

- **LBLOCA** **DVI**
MARS 가

Assessment of MARS 2.0 for Direct DVI Bypass during LBLOCA Reflood
using KAERI Air-Water DVI Tests

, , ,

150

MARS 가 , 1/50 -
(DVI: Direct Vessel Injection) 가 . 가
, DVI 1.0 ~ 1.6 m/sec 20 ~ 35 m/sec,
DVI . , 1/50
DVI 가 , DVI
가 . 가 ,
DVI MARS .

Abstract

MARS code has been assessed for the direct ECC (Emergency Core Cooling) bypass that occurs during LBLOCA reflood of KNGR (Korean Next Generation Reactor) using the KAERI air-water DVI (Direct Vessel Injection) tests that are 1/50 scale-down tests simulating the LBLOCA reflood of KNGR. Assessment matrix is selected for the single and double DVI configurations with typical LBLOCA reflood conditions, that is, DVI injection velocity of 1.0 ~ 1.6 m/sec and air injection velocity of 20 ~ 35 m/sec. First, the MARS calculation is adjusted to match the DVI film distribution with the 1/50 scale test results, then the code assessments are carried out for the selected direct DVI bypass tests using the adjusted DVI film distribution. From the assessments, it has been found that the MARS is capable of predicting the direct DVI bypass phenomena as well as the multi-dimensional thermal hydraulics in the downcomer.

1.

3893 MWt 2x4 가 ,
 (DVI) [1]. DVI
 (HPSI: High Pressure Safety Injection) (SIT: Safety Injection
 Tank) 4 Train
 (2.1m) , , DVI
 , DVI
 가 [2].
 (Direct Bypass) Sweep-out DVI
 가 가 .
 , DVI UPTF[3] . UPTF
 DVI 4 Babcock & Wilcox 가 , DVI
 0.35 m 2 . UPTF DVI
 1) DVI , DVI
 2) DVI 가 .
 가 0.75 ~ 1.2 m DVI
 Sweep-out .
 DVI UPTF DVI UPTF
 . , UPTF
 DVI DVI
 가 DVI DVI
 UPTF , DVI
 -
 , DVI 가
 (Steam Jet Impingement)

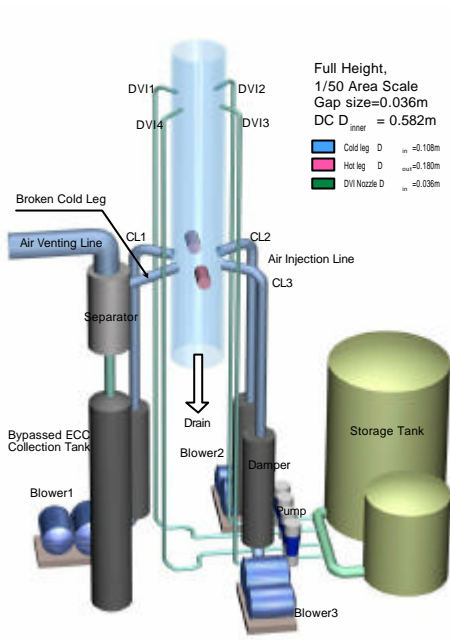
가 DVI , , DVI
Sweep-out DVI
. DVI
[2].
, DVI 가
(Reflood Head) , [4].
가
, [2].
MARS[5] USNRC TRAC-PF1[6] 가
, DVI 가가
가 . ,
. 1/24.3 - DVI [7]
, 1/50 - DVI [8]
. - DVI MARS
가 DVI MARS
가 . 가 , DVI 1.0 ~ 1.6
m/sec 20 ~ 35 m/sec, DVI . , 1/50
가 DVI MARS 가 .
가
DVI MARS .

2. - DVI

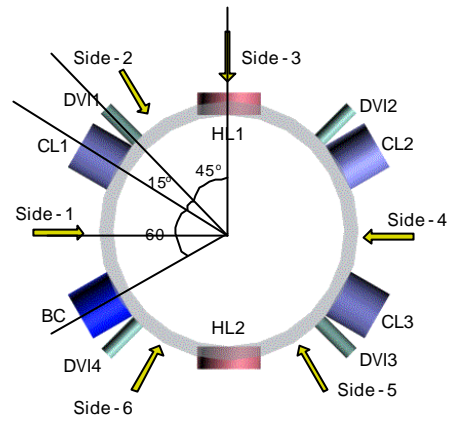
2.1

DVI
- DVI [8].
- 1 , 1/50 1/7.1
DVI .
, DVI
DVI DVI ,
DVI Sweep-out . ,
가 가 .
DVI , , , DVI

DVI , DVI
 DVI
 Sweep-out DVI
 Drain



Parameter	
	1/50
	1/1
(m)	0.582
(m)	0.654
(m)	0.036
(m)	0.108
(m)	0.160
DVI (m)	0.031



1. - DVI [8]

2.2 가 Matrix

MARS 가가 , - DVI
 DVI 가
 Matrix

가 Matrix 1 , DVI-2 DVI-4 DVI-2/4

20 ~ 35 m/sec DVI 1.0 ~1.6 m/sec ,
 KVxxVyyFzz , xx DVI yy
 (m/sec) zz DVI (lpm)

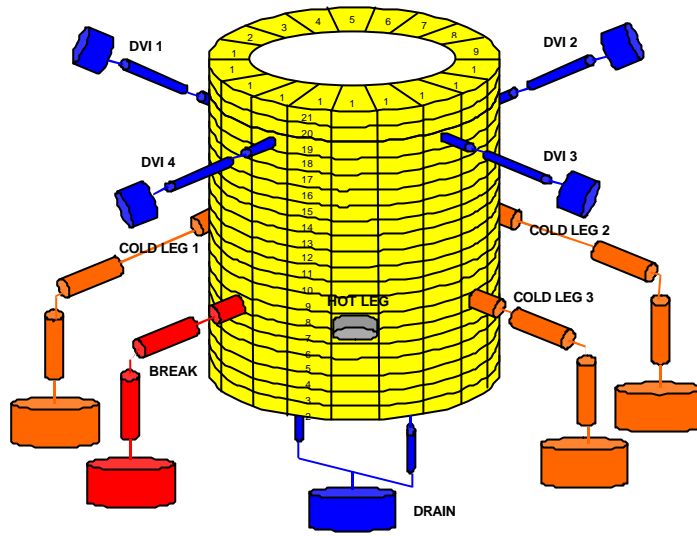
1. 가 Matrix

ID	DVI			AIR-1	AIR-2	AIR -3	(bar)	(K)	VOID HEIGHT (m)
	DVI-2 (m/s)	DVI-4 (m/s)	DVI (K)						
KV2V30F44	1.06	0.	281.41	15.44	15.39	15.35	1.2132	302.53	0.8172
KV2V31F44	1.05	0.	281.38	16.37	16.19	16.23	1.2758	303.6	0.8177
KV2V33F44	1.03	0.	281.31	17.37	17.38	17.16	1.3673	306.61	0.8183
KV2V35F44	1.0	0.	281.42	18.08	18.25	17.65	1.5161	321.57	0.8177
KV2V22F70	1.62	0.	284.91	11.44	11.32	11.40	1.1297	299.42	0.8590
KV2V24F70	1.61	0.	284.89	12.43	12.49	12.39	1.1719	298.30	0.8598
KV2V26F70	1.61	0.	286.10	13.20	13.01	13.22	1.2312	302.58	0.8594
KV2V27F70	1.63	0.	285.99	14.14	14.01	14.17	1.2683	303.24	0.8588
KV2V29F70	1.62	0.	284.87	15.16	14.89	15.08	1.3022	306.72	0.8587
KV2V32F70	1.61	0.	284.96	16.80	16.70	16.84	1.4944	316.05	0.8580
KV4V22F44	0.	1.02	280.94	11.23	11.23	11.18	1.1870	292.88	0.8172
KV4V26F44	0.	1.02	280.79	13.54	13.47	13.51	1.2902	300.28	0.8173
KV4V21F70	0.	1.60	285.79	11.08	11.12	10.96	1.2685	299.09	0.8565
KV4V26F70	0.	1.59	285.26	13.65	13.35	13.67	1.3812	306.85	0.8586
KV24V22F44	1.01	1.0	281.66	11.73	11.66	11.52	1.2176	295.76	0.8181
KV24V25F44	1.01	1.0	281.66	13.13	13.19	13.07	1.3021	301.96	0.8173
KV24V27F44	1.01	1.0	280.36	14.34	14.26	14.32	1.3944	305.03	0.8176
KV24V30F44	1.01	1.0	280.67	15.40	15.96	15.74	1.6327	325.75	0.8184
KV24V20F70	1.60	1.60	285.11	10.49	10.51	10.38	1.2197	299.12	0.8584
KV24V22F70	1.60	1.60	285.58	11.58	11.54	11.35	1.3170	304.21	0.8607
KV24V24F70	1.61	1.59	285.58	12.58	12.50	12.60	1.3833	311.90	0.8587
KV24V25F70	1.59	1.58	287.09	13.40	13.37	13.26	1.5225	323.11	0.8594

3. MARS 가

3.1 MARS

MARS(Multi-dimensional and Multi-purpose Analysis of Reactor Safety)
 , USNRC RELAP5[9] COBRA-TF[10] 1 3 ,
 Restructuring
 MARS 2.0 3
 MASTER[11] - CONTEMPT4[12]
 , 3
 GUI(Graphic User Interface)
 MARS 가 14 가/ 가
 MARS 가



2. KAERI

MARS Nodalization

4. MARS 가

4.1 DVI

1/50

, DVI

. DVI

DVI

, MARS 가

, DVI-2/4

DVI

가

가 , MARS

1/50

DVI

가

MARS 가

DVI

가

, MARS

MARS

가

가

DVI

DVI

가 DVI

MARS

DVI

가

가

DVI

DVI

DVI

가

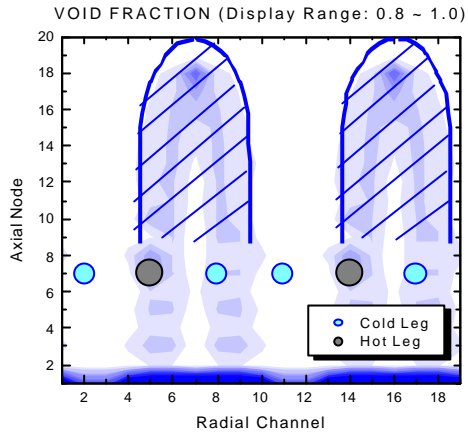
3

MARS

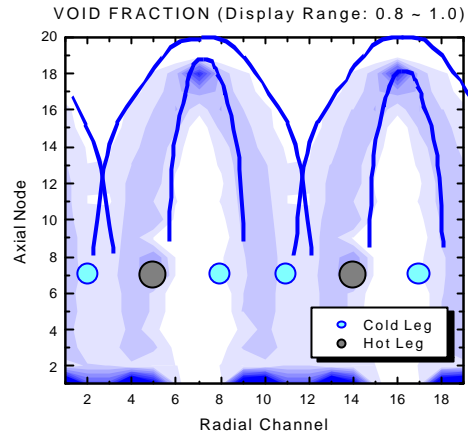
가

, MARS

Node



a) DVI Velocity = 1.0 m/sec



b) DVI Velocity = 1.6 m/sec

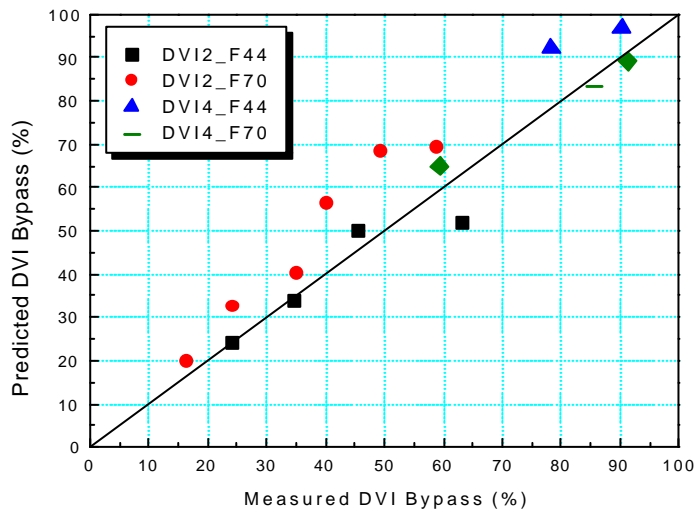
3. DVI

4.2 DVI

DVI 가 , DVI-2 DVI-4
DVI DVI 가 가 Matrix 2.2
, DVI 가 4

lpm DVI MARS DVI -17.8 ~ 10.1 %
, 35 m/sec
(-17.8 %) 4.1

MARS 가



4. DVI-2 DVI-4 MARS 가

40.2 % DVI 70 lpm MARS DVI 14.7 ~ ,

MARS 70 lpm DVI , 4.1 , MARS

32 m/sec 44 lpm

가 ,

가 ,

MARS 가 .

DVI-4 , DVI 70 lpm

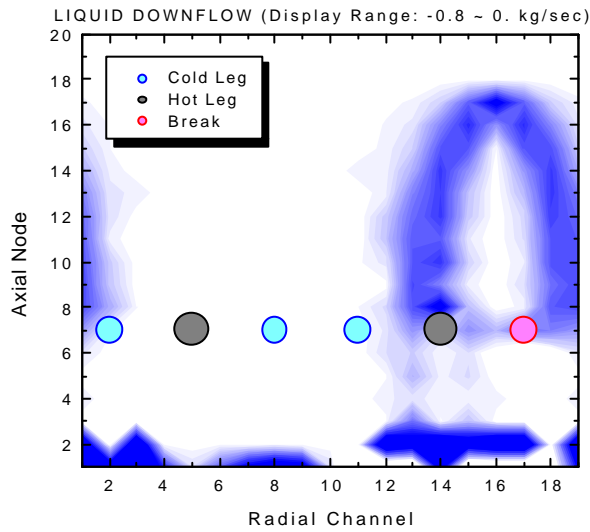
DVI MARS DVI -2.7 ~ 17.6 %

Penetration) 가 , 5 (ECC

가 , 4 , 44 lpm DVI

가 DVI

가 .



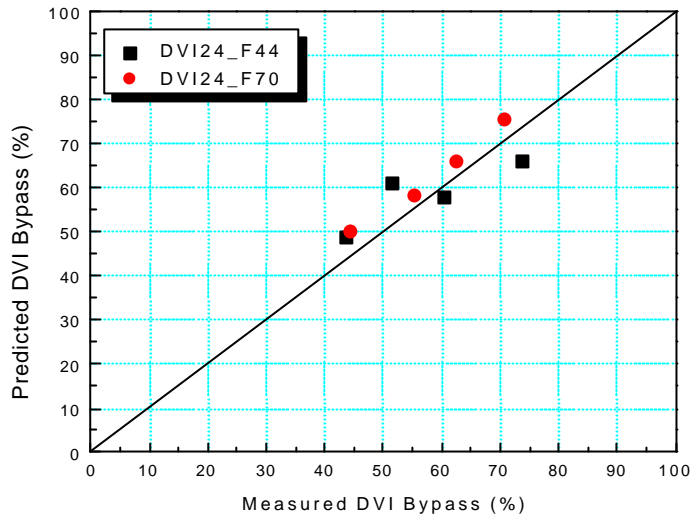
5. (KV4V21F70)

4.2 DVI

DVI 가 , DVI-2/4 DVI

DVI 가 Matrix 2.2

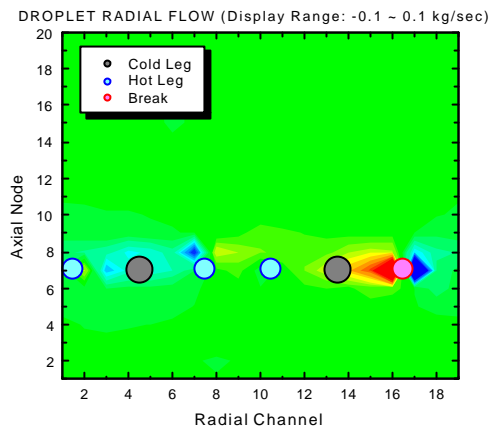
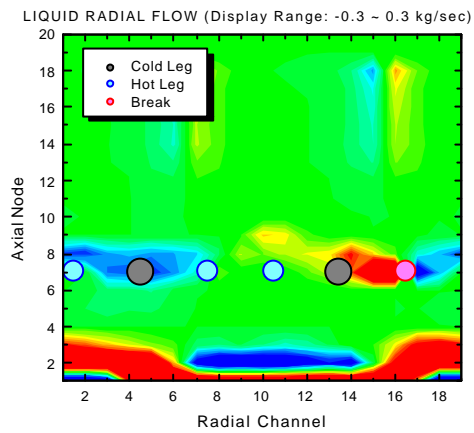
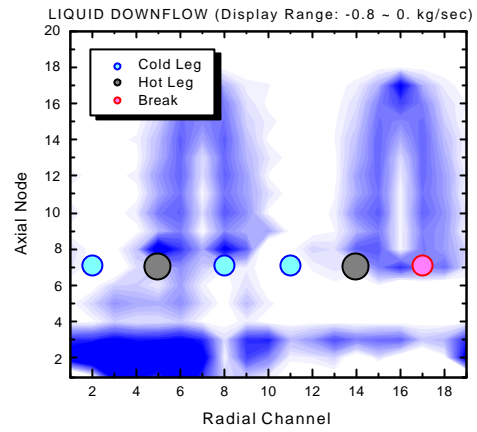
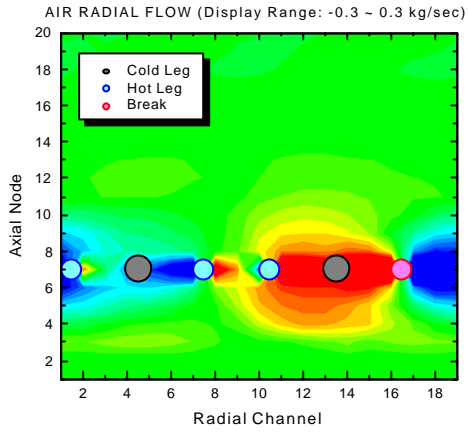
, MARS 가 6 .



6. DVI-2/4

MARS 가

가 , MARS -10.6 ~ 18.6 % DVI
 . 44 lpm DVI , DVI 가
 , DVI-4
 , DVI-2
 가 . 70 lpm DVI , MARS DVI 가
 , DVI 가
 DVI-2 .
 MARS 가 ,
 KV2V35F44 가 2 . 7
 , 가 ,
 ,
 DVI-2 ,
 - (Steam Jet Impingement)
 , DVI-2
 , DVI-2
 (ECC Penetration) ,
 . DVI-2 -2 -3
 , DVI-4
 , DVI-2 가



7. 가 (KV2V35F44)

, 가 MARS , DVI

5.

DVI MARS

가 , 1/50 - DVI

가 MARS 가 DVI

DVI , DVI

가 , MARS , DVI

- (Steam Jet Impingement) , 가

- MARS DVI

, UPTF DVI 가 - - DVI

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