

SCDAP/RELAP5/MOD3

Analysis of High Pressure In-Vessel Melt Progression Using SCDAP/RELAP5/MOD3 Computer Code

, ,

150

SCDAP/RELAP5/MOD3.3 가

가 , surge

가 80-90 %

가 surge 40-60 % 가

Abstract

High-pressure in-vessel melt progressions of a typical PWR (Pressurized Water Reactor) have been analyzed using the SCDAP/RELAP5/MOD3.3 computer code. The total loss of feed waters (LOFW) to steam generators with/without intentional RCS depressurization using the safety depressurization system and the station blackout (SBO) have been estimated from transient initiation to reactor vessel failure. The SCDAP/RELAP5/MOD3.3 results have shown that the pressurizer surge line had failed before reactor vessel failure, which results in a rapid decrease of RCS pressure in the high-pressure sequences of the LOFW and the SBO transients. In all high-pressure transients, approximately 80–90 % of the core material was melted and relocated to the lower plenum of the reactor vessel at the time of reactor vessel failure. The LOFW with intentional RCS depressurization using the safety injection system prevents failure of the pressurizer surge line and results in actuation of the safety injection tanks. At the time of reactor vessel failure, approximately 40-60 % of the fuel rod cladding was oxidized in the LOFW and the SBO transients of the typical PWR.

1.

가 가 가

가 (Direct Containment Heating) (early

containment failure)

가

[1].

2

가

seal

가

(ballooning)

(steam starvation),

eutectic

(late phase melt

progression)

pool

PBF[2], FLHT[3], Phebus[4], CORA[5],

OECD-LOFT[6]

가

SONATA

[7]

OECD/NEA

MASCA

[8]

[9]

가

가

가

가

가

SCDAP/RELAP5/MOD3.3

2.

2

가

가

2

가

INEEL USNRC 2001

SCDAP/RELAP5/MOD3.3 SCDAP/RELAP5

RELAP5/MOD3 [11],

SCDAP/MOD1 [12], (Finite

Element Method) COUPLE [13] 가

가

SCDAP/RELAP5 1988 version MOD0가

가 . 2001 SCDAP/RELAP5/MOD3

FCI(Fuel Coolant Interaction) 가,

pool

SCDAP/RELAP5/MOD3.3 가

가

, 가 ,

3 channel channel

cross flow junction 가 . 3

component 3 component 6 10 node

component 6 , 2

node

COUPLE

가 2

가

가 POSRV(Power Operated

Safety Relief Valve) 2

POSRV vessel, , 가

surge ,

가

가

3.

1 가

SCDAP/RELAP5/MOD3.3

가 surge

가

4,605

가 surge 가

가 surge

가 surge

가 surge

가

가 1

가 POSRV가 10 POSRV

가 surge

가

가

가 surge

가

surge

가 40

1 2

가

SCDAP/

RELAP5/MOD3.3

가

가 POSRV

가

surge

가

가

가

3 4

가

SCDAP /RELAP5/MOD3.3

가

POSRV

가

가

가

가

가

가

가

가 가

5 6

SCDAP/RELAP5/MOD3.3

가 surge

가 surge

SCDAP/RELAP5/MOD3.3

가 1,000 K

가 , 가 1,700 K

2

가

가

가

, surge

가

500-600 kg

가 [13]

800-850

kg 가

9

SCDAP/RELAP5/MOD3.3

가

10

가

surge

SCDAP/RELAP5/

MOD3.3

가

가

4,605

11

pool

2

154

80-90 %가

가

13

vessel

creep

4.

SCDAP/RELAP5/MOD3.3

가

가

가

surge

, 80-90 %

가

. 가

surge

40

가

POSRV

가

가

surge

가

가

40-60 %가

30-40 %

1. , “ 1 , 1 , ” , '90 , 1990 5 25
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1. 가

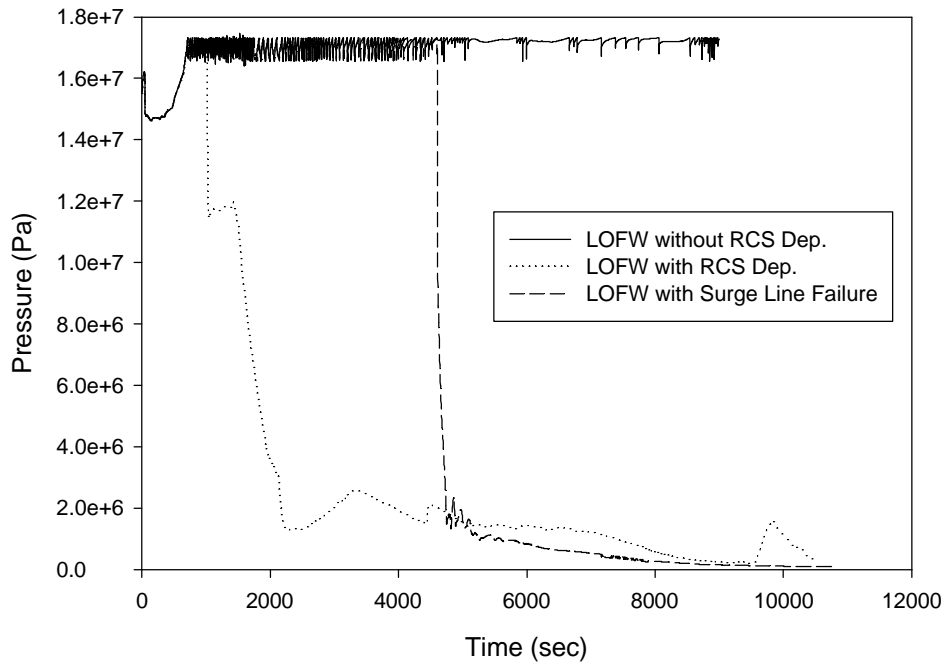
SCDAP/RELAP5/MOD3

Events	Total LOFW			SBO	
	Without RCS Dep		With RCS Dep.	Without Surge Line Failure	With Surge Line Failure
	Without Surge Line Failure	With Surge Line Failure			
Transient Initiation	0	0	0	0	0
Core Uncovery	2568	3568	1672	5574	5574
Cladding Failure	3187	3187	1891	6410	6410
SIT Actuation	-	4730	1924	-	8304
Core Melting	3856	3856	7942	7073	7073
Prez. Surge Line Failure	(4,605)	4,605	-	(8180)	8180
Initial Relocation to the Lower Plenum	7685	10,378	8958	11899	14267
Reactor Vessel Failure	9109	N/A	10305	13242	15500

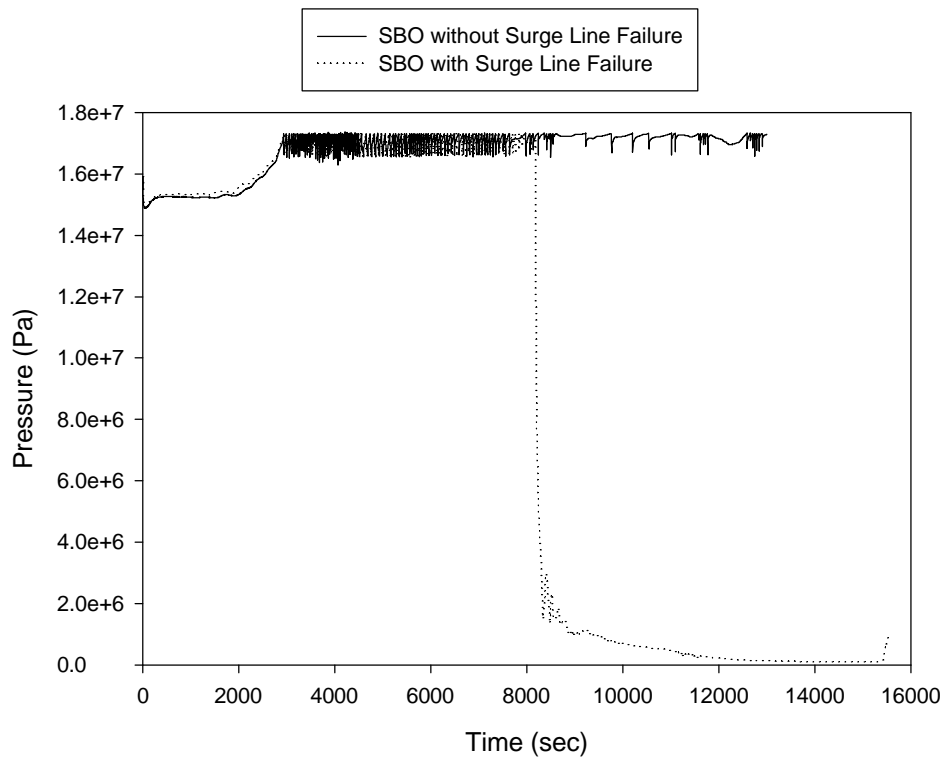
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SCDAP/RELAP5/MOD3

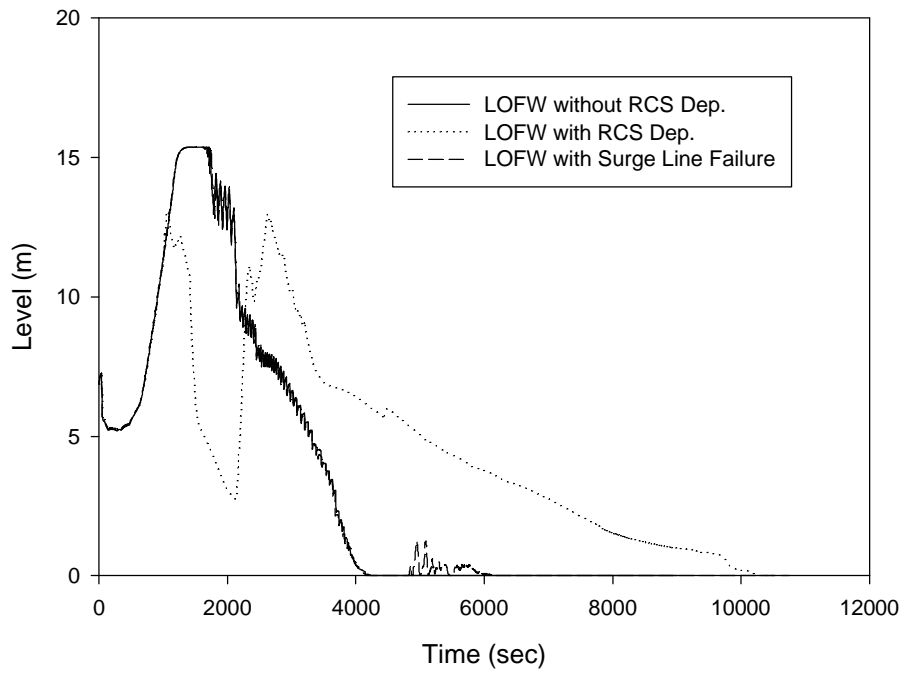
	Total LOFW			SBO	
	Without RCS Dep		With RCS Dep.	Without Surge Line Failure	With Surge Line Failure
	Without Surge Line Failure	With Surge Line Failure			
Clad. Oxidation Rate (%)	54.8	55.5	38.5	56.0	56.1
Hydrogen Gene. Mass (kg)	818	829	575	836	838
Total Relocated Corium Mass in the Lower Plenum (ton)	145.7	N/A	120.2	142.9	134.8



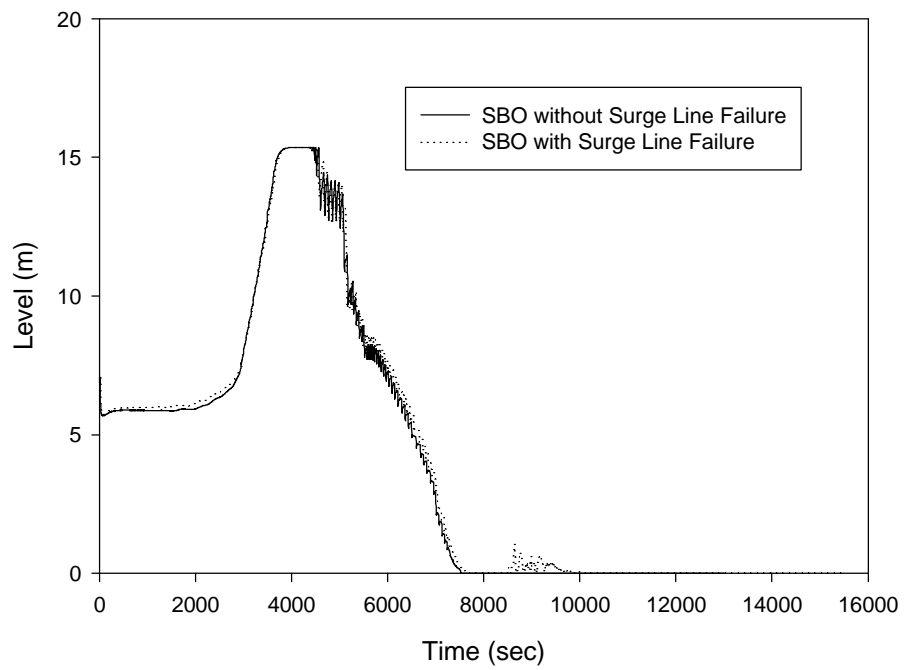
1. 가 SCDAP/RELAP5



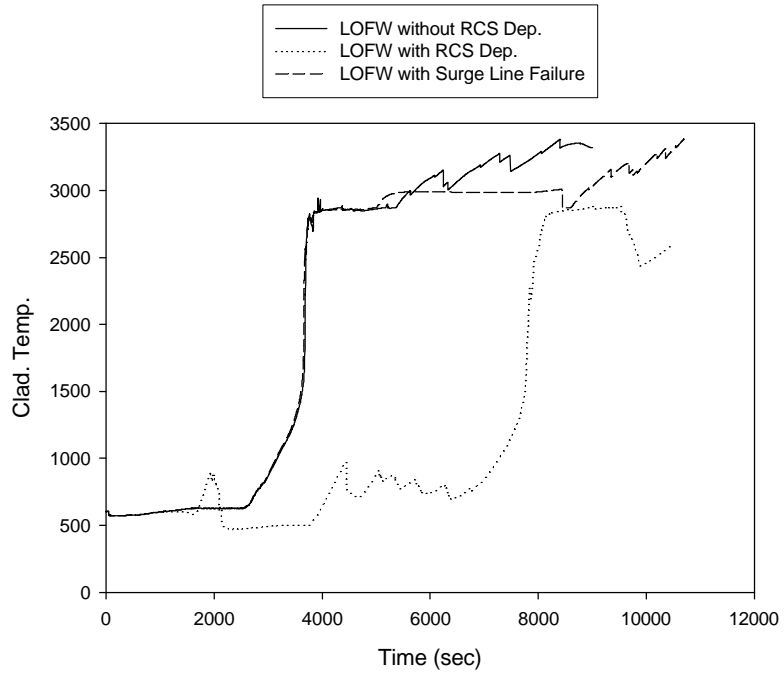
2. 가 SCDAP/RELAP5



3. 가 SCDAP/RELAP5

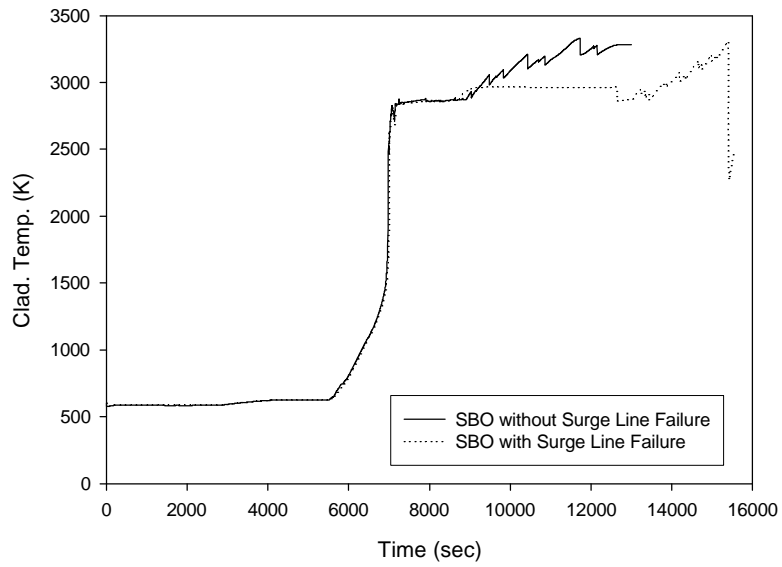


4. 가 SCDAP/RELAP5



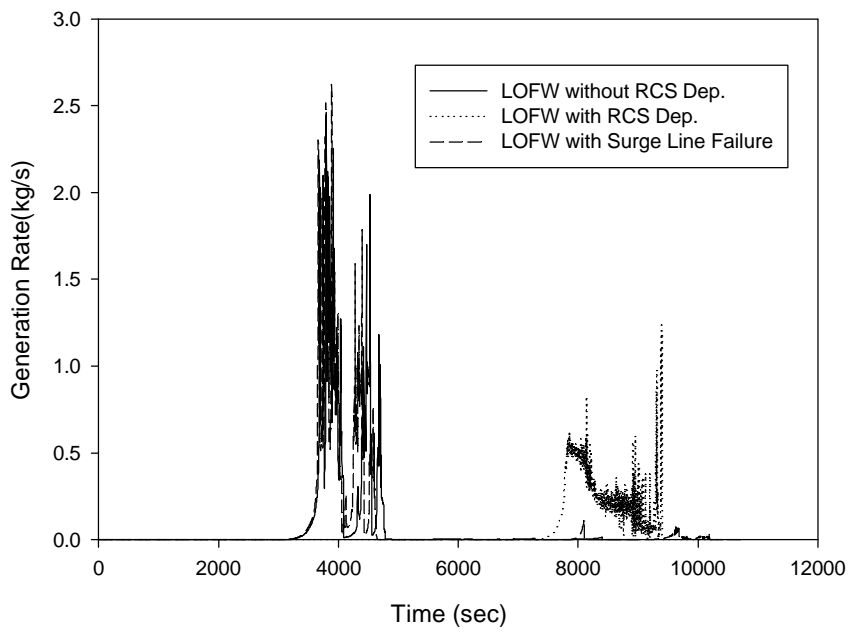
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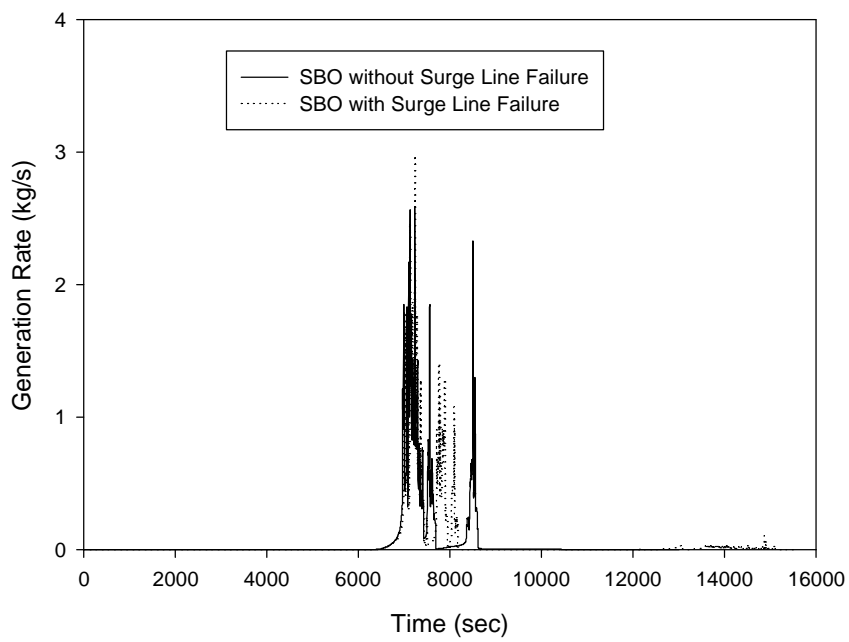
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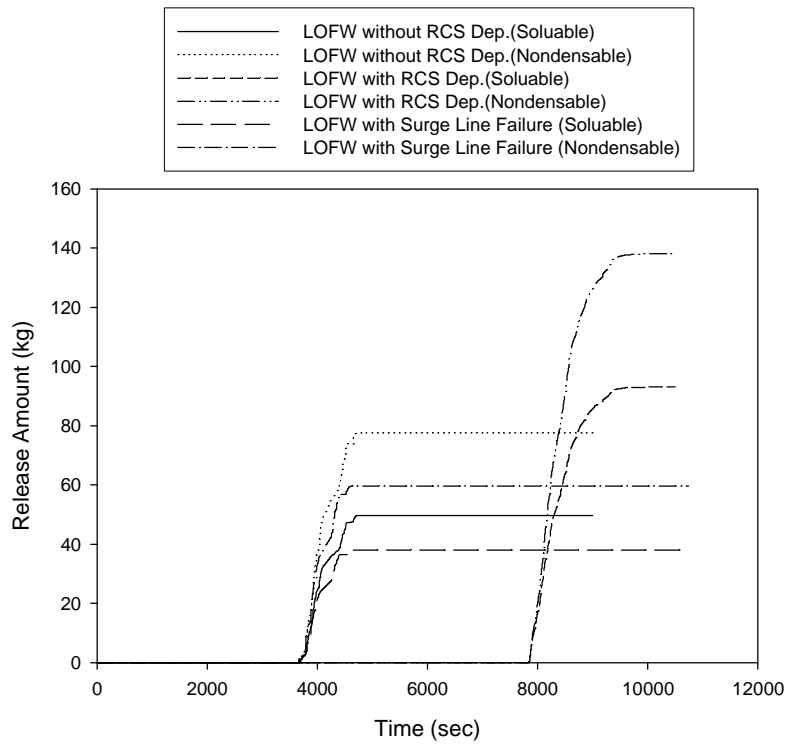
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SCDAP/RELAP5



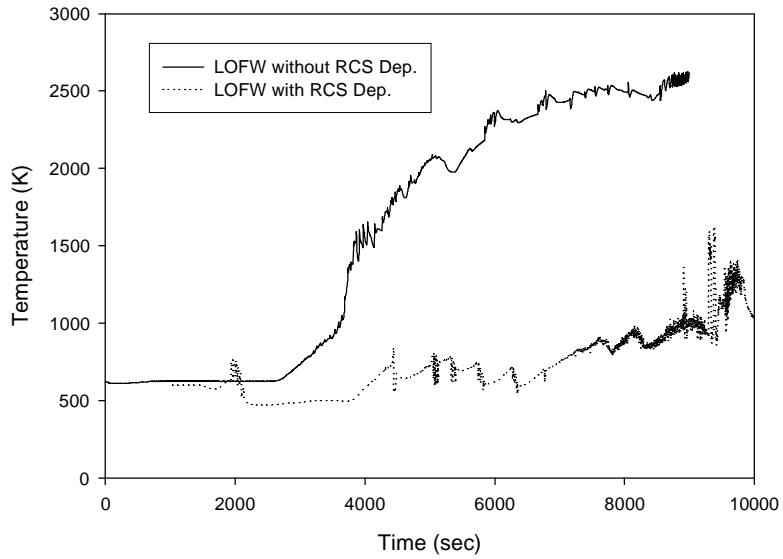
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SCDAP/RELAP5



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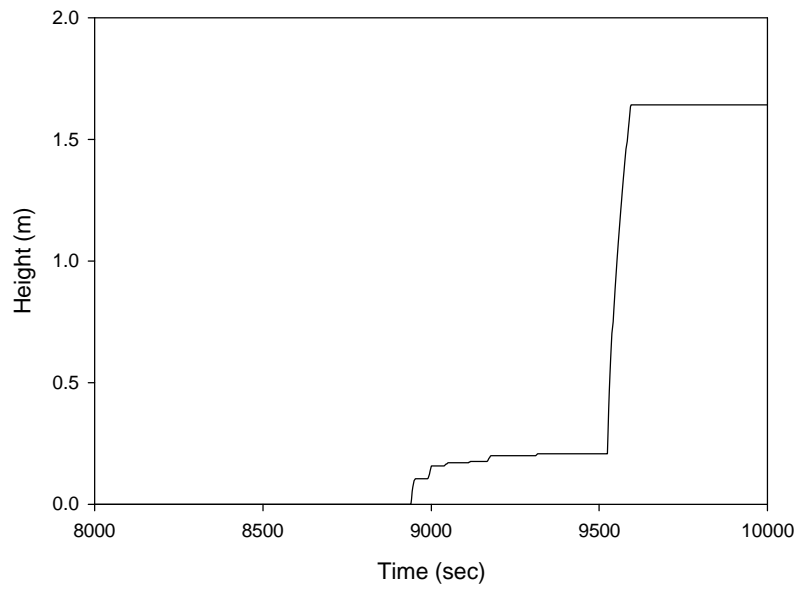
SCDAP/RELAP5



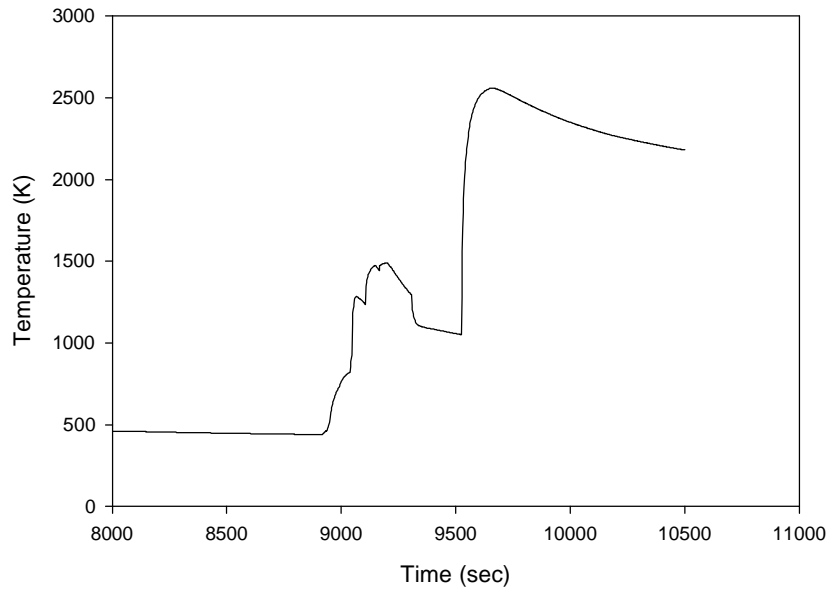
10.

가 surge

SCDAP/RELAP5



11. SCDAP/RELAP5 ()



13. SCDAP/RELAP5 ()