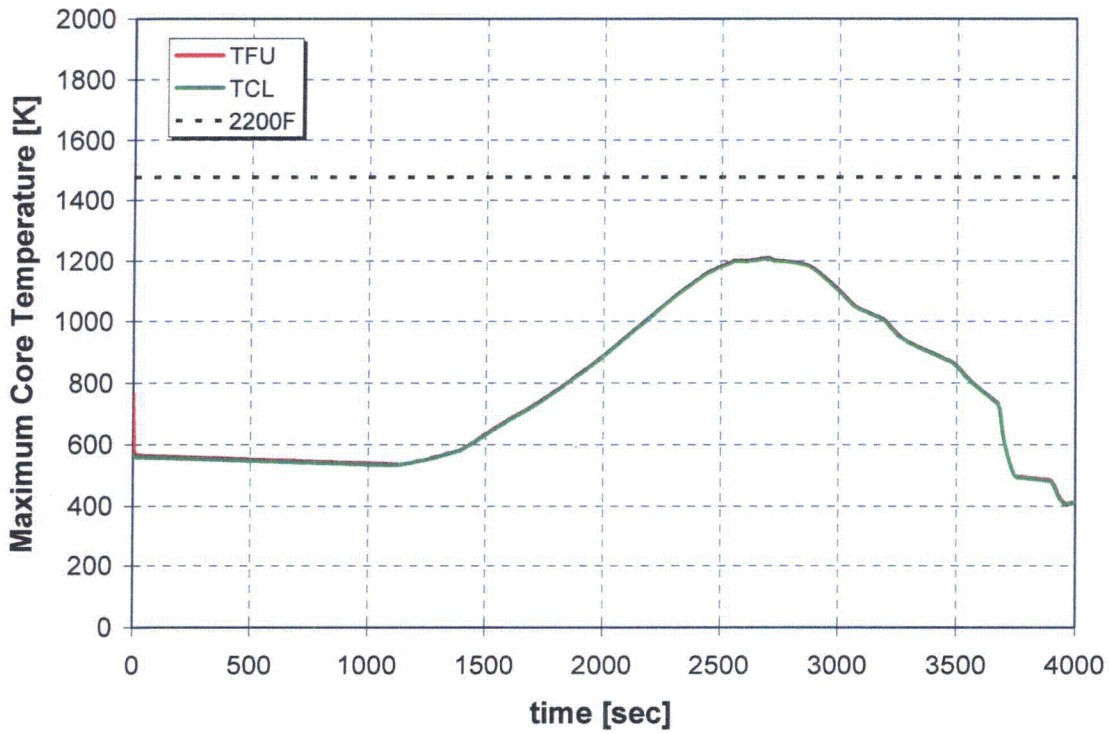


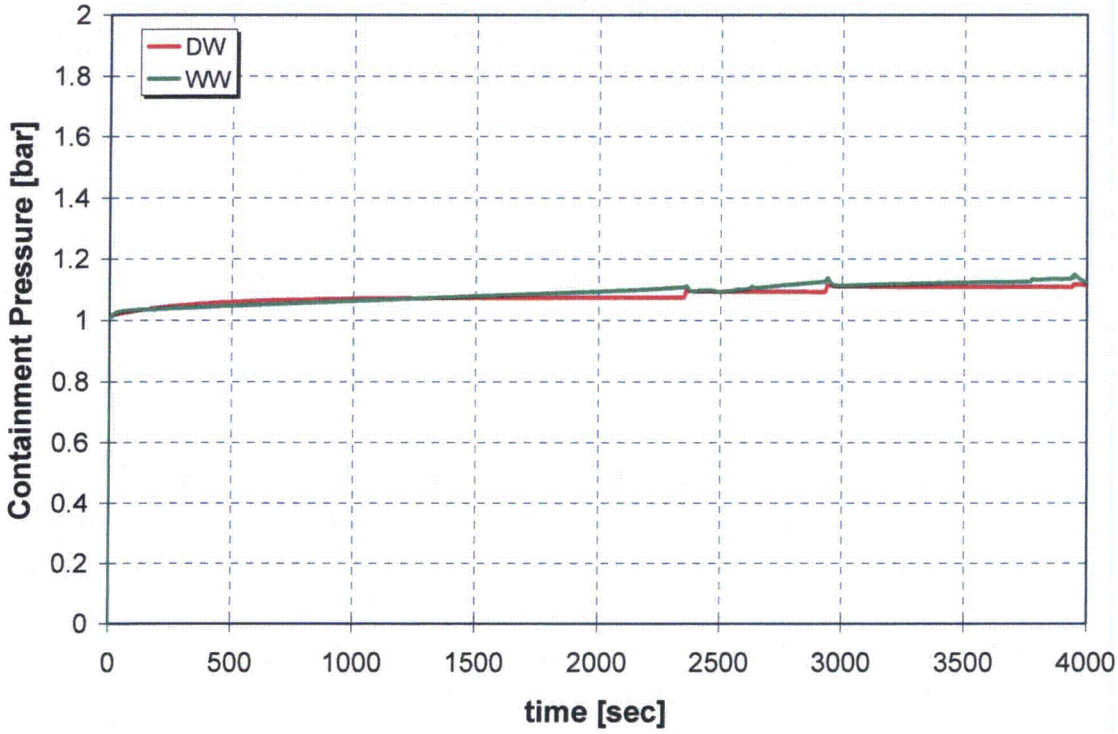


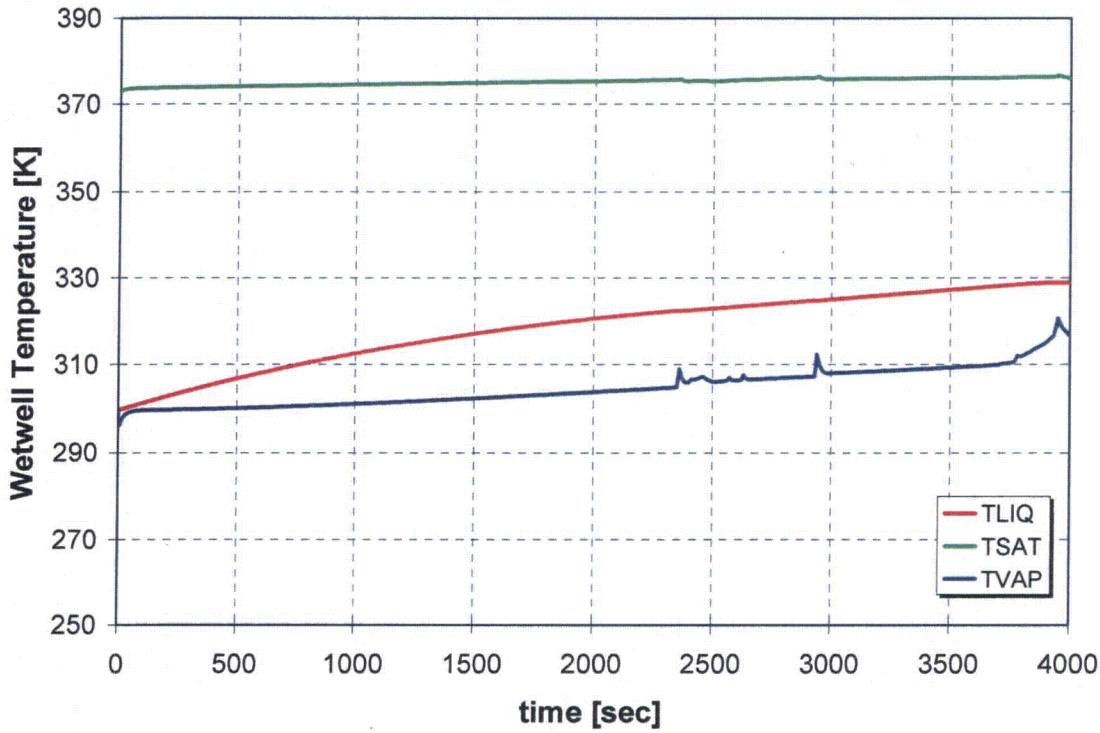

Reactor Water Level (m)
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
JP
DC
Core (R1)
BAF
TAF

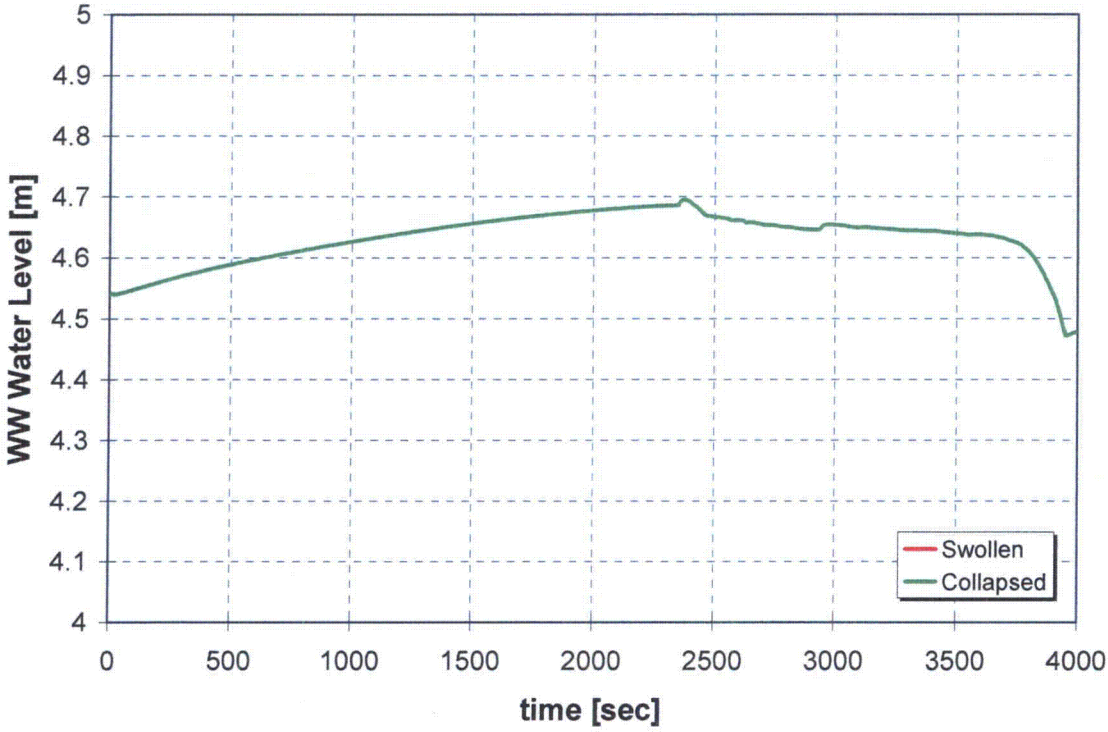

Total Mass Flow Rate [kg/s]
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


LPCI(I)
LPCI(II)
SPC(I)
SPC(II)
Total Mass Flow Rate [kg/s]
900
800
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]


TFU
TCL
2200F
Maximum Core Temperature [K]
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]


DW
WW
Containment Pressure [bar]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]


Wetwell Temperature [K]
390
370
350
330
310
290
270
250
TLIQ
TSAT
TVAP
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]


WW Water Level [m]
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
0
500
1000
1500
2000
2500
3000
3500
4000
time [sec]
Swollen
Collapsed

B.2 Boiling-Water Reactor Station Blackout

Analysis Summary

Table 3 through Table 6 below provide results for this portion of the analysis.

Table 3 Peach Bottom Station Blackout Results

Case	RCIC	HPCI	ac/dc	SRV Sticks Open?	HCTL Depress?	Core Uncovery (hr)	Core Damage (hr)
1	No	No	-	No[1]	No	0.5	1.2
1a			ac recovery at 1.2 hr	No		0.5	1.2[2]
2			-	At t = 0		0.3	0.8
3	Yes		Infinite dc	No		17.7	19.4
4					Yes	6.0	7.2
5			2 hr of dc		No	3.3	4.3
6			Infinite dc	At 187 lifts		6.0	7.2
7	No	Yes		No		17.5	19.3
8					Yes	9.3	10.8
9			2 hr of dc		No	3.8	4.9
10			Infinite dc	At 187 lifts		9.2	10.7

[1] For this case, the SRV does not stick open until after core damage, so this assumption does not affect the outcome.

[2] Recovery of injection upon reaching 2,200 degrees F (1,204 degrees C) quickly arrests further heatup.

Table 4 Peach Bottom Station Blackout Key Timings (Cases 1, 1a, and 2)

Event	Case 1 (hr)	Case 1a (hr)	Case 2 (hr)
Reactor trip, MSIV closure	0	0	0
Downcomer level reaches L2	0.16	0.16	0.16
Downcomer level reaches L1	0.50	0.50	0.27
Downcomer level below TAF	0.50	0.50	0.27
Gap release: 900 °C (1,652 °F)	1.02	1.02	0.69
Core damage: max temp > 1204 °C (2,200 °F)	1.17	1.17	0.79
HPCI, RCIC, CRD Injection start	-	1.17	-
ADS actuated	-	1.24	-
Downcomer level recovers above TAF	-	1.27	-
SRV sticks open due to high # of cycles	1.75	-	-

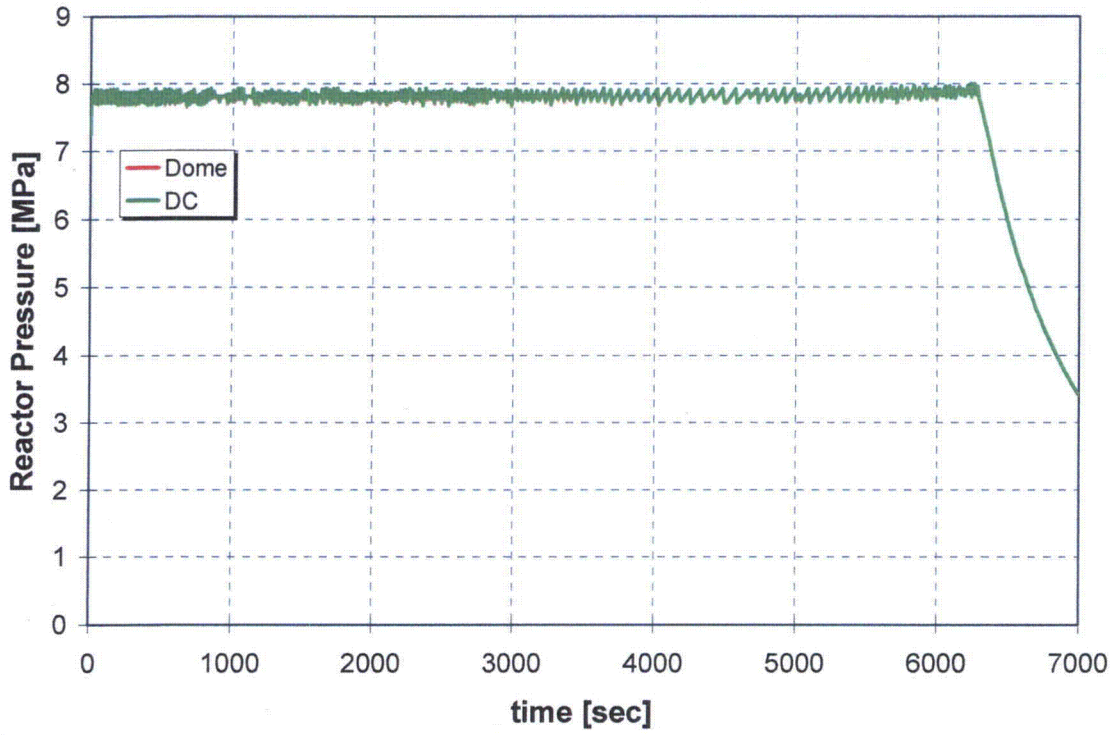
Table 5 Peach Bottom Station Blackout Key Timings (Cases 3–6)

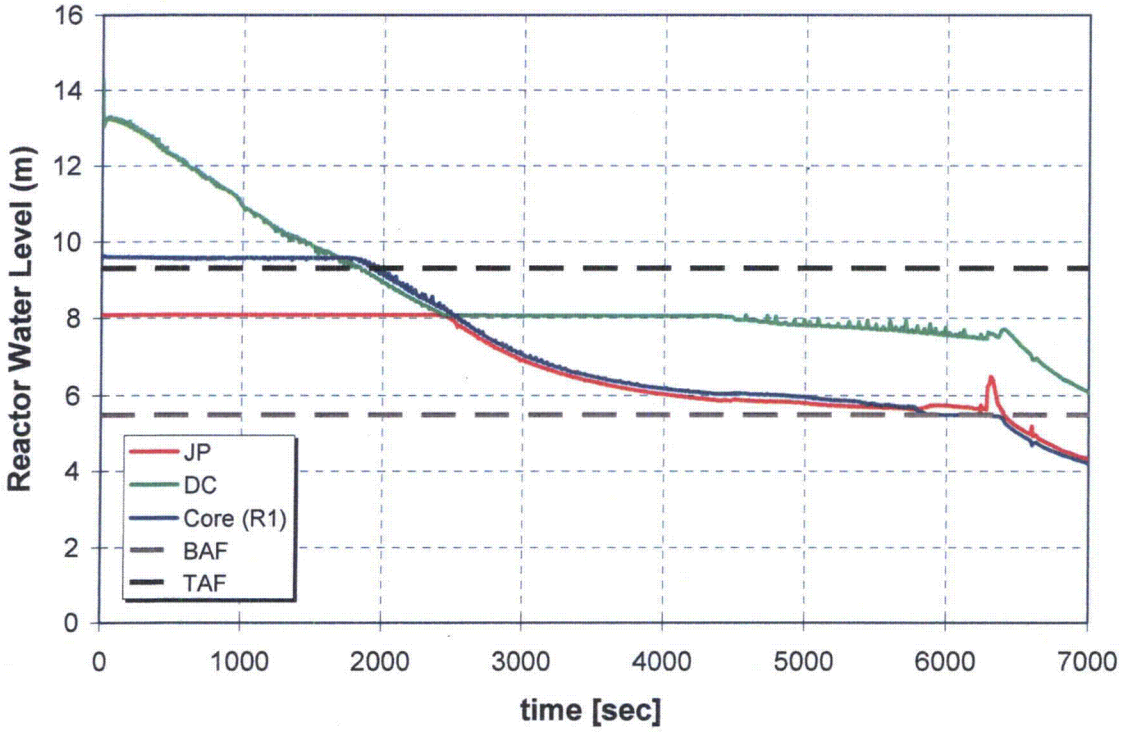
Event	Case 3 (hr)	Case 4 (hr)	Case 5 (hr)	Case 6 (hr)
Reactor trip, MSIV closure	0	0	0	0
Downcomer level first reaches L2	0.16	0.16	0.16	0.16
RCIC started (CST injection mode)	0.17	0.17	0.17	0.17
RCIC fails due to loss of dc	-	-	2.00	-
HCTL limit reached	2.46 (no action taken)	2.46	2.46 (no action taken)	2.46 (no action taken)
SRV sticks open due to high # of cycles	-	-	-	2.47
RCIC NPSH limit exceeded	11.57	-	-	-
RCIC pump isolation: low steam line pressure < 0.52 MPa (75 psig)	-	3.90	-	3.92
RCIC injection ends due to CST level < 5 ft (1.5 m)	14.43	-	-	-
Downcomer level reaches L1	17.68	5.61	3.25	5.62
Downcomer level below TAF	17.68	5.61	3.25	5.62
Gap release: 900 °C (1,652 °F)	19.06	6.99	4.04	7.00
Core damage max temp > 1,204 °C (2,200 °F)	19.42	7.17	4.25	7.18
Exhaust pressure exceeded: 0.35 MPa (50 psig)	20.14	-	-	-

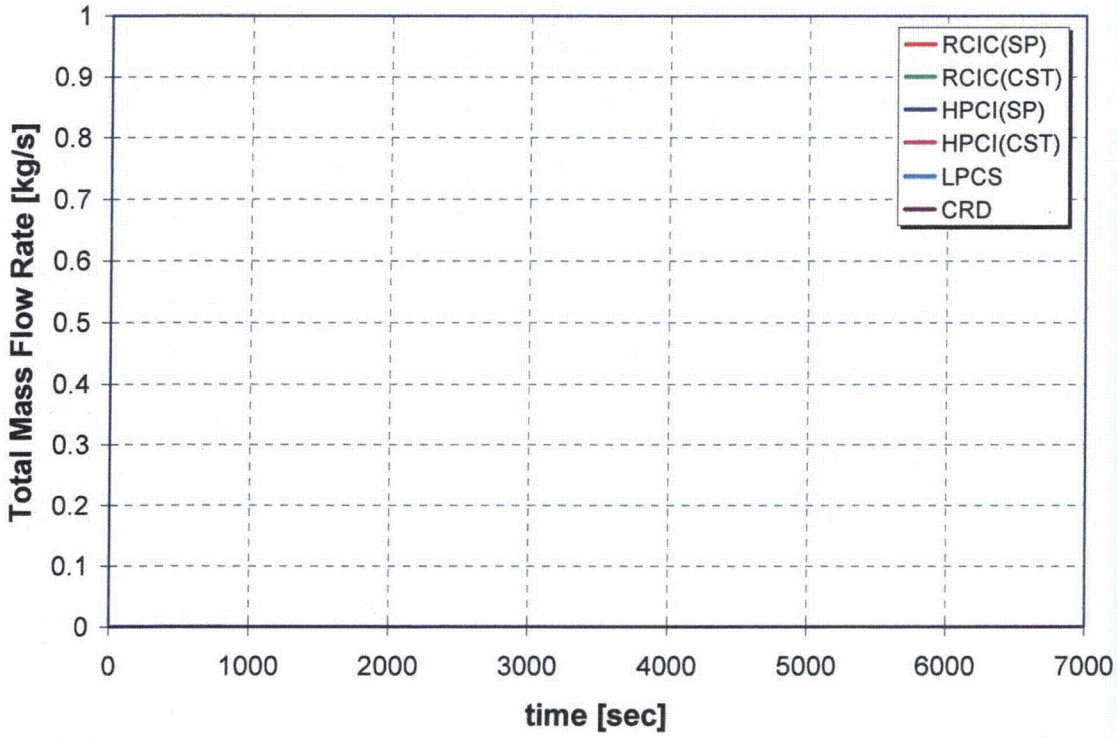
Table 6 Peach Bottom Station Blackout Key Timings (Cases 7–10)

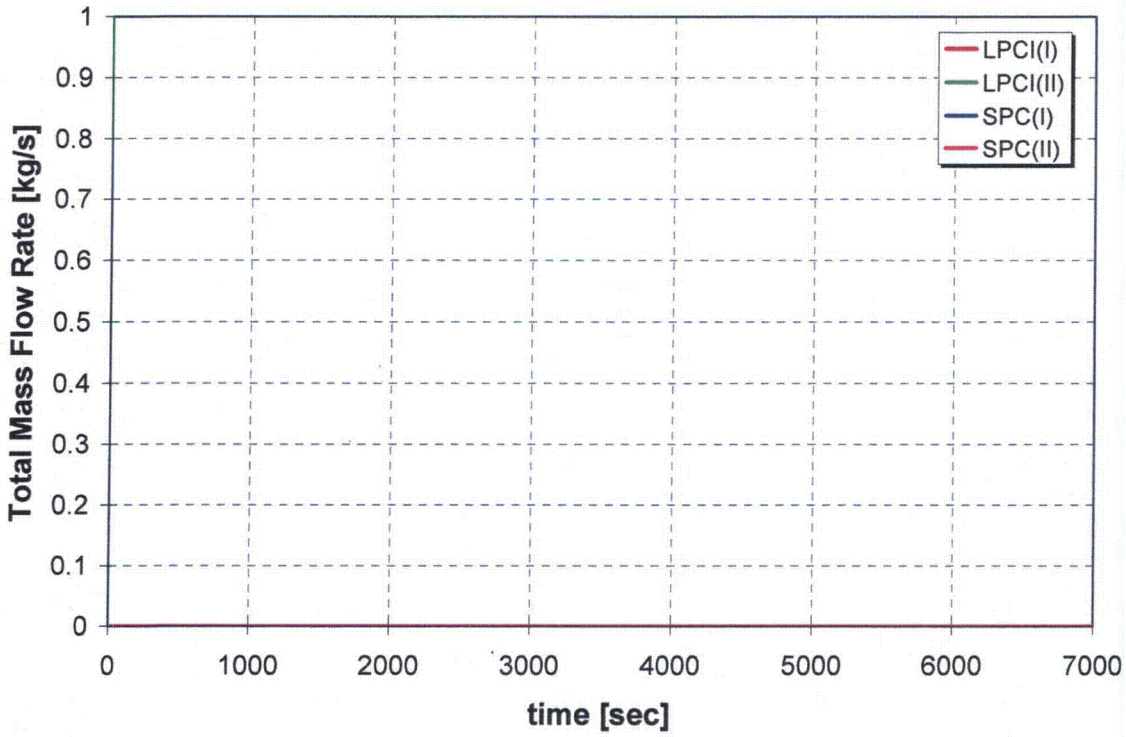
Event	Case 7 (hr)	Case 8 (hr)	Case 9 (hr)	Case 10 (hr)
Reactor trip, MSIV closure	0	0	0	0
Downcomer level first reaches L2	0.16	0.16	0.16	0.16
HPCI started (CST injection mode)	0.17	0.17	0.17	0.17
HPCI fails due to loss of dc	-	-	2.00	-
SRV sticks open due to high # of cycles	-	-	-	2.53
HCTL limit reached	2.67 (no action taken)	2.67	2.67 (no action taken)	2.67 (no action taken)
HPCI NPSH limit exceeded	12.07	-	-	-
HPCI pump isolation: low steam line pressure < 0.52 MPa (75 psig)	-	5.72	-	5.61
HPCI injection ends due to CST level < 5 ft (1.5 m)	16.05	-	-	-
Downcomer level reaches L1	17.53	8.97	3.82	8.94
Downcomer level below TAF	17.53	9.06	3.82	8.94
Gap release: 900 °C (1,652 °F)	18.96	10.59	4.63	10.46
Core damage max temp > 1,204 °C (2,200 °F)	19.31	10.8	4.85	10.68
Exhaust pressure exceeded: 1.04 MPa (150 psig)	-	-	-	-

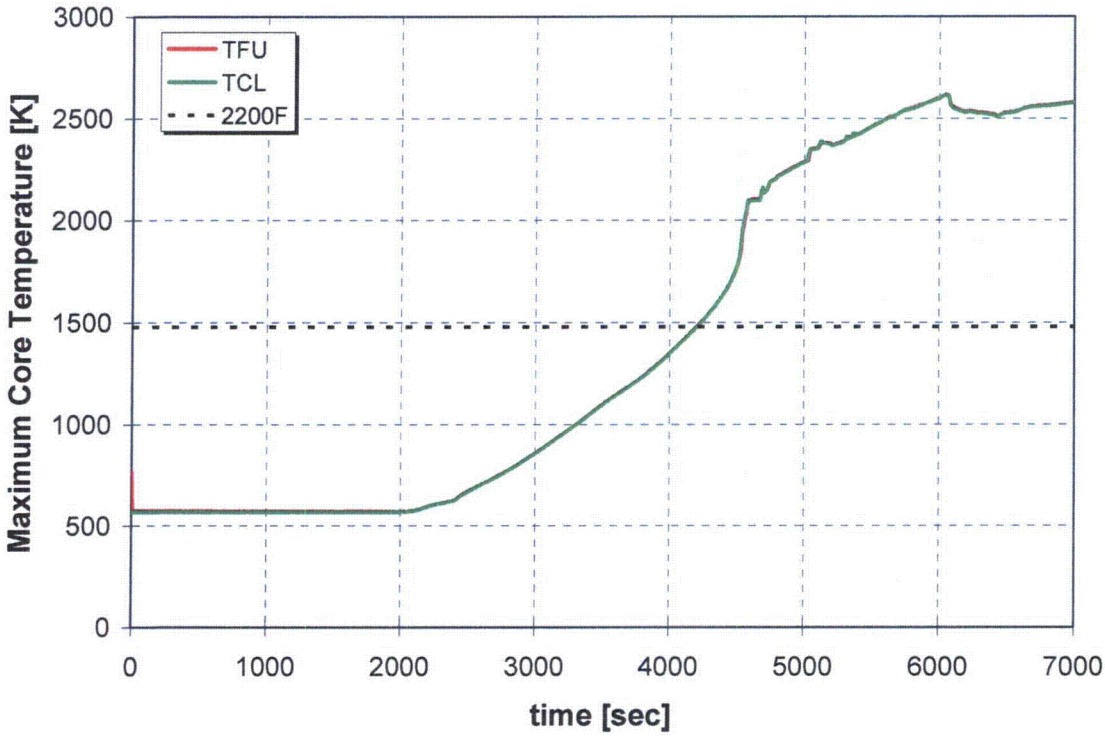
B.2.1 Case 1: Station Blackout with No Injection

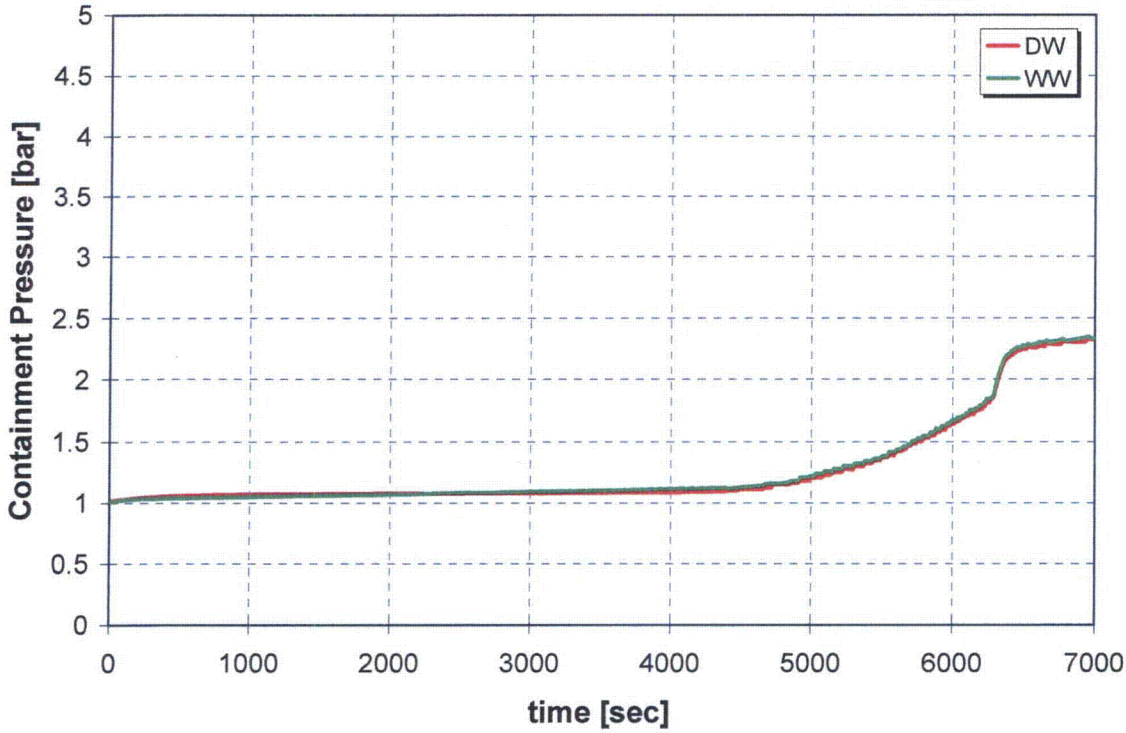


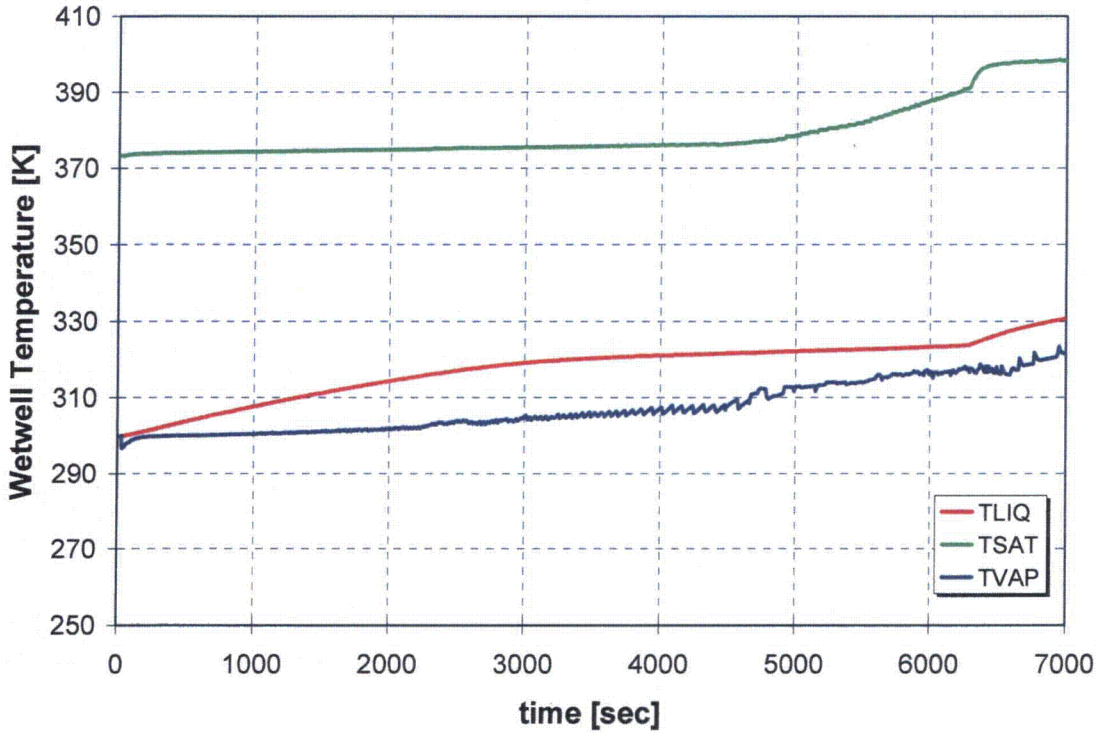


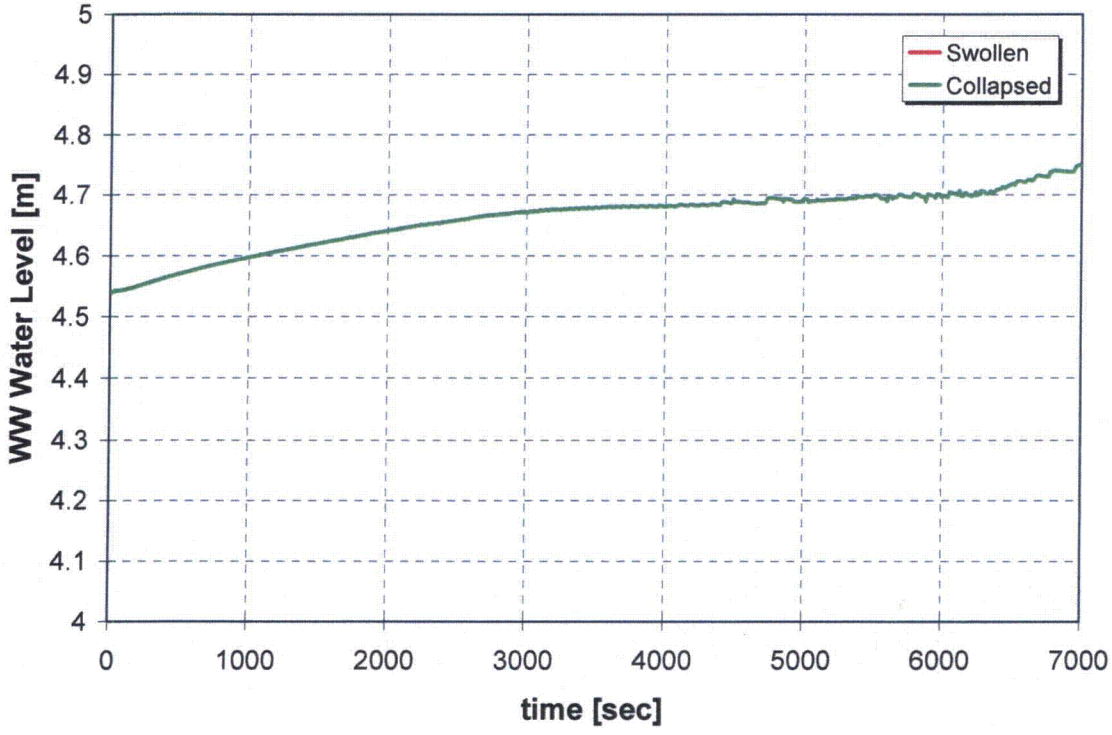

Total Mass Flow Rate [kg/s]
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1000
2000
3000
4000
5000
6000
7000


Total Mass Flow Rate [kg/s]
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1000
2000
3000
4000
5000
6000
7000

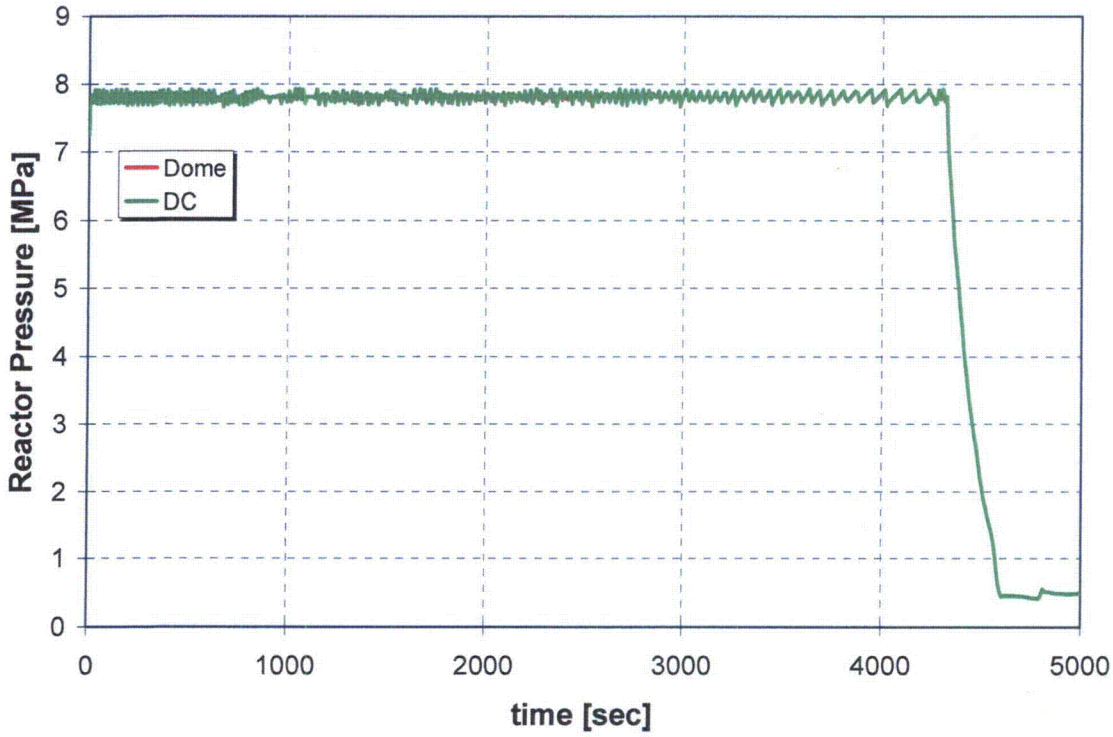

Maximum Core Temperature [K]
3000
2500
2000
1500
1000
500
0
TFU
TCL
2200F
0
1000
2000
3000
4000
5000
6000
7000
time [sec]

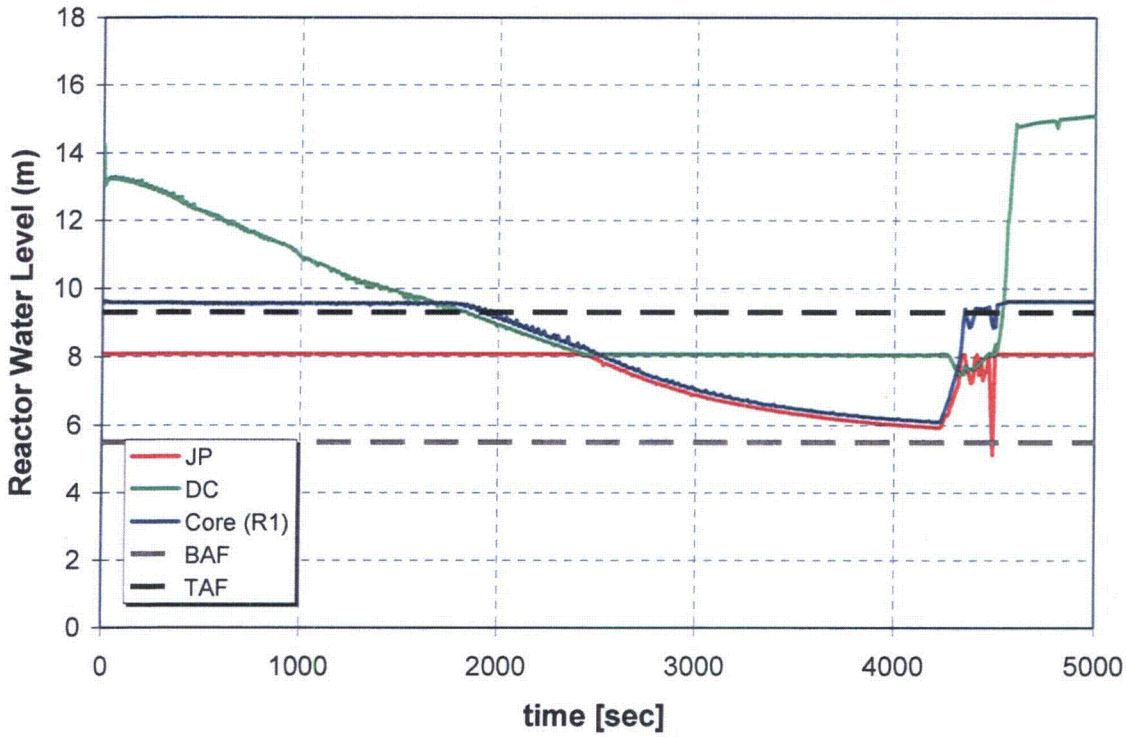

Containment Pressure [bar]
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
DW
WW
0
1000
2000
3000
4000
5000
6000
7000
time [sec]

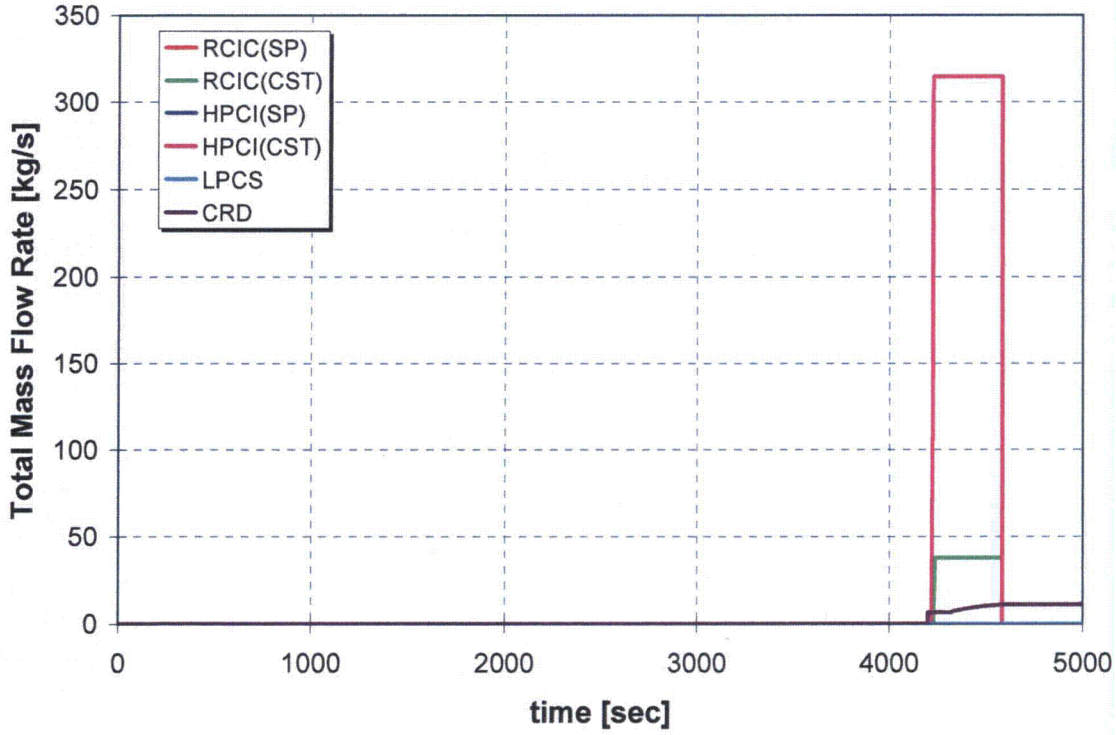

Wetwell Temperature [K]
410
390
370
350
330
310
290
270
250
0
1000
2000
3000
4000
5000
6000
7000
time [sec]
TLIQ
TSAT
TVAP

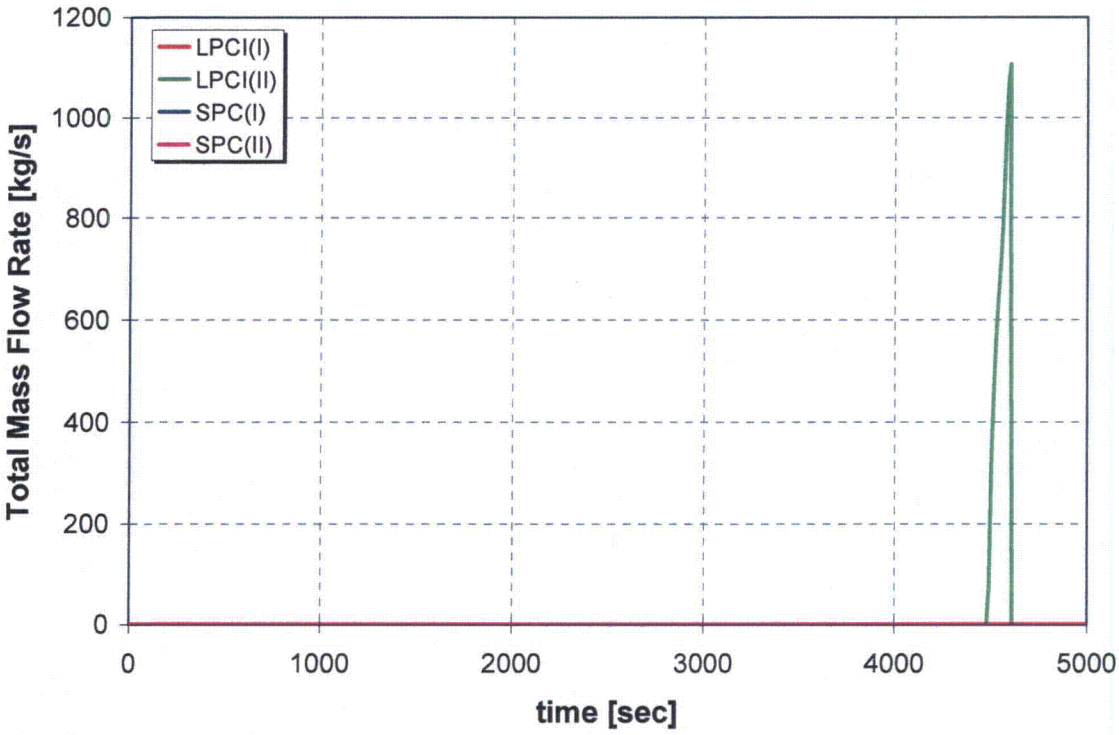

WW Water Level [m]
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
0
1000
2000
3000
4000
5000
6000
7000
time [sec]
Swollen
Collapsed

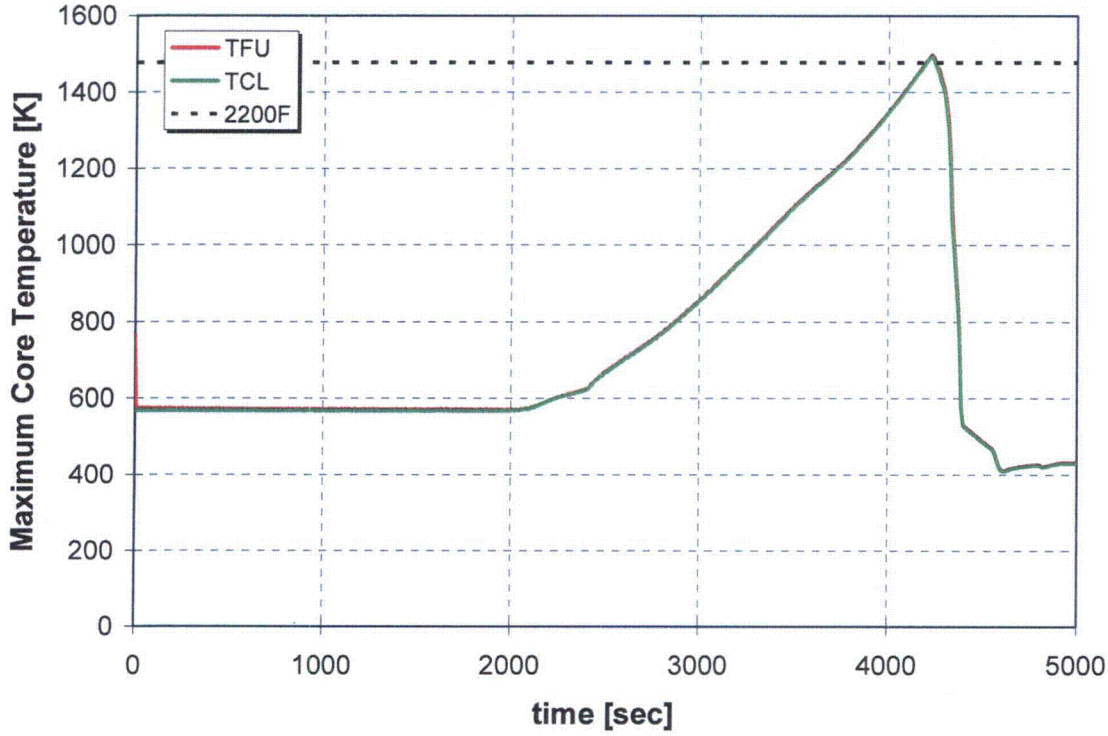
B.2.1.1 Case 1a: Station Blackout with No Injection and Power Recovery at Core Damage

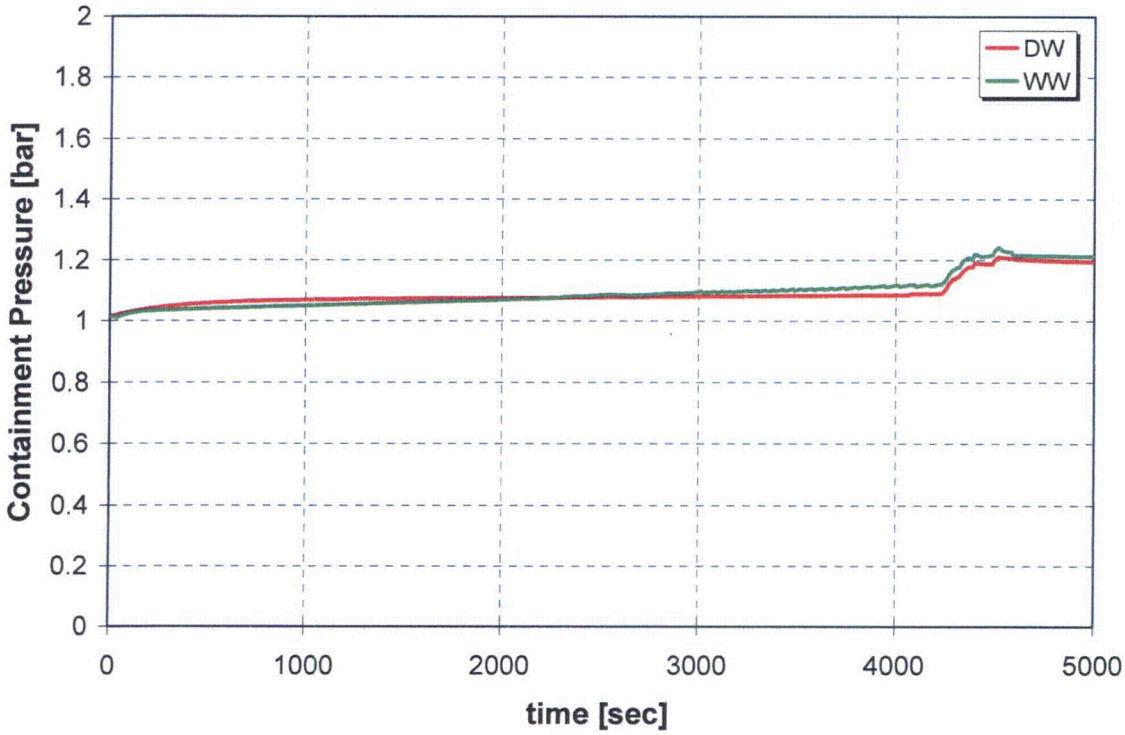


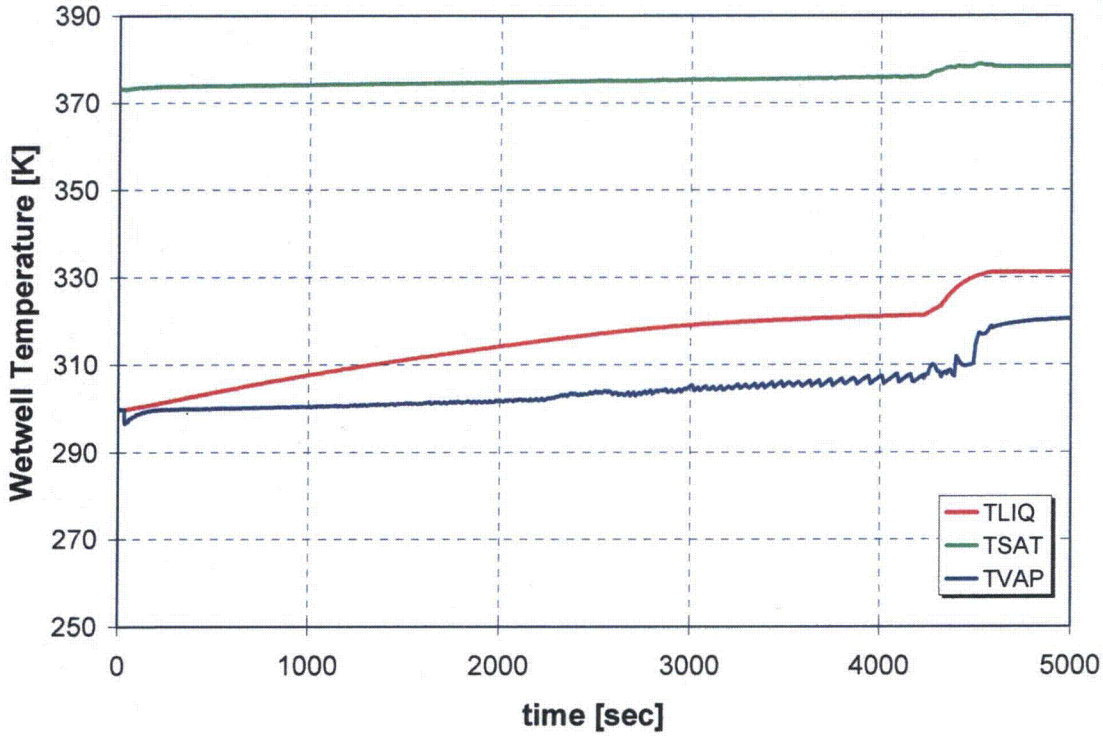


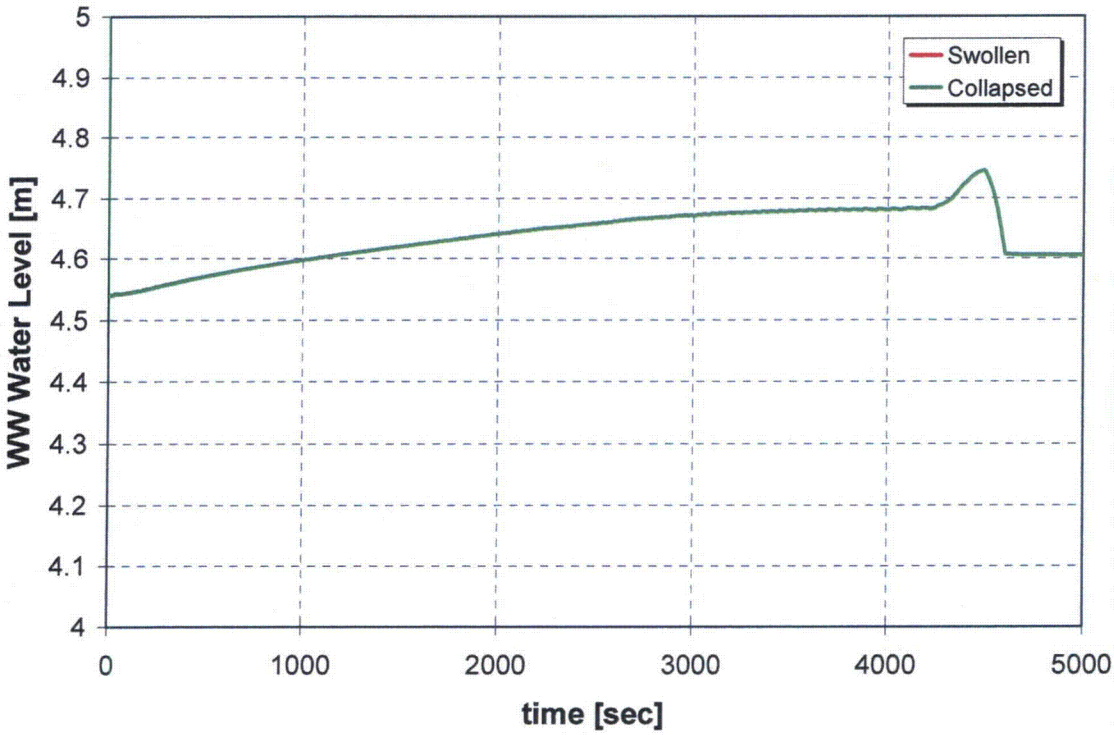

RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD
Total Mass Flow Rate [kg/s]
350
300
250
200
150
100
50
0
0
1000
2000
3000
4000
5000
time [sec]


LPCI(I)
LPCI(II)
SPC(I)
SPC(II)
Total Mass Flow Rate [kg/s]
1200
1000
800
600
400
200
0
0
1000
2000
3000
4000
5000
time [sec]

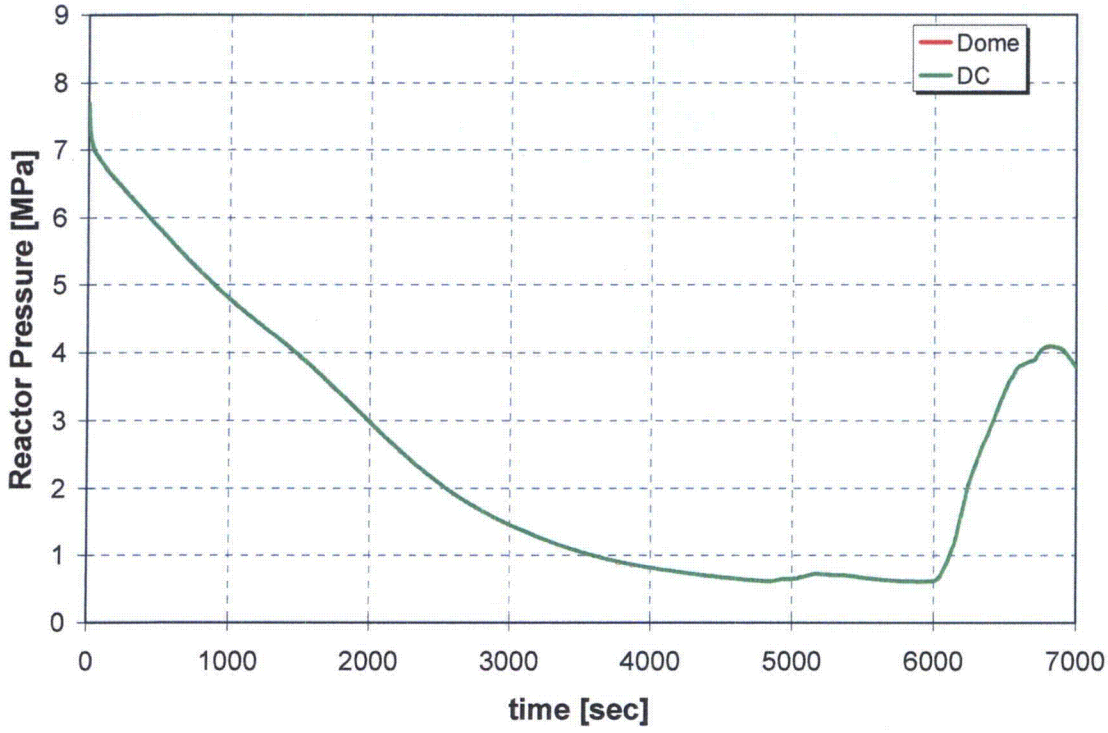

TFU
TCL
2200F
Maximum Core Temperature [K]
1600
1400
1200
1000
800
600
400
200
0
0
1000
2000
3000
4000
5000
time [sec]

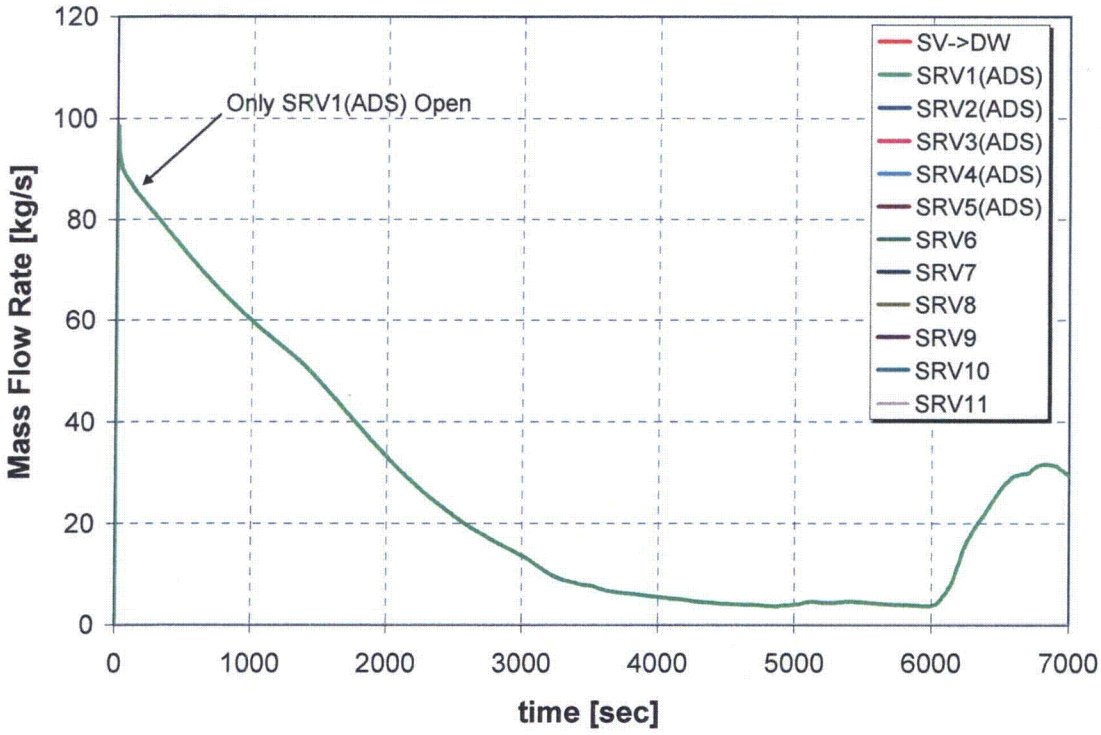

DW
WW
Containment Pressure [bar]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1000
2000
3000
4000
5000
time [sec]

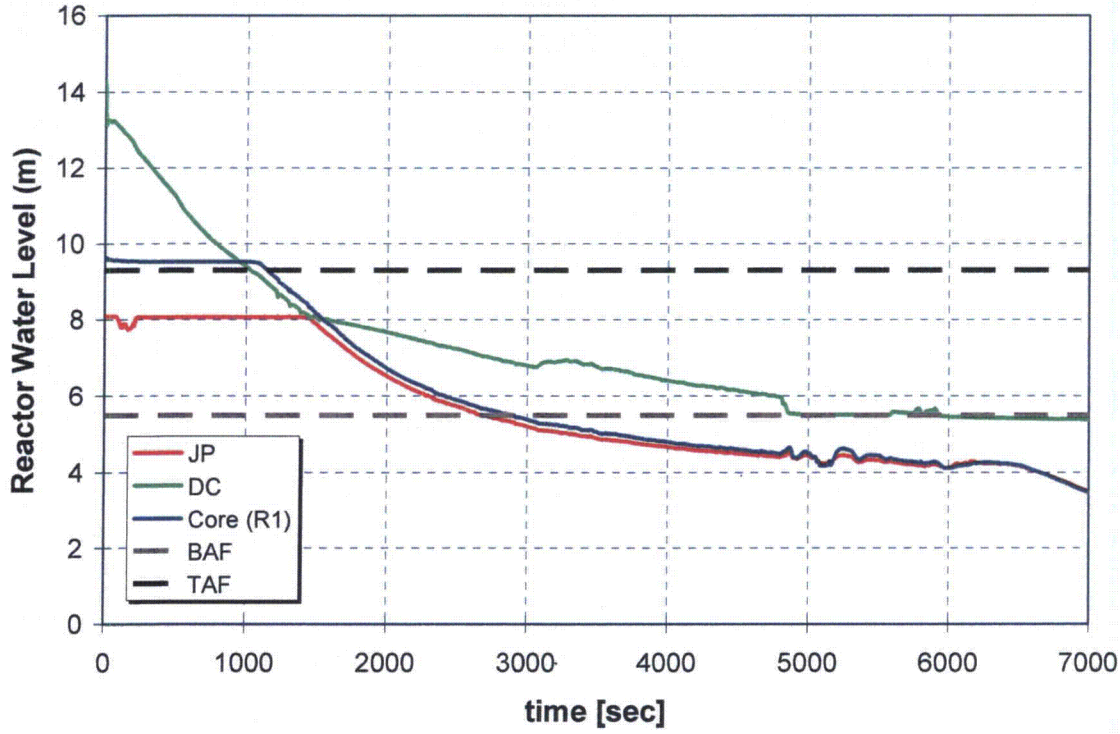

Wetwell Temperature [K]
390
370
350
330
310
290
270
250
0
1000
2000
3000
4000
5000
time [sec]
TLIQ
TSAT
TVAP

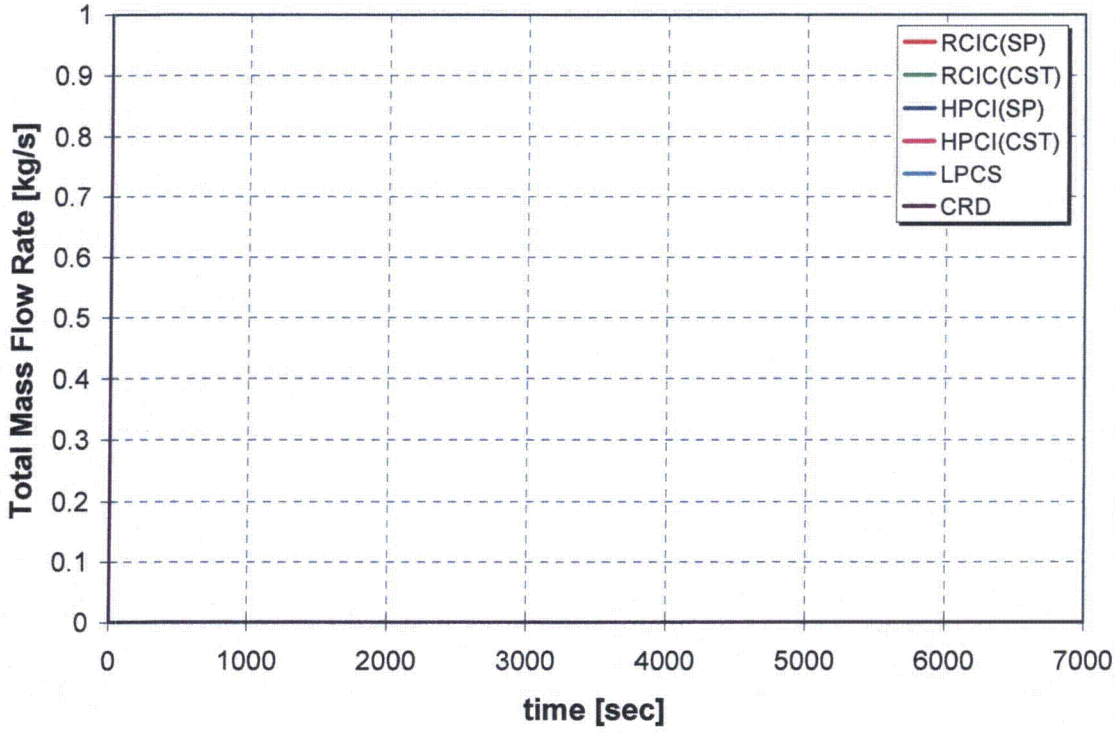

WW Water Level [m]
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
0
1000
2000
3000
4000
5000
time [sec]
Swollen
Collapsed

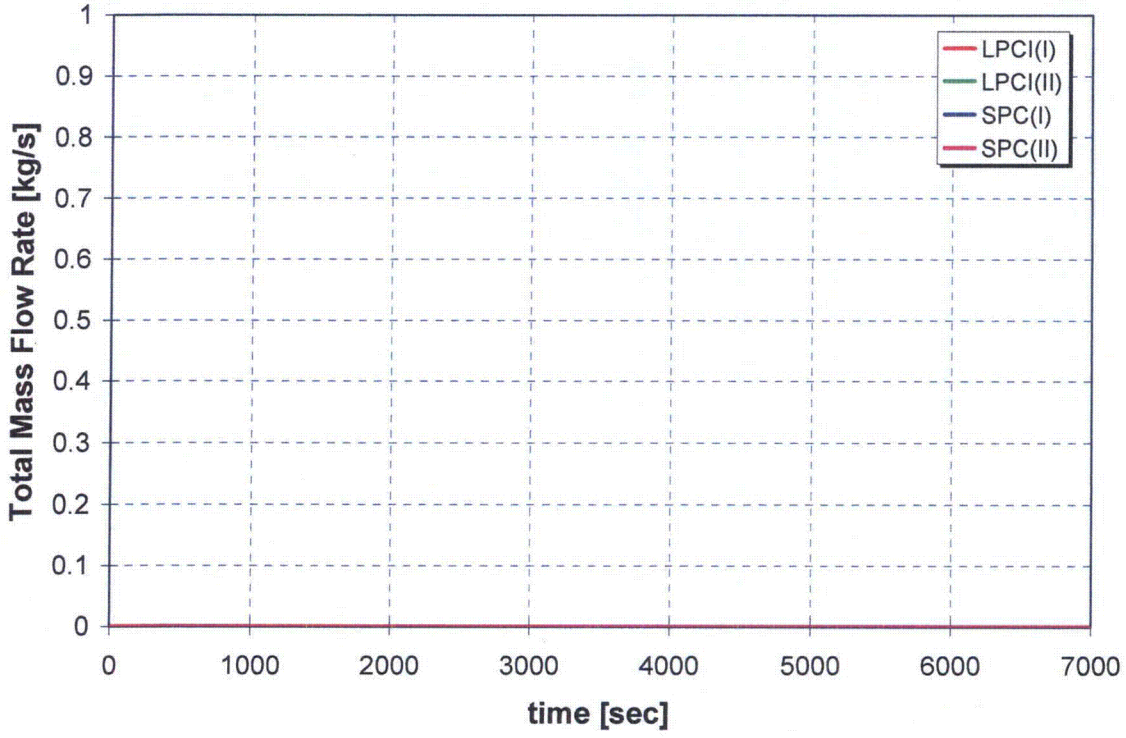
B.2.2 Case 2: Station Blackout and Safety Relief Valve Open at t = 0

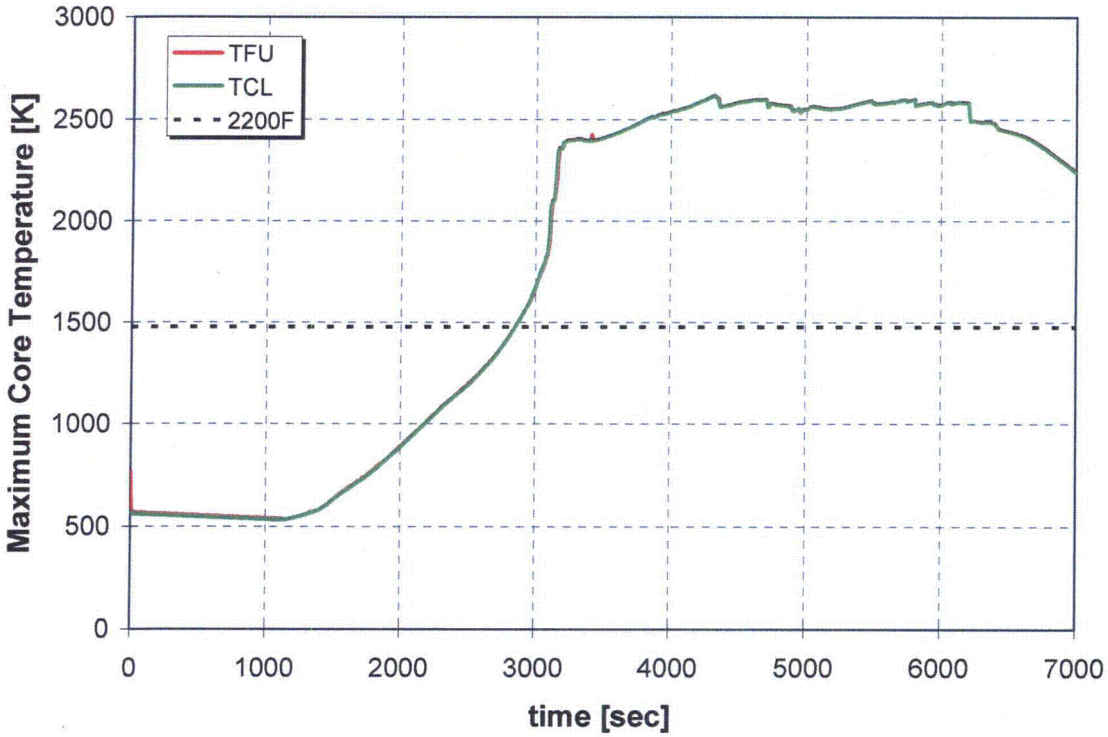


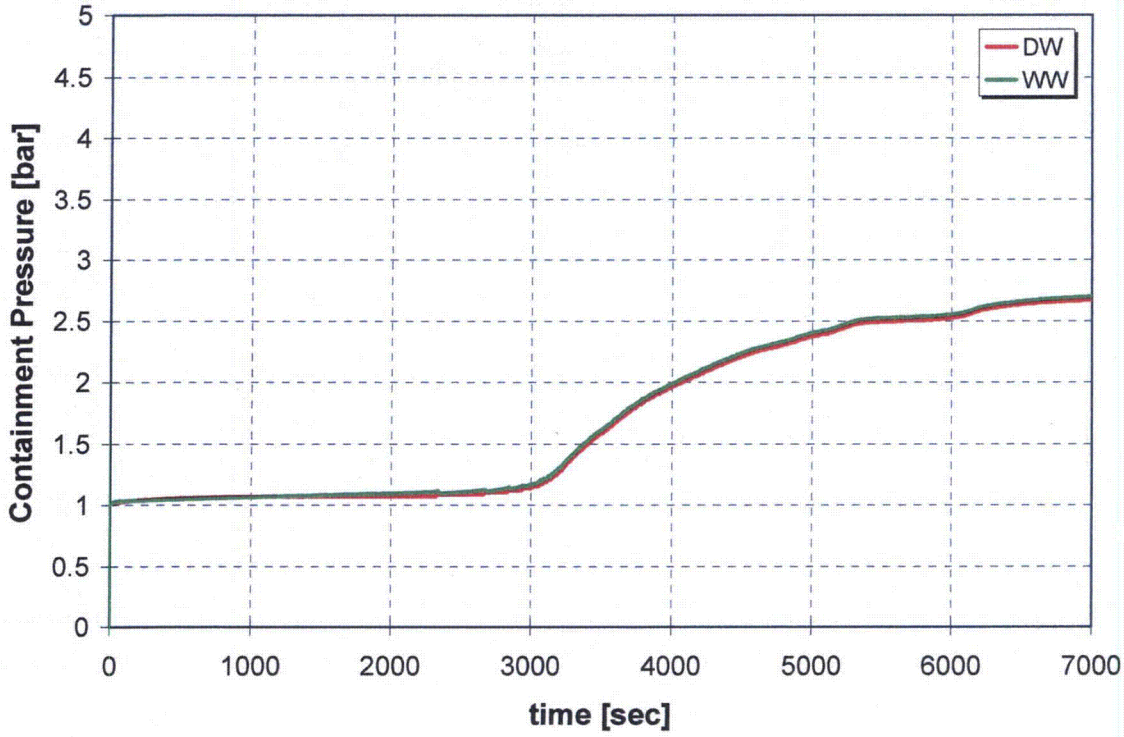


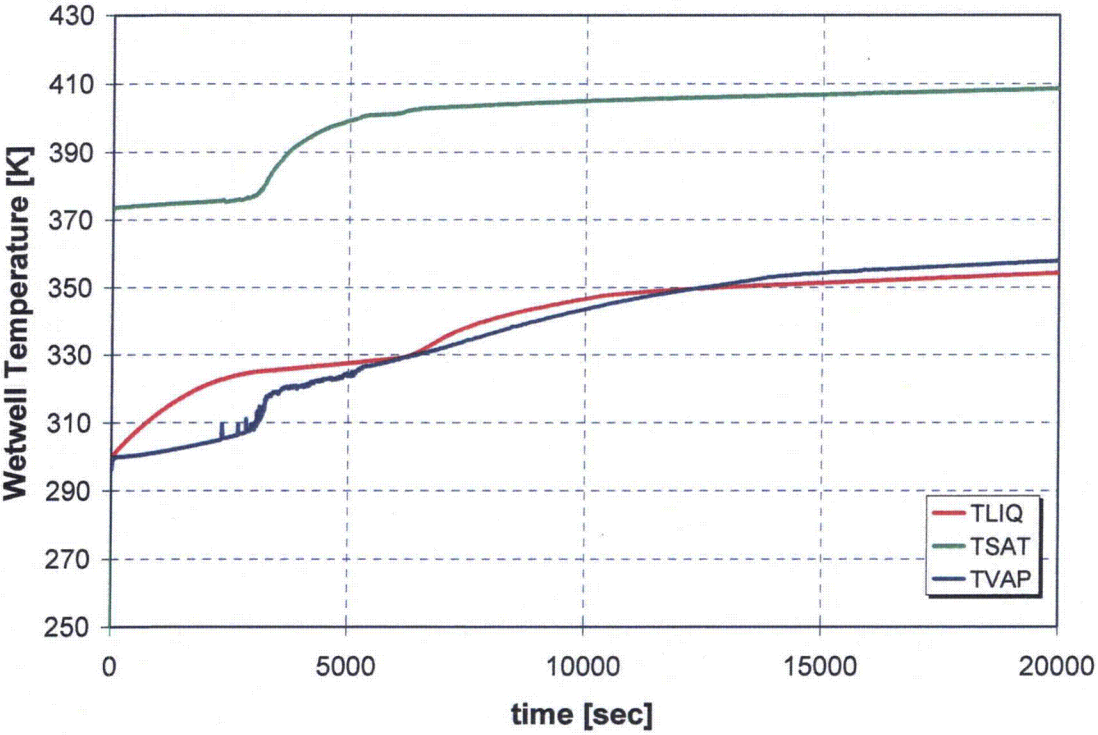

Reactor Water Level (m)
16
14
12
10
8
6
4
2
0
0
1000
2000
3000
4000
5000
6000
7000
time [sec]
JP
DC
Core (R1)
BAF
TAF

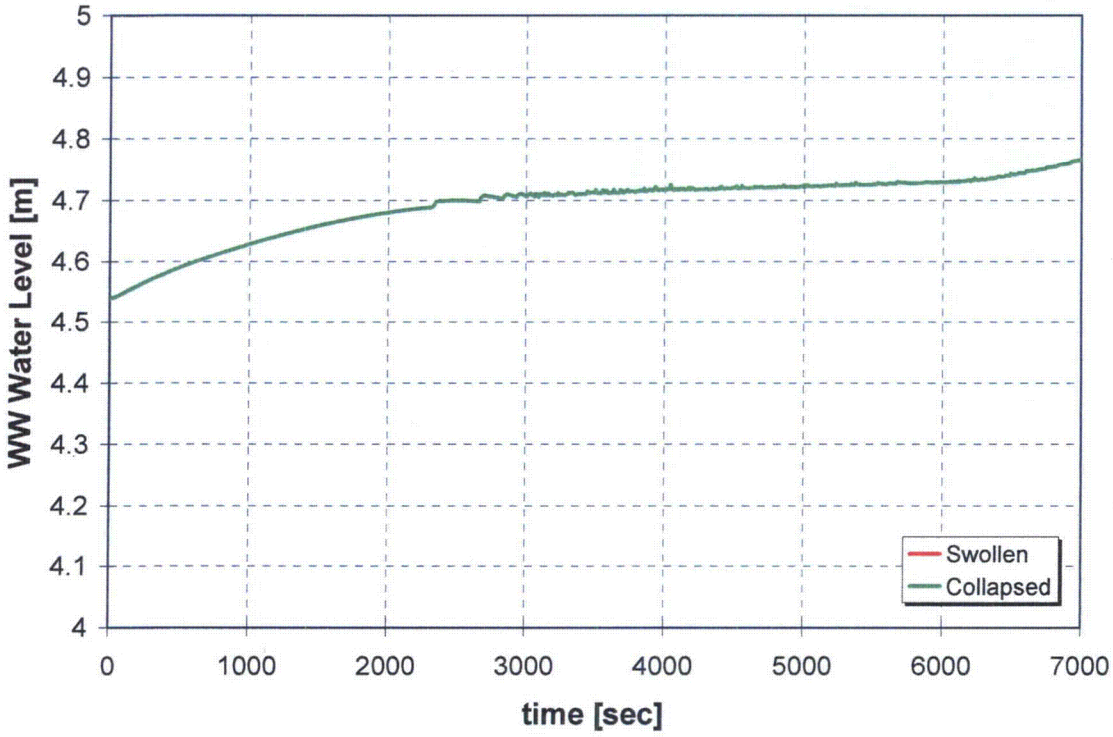

Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1000
2000
3000
4000
5000
6000
7000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1000
2000
3000
4000
5000
6000
7000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)


Maximum Core Temperature [K]
3000
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
6000
7000
time [sec]
TFU
TCL
2200F

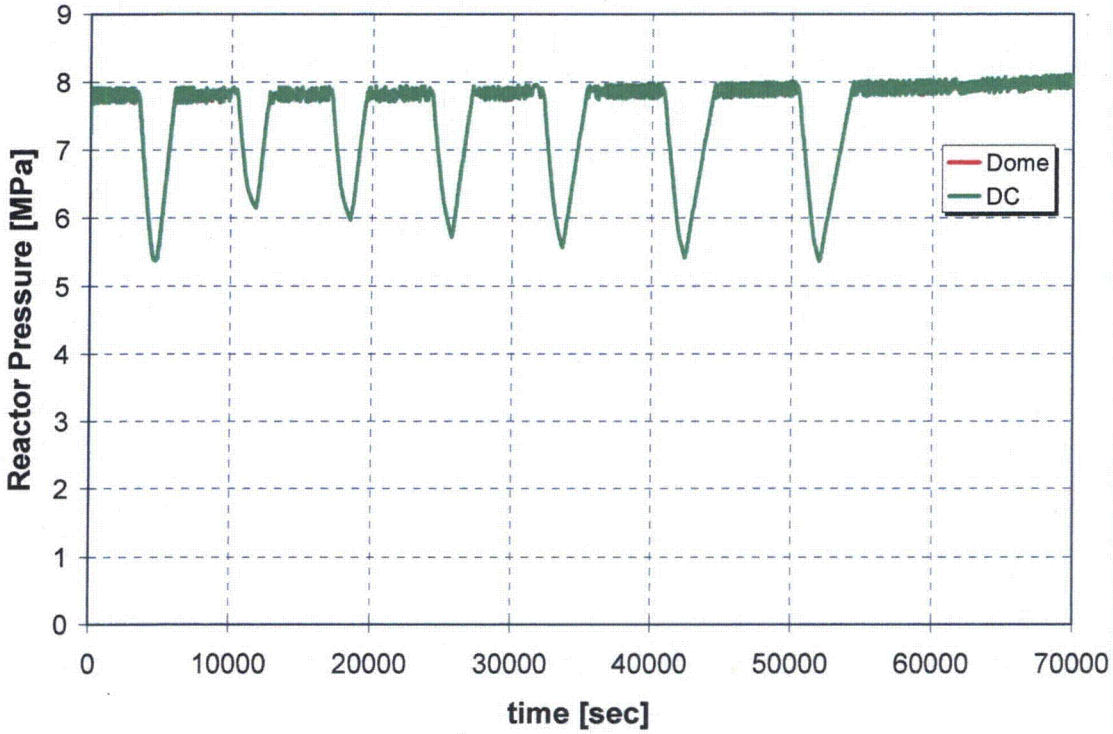

Containment Pressure [bar]
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
1000
2000
3000
4000
5000
6000
7000
time [sec]
DW
WW

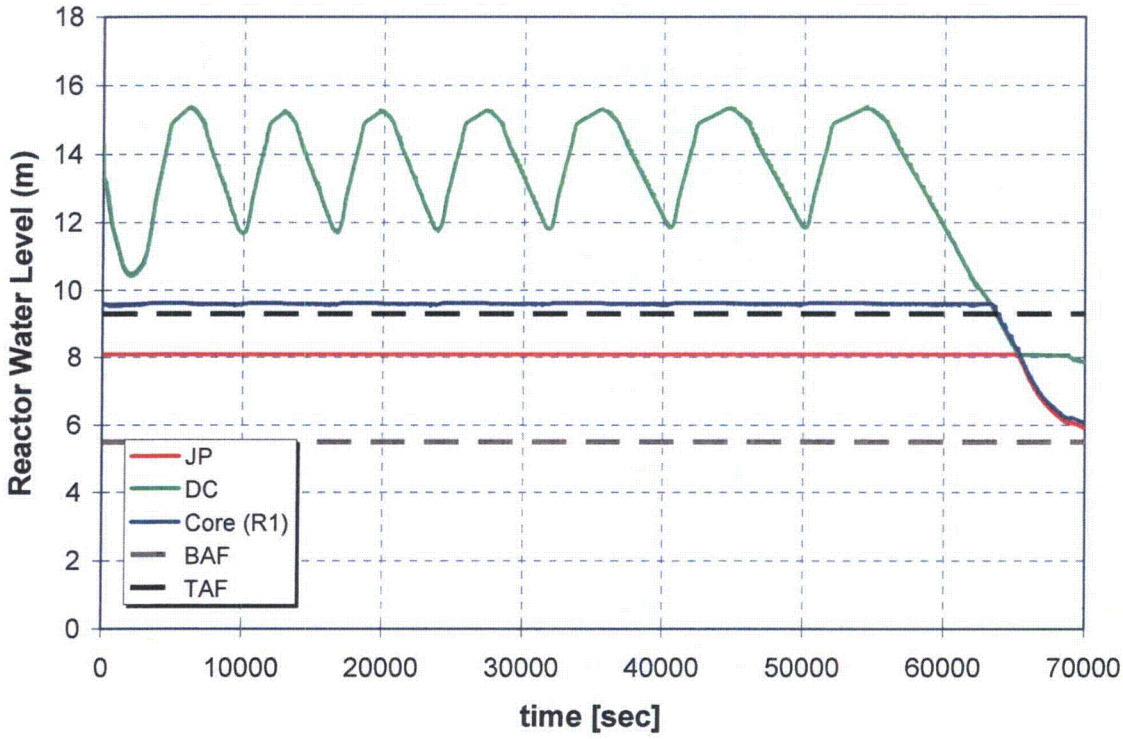

Wetwell Temperature [K]
430
410
390
370
350
330
310
290
270
250
0
5000
10000
15000
20000
time [sec]
TLIQ
TSAT
TVAP

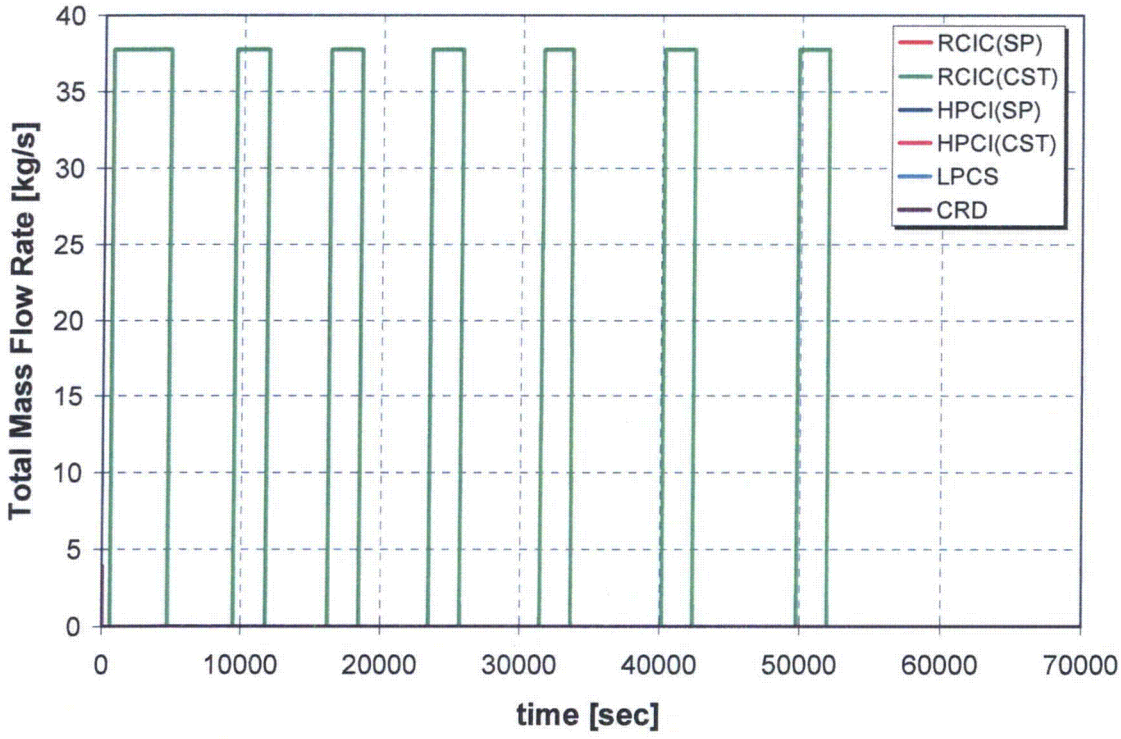

WW Water Level [m]
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
0
1000
2000
3000
4000
5000
6000
7000
time [sec]
Swollen
Collapsed

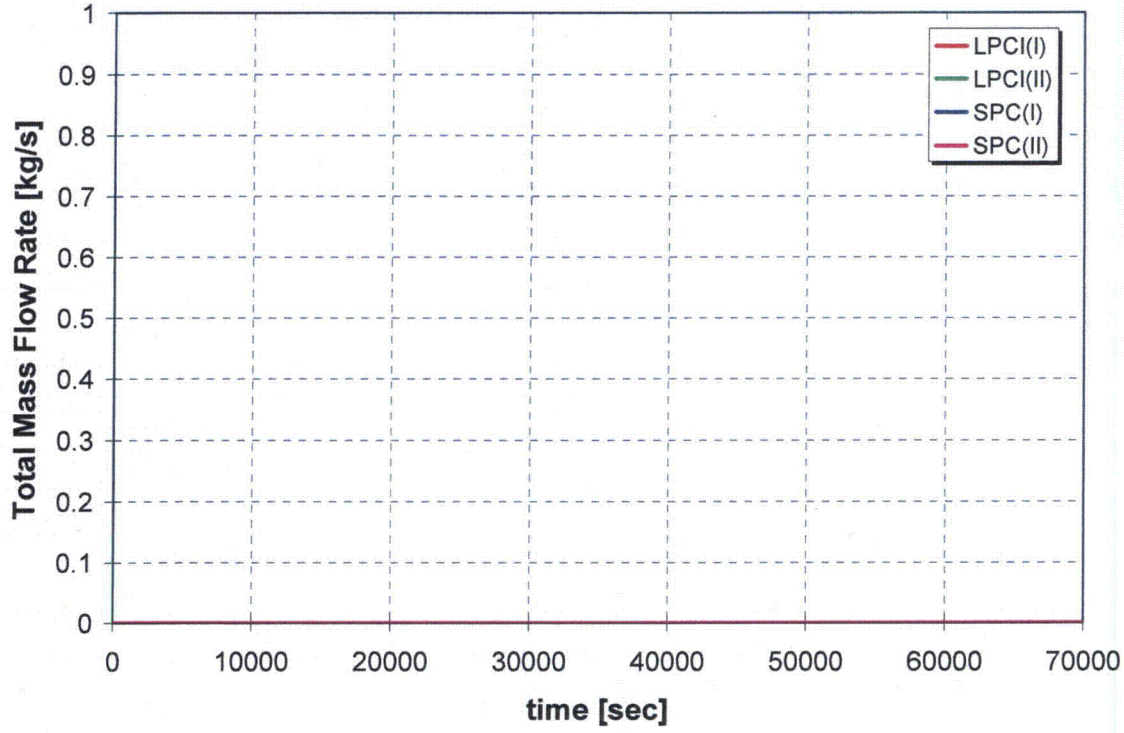
B.2.3 Case 3: Station Blackout and Reactor Core Isolation Cooling

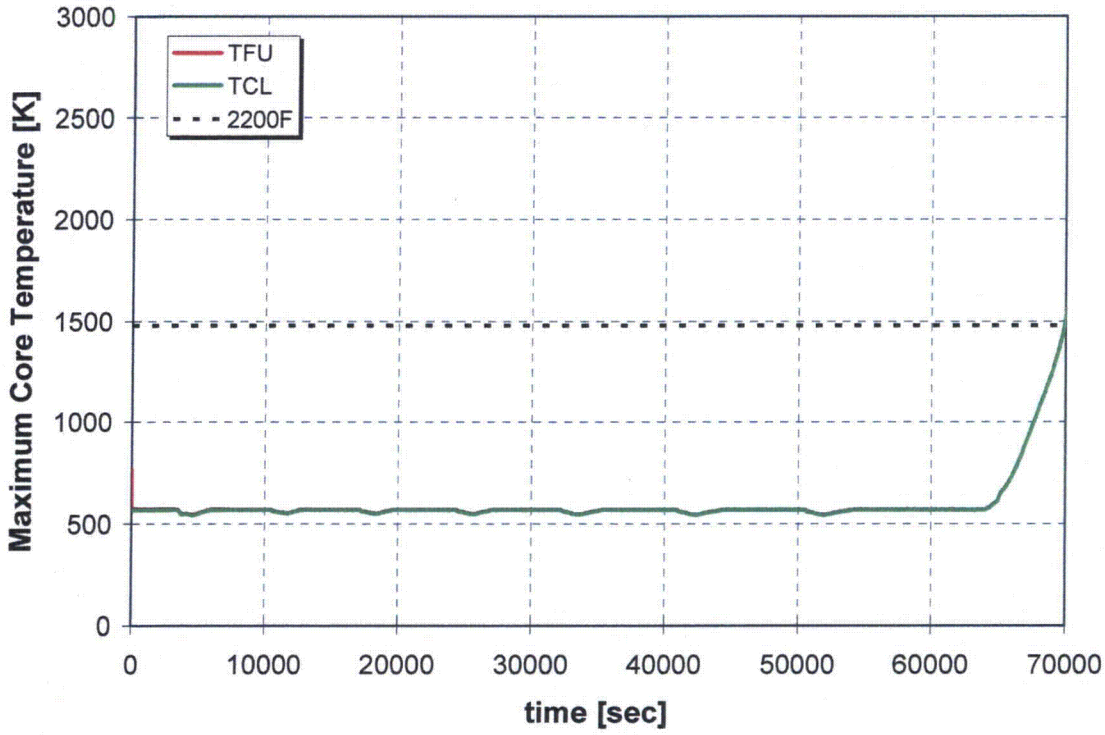
Note: By the time reactor core isolation cooling (RCIC) injection stops from condensate storage tank (CST) at 14.43 hours, the RCIC pump net positive suction head (NPSH) limit has already been exceeded, at 11.57 hours.

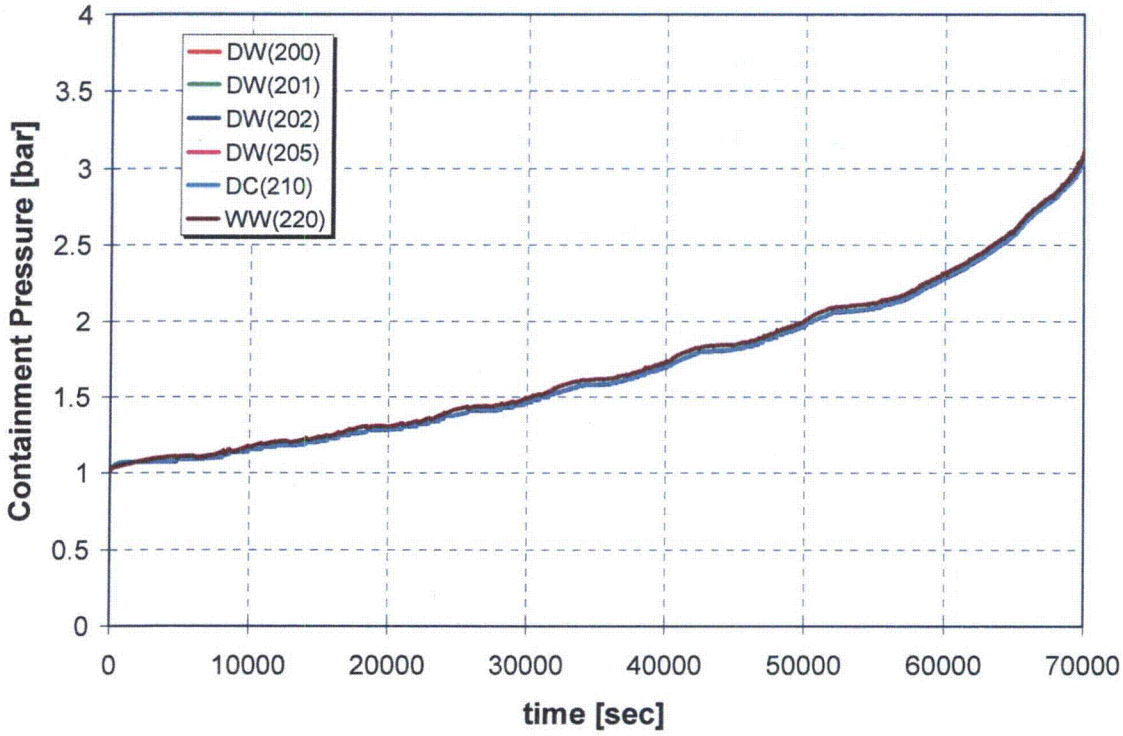


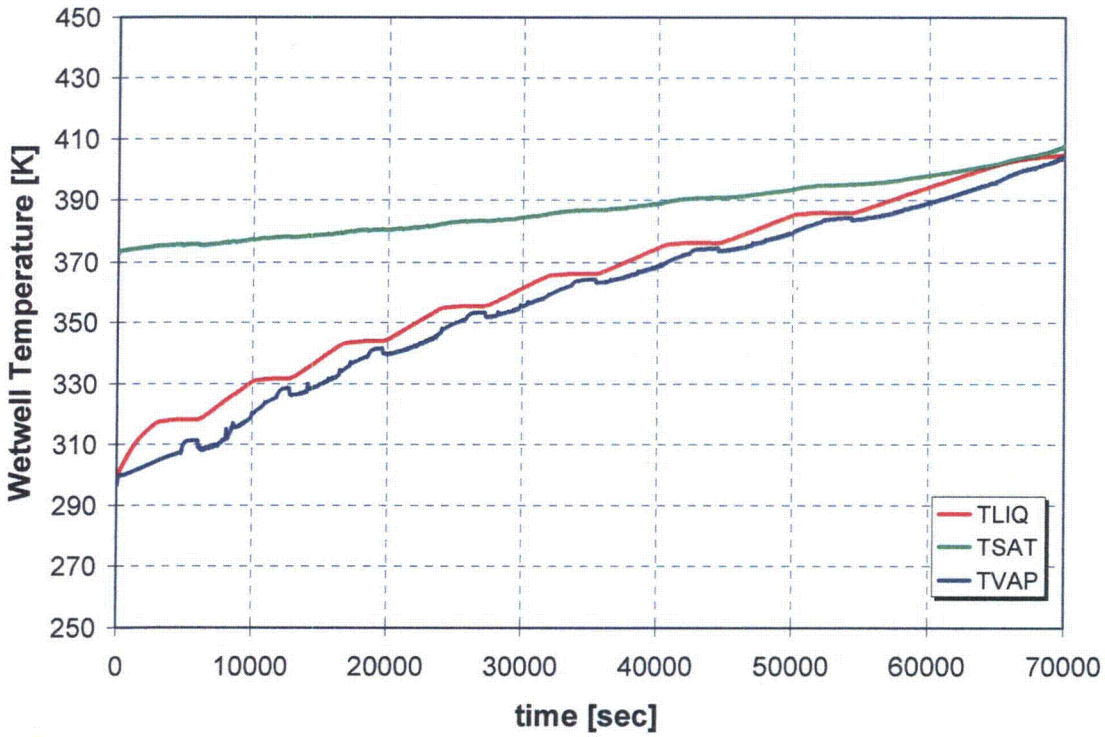

Reactor Water Level (m)
18
16
14
12
10
8
6
4
2
0
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
JP
DC
Core (R1)
BAF
TAF

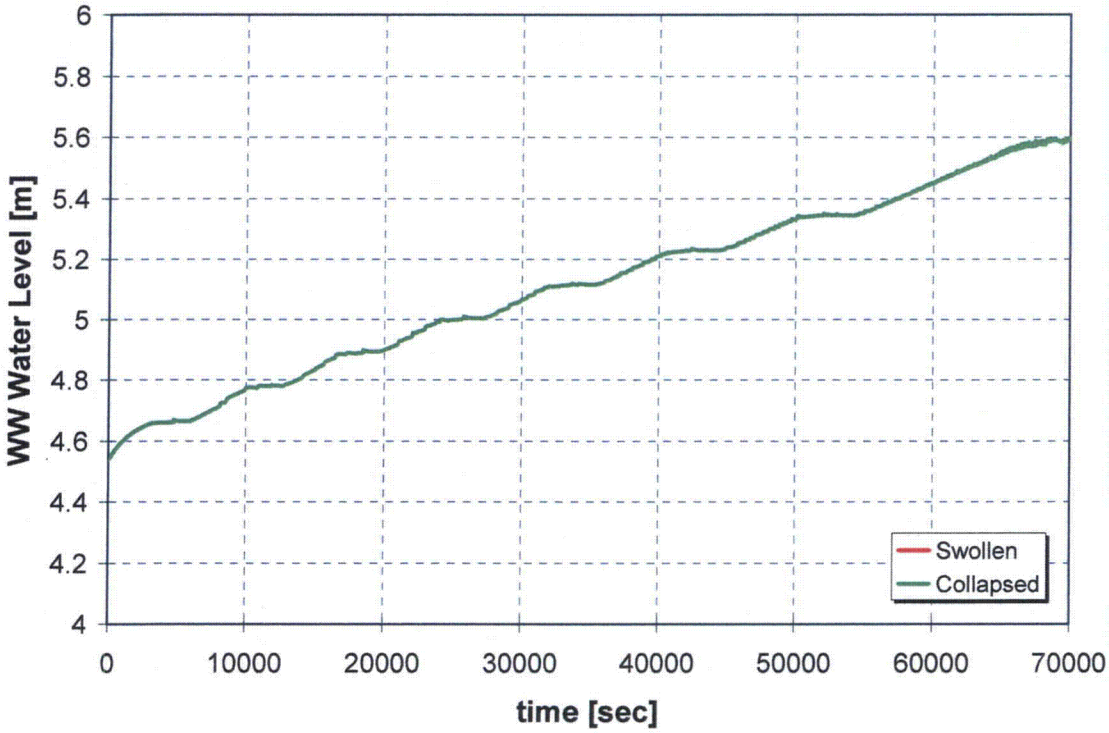

Total Mass Flow Rate [kg/s]
40
35
30
25
20
15
10
5
0
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)

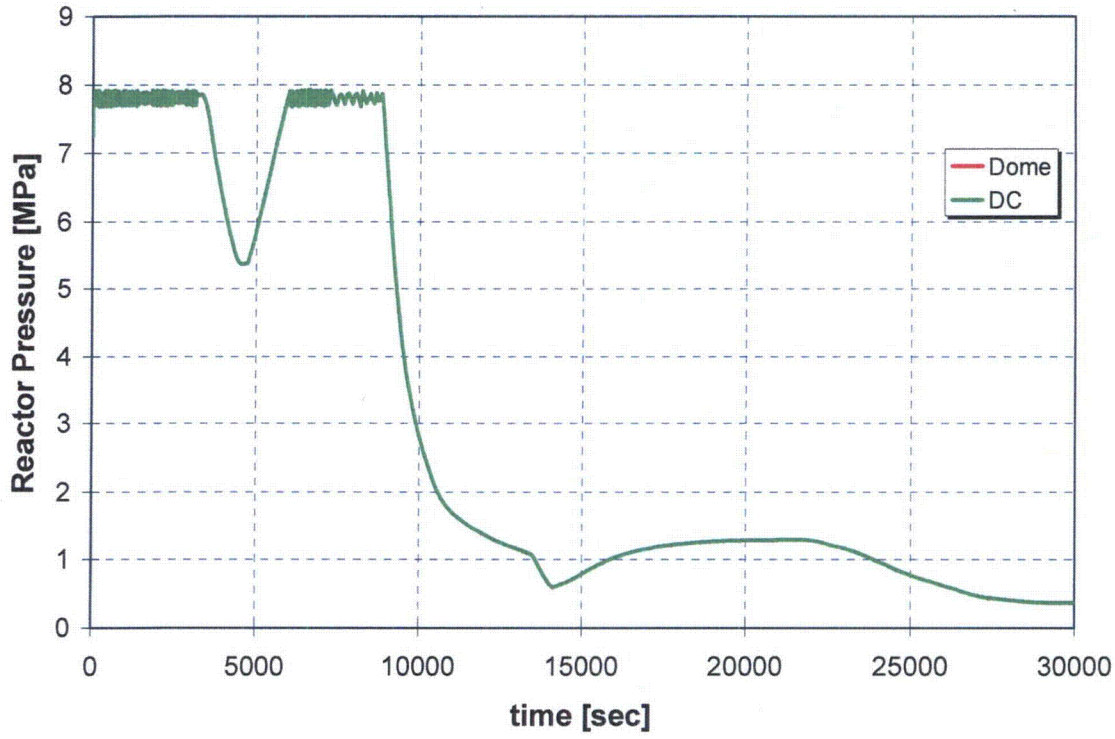

Maximum Core Temperature [K]
3000
2500
2000
1500
1000
500
0
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
TFU
TCL
2200F

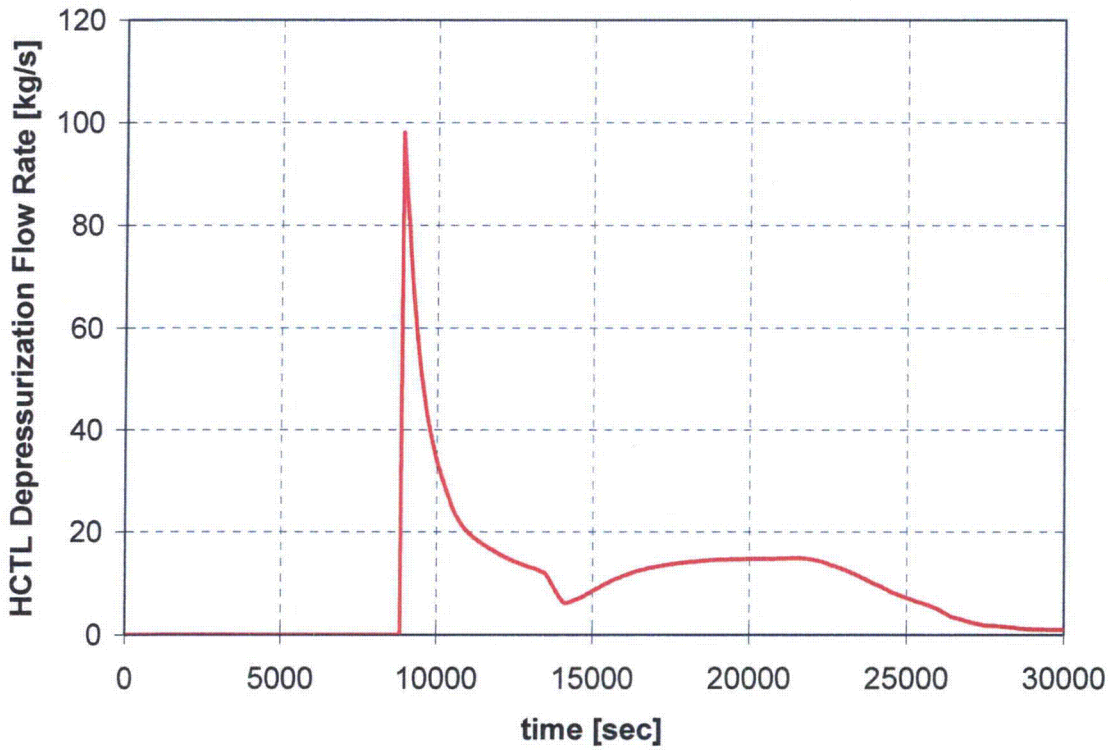

Containment Pressure [bar]
time [sec]
DW(200)
DW(201)
DW(202)
DW(205)
DC(210)
WW(220)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
10000
20000
30000
40000
50000
60000
70000

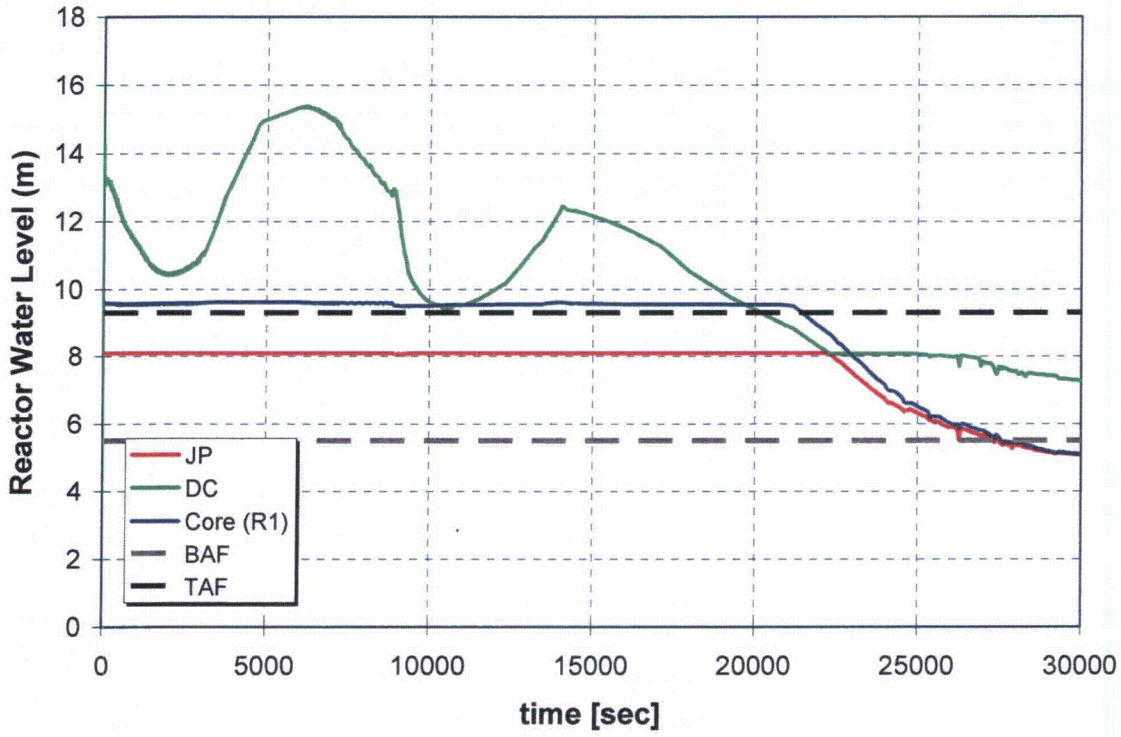

Wetwell Temperature [K]
time [sec]
TLIQ
TSAT
TVAP
250
270
290
310
330
350
370
390
410
430
450
0
10000
20000
30000
40000
50000
60000
70000

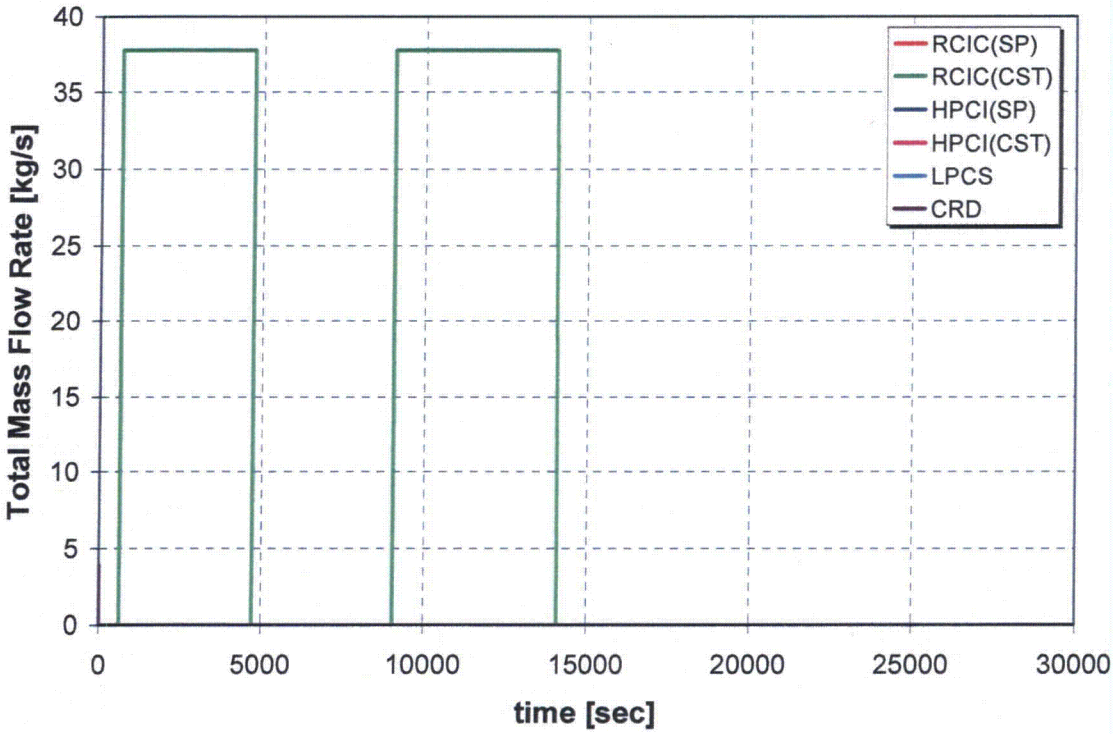

WW Water Level [m]
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
Swollen
Collapsed

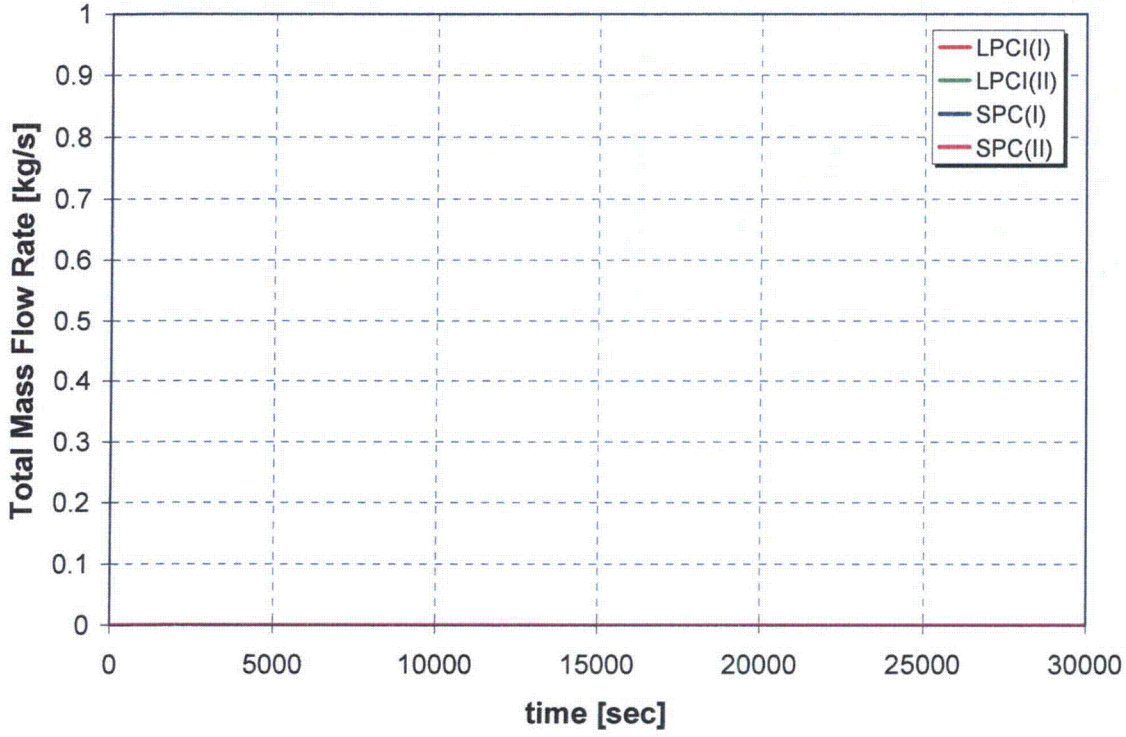
B.2.4 Case 4: Station Blackout and RCIC and HCTL Depressurization

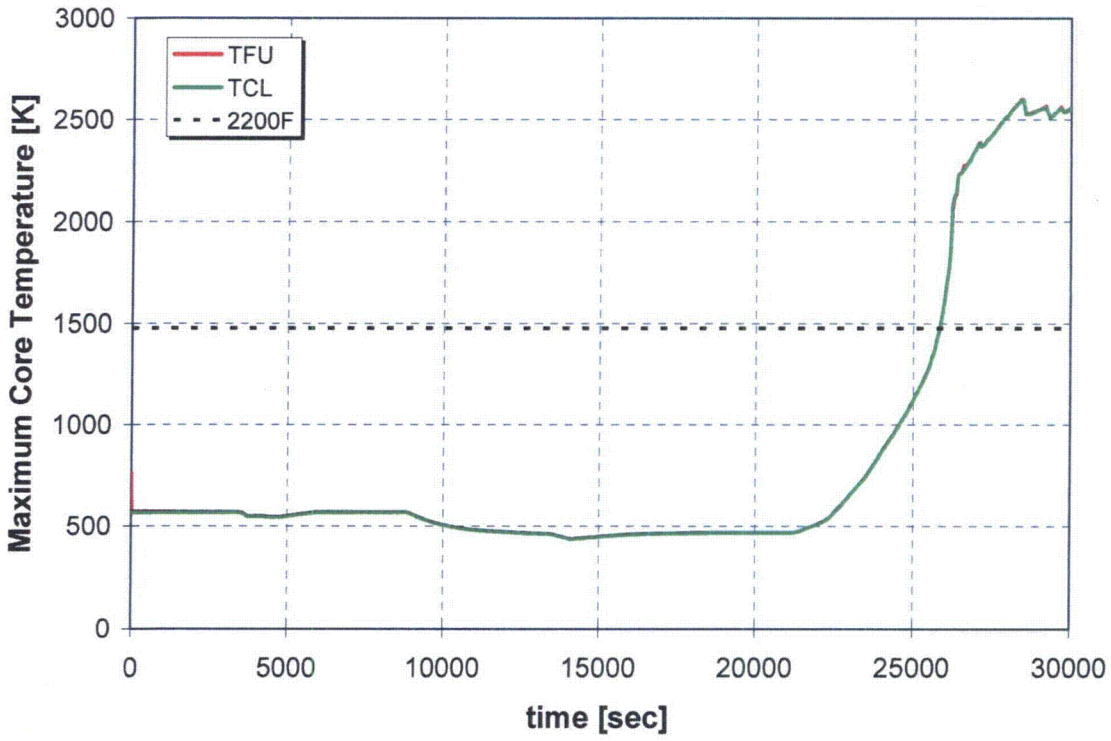


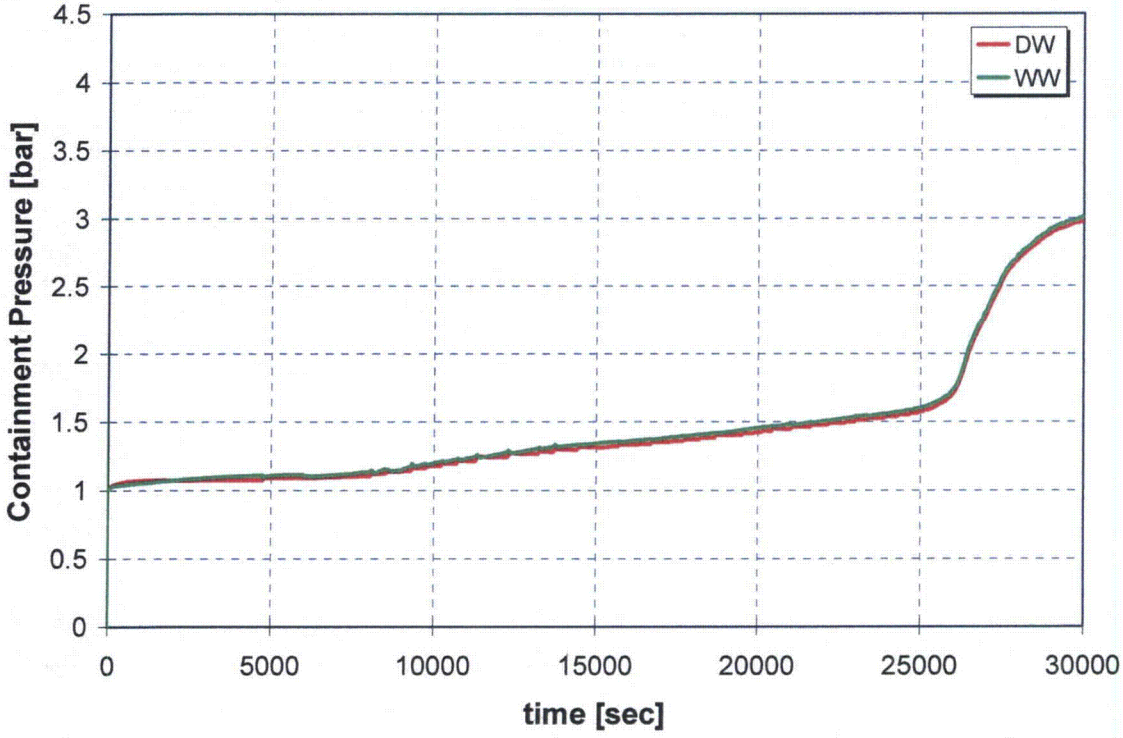


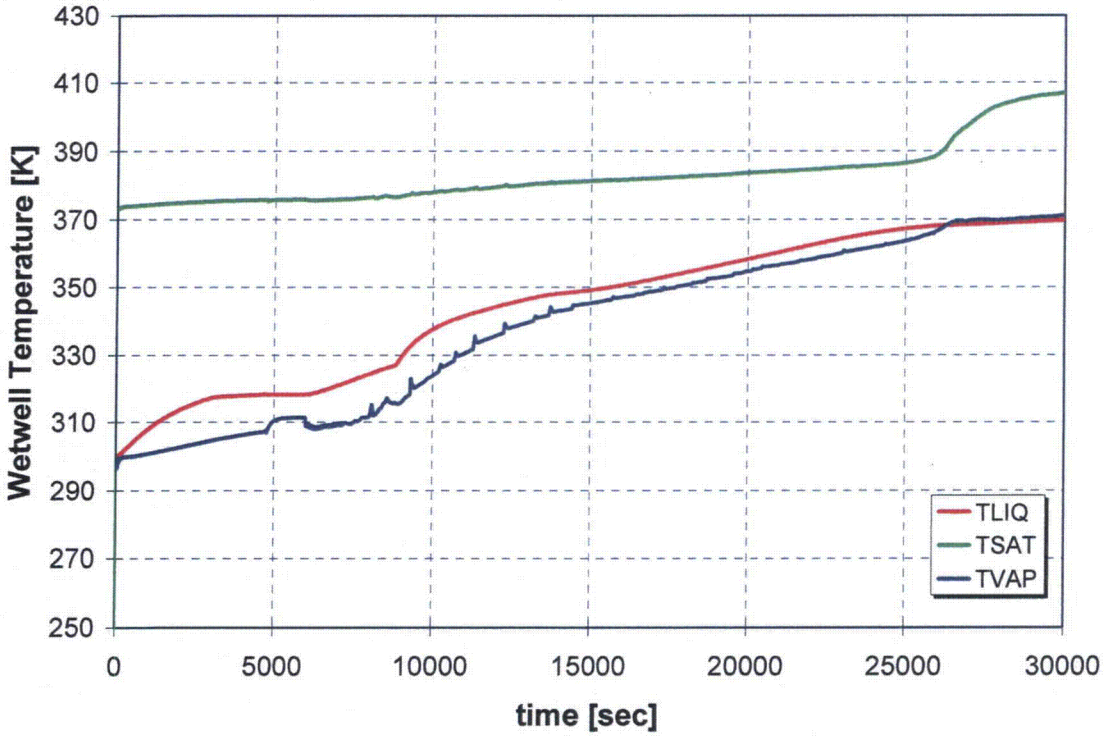

Reactor Water Level (m)
18
16
14
12
10
8
6
4
2
0
0
5000
10000
15000
20000
25000
30000
time [sec]
JP
DC
Core (R1)
BAF
TAF

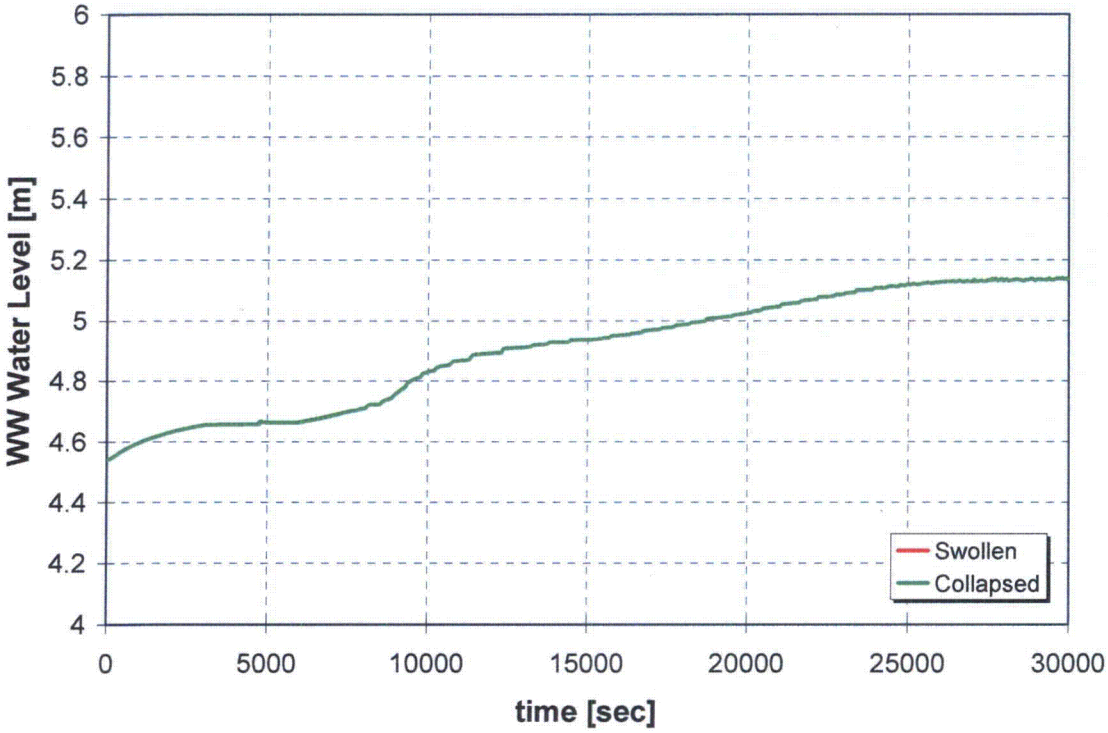

Total Mass Flow Rate [kg/s]
40
35
30
25
20
15
10
5
0
0
5000
10000
15000
20000
25000
30000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5000
10000
15000
20000
25000
30000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)

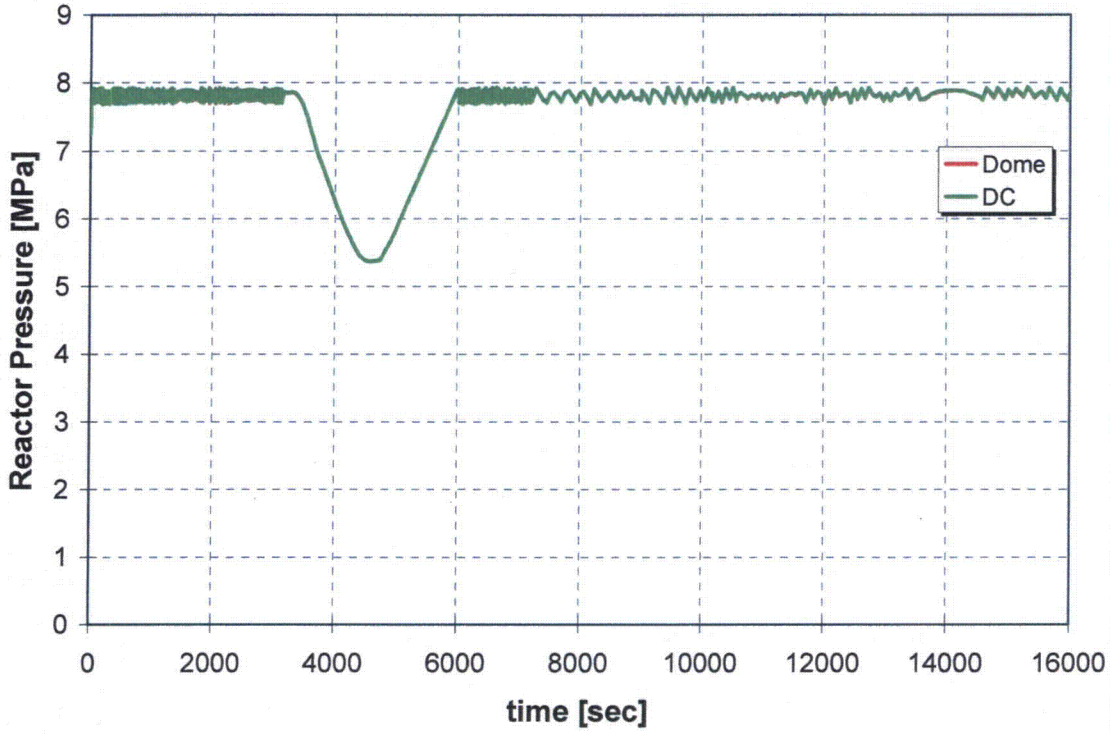

Maximum Core Temperature [K]
3000
2500
2000
1500
1000
500
0
0
5000
10000
15000
20000
25000
30000
time [sec]
TFU
TCL
2200F

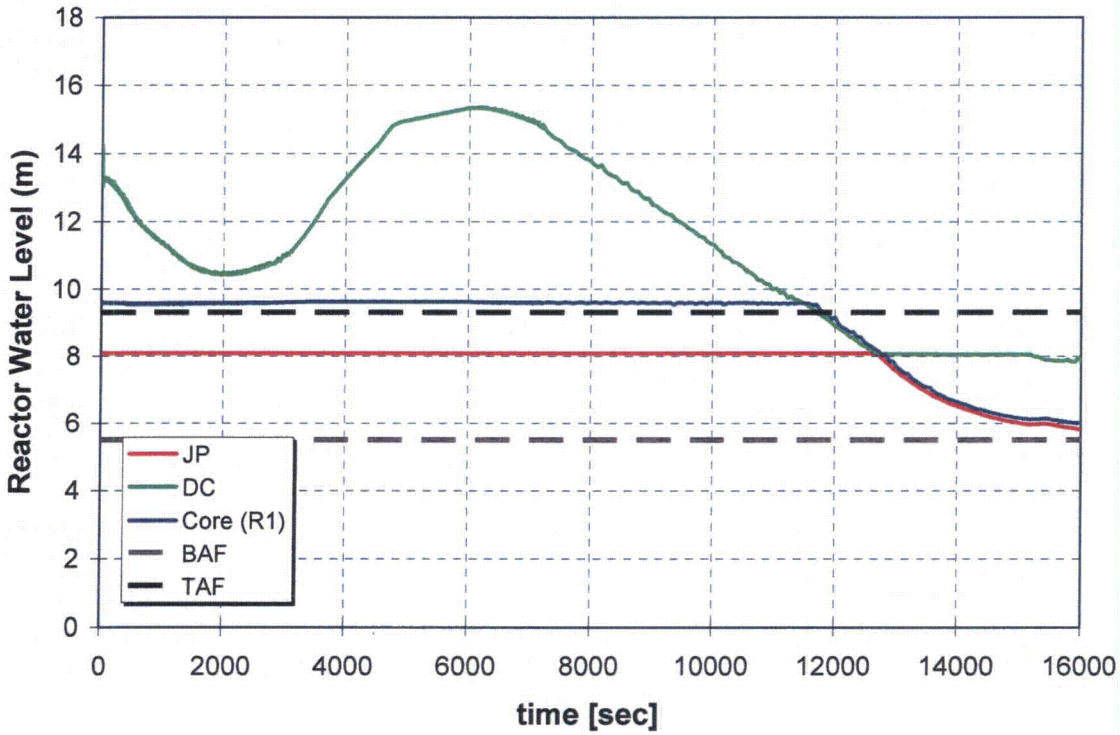

Containment Pressure [bar]
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
5000
10000
15000
20000
25000
30000
time [sec]
DW
WW

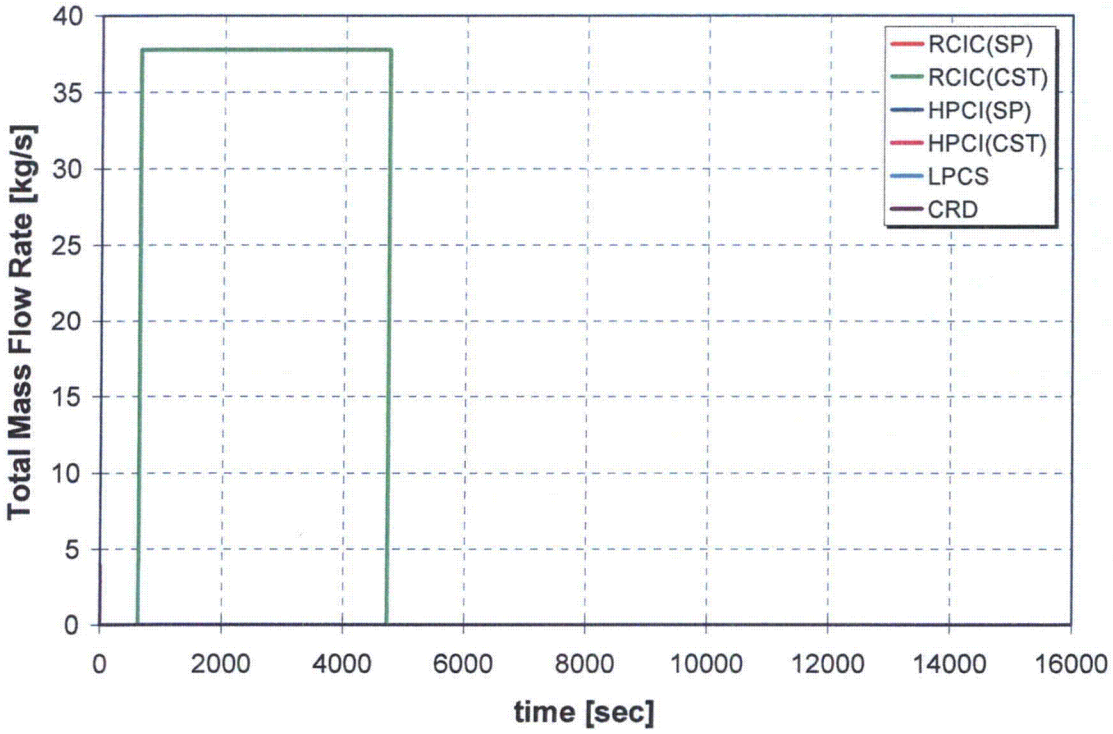

Wetwell Temperature [K]
430
410
390
370
350
330
310
290
270
250
0
5000
10000
15000
20000
25000
30000
time [sec]
TLIQ
TSAT
TVAP

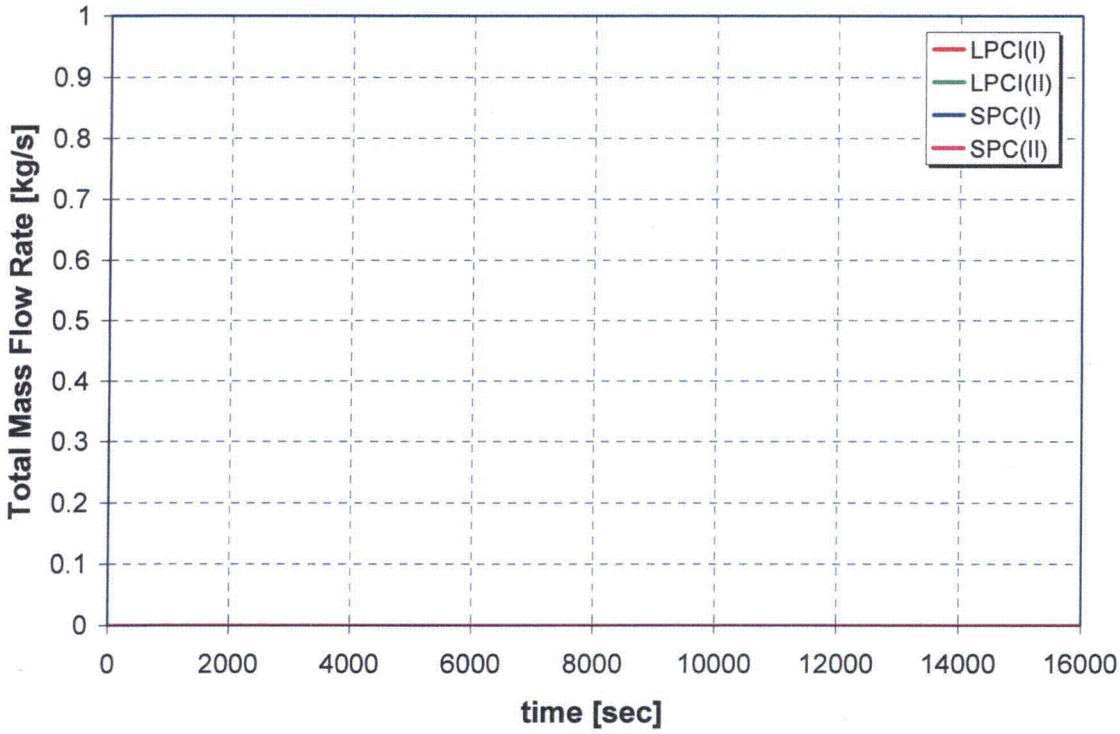

6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
WW Water Level [m]
0
5000
10000
15000
20000
25000
30000
time [sec]
Swollen
Collapsed

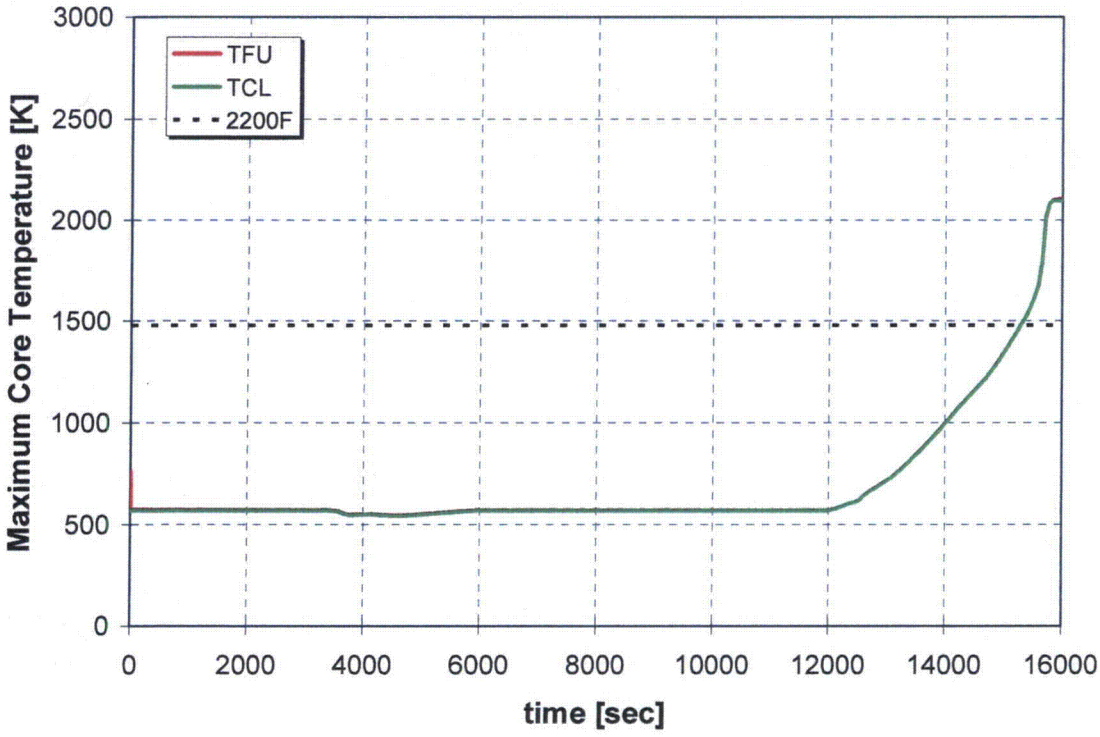
B.2.5 Case 5: Station Blackout and RCIC and 2-Hour Direct Current

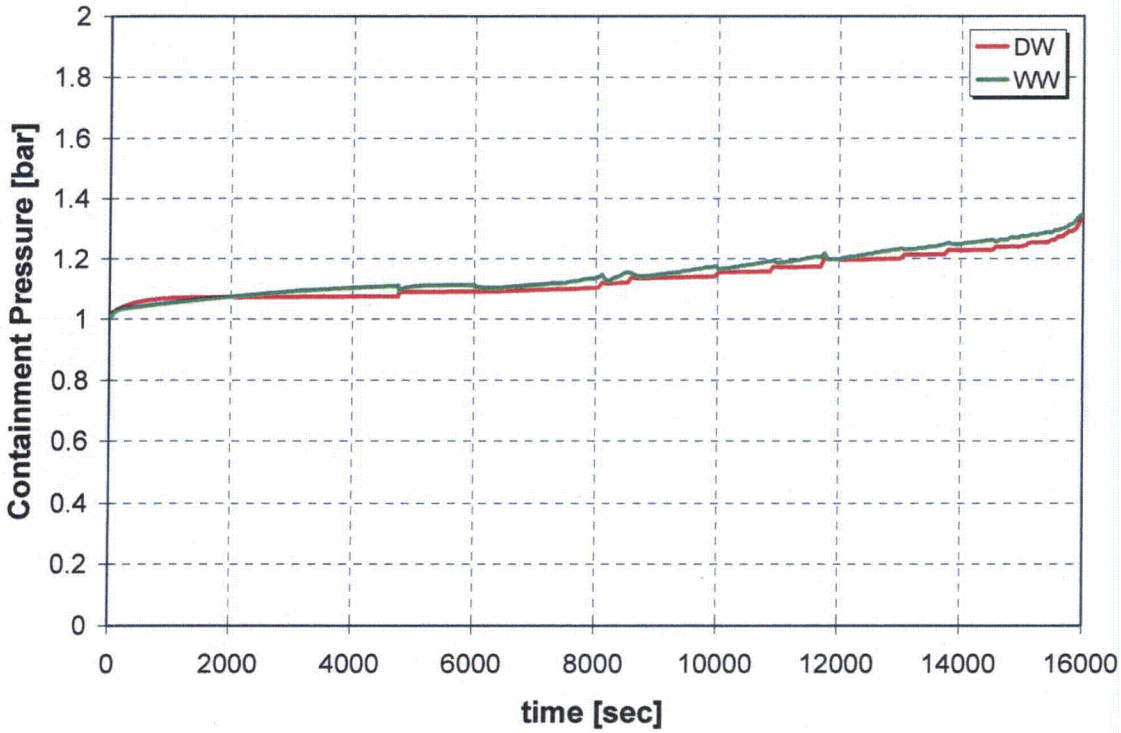


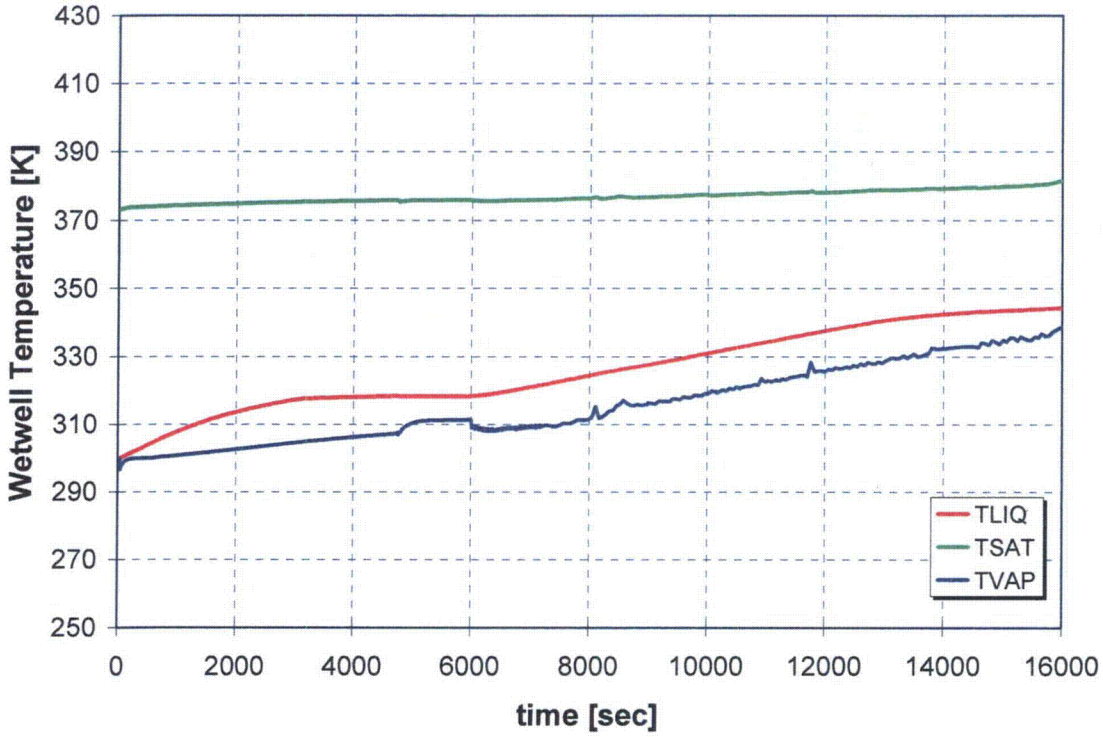


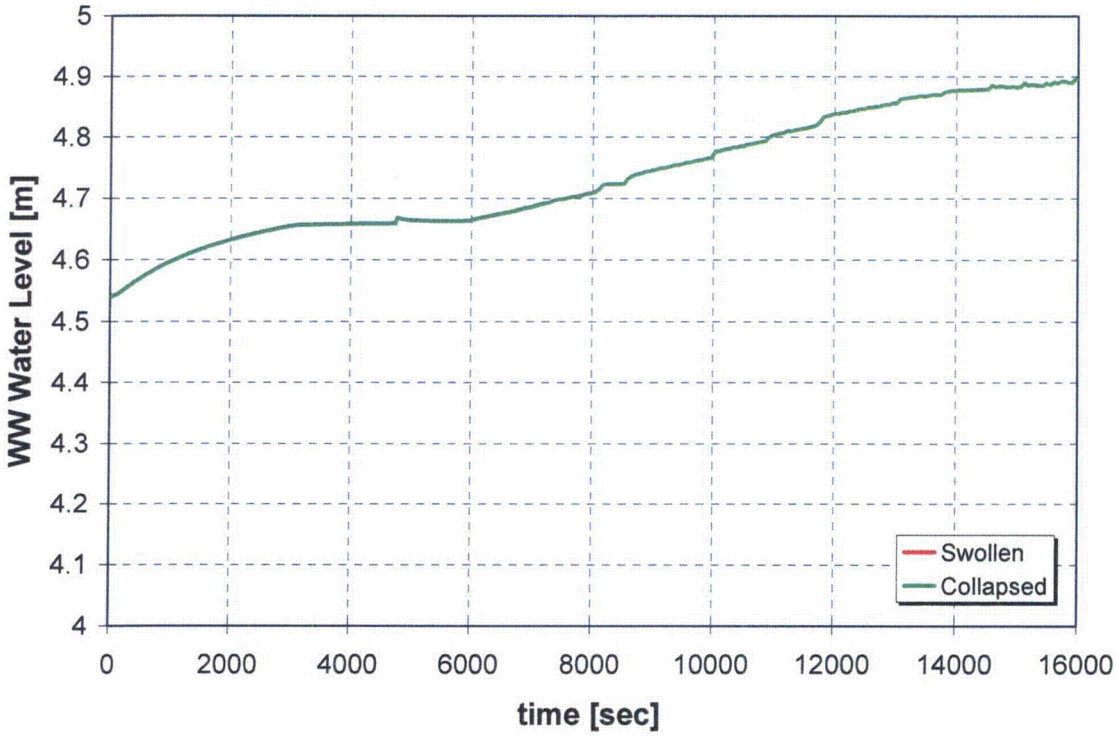

Total Mass Flow Rate [kg/s]
40
35
30
25
20
15
10
5
0
0
2000
4000
6000
8000
10000
12000
14000
16000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2000
4000
6000
8000
10000
12000
14000
16000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)

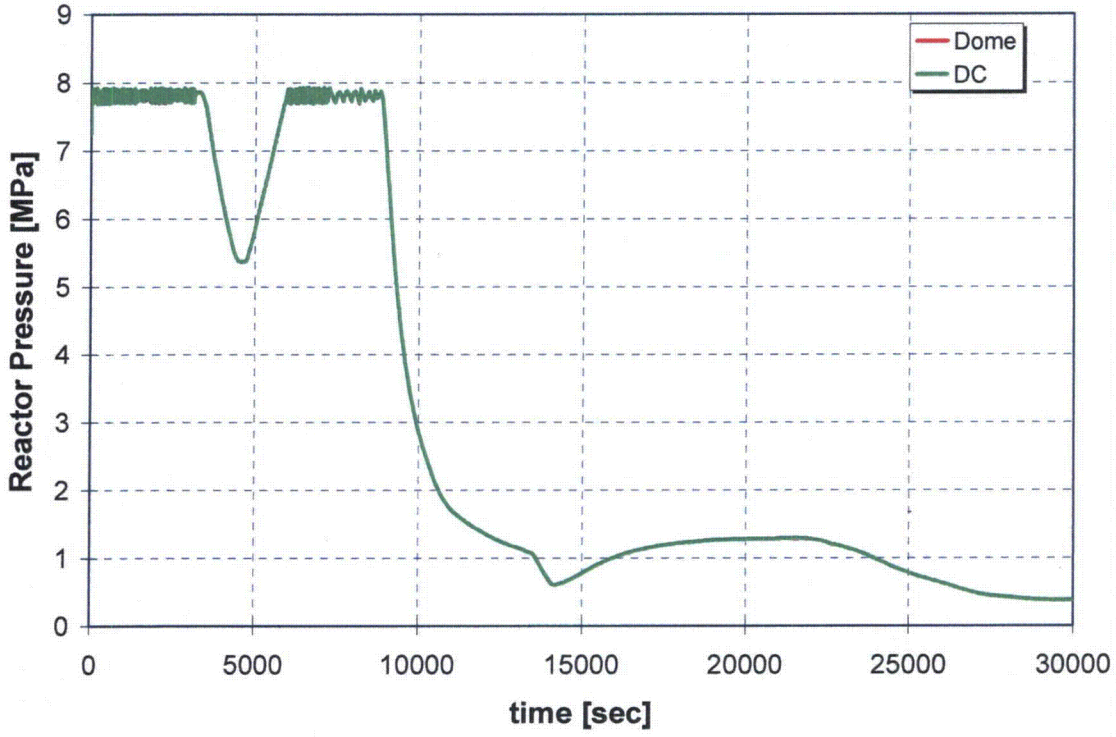

Maximum Core Temperature [K]
3000
2500
2000
1500
1000
500
0
TFU
TCL
2200F
0
2000
4000
6000
8000
10000
12000
14000
16000
time [sec]

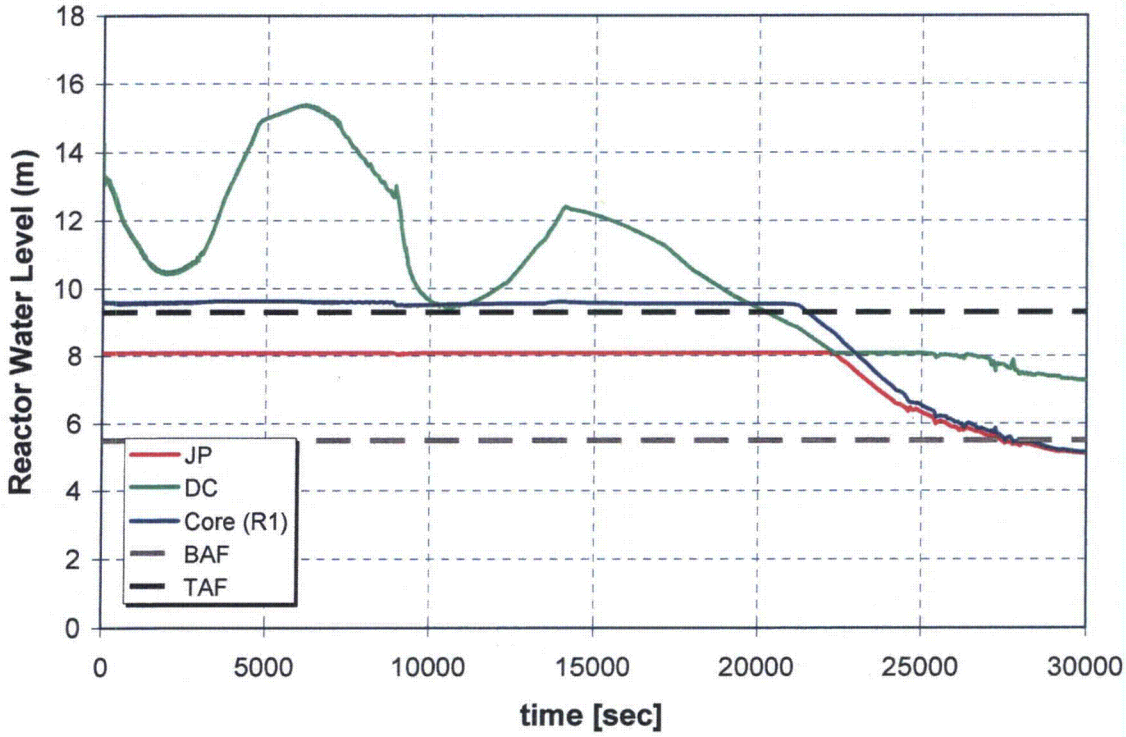

Containment Pressure [bar]
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
DW
WW
0
2000
4000
6000
8000
10000
12000
14000
16000
time [sec]

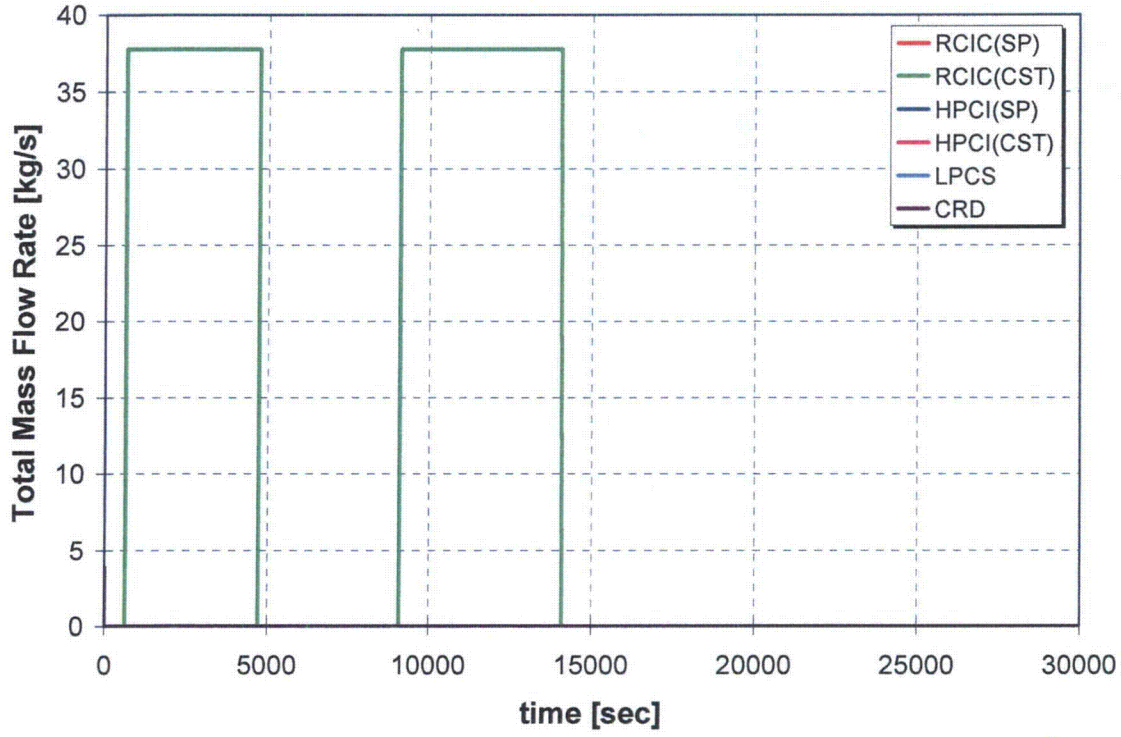

Wetwell Temperature [K]
430
410
390
370
350
330
310
290
270
250
0
2000
4000
6000
8000
10000
12000
14000
16000
time [sec]
TLIQ
TSAT
TVAP

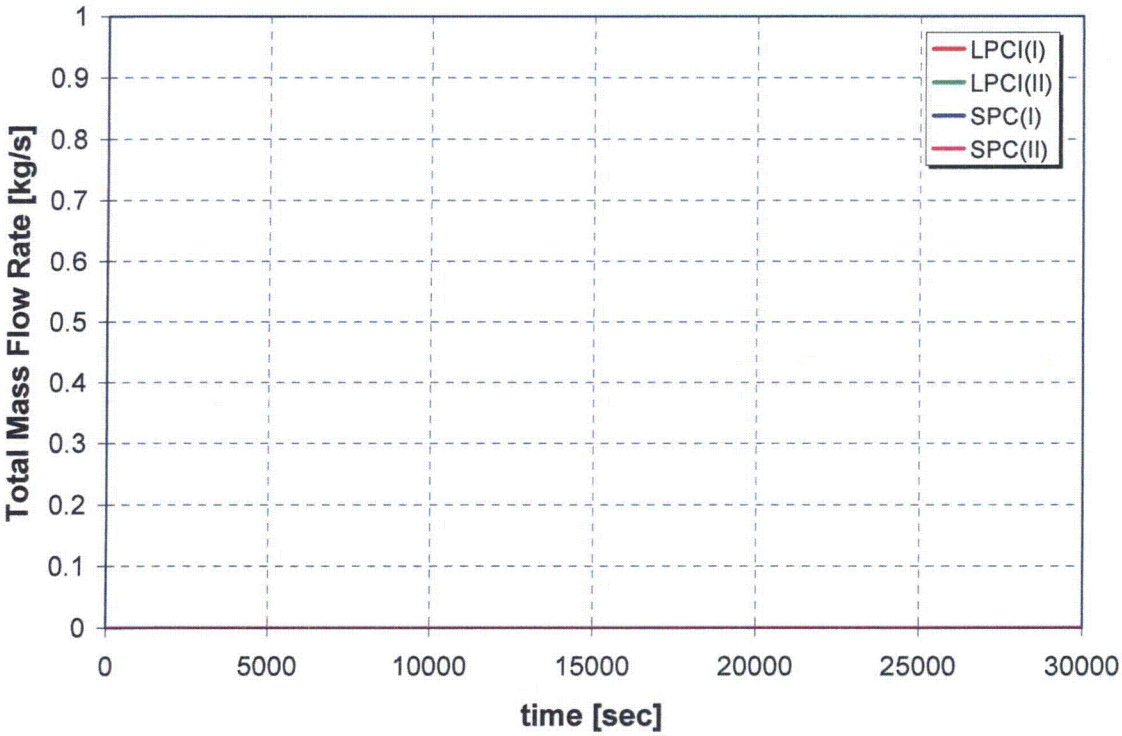

WW Water Level [m]
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
0
2000
4000
6000
8000
10000
12000
14000
16000
time [sec]
Swollen
Collapsed

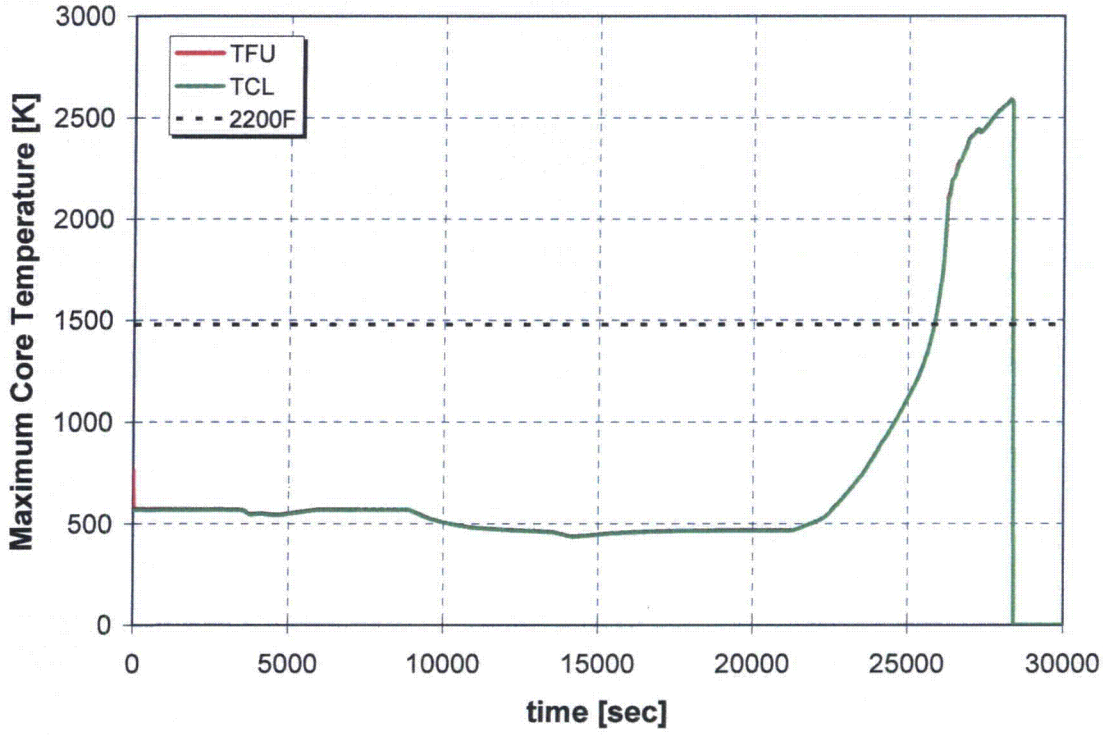
B.2.6 Case 6: Station Blackout and RCIC and SRV Stuck Open

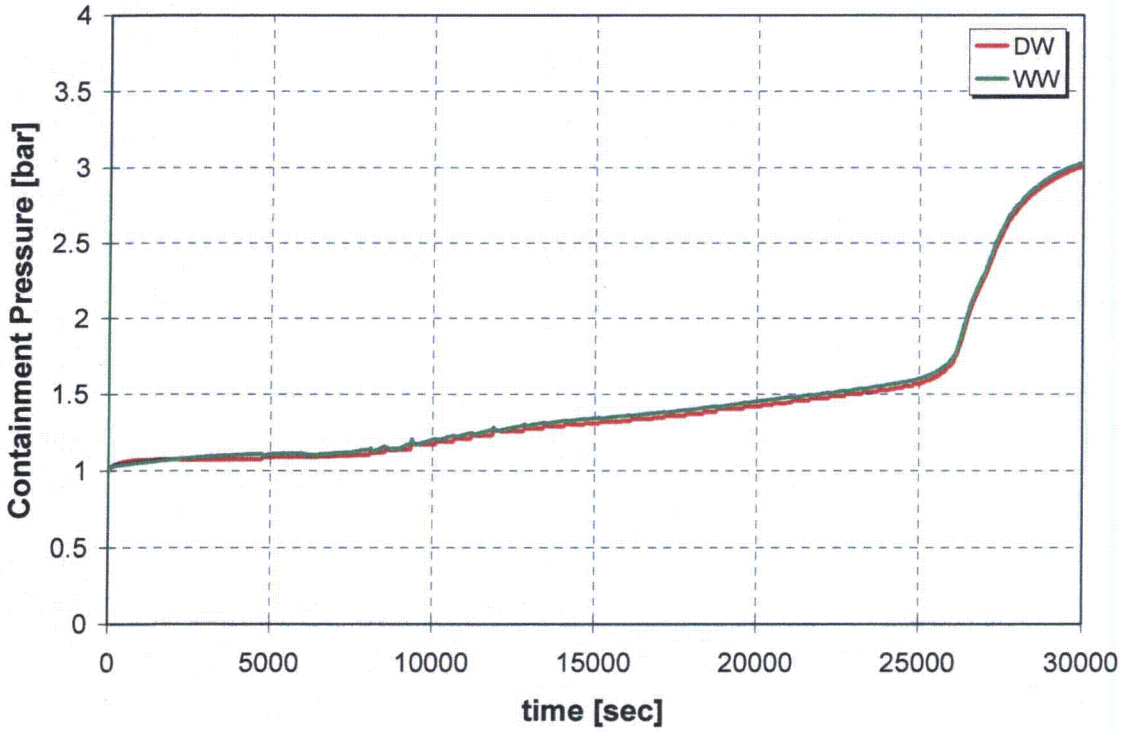


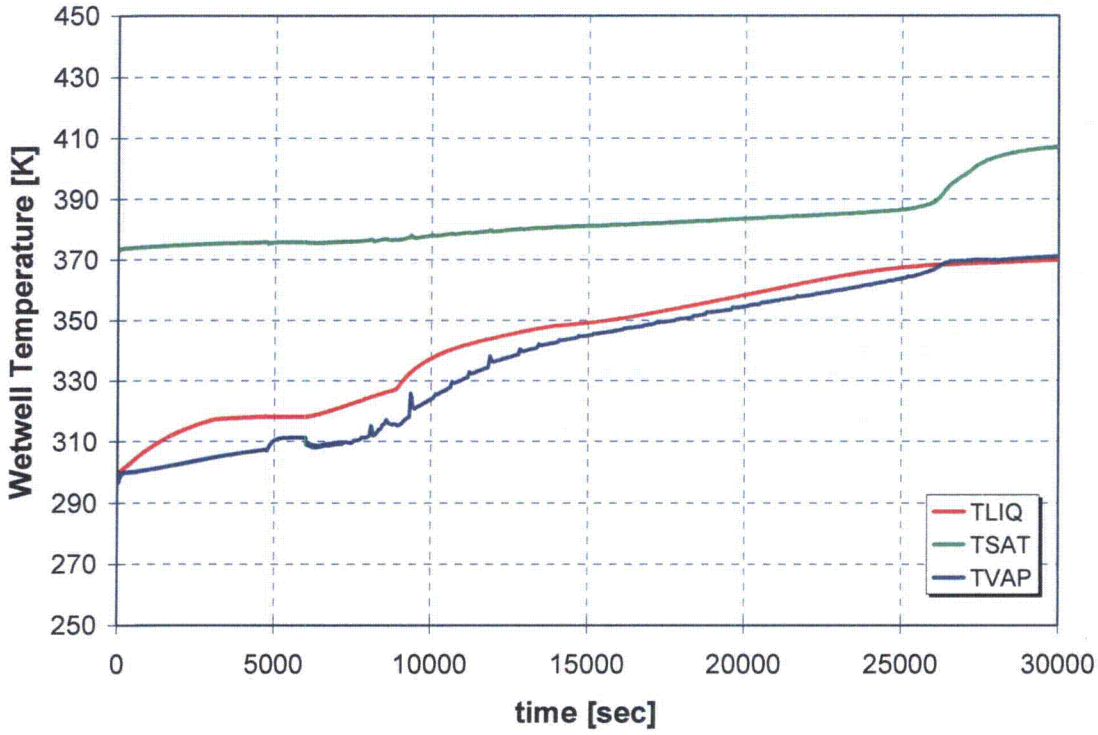


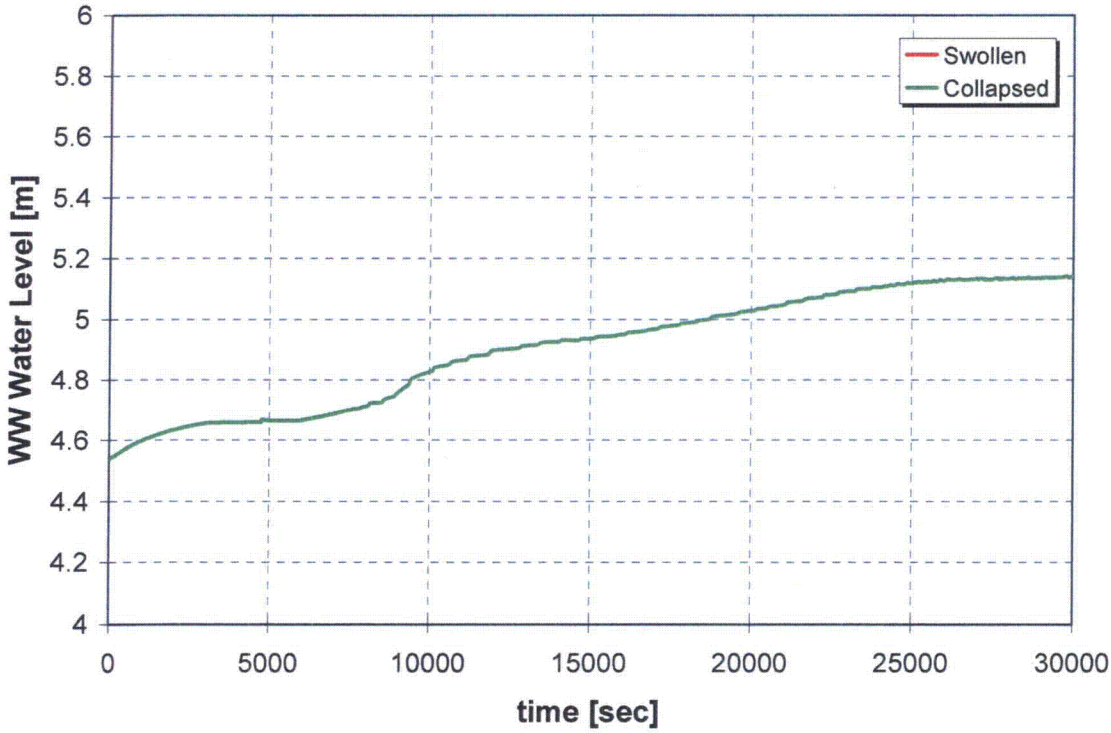

Total Mass Flow Rate [kg/s]
40
35
30
25
20
15
10
5
0
0
5000
10000
15000
20000
25000
30000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5000
10000
15000
20000
25000
30000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)


TFU
TCL
2200F
Maximum Core Temperature [K]
3000
2500
2000
1500
1000
500
0
0
5000
10000
15000
20000
25000
30000
time [sec]

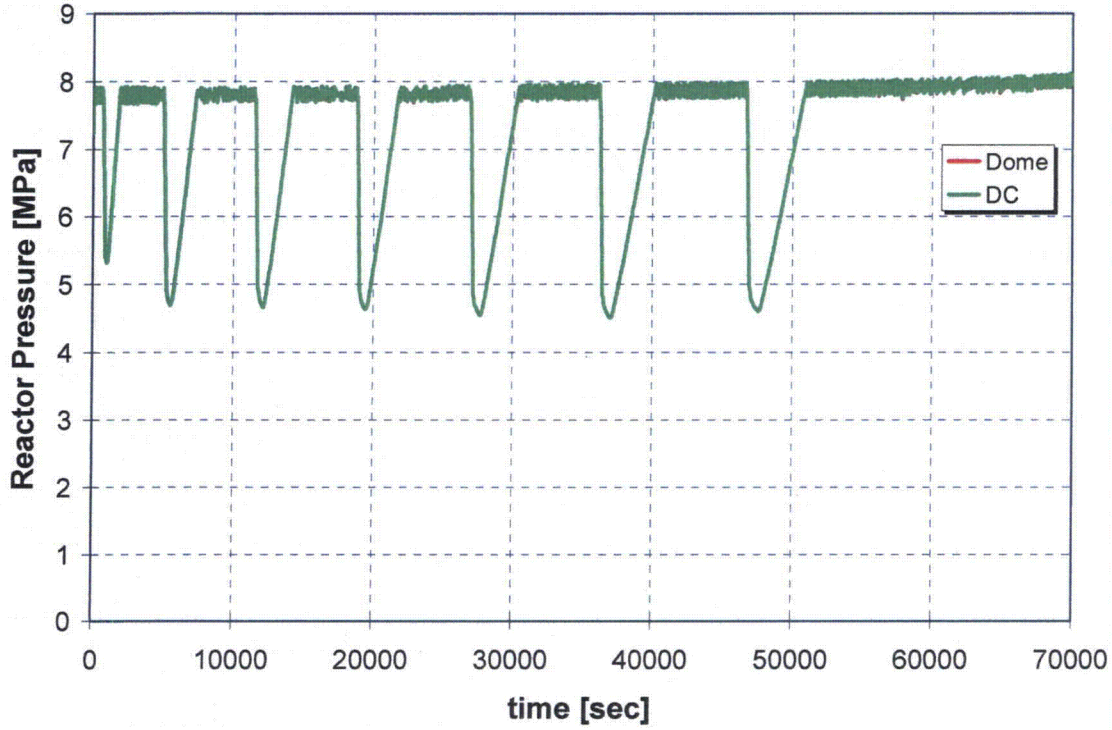

DW
WW
Containment Pressure [bar]
4
3.5
3
2.5
2
1.5
1
0.5
0
0
5000
10000
15000
20000
25000
30000
time [sec]

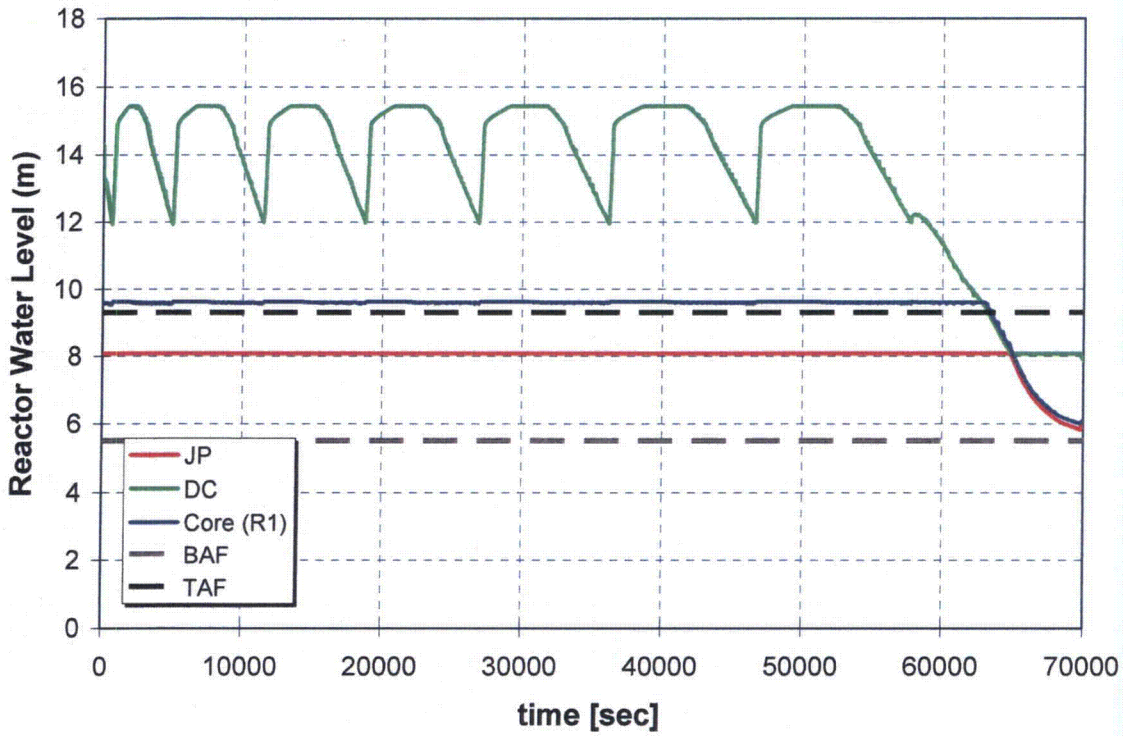

Wetwell Temperature [K]
450
430
410
390
370
350
330
310
290
270
250
0
5000
10000
15000
20000
25000
30000
time [sec]
TLIQ
TSAT
TVAP

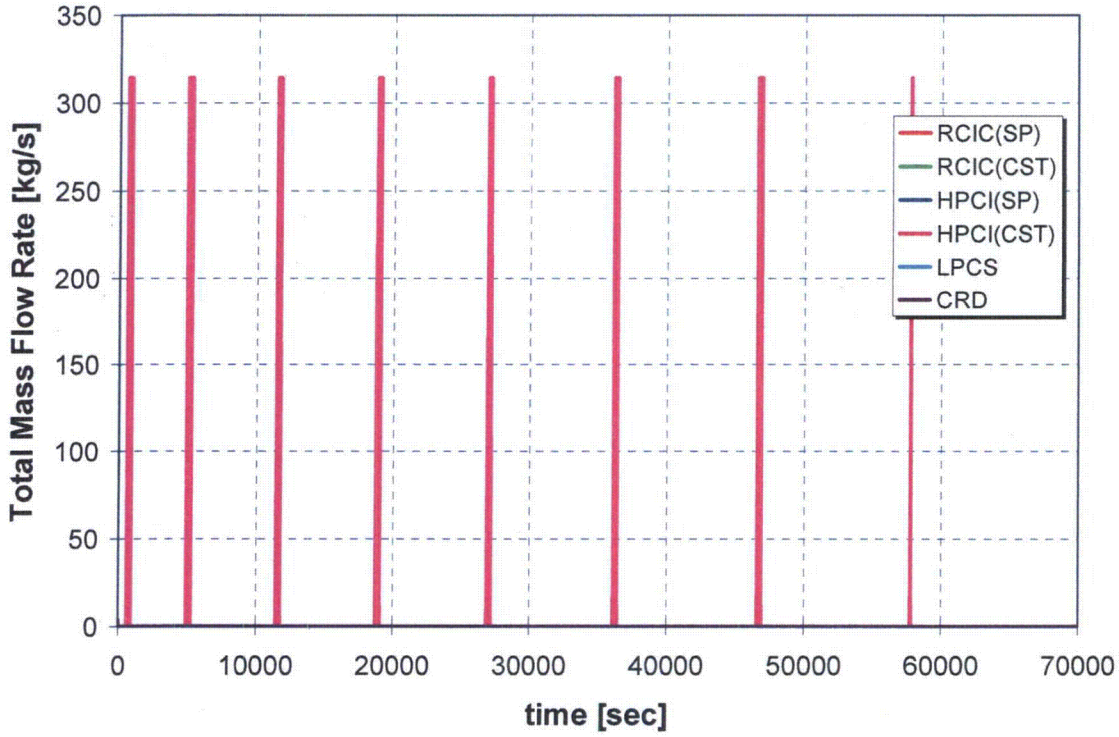

WW Water Level [m]
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
0
5000
10000
15000
20000
25000
30000
time [sec]
Swollen
Collapsed

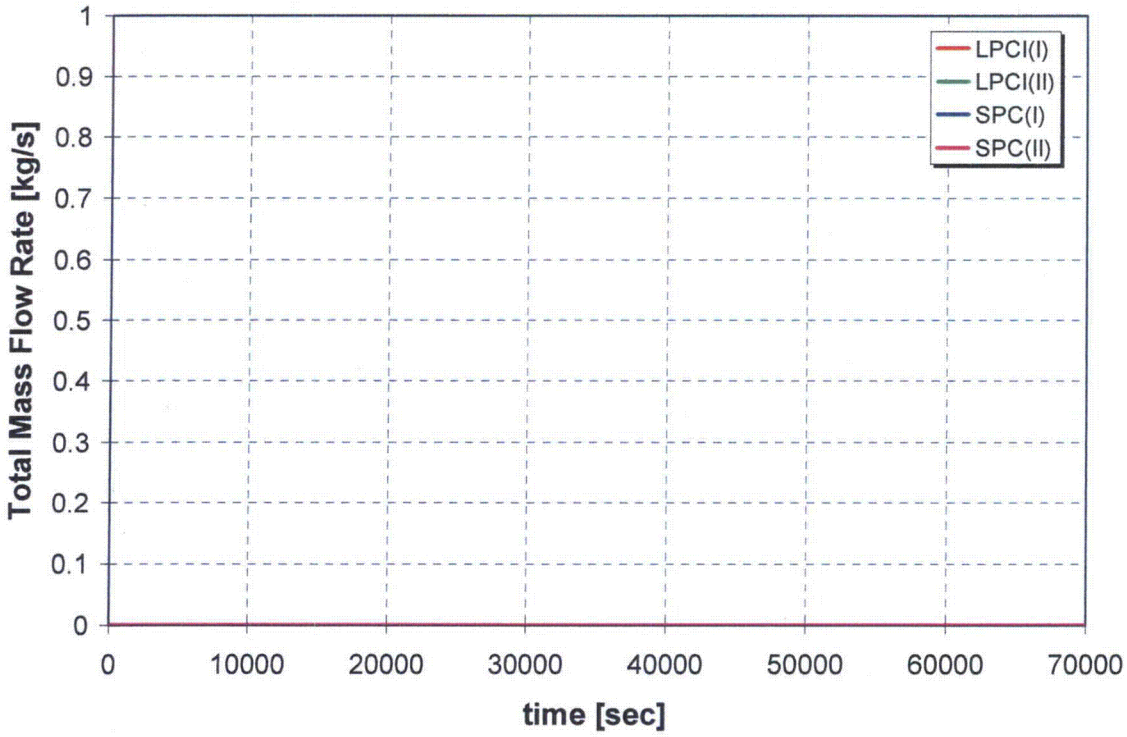
B.2.7 Case 7: Station Blackout and High-Pressure Core Injection

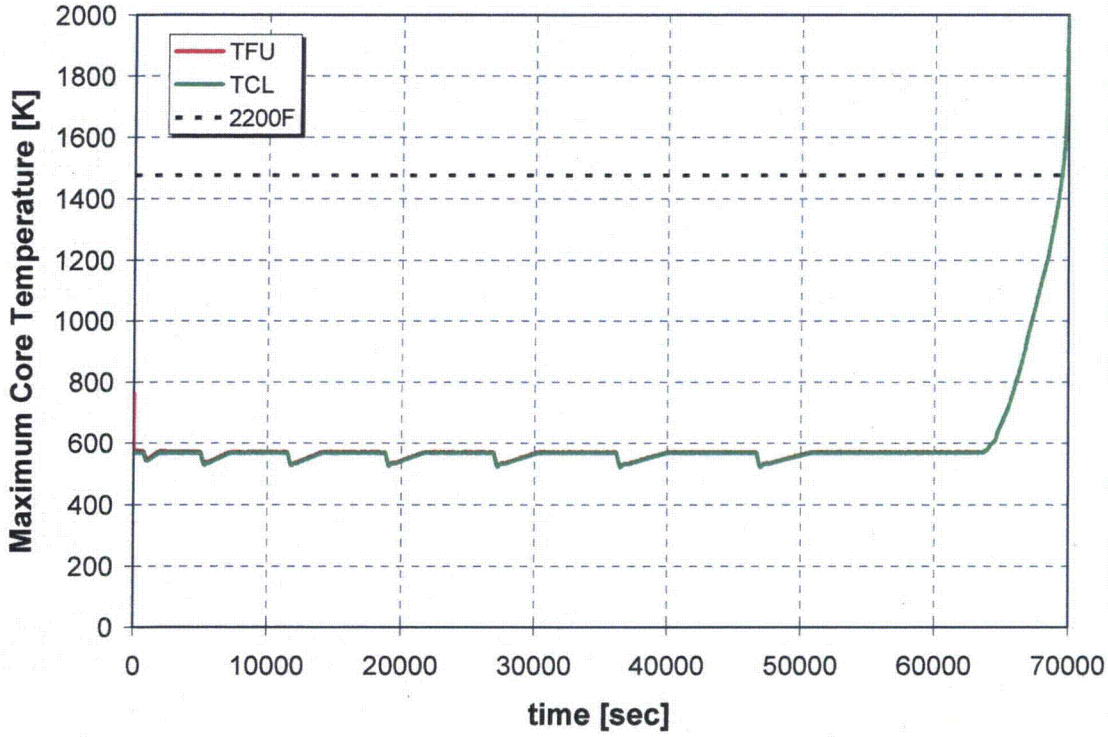
Note: By the time high-pressure core injection (HPCI) injection stops from CST at 16.05 hours, the HPCI pump NPSH limit has already been exceeded at 12.07 hours.

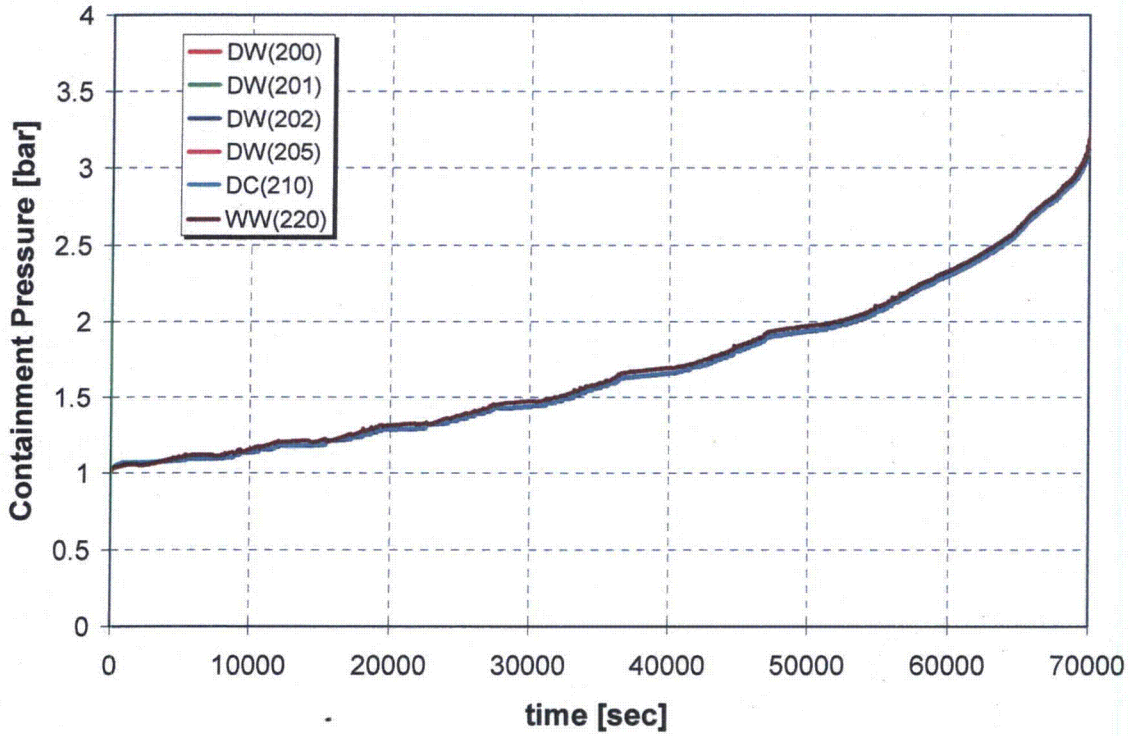


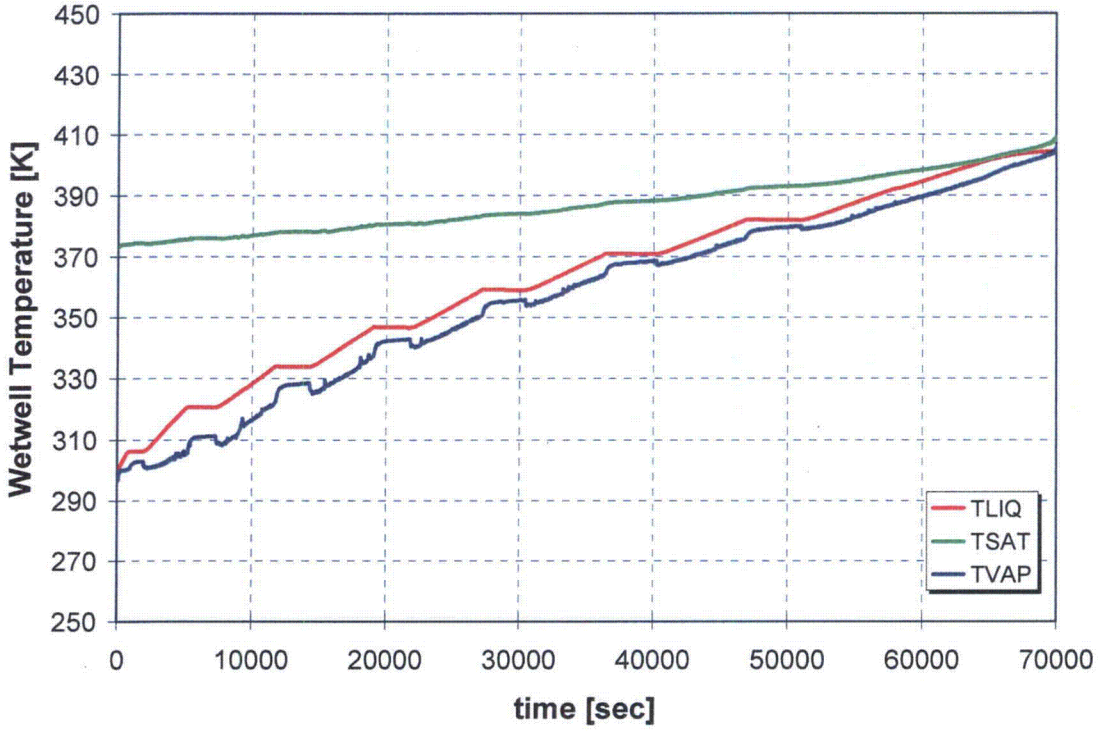


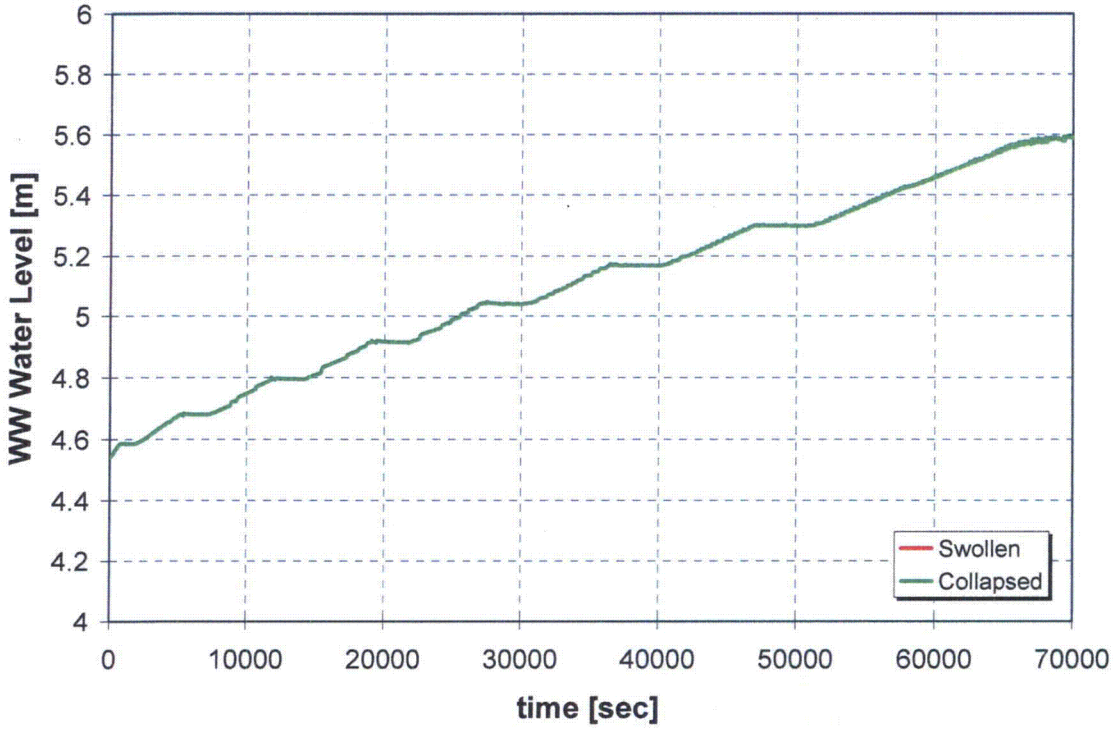

Total Mass Flow Rate [kg/s]
350
300
250
200
150
100
50
0
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)

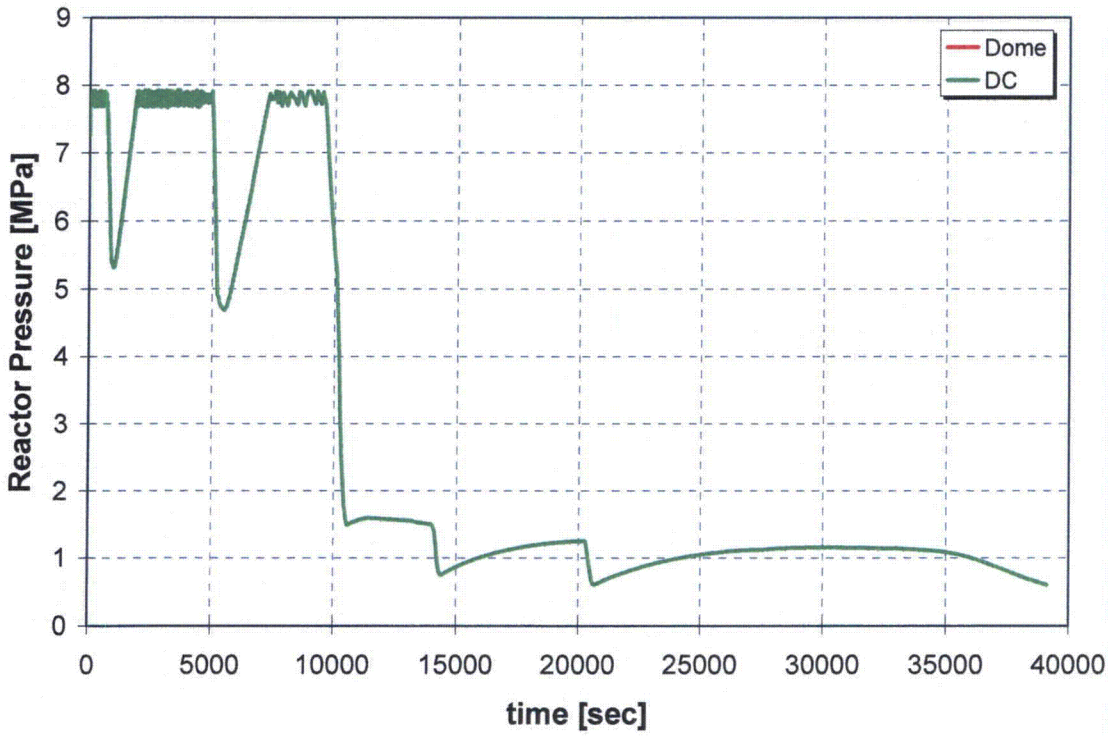

Maximum Core Temperature [K]
2000
1800
1600
1400
1200
1000
800
600
400
200
0
TFU
TCL
2200F
0
10000
20000
30000
40000
50000
60000
70000
time [sec]

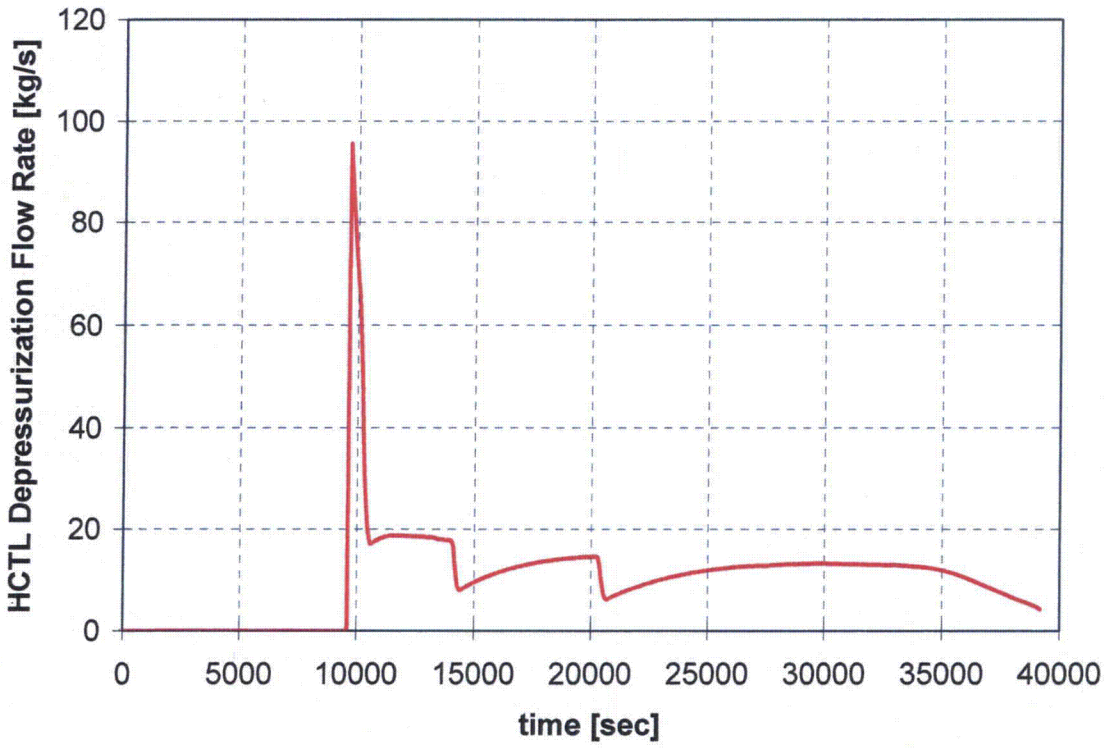

Containment Pressure [bar]
4
3.5
3
2.5
2
1.5
1
0.5
0
DW(200)
DW(201)
DW(202)
DW(205)
DC(210)
WW(220)
0
10000
20000
30000
40000
50000
60000
70000
time [sec]

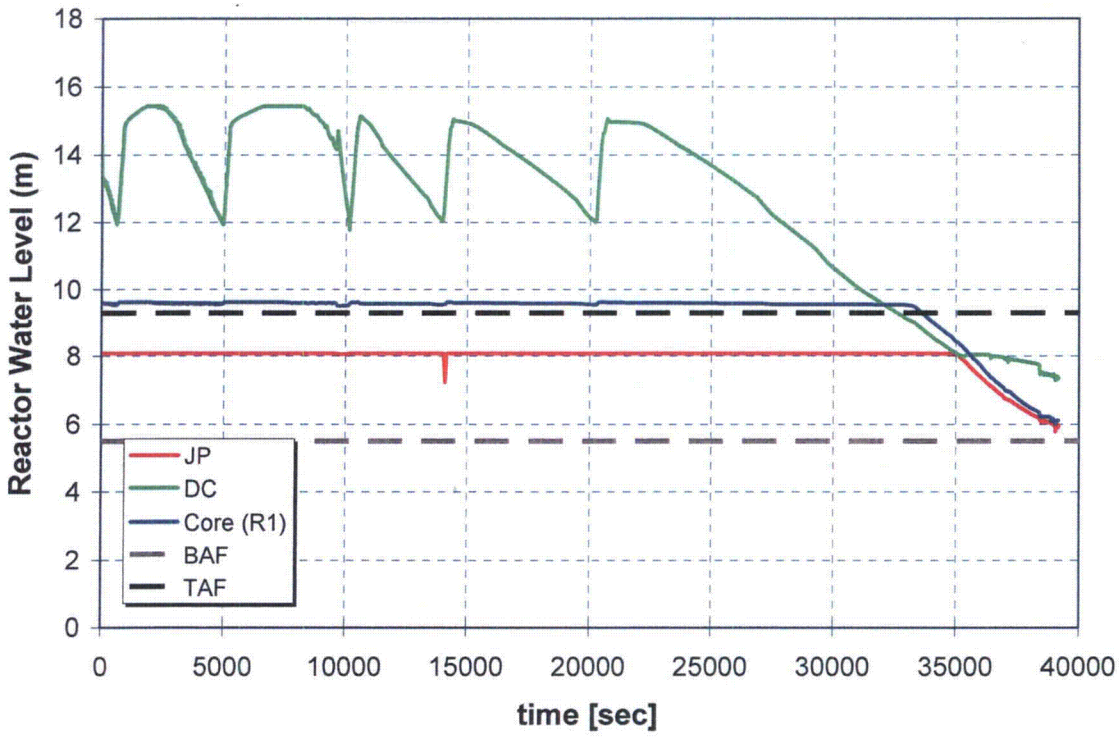

Wetwell Temperature [K]
450
430
410
390
370
350
330
310
290
270
250
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
TLIQ
TSAT
TVAP

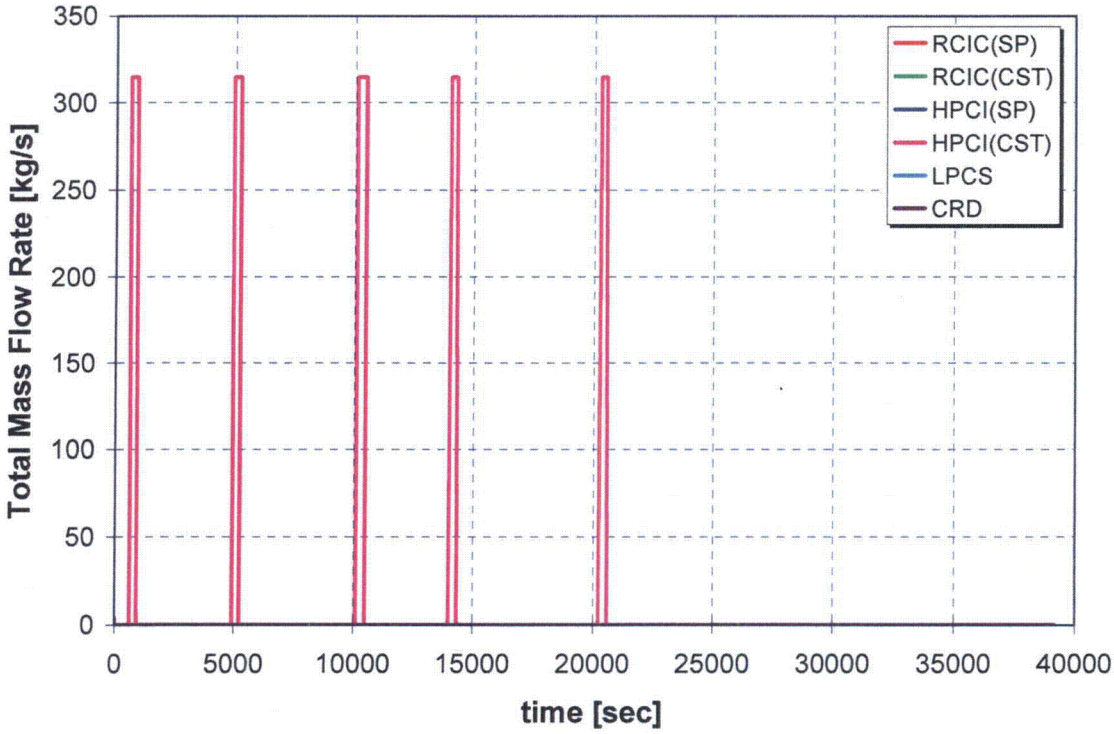

WW Water Level [m]
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
0
10000
20000
30000
40000
50000
60000
70000
time [sec]
Swollen
Collapsed

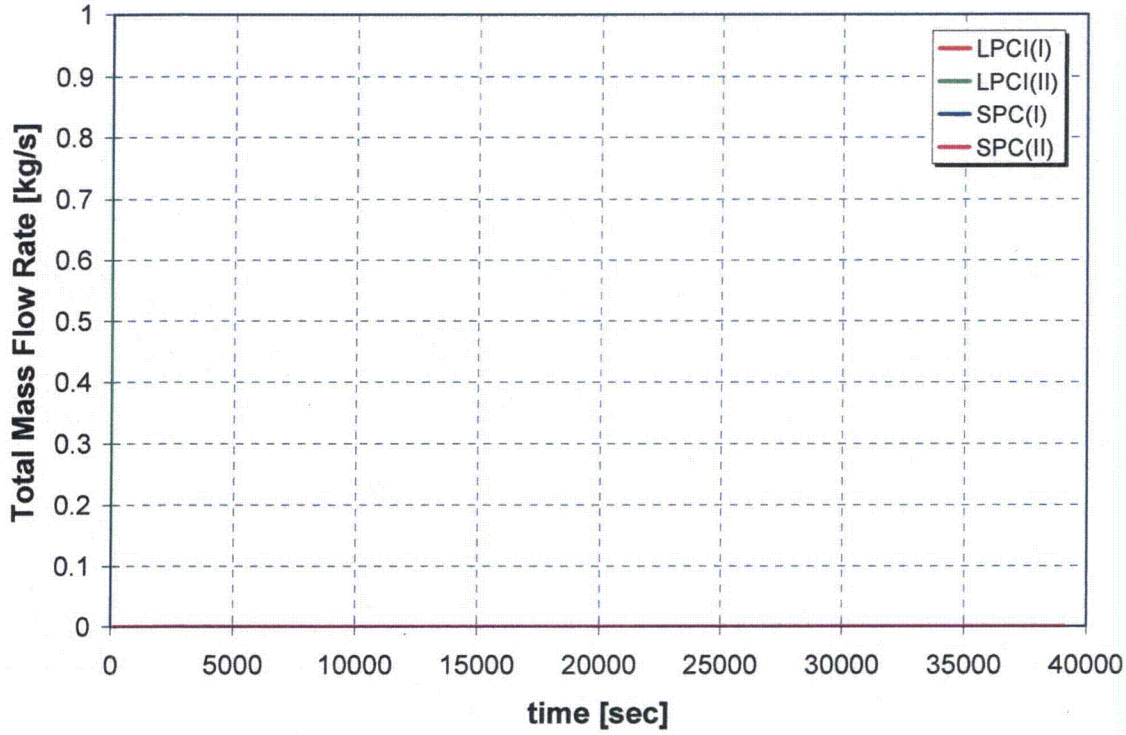
B.2.8 Case 8: Station Blackout and HPCI and HCTL Depressurization

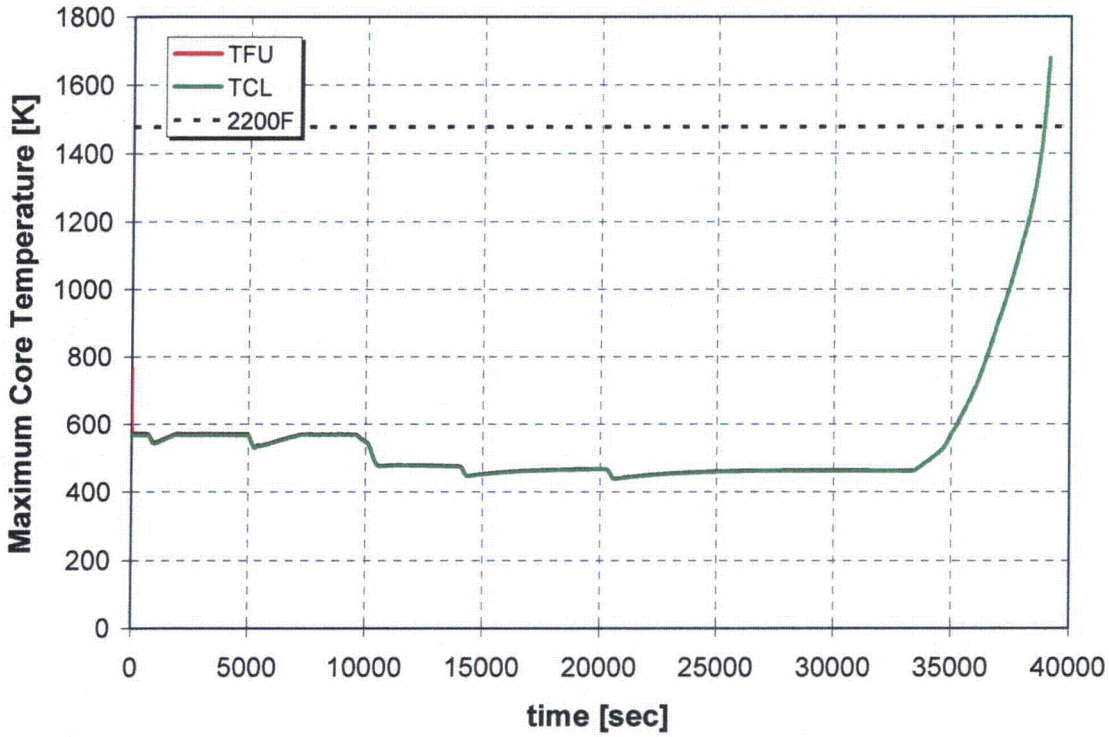


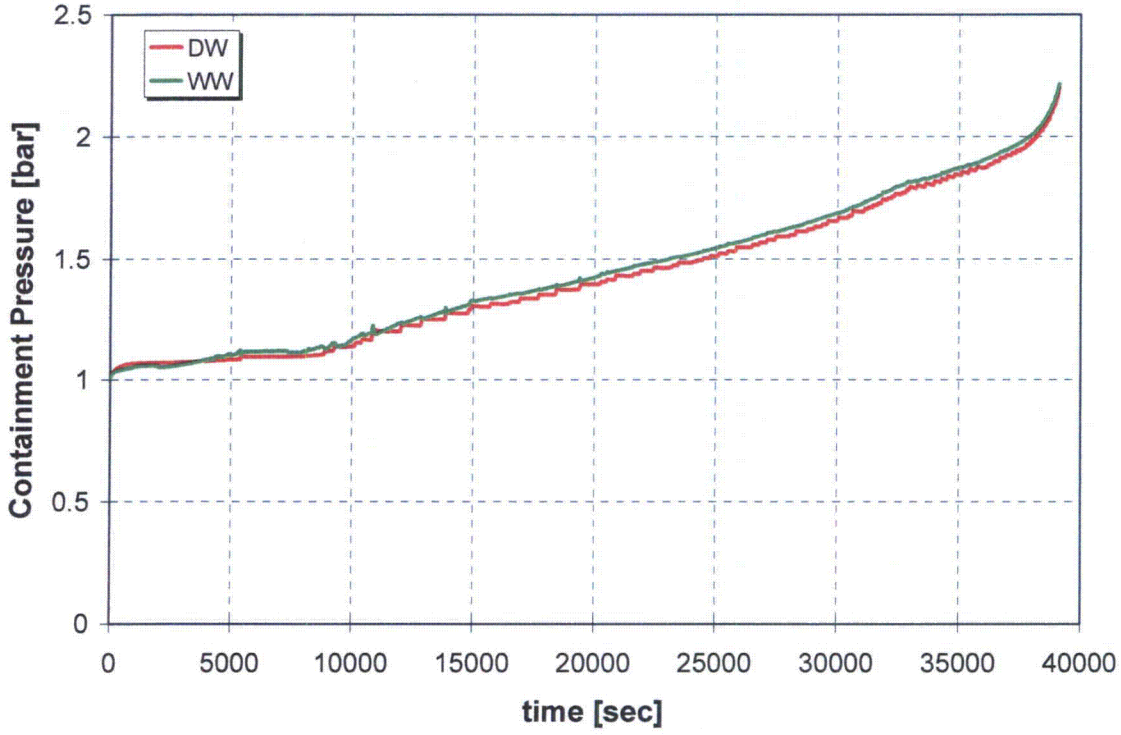


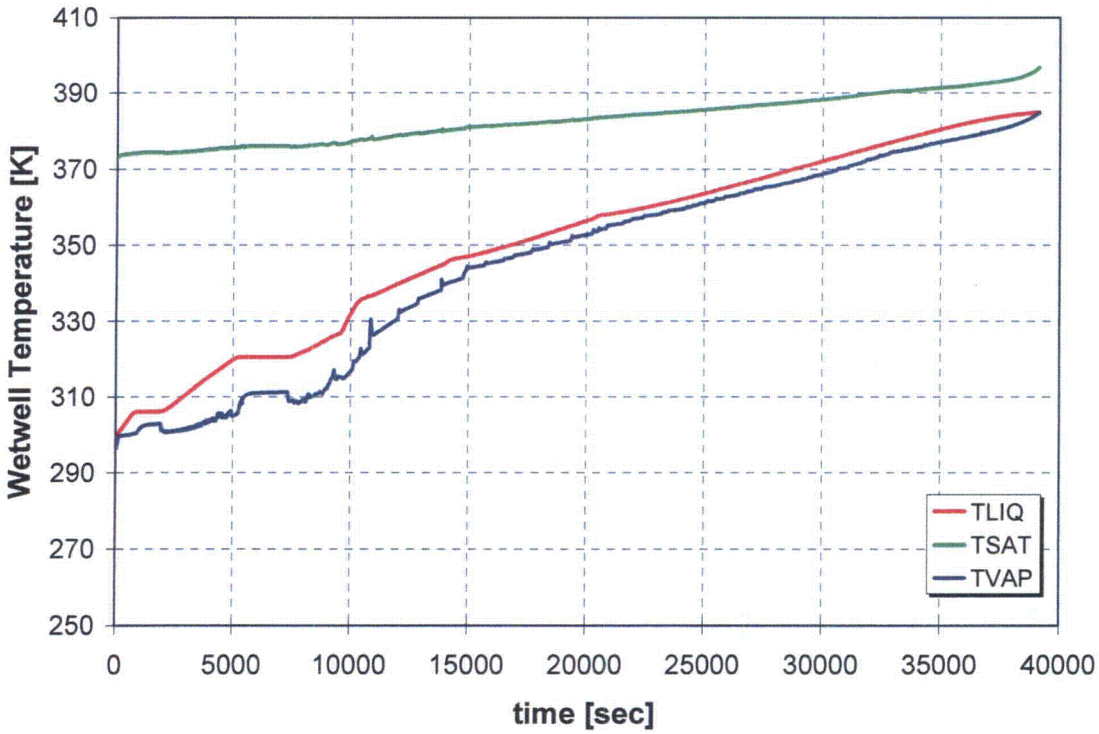

Reactor Water Level (m)
18
16
14
12
10
8
6
4
2
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
JP
DC
Core (R1)
BAF
TAF

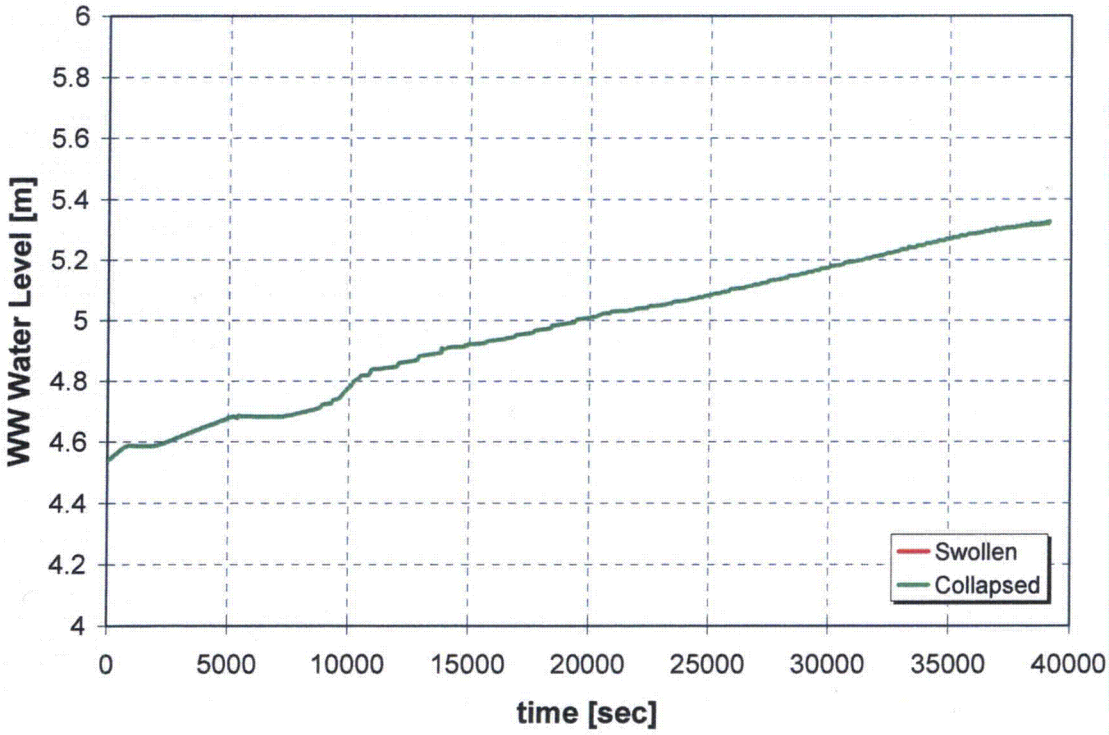

Total Mass Flow Rate [kg/s]
350
300
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)

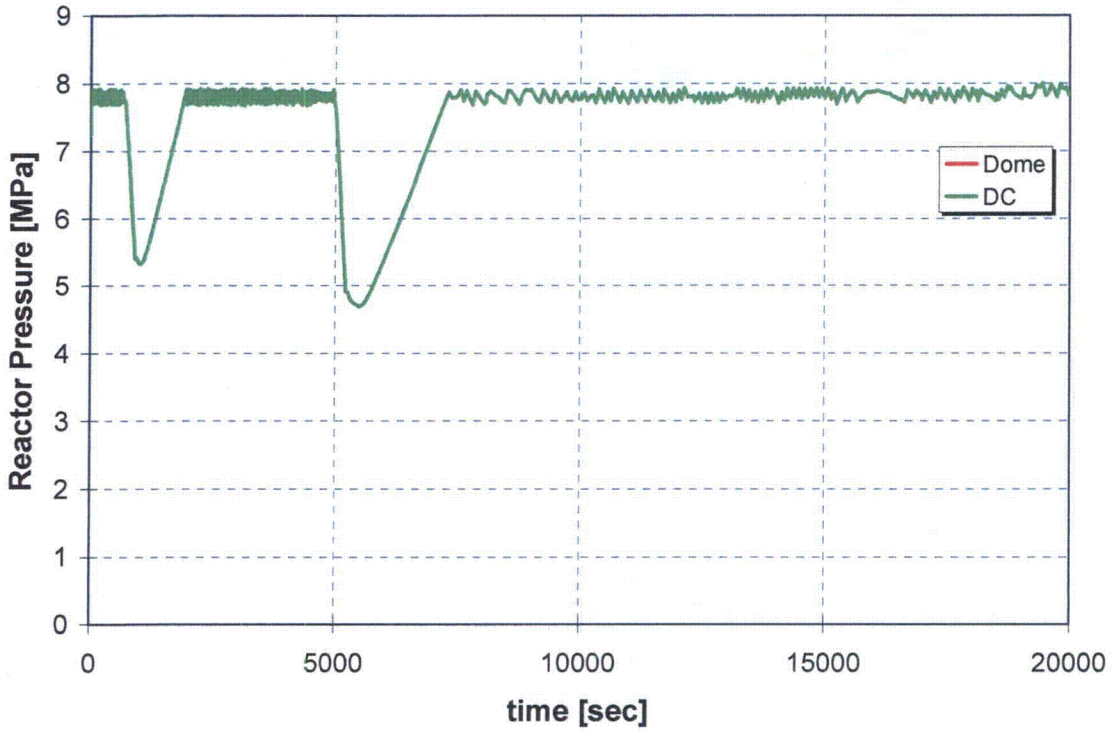

Maximum Core Temperature [K]
1800
1600
1400
1200
1000
800
600
400
200
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
TFU
TCL
2200F

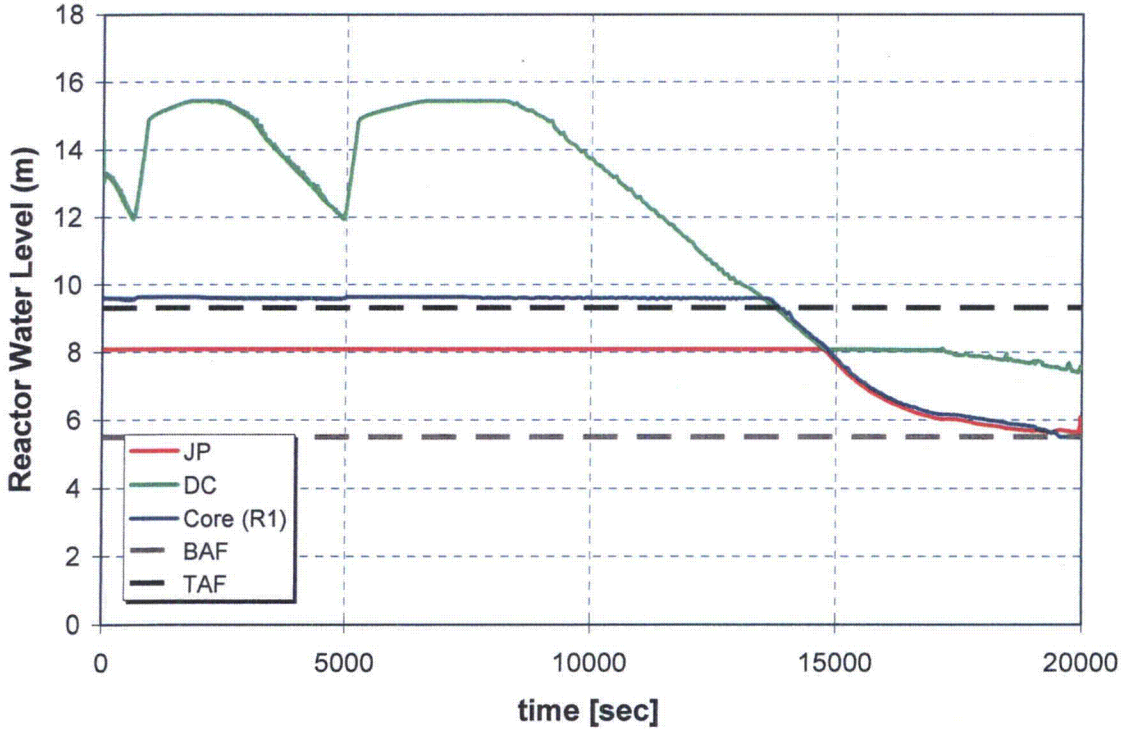

DW
WW
Containment Pressure [bar]
2.5
2
1.5
1
0.5
0
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]

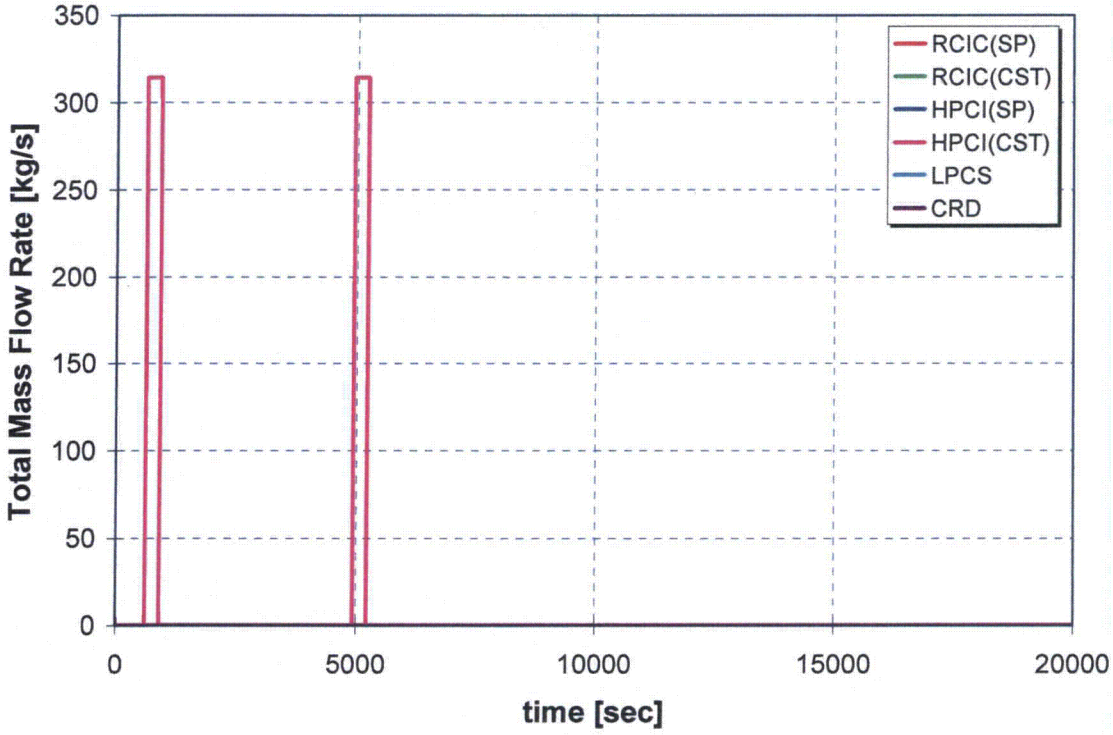

Wetwell Temperature [K]
410
390
370
350
330
310
290
270
250
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
TLIQ
TSAT
TVAP

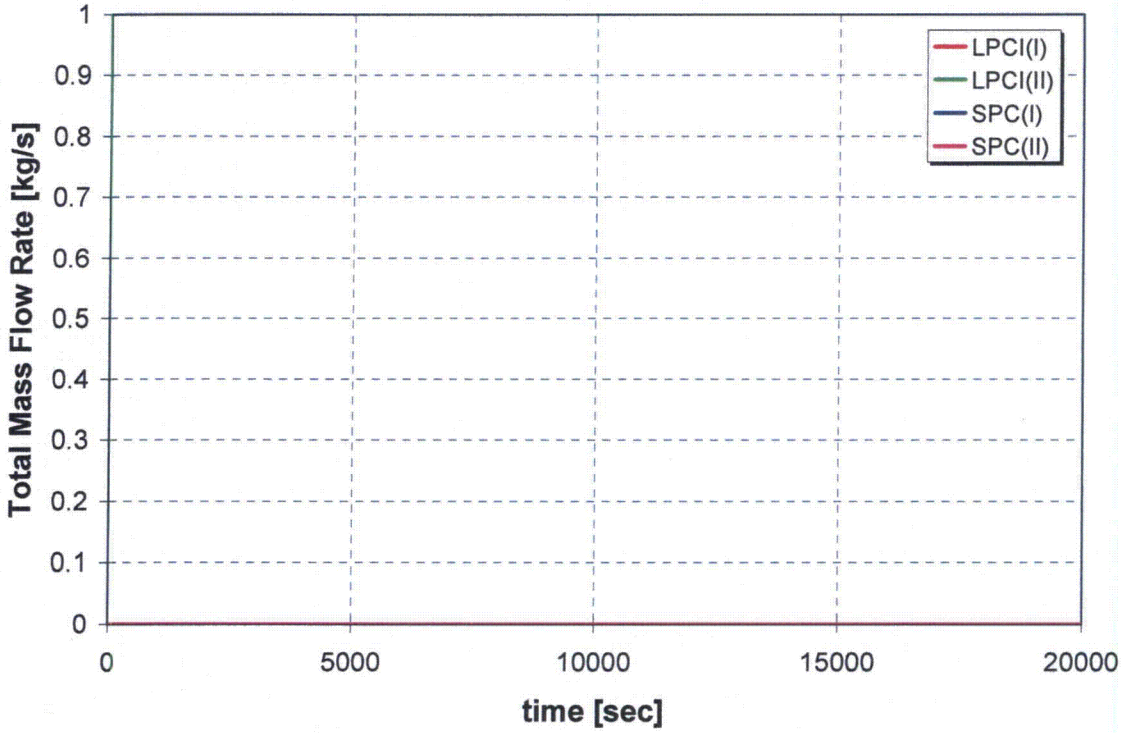

WW Water Level [m]
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
0
5000
10000
15000
20000
25000
30000
35000
40000
time [sec]
Swollen
Collapsed

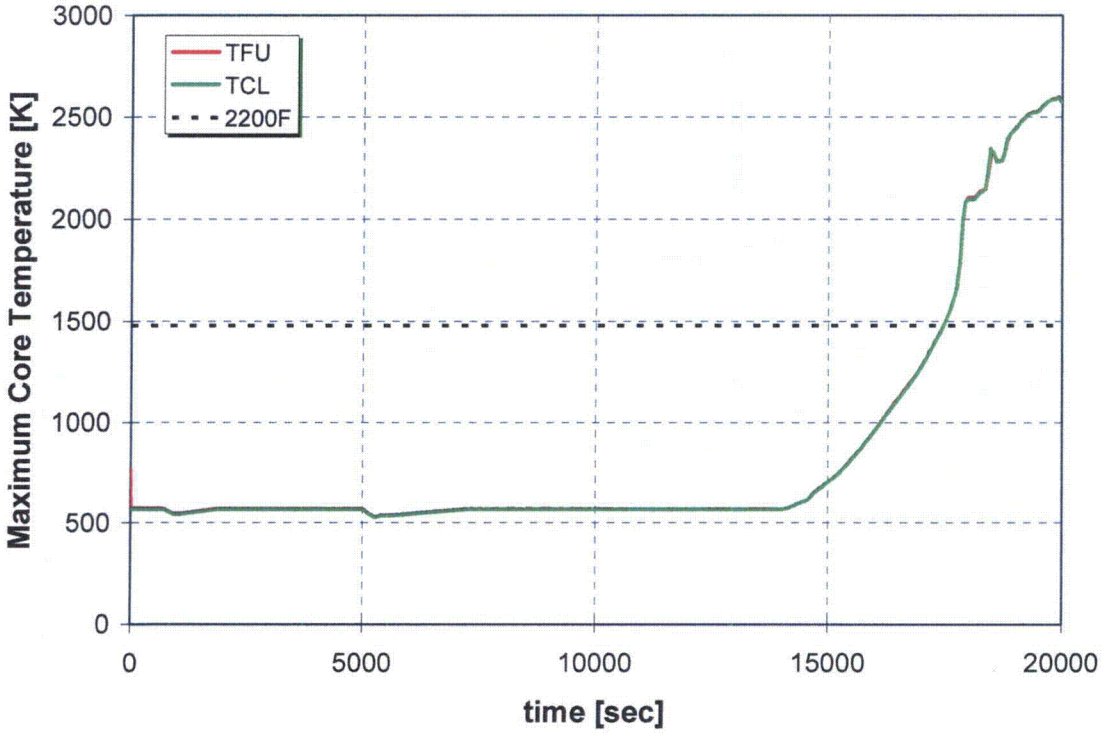
B.2.9 Case 9: Station Blackout and HPCI and 2-Hour Direct Current

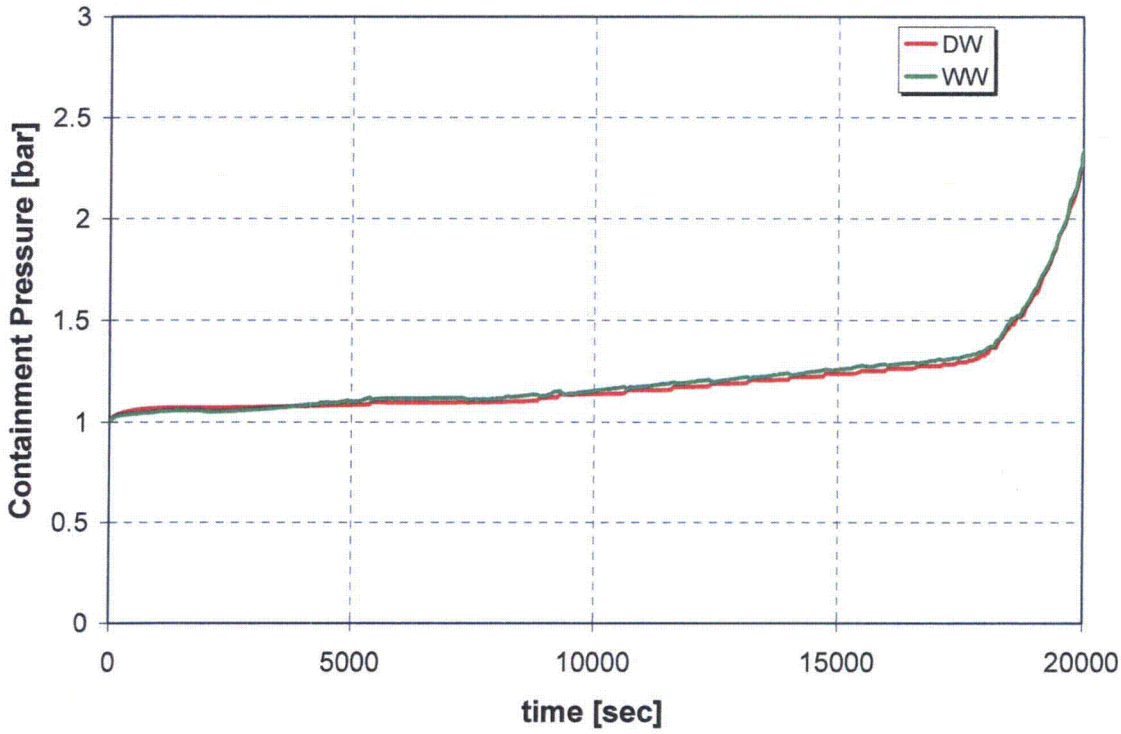


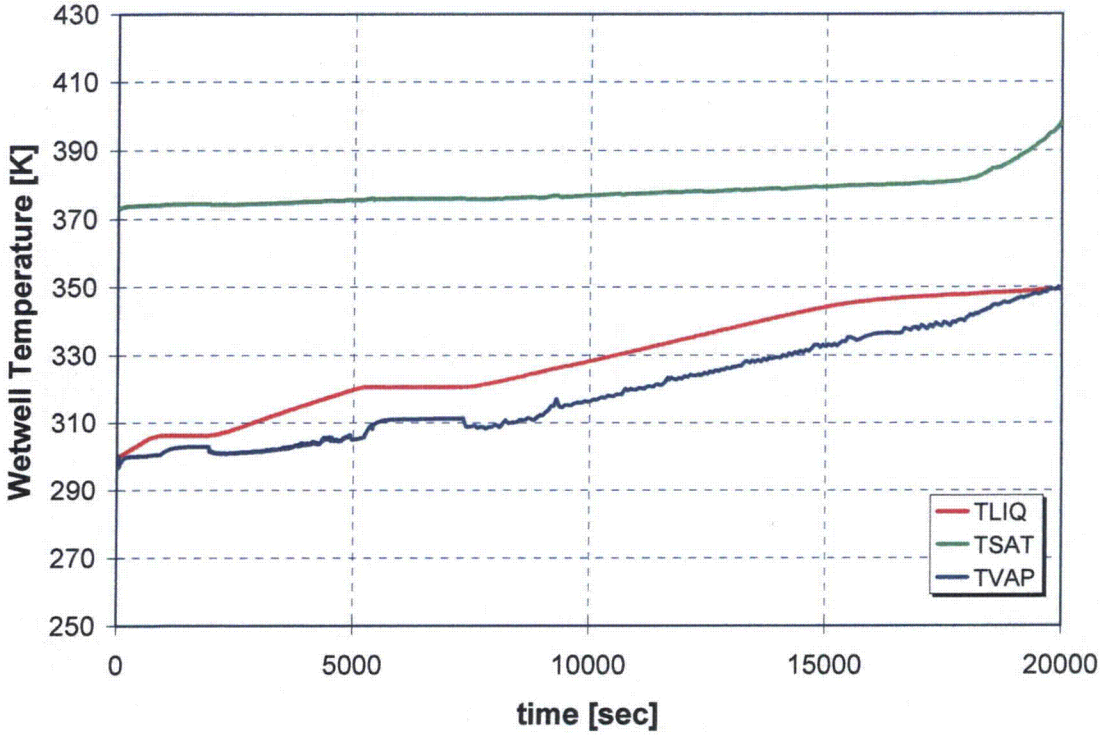


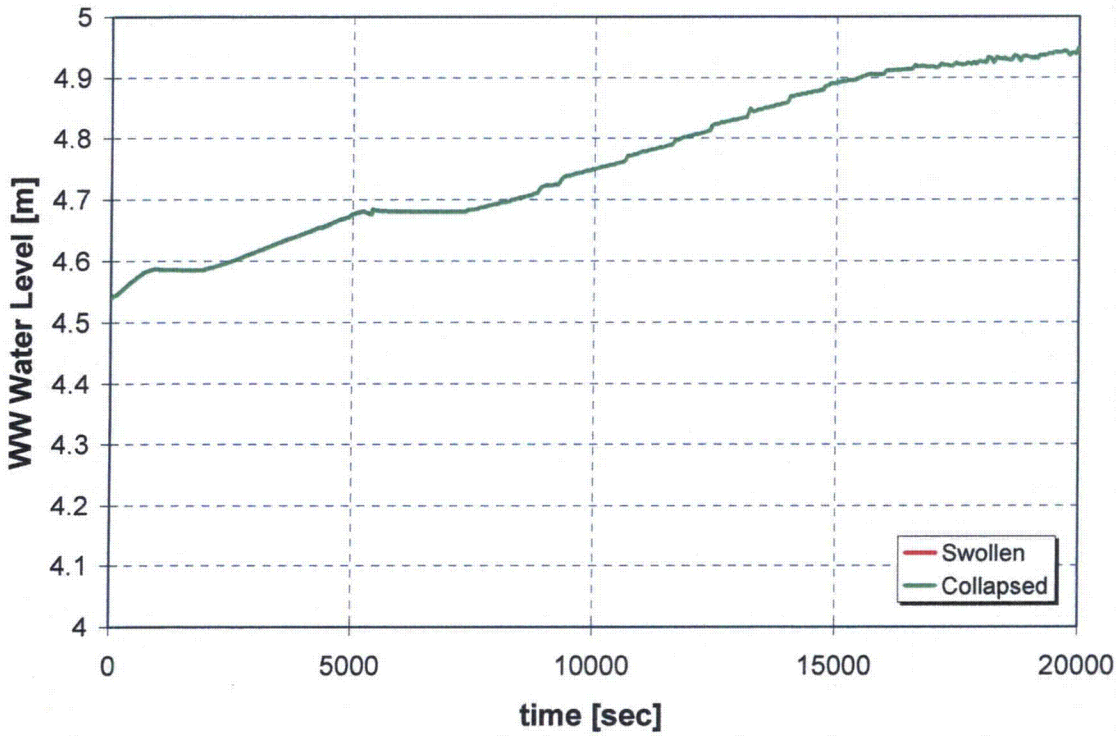

Total Mass Flow Rate [kg/s]
350
300
250
200
150
100
50
0
0
5000
10000
15000
20000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5000
10000
15000
20000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)

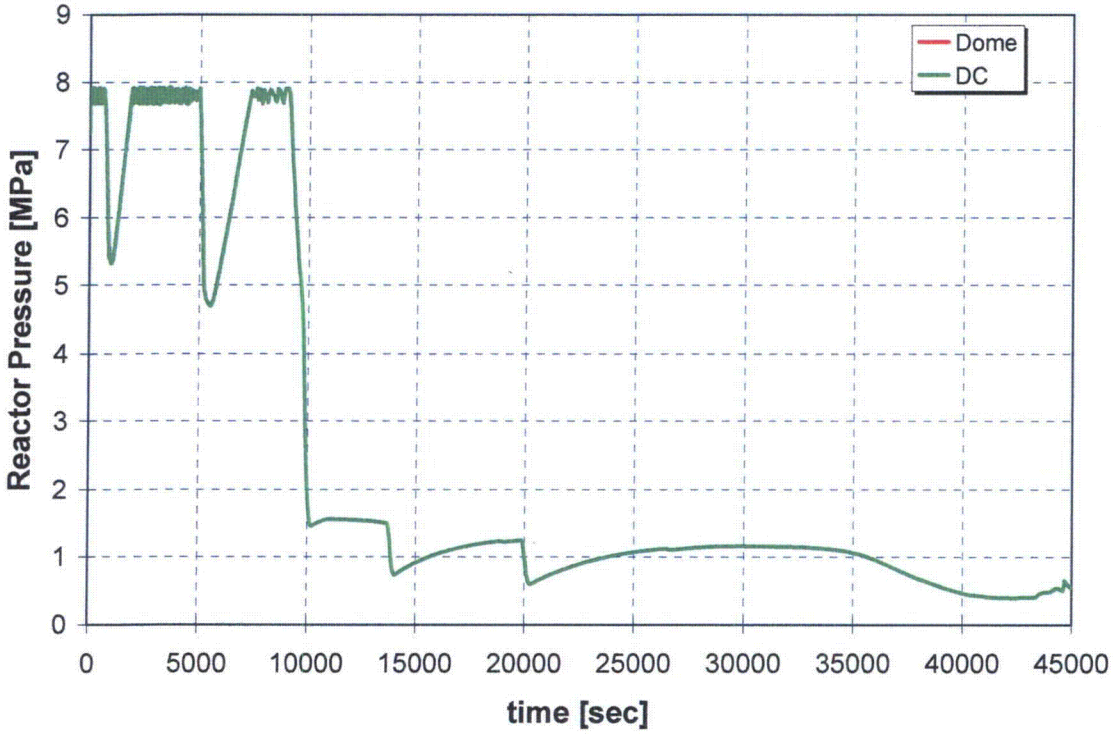

TFU
TCL
2200F
Maximum Core Temperature [K]
3000
2500
2000
1500
1000
500
0
0
5000
10000
15000
20000
time [sec]

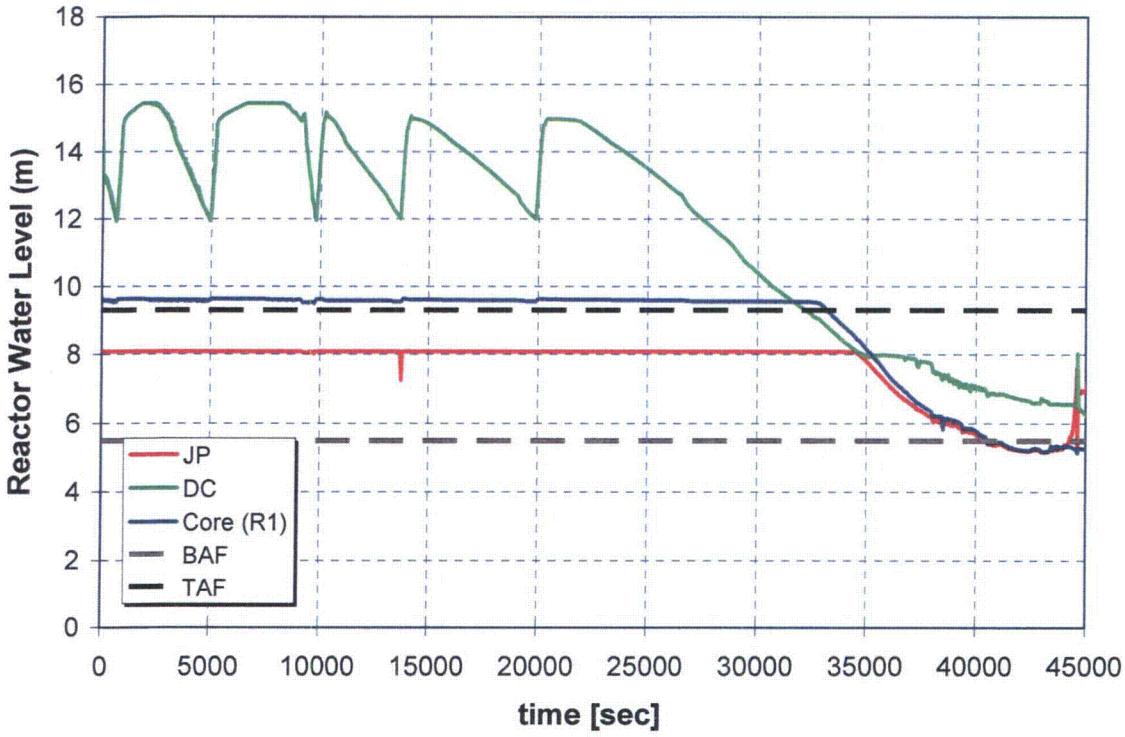

DW
WW
Containment Pressure [bar]
3
2.5
2
1.5
1
0.5
0
0
5000
10000
15000
20000
time [sec]

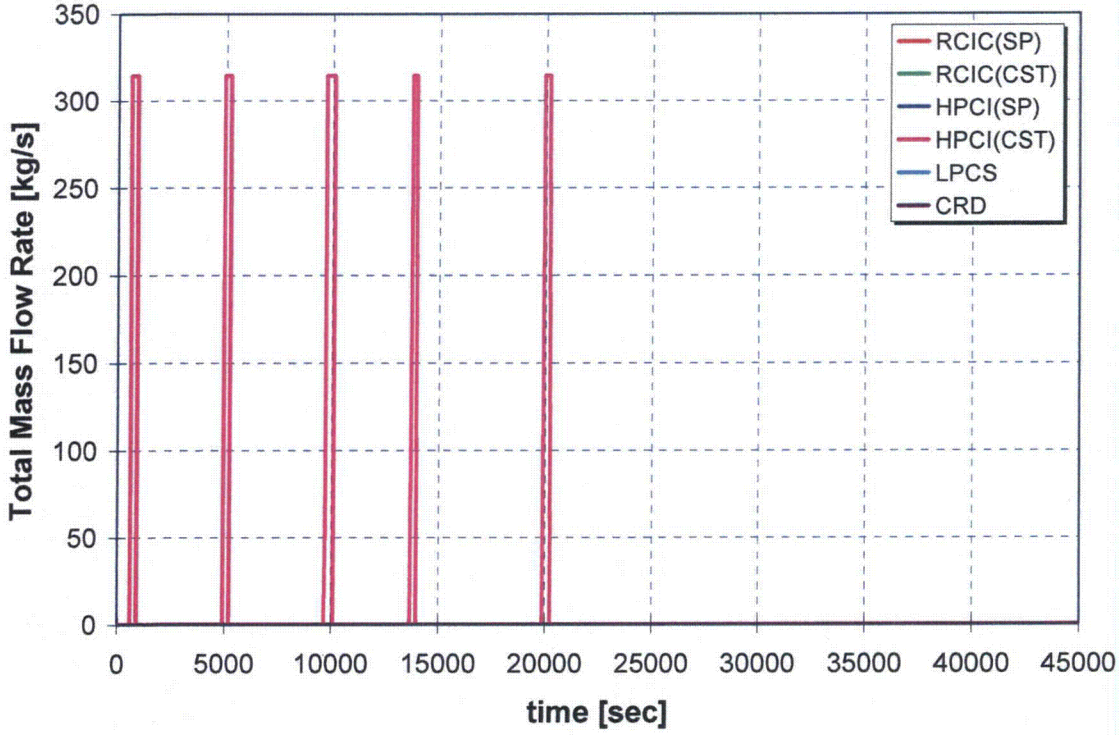

Wetwell Temperature [K]
430
410
390
370
350
330
310
290
270
250
0
5000
10000
15000
20000
time [sec]
TLIQ
TSAT
TVAP

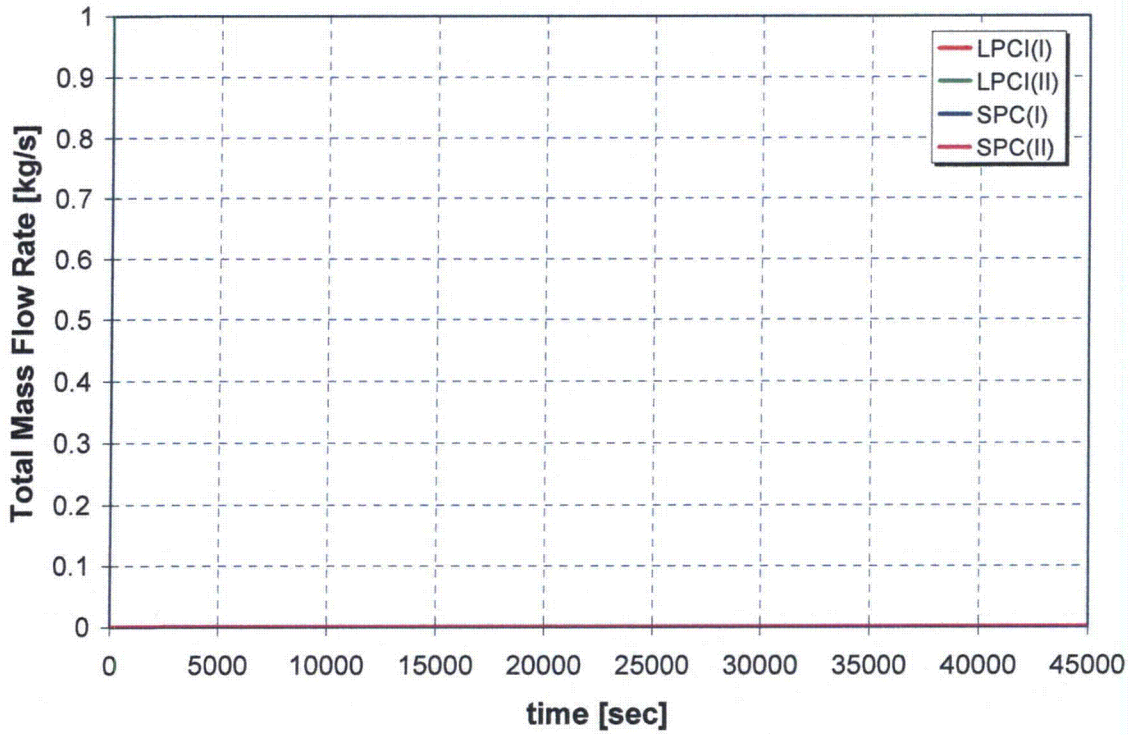

WW Water Level [m]
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
0
5000
10000
15000
20000
time [sec]
Swollen
Collapsed

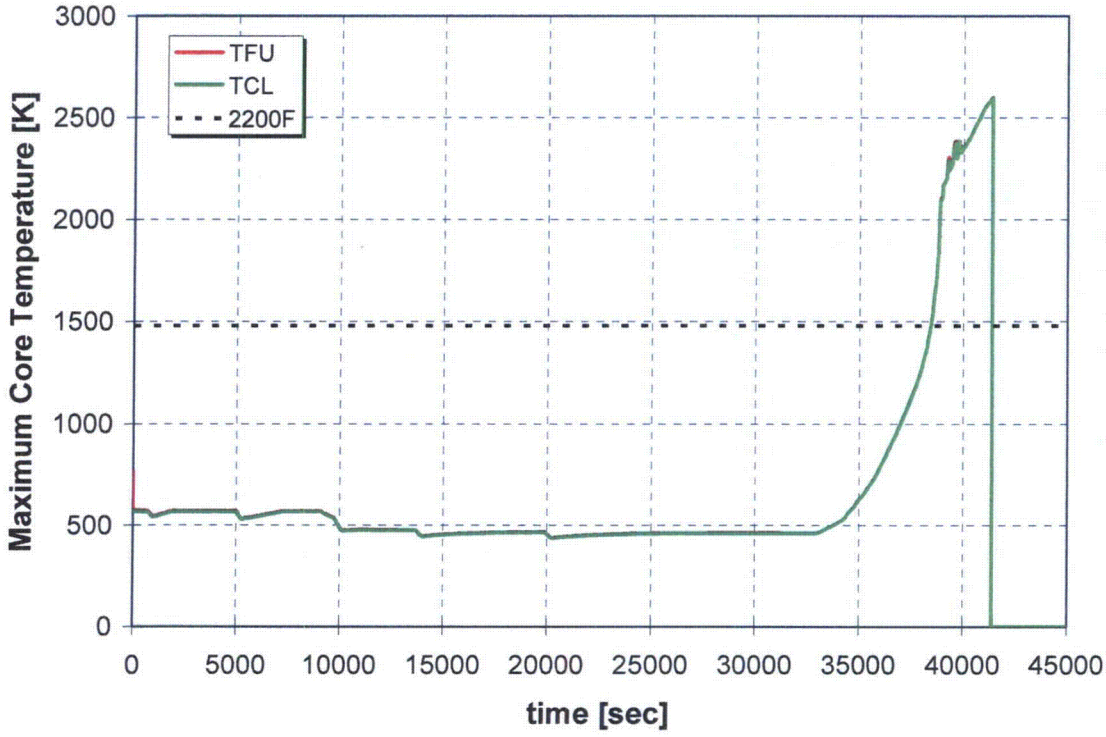
B.2.10 Case 10: Station Blackout and HPCI and SRV Stuck Open

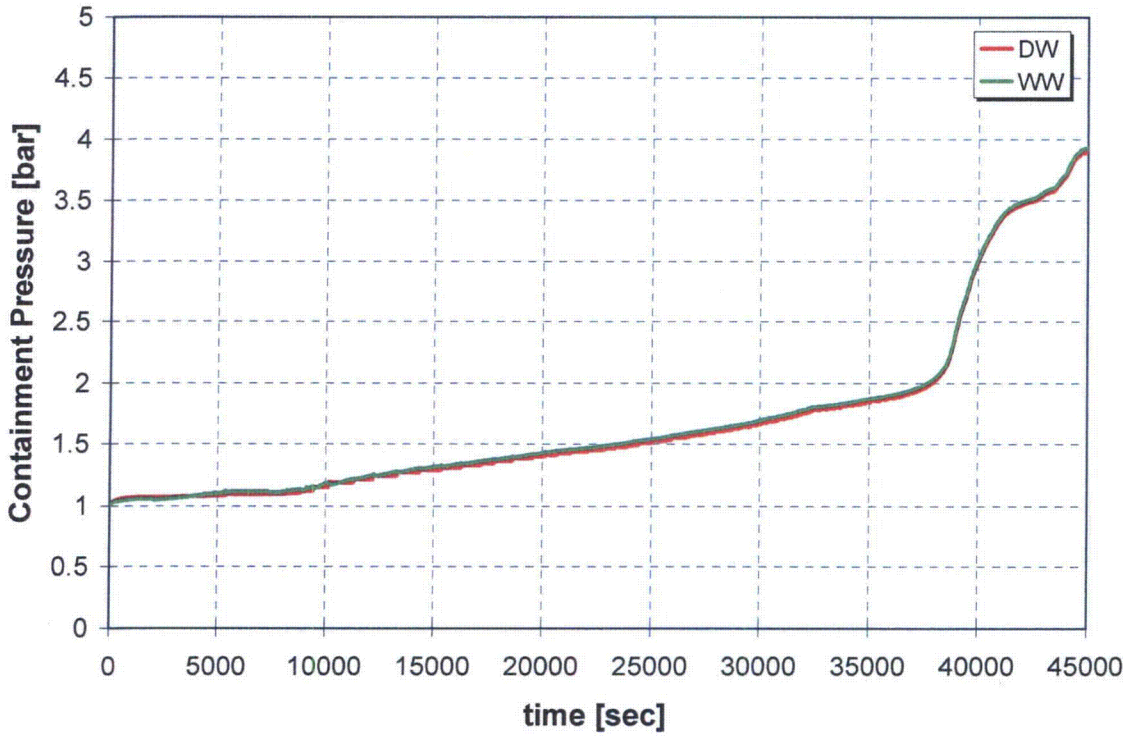


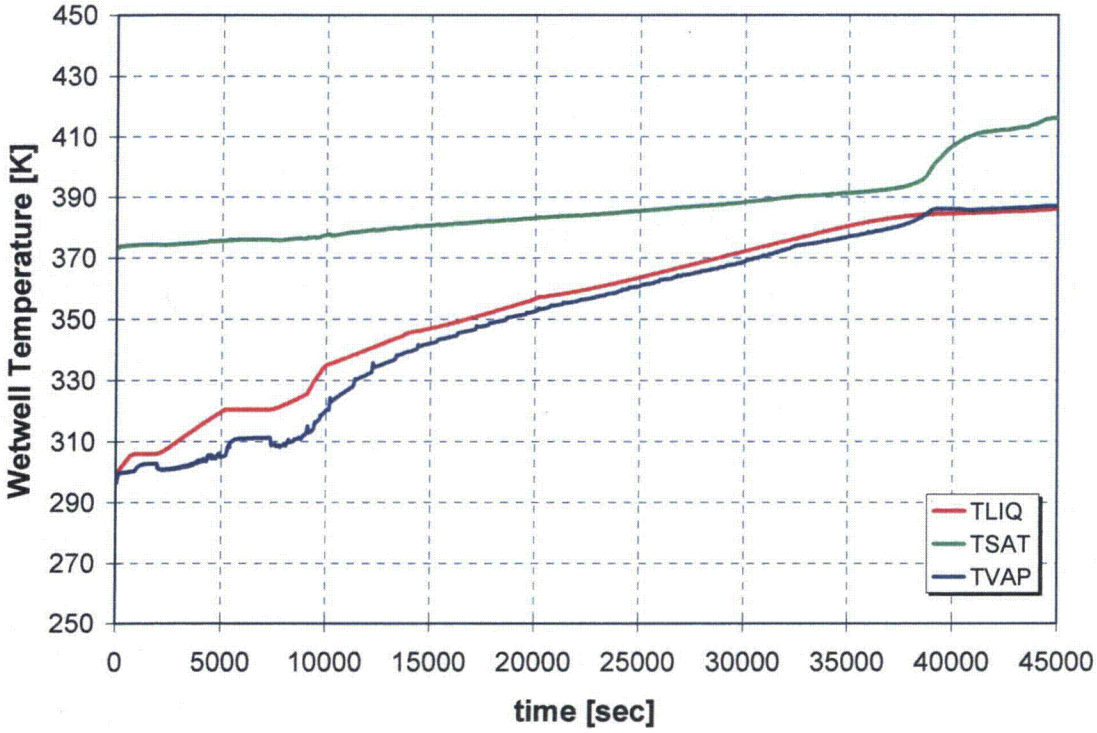


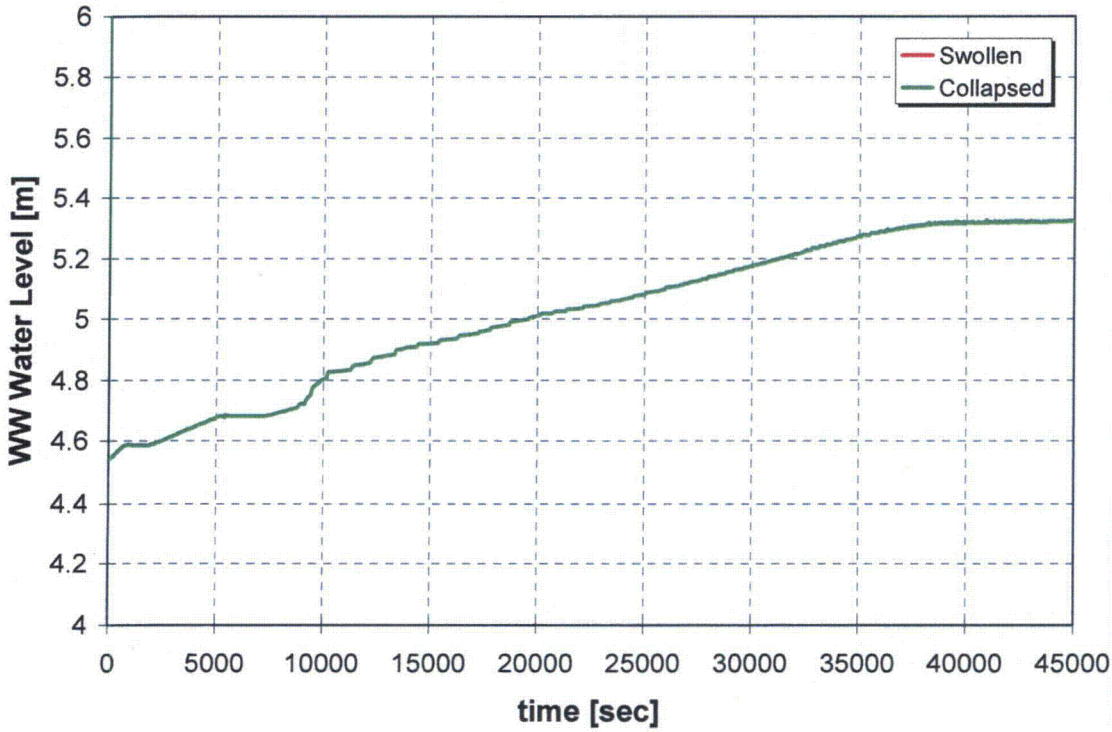

Total Mass Flow Rate [kg/s]
350
300
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
time [sec]
RCIC(SP)
RCIC(CST)
HPCI(SP)
HPCI(CST)
LPCS
CRD


Total Mass Flow Rate [kg/s]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
time [sec]
LPCI(I)
LPCI(II)
SPC(I)
SPC(II)


TFU
TCL
2200F
Maximum Core Temperature [K]
3000
2500
2000
1500
1000
500
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
time [sec]


DW
WW
Containment Pressure [bar]
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
time [sec]


Wetwell Temperature [K]
450
430
410
390
370
350
330
310
290
270
250
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
time [sec]
TLIQ
TSAT
TVAP


WW Water Level [m]
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
time [sec]
Swollen
Collapsed

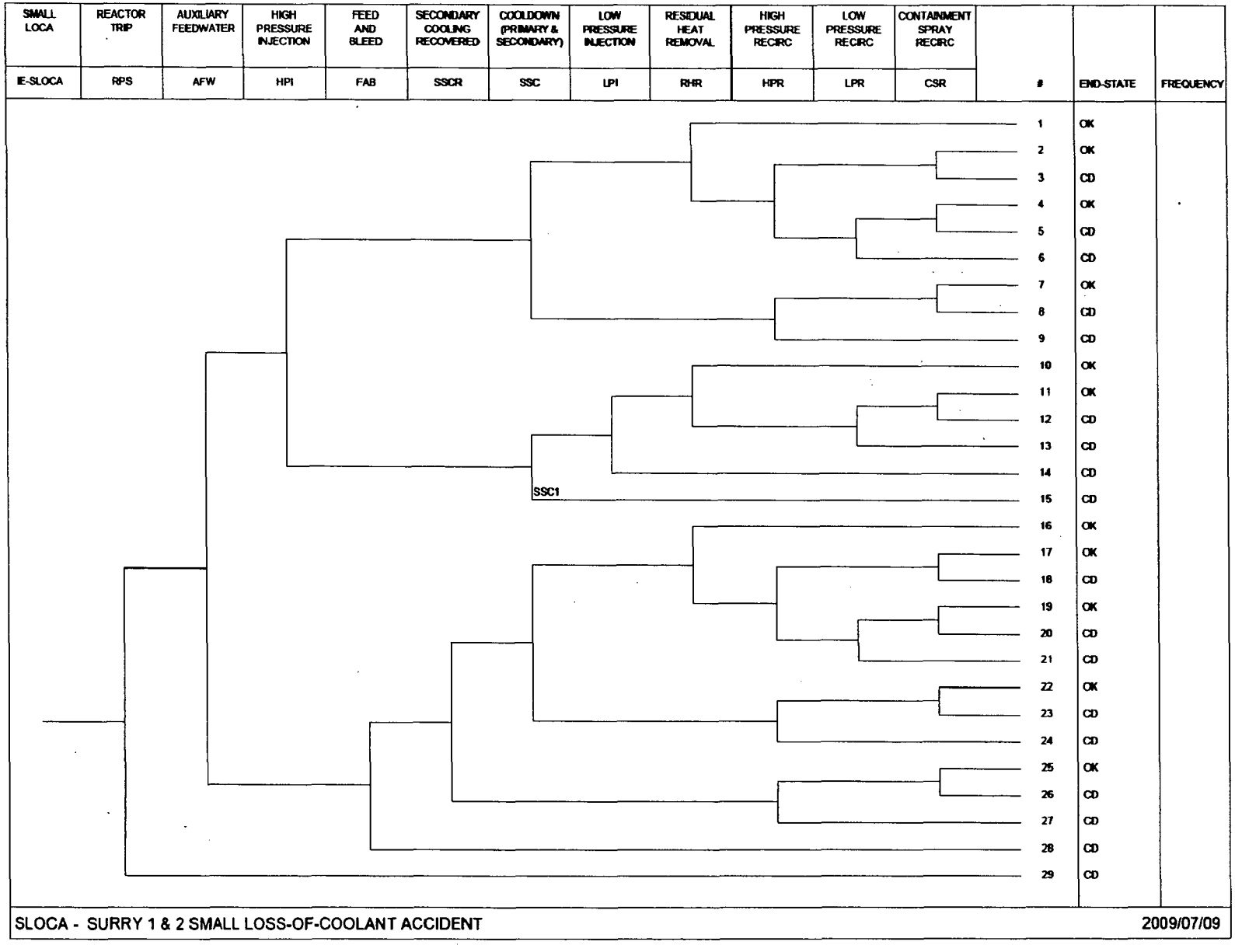
APPENDIX C

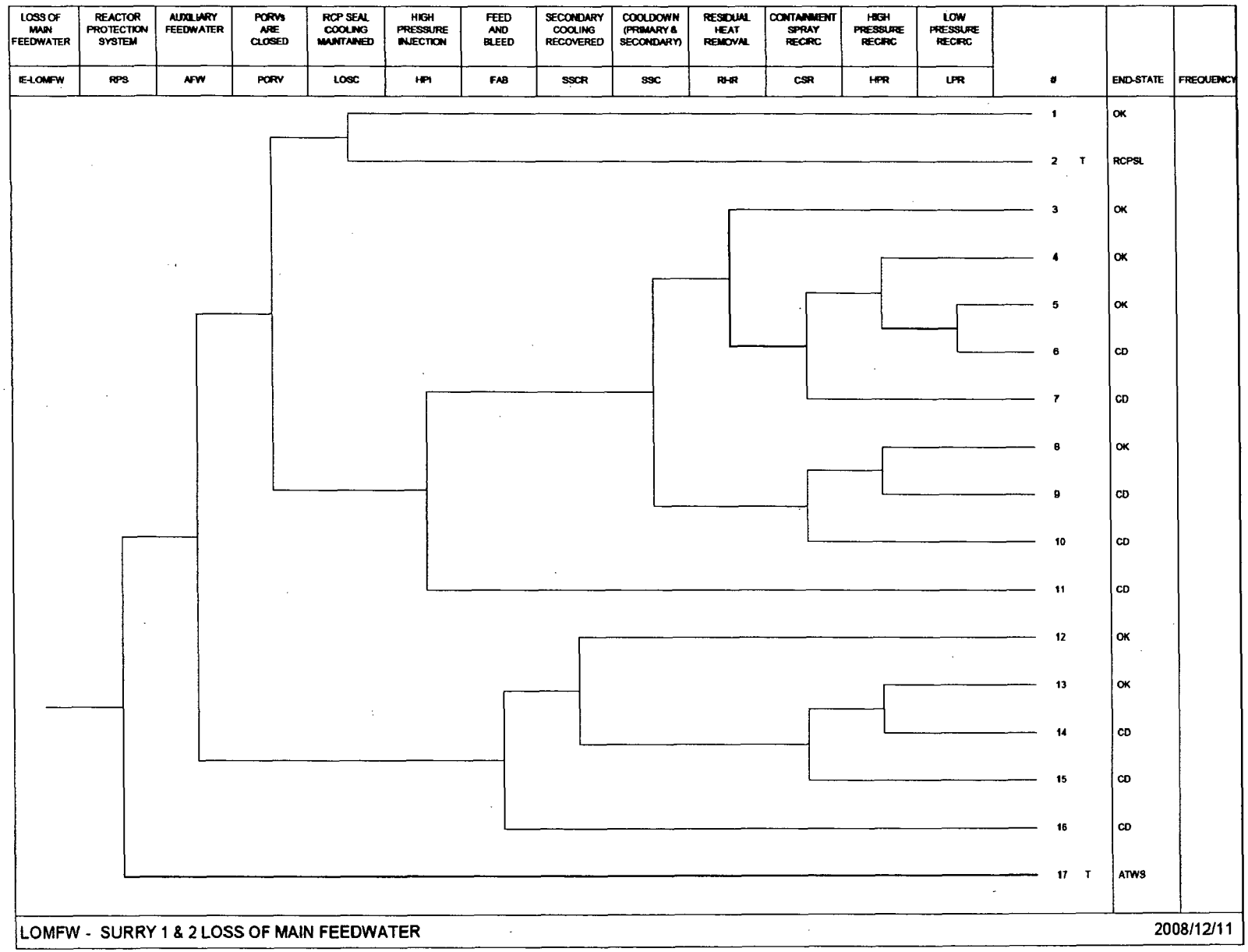
EVENT TREE MODELS FOR SURRY AND PEACH BOTTOM

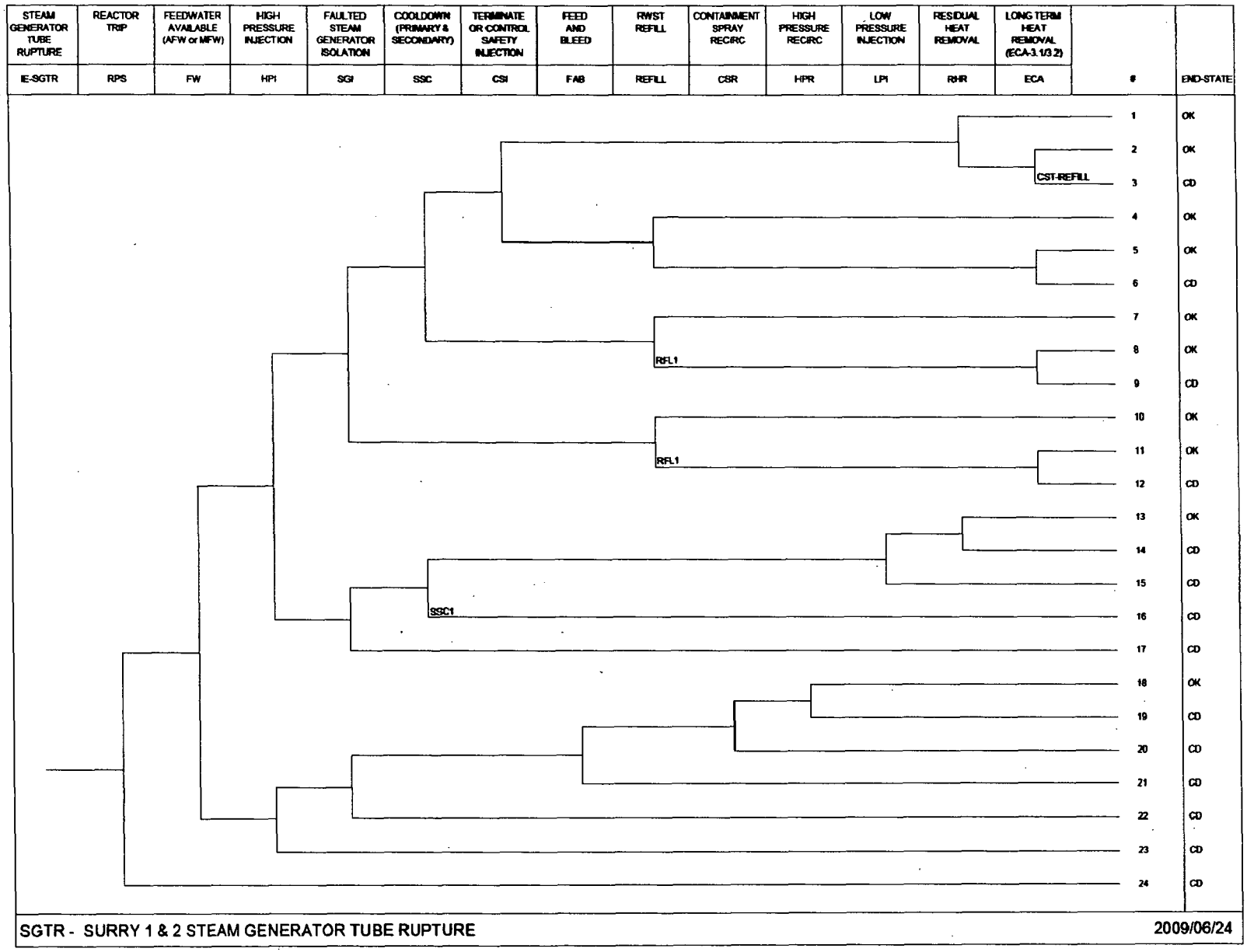
TABLE OF CONTENTS

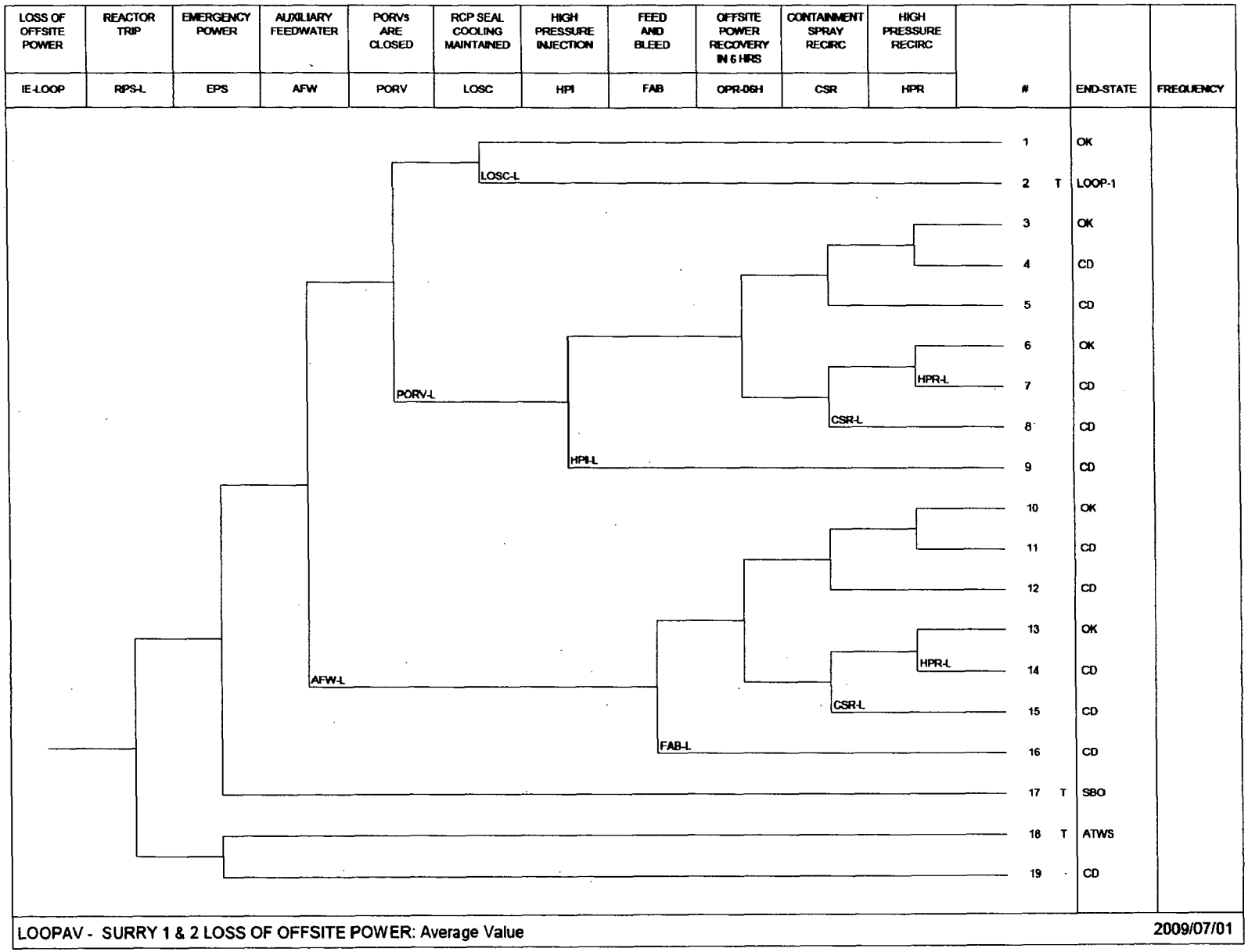
C.1 Surry Event Trees

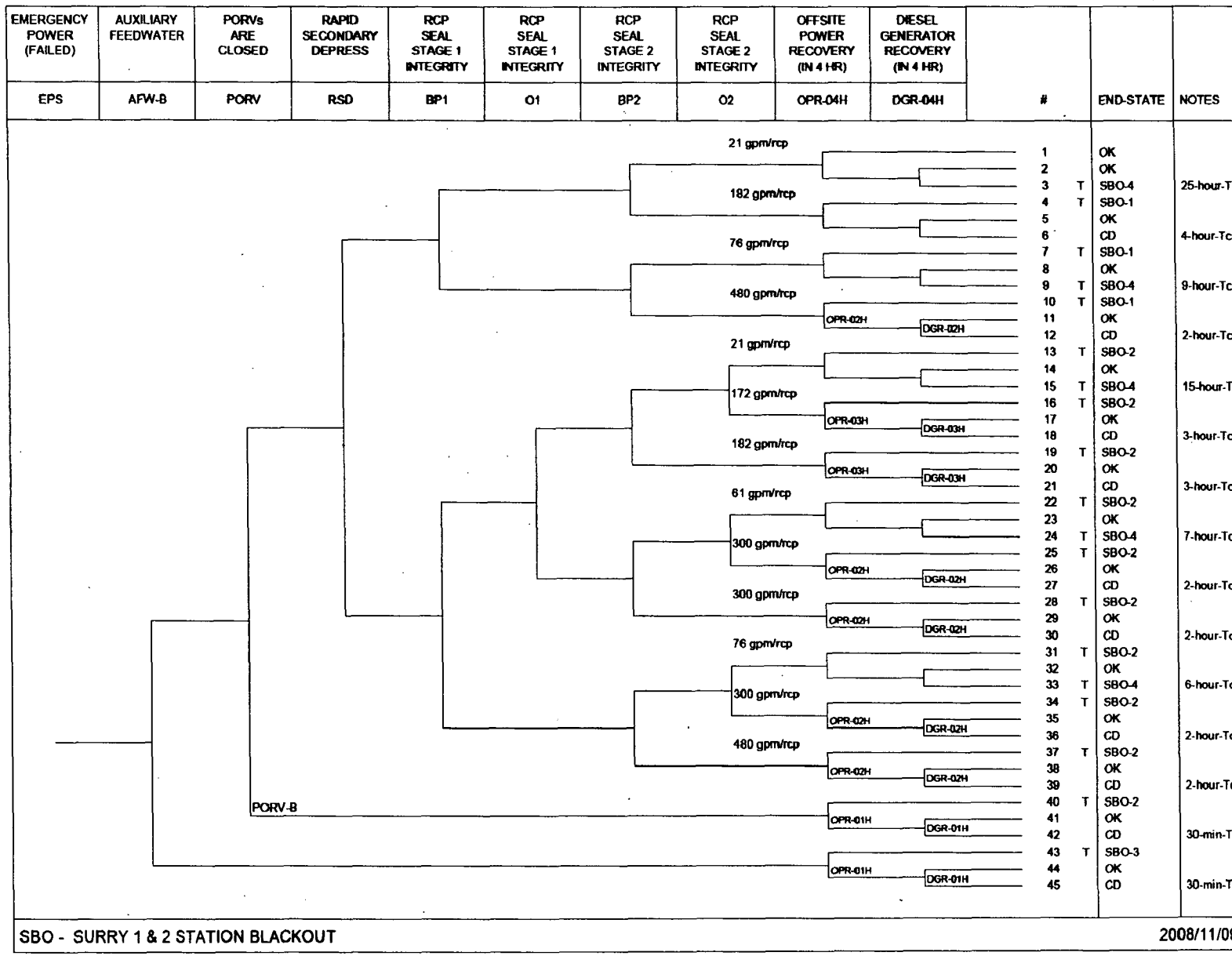
This section provides the relevant event trees from the Surry (v3.52) Standardized Plant Analysis Risk model, dated November 2009. These event trees show the sequences described in the main report.


SMALL LOCA
REACTOR TRIP
AUXILIARY FEEDWATER
HIGH PRESSURE INJECTION
FEED AND BLEED
SECONDARY COOLING RECOVERED
COOLDOWN (PRIMARY & SECONDARY)
LOW PRESSURE INJECTION
RESIDUAL HEAT REMOVAL
HIGH PRESSURE RECIRC
LOW PRESSURE RECIRC
CONTAINMENT SPRAY RECIRC
IE-SLOCA
RPS
AFW
HPI
FAB
SSCR
SSC
LPI
RHR
HPR
LPR
CSR
#
END-STATE
FREQUENCY
SSC1
1 OK
2 OK
3 CD
4 OK
5 CD
6 CD
7 OK
8 CD
9 CD
10 OK
11 OK
12 CD
13 CD
14 CD
15 CD
16 OK
17 OK
18 CD
19 OK
20 CD
21 CD
22 OK
23 CD
24 CD
25 OK
26 CD
27 CD
28 CD
29 CD
SLOCA - SURRY 1 & 2 SMALL LOSS-OF-COOLANT ACCIDENT
2009/07/09

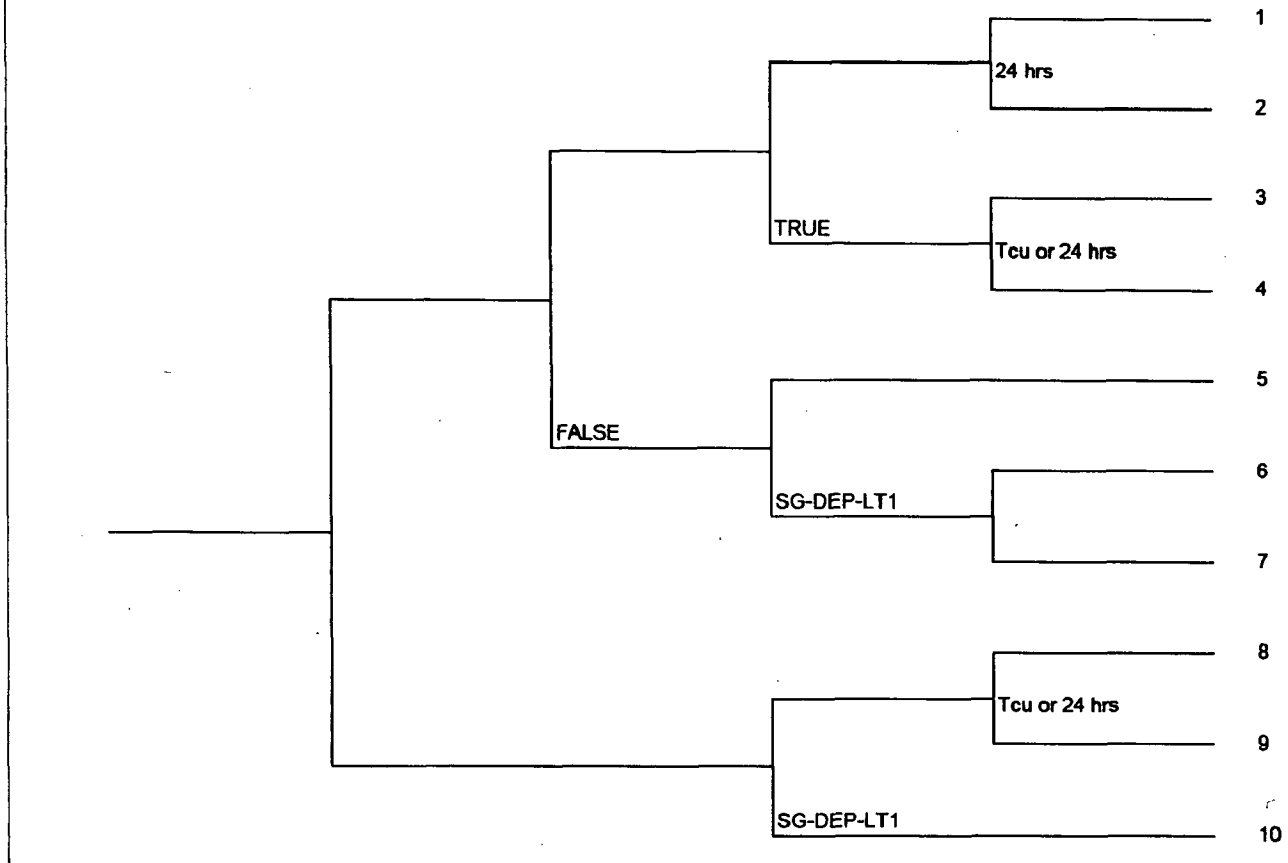

LOSS OF MAIN FEEDWATER
REACTOR PROTECTION SYSTEM
AUXILIARY FEEDWATER
PORVs ARE CLOSED
RCP SEAL COOLING MAINTAINED
HIGH PRESSURE INJECTION
FEED AND BLEED
SECONDARY COOLING RECOVERED
COOLDOWN (PRIMARY & SECONDARY)
RESIDUAL HEAT REMOVAL
CONTAINMENT SPRAY RECIRC
HIGH PRESSURE RECIRC
LOW PRESSURE RECIRC
IE-LOMFW
RPS
AFW
PORV
LOSC
HPI
FAB
SSCR
S3C
RHR
CSR
HPR
LPR
#
END-STATE
FREQUENCY
1 OK
2 T RCPSL
3 OK
4 OK
5 OK
6 CD
7 CD
8 OK
9 CD
10 CD
11 CD
12 OK
13 OK
14 CD
15 CD
16 CD
17 T ATWS
LOMFW - SURRY 1 & 2 LOSS OF MAIN FEEDWATER
2008/12/11


STEAM GENERATOR TUBE RUPTURE
REACTOR TRIP
FEEDWATER AVAILABLE (AFW or MFW)
HIGH PRESSURE INJECTION
FAULTED STEAM GENERATOR ISOLATION
COOLDOWN (PRIMARY & SECONDARY)
TERMINATE OR CONTROL SAFETY INJECTION
FEED AND BLEED
RWST REFILL
CONTAINMENT SPRAY RECIRC
HIGH PRESSURE RECIRC
LOW PRESSURE INJECTION
RESIDUAL HEAT REMOVAL
LONG TERM HEAT REMOVAL (ECA-3.1/3.2)
IE-SGTR
RPS
FW
HPI
SGI
SSC
CSI
FAB
REFILL
CSR
HPR
LPI
RHR
ECA
#
END-STATE
CST-REFILL
RFL1
RFL1
SSC1
1 OK
2 OK
3 CD
4 OK
5 OK
6 CD
7 OK
8 OK
9 CD
10 OK
11 OK
12 CD
13 OK
14 CD
15 CD
16 CD
17 CD
18 OK
19 CD
20 CD
21 CD
22 CD
23 CD
24 CD
SGTR - SURRY 1 & 2 STEAM GENERATOR TUBE RUPTURE
2009/06/24


LOSS OF OFFSITE POWER
REACTOR TRIP
EMERGENCY POWER
AUXILIARY FEEDWATER
PORVs ARE CLOSED
RCP SEAL COOLING MAINTAINED
HIGH PRESSURE INJECTION
FEED AND BLEED
OFFSITE POWER RECOVERY IN 6 HRS
CONTAINMENT SPRAY RECIRC
HIGH PRESSURE RECIRC
IE-LOOP
RPS-L
EPS
AFW
PORV
LOSC
HPI
FAB
OPR-06H
CSR
HPR
#
END-STATE
FREQUENCY
LOSC-L
PORV-L
HPI-L
HPR-L
CSR-L
AFW-L
HPR-L
CSR-L
FAB-L
1 OK
2 T LOOP-1
3 OK
4 CD
5 CD
6 OK
7 CD
8 CD
9 CD
10 OK
11 CD
12 CD
13 OK
14 CD
15 CD
16 CD
17 T SBO
18 T ATWS
19 CD
LOOPAV - SURRY 1 & 2 LOSS OF OFFSITE POWER: Average Value
2009/07/01

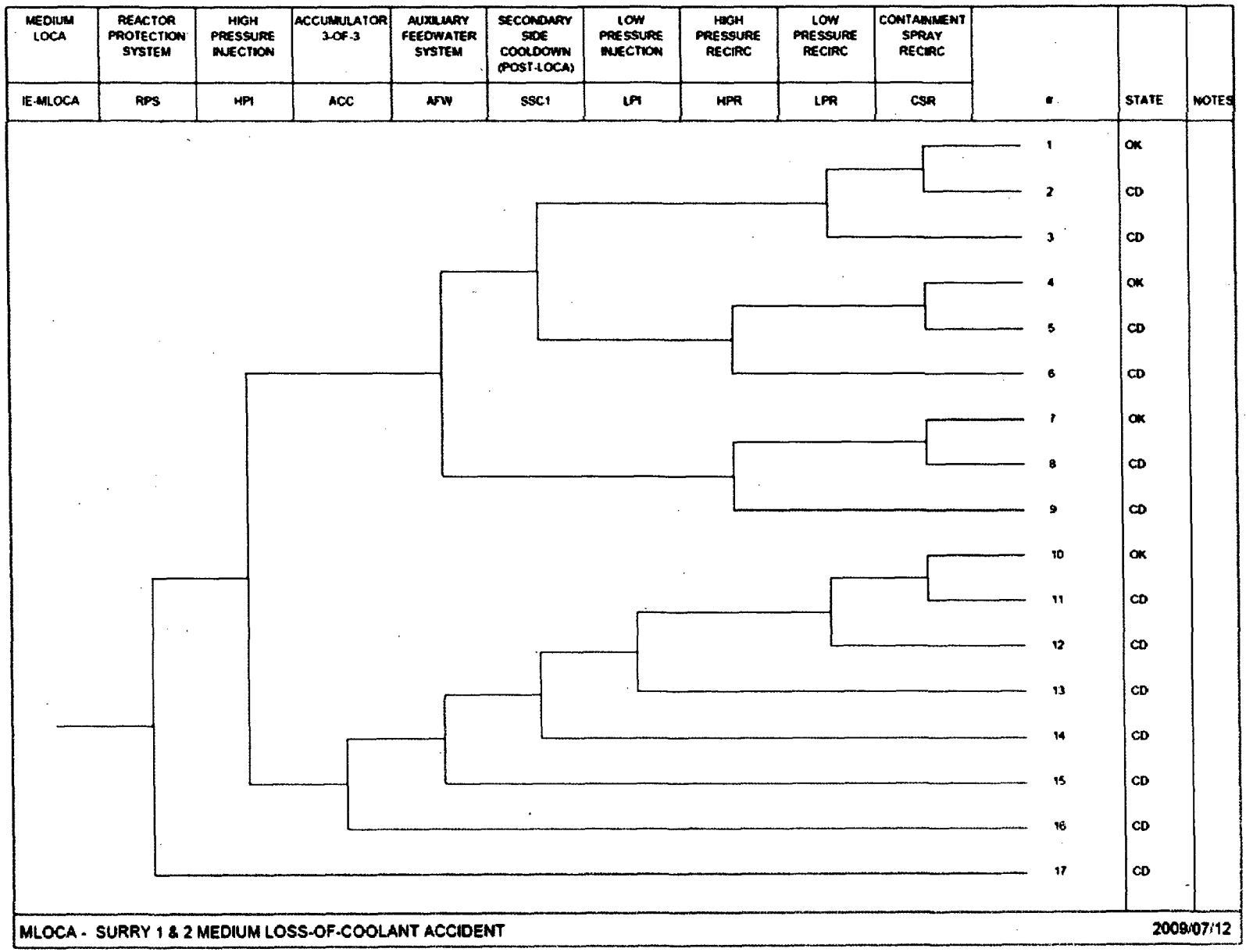

EMERGENCY POWER (FAILED)
AUXILIARY FEEDWATER
PORVs ARE CLOSED
RAPID SECONDARY DEPRESS
RCP SEAL STAGE 1 INTEGRITY
RCP SEAL STAGE 1 INTEGRITY
RCP SEAL STAGE 2 INTEGRITY
RCP SEAL STAGE 2 INTEGRITY
OFFSITE POWER RECOVERY (IN 4 HR)
DIESEL GENERATOR RECOVERY (IN 4 HR)
#
END-STATE
NOTES
EPS
AFW-B
PORV
RSD
BP1
O1
BP2
O2
OPR-04H
DGR-04H
21 gpm/rcp
182 gpm/rcp
76 gpm/rcp
480 gpm/rcp
21 gpm/rcp
172 gpm/rcp
182 gpm/rcp
61 gpm/rcp
300 gpm/rcp
300 gpm/rcp
76 gpm/rcp
300 gpm/rcp
480 gpm/rcp
PORV-B
OPR-02H
DGR-02H
OPR-03H
DGR-03H
OPR-01H
DGR-01H
1 OK
2 OK
3 T SBO-4 25-hour-Tcu
4 T SBO-1
5 OK
6 CD 4-hour-Tcu
7 T SBO-1
8 OK
9 T SBO-4 9-hour-Tcu
10 T SBO-1
11 OK
12 CD 2-hour-Tcu
13 T SBO-2
14 OK
15 T SBO-4 15-hour-Tcu
16 T SBO-2
17 OK
18 CD 3-hour-Tcu
19 T SBO-2
20 OK
21 CD 3-hour-Tcu
22 T SBO-2
23 OK
24 T SBO-4 7-hour-Tcu
25 T SBO-2
26 OK
27 CD 2-hour-Tcu
28 T SBO-2
29 OK
30 CD 2-hour-Tcu
31 T SBO-2
32 OK
33 T SBO-4 6-hour-Tcu
34 T SBO-2
35 OK
36 CD 2-hour-Tcu
37 T SBO-2
38 OK
39 CD 2-hour-Tcu
40 T SBO-2
41 OK
42 CD 30-min-Tcu
43 T SBO-3
44 OK
45 CD 30-min-Tcu
SBO - SURRY 1 & 2 STATION BLACKOUT
2008/11/09

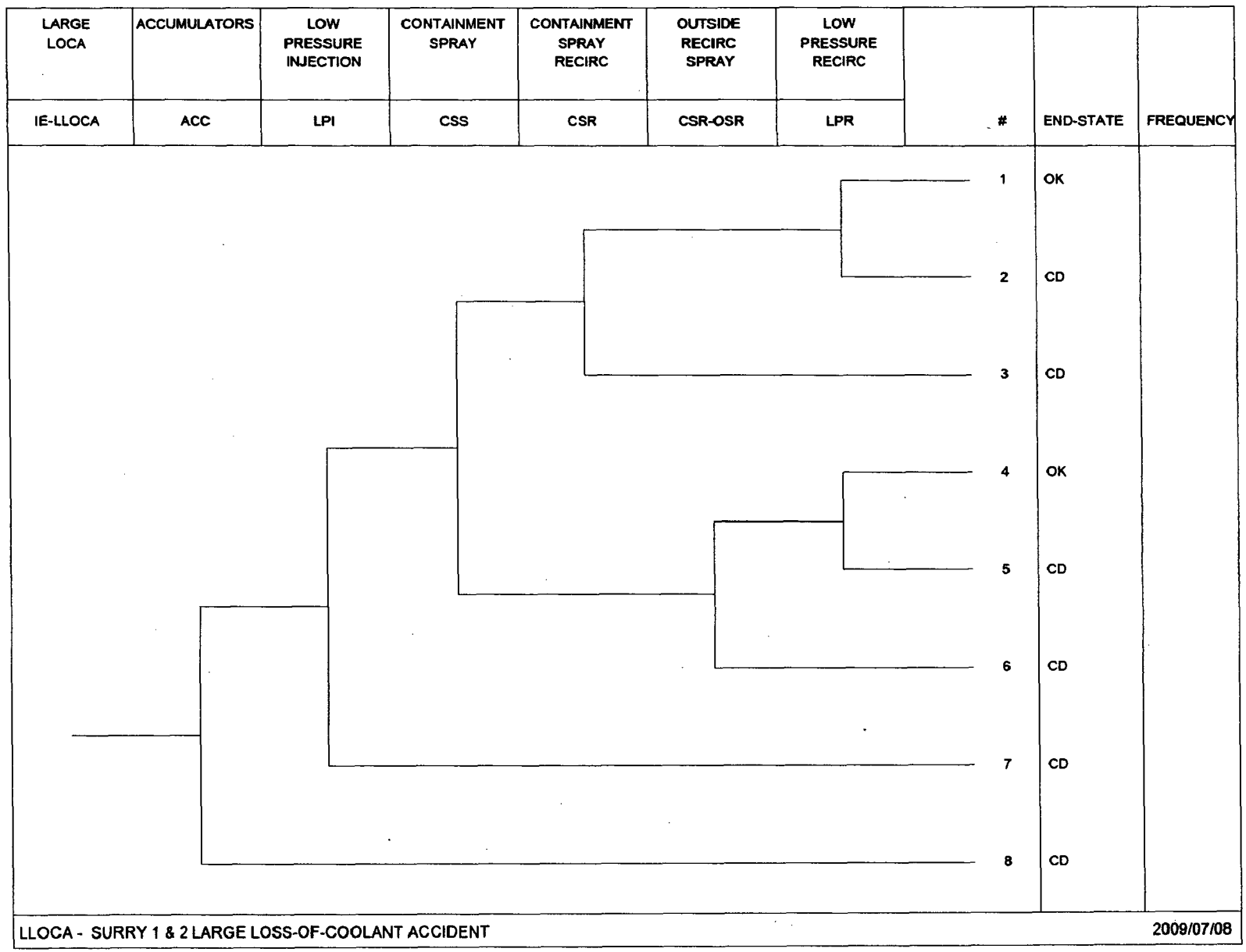
POWER RECOVERY FAILED	MANUAL CONTROL AFW	CONDENSATE STORAGE TANK REFILL LONG-TERM	DEPRESSURIZE SGs	LATE POWER RECOVERY			
OPR	AFW-MAN	CST-REFILL-LT	SG-DEP-LT	PWR-REC	#	END-STATE	FREQUENCY



#	END-STATE
1	OK
2	CD
3	OK
4	CD
5	OK
6	OK
7	CD
8	OK
9	CD
10	CD

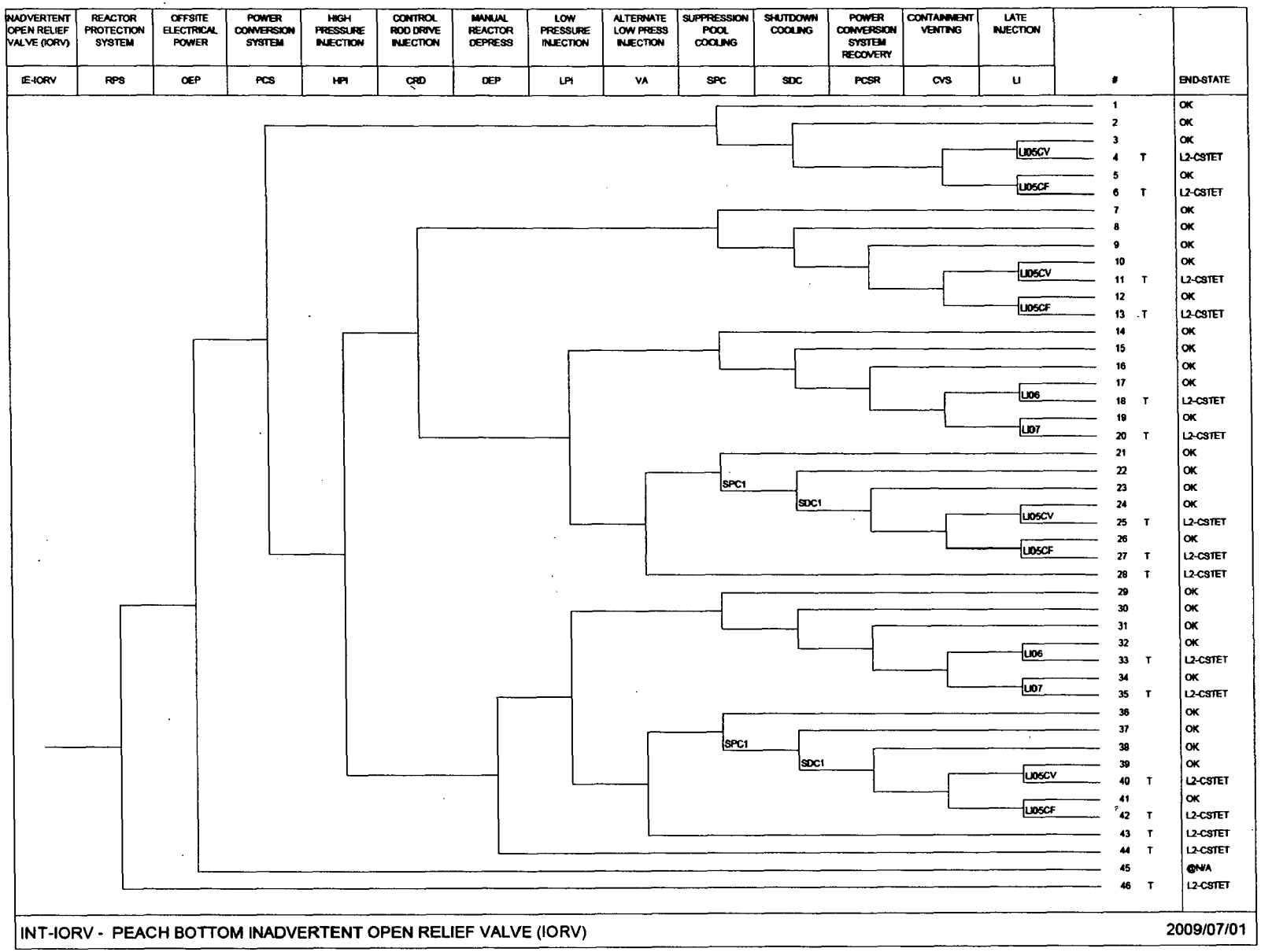
SBO-4 - SURRY 1 & 2 STATION BLACKOUT - CONTINUED 2008/12/19

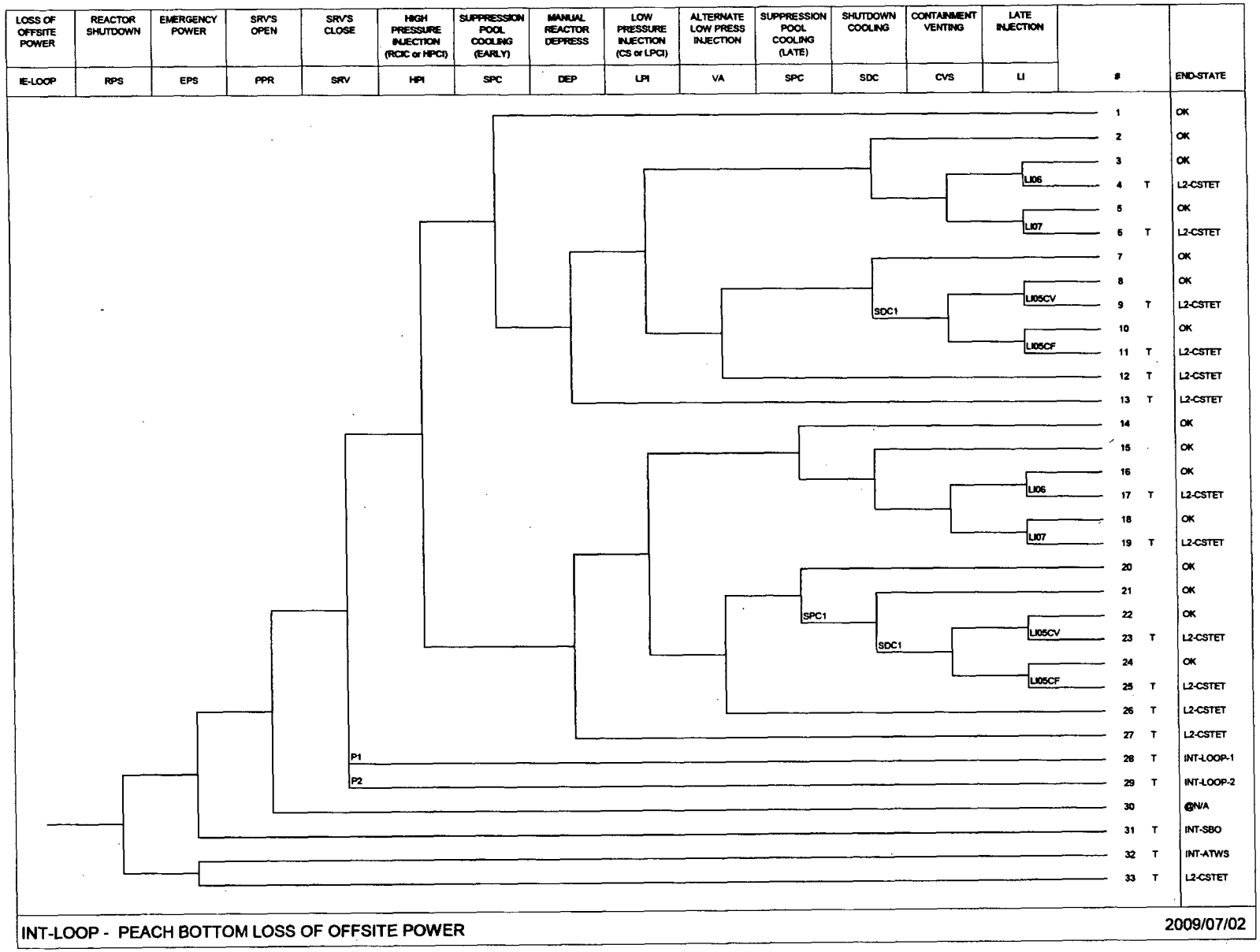

MEDIUM LOCA
REACTOR PROTECTION SYSTEM
HIGH PRESSURE INJECTION
ACCUMULATOR 3-OF-3
AUXILIARY FEEDWATER SYSTEM
SECONDARY SIDE COOLDOWN (POST-LOCA)
LOW PRESSURE INJECTION
HIGH PRESSURE RECIRC
LOW PRESSURE RECIRC
CONTAINMENT SPRAY RECIRC
IE-MLOCA
RPS
HPI
ACC
AFW
SSC1
LPI
HPR
LPR
CSR
#
STATE
NOTES
1 OK
2 CD
3 CD
4 OK
5 CD
6 CD
7 OK
8 CD
9 CD
10 OK
11 CD
12 CD
13 CD
14 CD
15 CD
16 CD
17 CD
MLOCA - SURRY 1 & 2 MEDIUM LOSS-OF-COOLANT ACCIDENT
2009/07/12

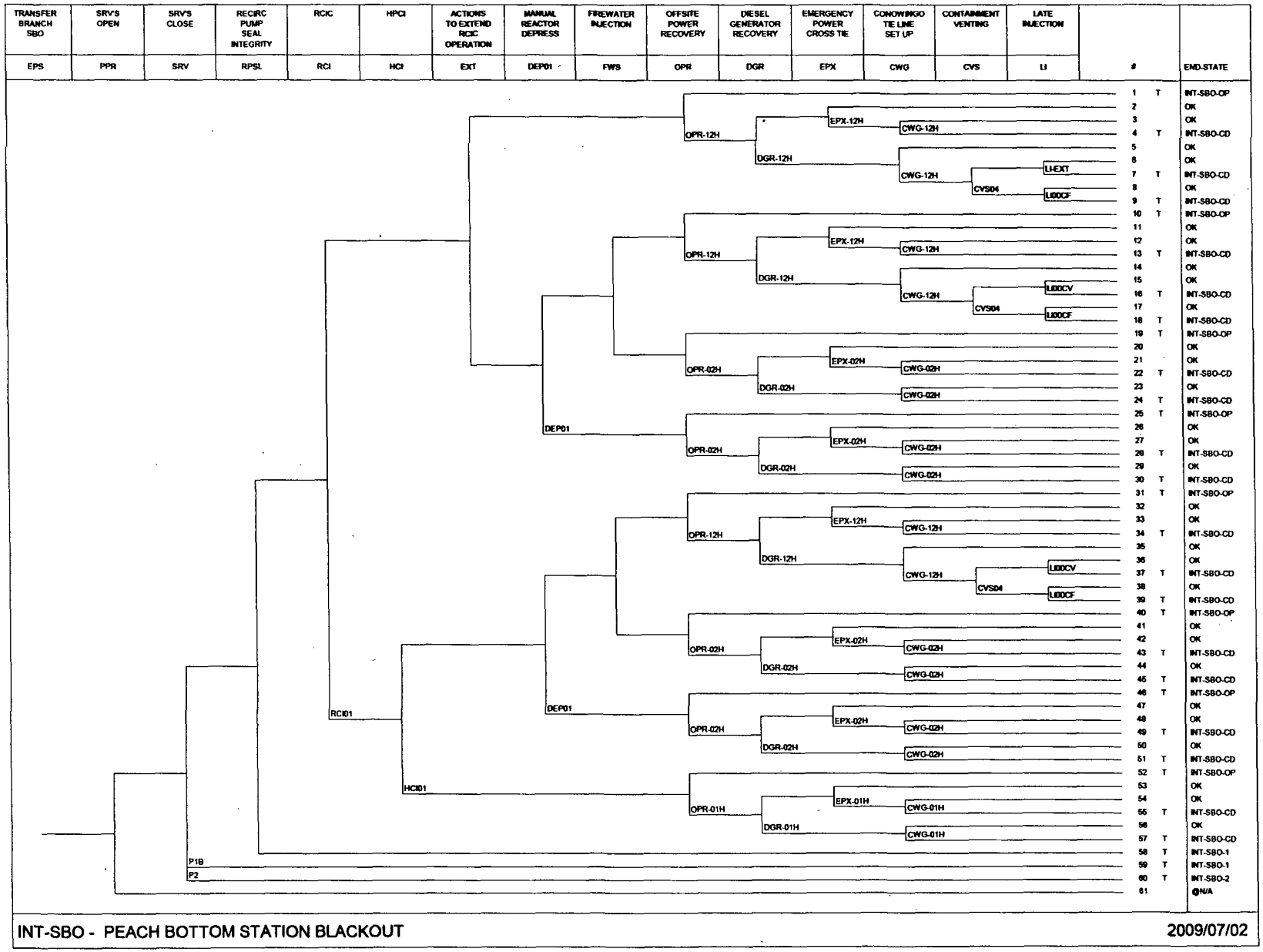

LARGE LOCA
ACCUMULATORS
LOW PRESSURE INJECTION
CONTAINMENT SPRAY
CONTAINMENT SPRAY RECIRC
OUTSIDE RECIRC SPRAY
LOW PRESSURE RECIRC
IE-LLOCA
ACC
LPI
CSS
CSR
CSR-OSR
LPR
#
END-STATE
FREQUENCY
1 OK
2 CD
3 CD
4 OK
5 CD
6 CD
7 CD
8 CD
LLOCA - SURRY 1 & 2 LARGE LOSS-OF-COOLANT ACCIDENT
2009/07/08

C.2 Peach Bottom Event Trees

This section provides the relevant event trees from the Peach Bottom (v3.50) Standardized Plant Analysis Risk model, dated October 2009. These event trees show the sequences described in the main report.

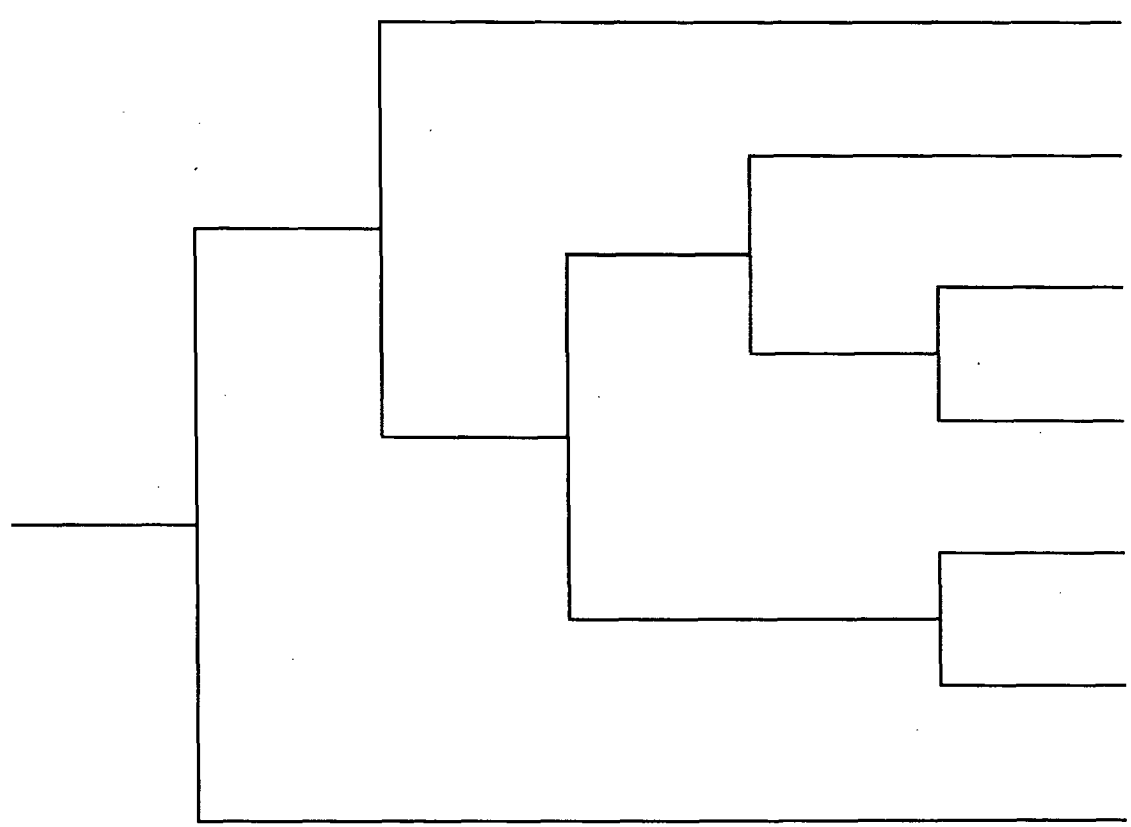

INADVERTENT OPEN RELIEF VALVE (IORV)
REACTOR PROTECTION SYSTEM
OFFSITE ELECTRICAL POWER
POWER CONVERSION SYSTEM
HIGH PRESSURE INJECTION
CONTROL ROD DRIVE INJECTION
MANUAL REACTOR DEPRESS
LOW PRESSURE INJECTION
ALTERNATE LOW PRESS INJECTION
SUPPRESSION POOL COOLING
SHUTDOWN COOLING
POWER CONVERSION SYSTEM RECOVERY
CONTAINMENT VENTING
LATE INJECTION
IE-IORV
RPS
OEP
PCS
HPI
CRD
DEP
LPI
VA
SPC
SDC
PCSR
CVS
LI
#
END-STATE
LI05CV
LI05CF
LI06
LI07
SPC1
SDC1
1 OK
2 OK
3 OK
4 T L2-CSTET
5 OK
6 T L2-CSTET
7 OK
8 OK
9 OK
10 OK
11 T L2-CSTET
12 OK
13 T L2-CSTET
14 OK
15 OK
16 OK
17 OK
18 T L2-CSTET
19 OK
20 T L2-CSTET
21 OK
22 OK
23 OK
24 OK
25 T L2-CSTET
26 OK
27 T L2-CSTET
28 T L2-CSTET
29 OK
30 OK
31 OK
32 OK
33 T L2-CSTET
34 OK
35 T L2-CSTET
36 OK
37 OK
38 OK
39 OK
40 T L2-CSTET
41 OK
42 T L2-CSTET
43 T L2-CSTET
44 T L2-CSTET
45 @N/A
46 T L2-CSTET
INT-IORV - PEACH BOTTOM INADVERTENT OPEN RELIEF VALVE (IORV)
2009/07/01


LOSS OF OFFSITE POWER
REACTOR SHUTDOWN
EMERGENCY POWER
SRV'S OPEN
SRV'S CLOSE
HIGH PRESSURE INJECTION (RCIC or HPCI)
SUPPRESSION POOL COOLING (EARLY)
MANUAL REACTOR DEPRESS
LOW PRESSURE INJECTION (CS or LPCI)
ALTERNATE LOW PRESS INJECTION
SUPPRESSION POOL COOLING (LATE)
SHUTDOWN COOLING
CONTAINMENT VENTING
LATE INJECTION
#
END-STATE
IE-LOOP
RPS
EPS
PPR
SRV
HPI
SPC
DEP
LPI
VA
SPC
SDC
CVS
LI
LI06
LI07
SDC1
LI05CV
LI05CF
SPC1
P1
P2
INT-LOOP - PEACH BOTTOM LOSS OF OFFSITE POWER
2009/07/02



INT-SBO - PEACH BOTTOM STATION BLACKOUT 2009/07/02

ONE STUCK OPEN SRV	HIGH PRESSURE INJECTION	OFFSITE POWER RECOVERY IN 2 HRS	DIESEL GENERATOR RECOVERY IN 2 HRS	EMERGENCY POWER CROSS TIE IN 2 HRS	CONOWINGO TIE LINE SET UP IN 2 HRS	#	END-STATE
P1	HPI	OPR-02H	DGR-02H	EPX-02H	CWG-02H		



#		END-STATE
1		OK
2		OK
3		OK
4	T	INT-SBO-CD
5		OK
6	T	INT-SBO-CD
7	T	INT-SBO-CD

INT-SBO-1 - PEACH BOTTOM ONE STUCK OPEN SAFETY/RELIEF VALVE 2009/07/01

NRC FORM 335
(9-2004)
NRCMD 3.7

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER
(Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-1953

2. TITLE AND SUBTITLE

Confirmatory Thermal-Hydraulic Analysis to Support Specific Success Criteria in the Standardized Plant Analysis Risk Models - Surry and Peach Bottom

Draft Report for Comment

3. DATE REPORT PUBLISHED

MONTH	YEAR
11	2010

4. FIN OR GRANT NUMBER

N/A

5. AUTHOR(S)

H. Esmaili (NRC), D. Helton (NRC), D. Marksberry (NRC), R. Sherry (NRC, retired), P. Appignani (NRC), D. Dube (NRC), M. Tobin (NRC)
R. Buell (Idaho National Laboratory) T. Koonce (Idaho National Laboratory), J. Schroeder (Idaho National Laboratory)

6. TYPE OF REPORT

NUREG

7. PERIOD COVERED *(Inclusive Dates)*

8/1/2008 - 8/30/2010

8. PERFORMING ORGANIZATION - NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

Division of Risk Analysis, Office of Nuclear Regulatory Research, US Nuclear Re gulatory Commission, MS CSB4-A7M, Washington, DC 20555-0001

Idaho National Laboratory, P.O. Box 1625, Idaho Falls, ID 83415

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Same as above

10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

This report describes MELCOR analyses performed to augment the technical basis for supporting or modifying specific success criteria for the Surry and Peach Bottom Standardized Plant Analysis Risk models . First, the report provides a basis for using a core damage surrogate of 2,220 degree Fahrenheit (1,204 degrees Celsius) peak c ladding temperature, based on MELCOR analyses for representative sequences and a consideration of historical core da mage surrogates. Following this are descriptions of the major plant characteristics for the two plants used for thi s analysis (Surry Power Station and Peach Bottom Atomic Power Station) and of the MELCOR models used to represent these plants. Finally, the report presents the results of many MELCOR calculations and translates these results into specific candidate S PAR model upgrades for Surry and Peach Bottom.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

SPAR
Surry
Peach Bottom
MELCOR
success criteria
loss-of-coolant accident
loss of main feedwater
steam generator tube rupture
station blackout
inadvertent open relief valve

13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

(This Page)
unclassified

(This Report)
unclassified

15. NUMBER OF PAGES

16. PRICE