

Development of Risk-Informed System Design Methodology for Future Nuclear Power Plants

, , , , ,

360-9

가 . LOCA NUREG/CR-5750 가 .

MARS 2.1 .

가 50% 가 .
가 가 가 가

Abstract

The purpose of this analysis is to develop the risk assessment evaluation process that can reduce the conservatism involved in the LOCA quantification. The frequency estimation for LOCA was performed according to NUREG/CR-5750. The raw data for LOCA events described in NUREG/CR-5750 was applied to this project. Lots of thermal hydraulic analyses for various break sizes were performed to find the boundary conditions that can effect the success criteria of event mitigation. The MARS 2.1 code, best-estimated computer code, was used in this analysis. The analysis result shows that conservatism in the LOCA quantification can be reduced when the detailed LOCA breakdown supported thermal hydraulic analysis is performed in the PSA model. The CDF for new re-classified LOCA events was reduced about 50% of current model's. Concurrent with the LOCA re-classification, the operator's available time for the feed and bleed operation using Safety Depressurization System (SDS) valves during small LOCA and its contribution to CDF were considered. Its results did not have an effect of CDF reduction, but it is believed that the iterative approach and findings are very useful.

1.

40

가

35 40%

가

가

Nuclear Energy Research Initiatives(NERI)

가

NERI

Westinghouse 가

“

”(Risk-Informed Assessment of Regulatory and

Design Requirements for Future Nuclear Power Plant)

2

, 1

[1]

, 2

가

LOCA

가

2

LOCA

가

2.

가

가

PSA (Probabilistic Safety Assessment)

(LOCA)

, , LOCA

LOCA

가

가

○

○

PSA

가

○

가

○

/

○

가

○

LOCA

가 LOCA

가

가

(feed & bleed)

가 ,

가

1

System80+

가 .

1 .

가. 가

(1) 1 NERI 가

PSA ,

○ LOCA :

○ LOCA : , 1

가 가

○ LOCA : 가

가

NERI 1 LOCA NUREG/CR-5750 [2]

1 .

1 .

KNGR/System80+ RELAP5/MOD3 [3]

System80+ [4] ,

1 1

가

1 .

(2) 가

2 ,

가

(가) 가

가 . 1 2

MARS 2.1 [5] . MARS 2.1

RELAP5/MOD3
MARS2. input deck .
2 .

()
PSA
가 .
, 3 가 가
7 가
가 . 가
NUREG/CR-5750 가 . 10
가 가 . , Chi-square
가 가 . 가 2

() 가 ,
가 .
가 3
7 가 .
, 가
2 .

(3)
3 . 3
LOCA LOCA 1.73E-7/
가 . 가 LOCA1 LOCA6
8.47E-8/
49% .
1 가 LOCA LOCA 5.0E-8/y, 3.6E-
6/y 가 LOCA1 ~ LOCA5
6.77E-7/y 5 가 3.39E-6/y .
가 LOCA 가 1

가 38% , 가 LOCA6 (3.0E-5/y)

가 LOCA6 (3.0E-5/y)
 LOCA LOCA7 가 LOCA
 LOCA7 가 가

가 NERI 1
 2 ,
 1 NERI PSA

(1)

0.02ft² (가
 APR1400) 0.03ft²(NERI 1 , System 80+) 가
 LOCA 가
 가 ,
 가 NERI 2 LOCA
 가 가
 (Peak Cladding Temperature : PCT)가 2200°F 가 가
 0.001ft² 가
 PCT 가 2200°F 0.007ft² PCT 가 2200°F
 0.008ft² 가
 20,000 PCT 가 2200°F 가 0.01ft²
 가 13,180 1
 2
 0.007ft² 0.008ft²
 , 0.008ft² 가
 LOCA 2

59.6%, 89.1%

3.

가
LOCA
가
LOCA
LOCA
LOCA1
1.73E-7/
LOCA6
가
8.47E-8/
49%
가
가
ASME PRA Standard
가
LOCA
가
LOCA
LOCA
LOCA
LOCA
LOCA
LOCA
가

1. , “ ”, 2001 ,
 , 2001.10.
2. Rates of Initiating Events at U.S. Nuclear Power Plants : 1987 - 1995, NUREG/CR-5750, USNRC, February, 1999.
3. NUREG/CR-5535, “RELAP5/MOD3 Code Manual (Draft),” June 1990.
4. CESSAR Design Certification Chapter 19, Combustion Engineering, 1993.
5. MARS 2.1 Code Manual, KAERI, Feb 2002.

1.

			ECC		
LOCA	5.0E-8/y	-	-	-	5.00E-8/y
LOCA	3.6E-6/y	1/2	2/2 3/4 DVIs		9.69E-8/y
LOCA	3.0E-5/y		1/2 3/4 DVIs		2.60E-8/y
LOCA	5.0E-4/y		1/2 1/4 DVIs	1	8.90E-8/y

2.

LOCA						
			SIT	ECC		
LOCA 1	23 in – 30 in	6.77E-7/y	2/2	2/2		1.82E-08/y
LOCA 2	22 in – 23 in	6.77E-7/y	2/2	1/2		1.15E-09/y
LOCA 3	18 in – 22 in	6.77E-7/y	1/2	2/2		1.77E-08/y
LOCA 4	16 in – 18 in	6.77E-7/y	1/2	1/2		6.32E-10/y
LOCA 5	10 in – 16 in	6.77E-7/y	0/2	2/2		1.76E-08/y
LOCA 6	1.2 in – 10 in	3.4E-5/y	0/2	1/2		2.94E-08/y
LOCA 7	1.2 in	5.0E-4/y	0/2	1/2		가

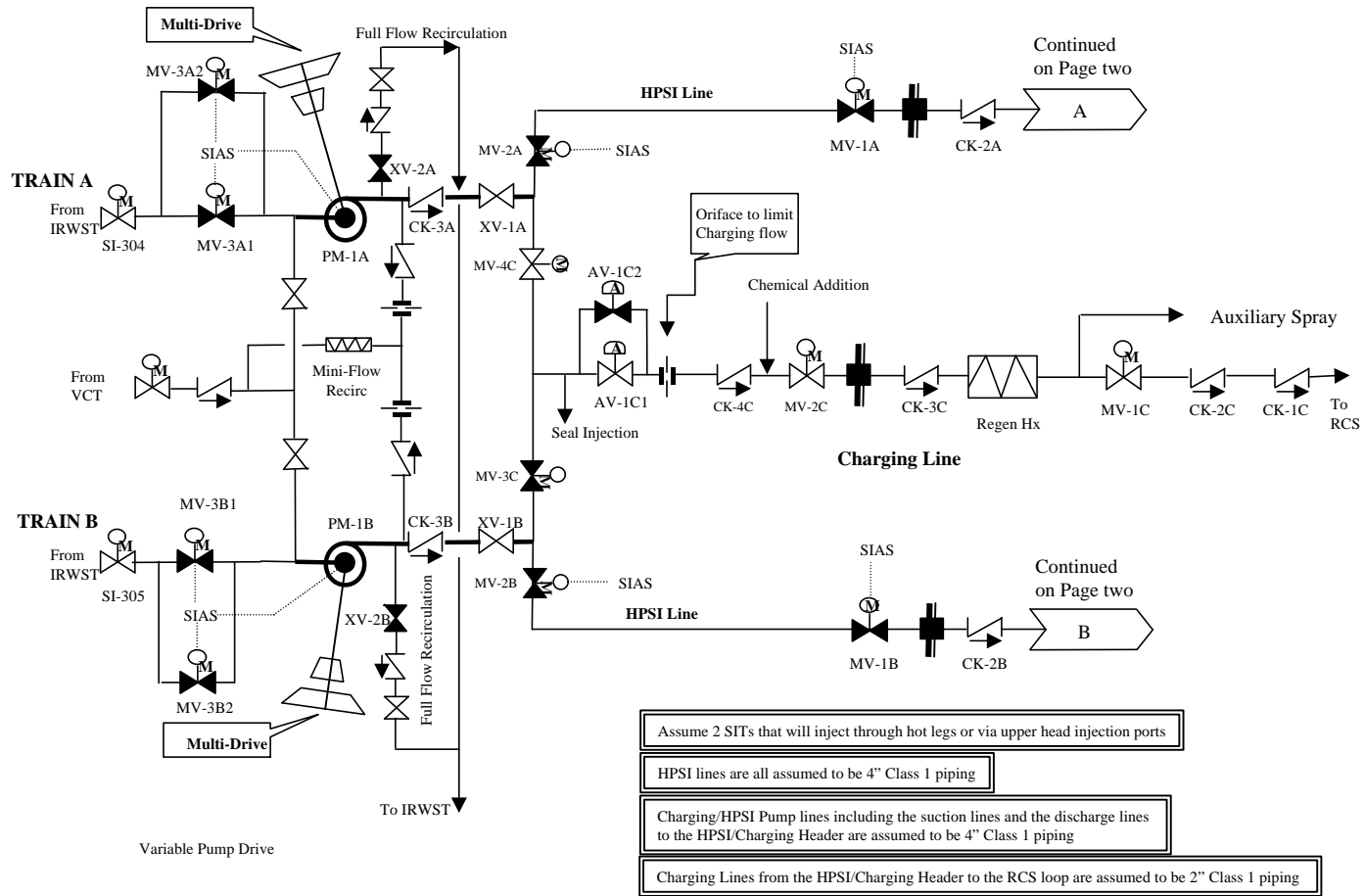
3.

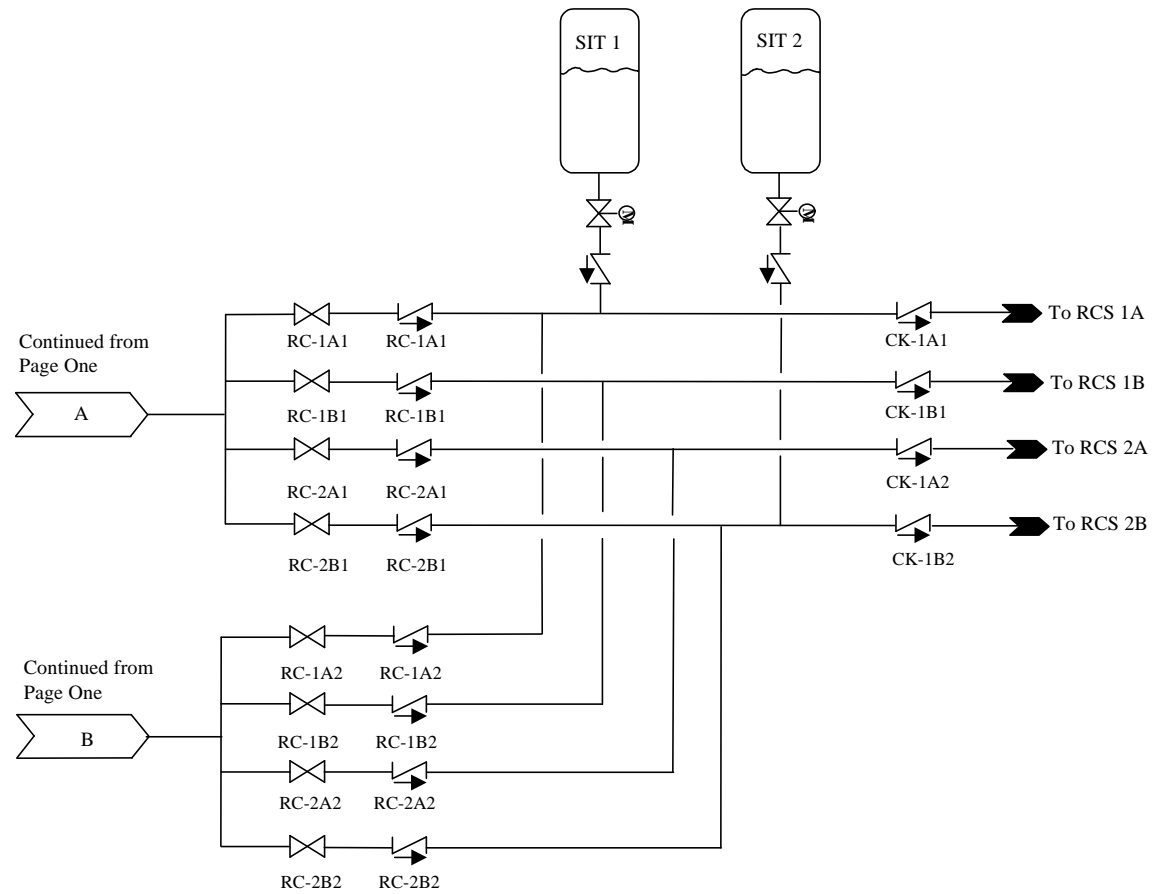
1		가		(B/A)
LOCA	(A)	LOCA	(B)	
LOCA LOCA (10 in – 30 in)	1.47E-7/y	LOCA 1 (23 in – 30 in)	1.82E-8/y	0.38
		LOCA 2 (22 in – 23 in)	1.15E-9/y	
		LOCA 3 (18 in – 22 in)	1.77E-8/y	
		LOCA 4 (16 in – 18 in)	6.32E-10/y	
		LOCA 5 (10 in – 16 in)	1.76E-8/y	
LCOA (2.4 in – 10 in)	2.60E-8/y	LOCA 6 (1.2 in – 10 in)	2.94E-8/y	1.13
	1.73E-7/y		8.47E-8/y	0.49

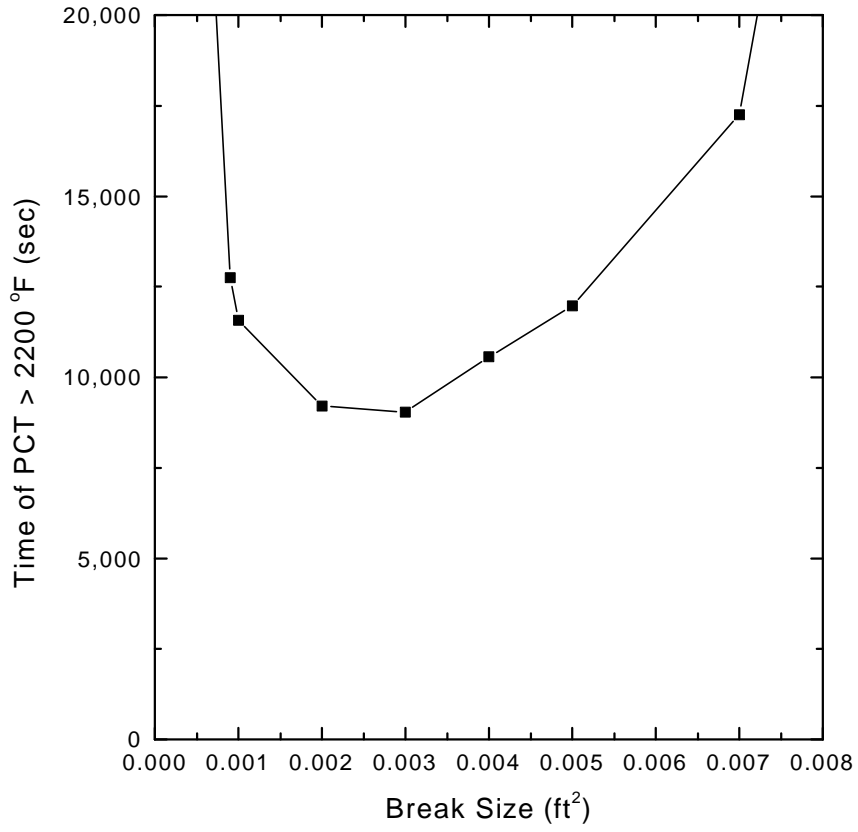
4.

LOCA

1	45	9.15E-3	1.09E-11/y	8.90E-8/y
2	1	3.70E-3	4.14E-12/y	8.90E-8/y
	2	1.00E-3	2.86E-12/y	8.90E-8/y







2. (PCT, 2200°F)
 (가)