

I&C

Development of Reliability Database for Safety-Related I&C Component Based on operating experience of KSNP

, ,
, 150

(3,4 3,4) I&C 8.63

CE I&C
가 CE

ABSTRACT

Reliability database for safety-related I&C components has been developed, based on domestic operating experience of total 8.63 years from four units - Yonggwang Units 3 and 4, and Ulchin Units 3 and 4. This plant-specific data of safety-related I&C components has compared with operating experience for CE-supplied plants in U.S.A. As a result, we found that on the whole the domestic reliability data was similar to CE-supplied plants in USA, though lots of failures occurred early in the commercial operation were included in our analyses without percolation.

1.

가

100

가

가

가

가가 가

가

/

가 (PSA; probabilistic safety assessment)

가

60

가,

가 ,

[1,2].

PSA 가

PSA quality 가 . Quality 가

가

가 ,

가

가

(3,4 3,4)

(PPS; plant

protection system)

2000.5

I&C

/ I&C

(RPS; reactor

protection system),

(ESFAS; Engineering safety feature actuation system)

(DPS; diverse protection system)

I&C

(

/ /)

2.

2.1

4

1

1

4

3,149 (8.63) .

I&C

1.

3	95.4.1	99.7.31	1340	3.68	
4	96.1.1	99.7.31	1155	3.16	
3	98.8.11	00.5.31	589	1.61	
4	00.1.1	00.5.31	65	0.18	
			3149	8.63	

2.2

I&C RPS, ESFAS, DPS I&C (RTSS; reactor trip switchgear system), interface relay, MG-set trip contact I&C (CPC; core protection calculator), (CEAC; control element assembly calculator) , test circuit, I&C I&C TR (Trouble Report) 3,4 NCR (Non-Confirmation Report) 가 TR

가

- I&C RPS/ESFAS [3] 가
- / TR 가 , TR /
- TR / , 가 OOS (out-of-service)
- 가

● , OOS , OOS

3,4 84 , 3,4

14 (

) 65 66%

2.3 I&C

I&C

(λ : time-related failure rate)

(P)

[4].

2

2. I&C

	3,4			3,4		
			(Yr)			(Yr)
Bistable	80	6566	547.20	72	1547	128.88
Bistable Relay	180	14774	1231.20	164	3523	293.56
CEA Calculator	2	164	13.68	2	43	3.58
Core Protection Calculator	4	328	27.36	4	86	7.16
Differential Pressure Transmitter	8		54.72	8		14.32
DPS AFAS Control Circuit	6	164	41.04	6	43	10.74
DPS MG Set Control Circuit	2	55	13.68	2	14	3.58
DPS Signal Processor	6	164	41.04	6	43	10.74
Hand Switch	50	4104	342.00	50	1074	89.50
Initiation Relay Card	60	4925	410.40	60	1289	107.40
Interface Relay	56	6895	383.04	56	1804	100.24
Interposing Relay Card	16	1313	109.44	16	344	28.64
Level Transmitter	24		164.16	24		42.96
Logic Matrix Relays	72	5910	492.48	72	1547	128.88
Neutron Flux Detector	12		82.08	12		21.48
Pressure Transmitter	26		177.84	26		46.54
RCP speed sensor	16		109.44	16		28.64
Reed Switch Position Transmitter	73		499.32	73		130.67
RCS Temperature Element	8		54.72	8		14.32
TCB, UV, Shunt trip device	4	2435	27.36	4	637	7.16
Ex-core Drawer	4	328	27.36	4	86	7.16

3. I&C

I&C CE

[5] 3 5 CE 12

LER(licensee event report) NPRDS(nuclear plant reliability data system)

3 3,4 3,4 I&C

6 3 (98)

가 66% 2

(/yr) (/demand)

3

zero-failure data

가 7 가

3. I&C

				CE [5]		
			(year)		(year)	
Trp Circuit Breaker	0	3072	34.52	0	58576	
Undervoltage Trip Devices	0	3072	34.52	57	32202	
Shunt Trip Devices	0	3072	34.52	5	42993	
Initiation Relays	0	6214	517.8	0	97890	
Logic Matrix Relays	0	7456	621.36	24	58902	
Bistable Relays	2	18297	1524.76	2	215196	
Bistables	0	8113	676.08	105		1671.00
Pressure Transmitter	3		224.38	9		269.40
Differential Pressure Transmitter	0		69.04			
Level Transmitter	2		207.12			
RCS Temperature Element	1		69.04	20		1165.60
Ex-core Neutron Flux Detectors	10		103.56	12		321.84
Axial Offset Calculators	7	414	34.52	21		160.91
Power Calculators	1	414	34.52	11		160.91
Core Protection Calculators	13	414	34.52	13		16.48
CEA Calculators	12	207	17.26	19		8.24
Hand Switch	1	5178	431.5	1	3392	
DPS AFAS Control Circuit	0	207	51.78			
DPS MG Set Control Circuit	0	69	17.26			
DPS Signal Processor	2	207	51.78			
Interface Relay	2	8699	483.28			
Interposing Relay Card	0	1657	138.08			
RCP speed sensor	5		138.08			
Reed Switch Position Transmitter	3		629.99			

4 3 가
CE .

4. CE

*	*	
Bistable Relays	11.73	1,2
Pressure Transmitter	0.53	
RCS Temperature Element	0.85	
Ex-core Neutron Flux Detectors	2.59	
Axial Offset Calculators	1.56	
Power Calculators	0.42	
Core Protection Calculators	0.48	
CEA Calculators	0.30	
Hand Switch	0.65	
Initiation Relay, TCB, 8	0.00	

3 4 .

- CE , UV trip device, shunt trip device, CE 105, 57, 5, 24

- 2
Glick[8]
record breaker 가 50 sample 4.5 100 sample
14.4
I&C 가

- 가

4.

(3,4 3,4) I&C

8.63

가 CE

I&C

가
가 'zero-failure data'
가
가

2

2

- [1] J. Ravetz, "Uncertainty, Ignorance and Policy," in *Science for Public Policy*, Pargamon, New York, 1987.
- [2] J. Linnerooth-Bayer, and B. Wahlstrom, "Applications of Probabilistic Risk Assessments: the Selection of Appropriate Tools," *Risk Analysis*, Vol.11, No.2, 1991.
- [3] 3,4 RPS/ESFAS, (to be published).
- [4] U.S. NRC, *PSA Procedures Guide*, NUREG/CR-2300, V01.1, 1983.
- [5] ABB-CE, *RPS/ESFAS Extended Test Interval Evaluation*, CEN-327, Prepared for the CE Owners Group, Combustion Engineering, 1986.
- [6] , " 4 , " KAERI-ISA-MEMO-ART-2001-002A, Memo, 2001.2.2.
- [7] R.T. Bailey, "Estimation from Zero-Failure Data," *Risk Analysis*, Vol.17, No.3, 1997.
- [8] N. Glick, "Breaking Records and Breaking Boards," *American Mathematical Monthly*, 1978.