

2003

4

The State of the Loss of Class 4 Power of HANARO

150

가
가 가

가 1995 2

8

4

Abstract

Electric power is essential for all industrial plants including nuclear facilities. All who use electric power desire perfect frequency, voltage stability, and reliability at all times. But this cannot be realized in practice because of the many causes of power supply disturbances that are beyond the control of the utility.

The major reasons of reactor trips were system malfunction and operators in initial stage of its operation since first criticality of HANARO. But the electric power outage becomes the major reason of the reactor trips as HANARO is stabilizing and the ability of the operator is improving.

This paper describes the state of electric power outage of KAERI and the reasons for the loss of class 4 power which have an effect on HANARO operation.

1.

1, 2, 3 4
154kV

22.9kV 2
6.6kV 2

1 2 6.6kV

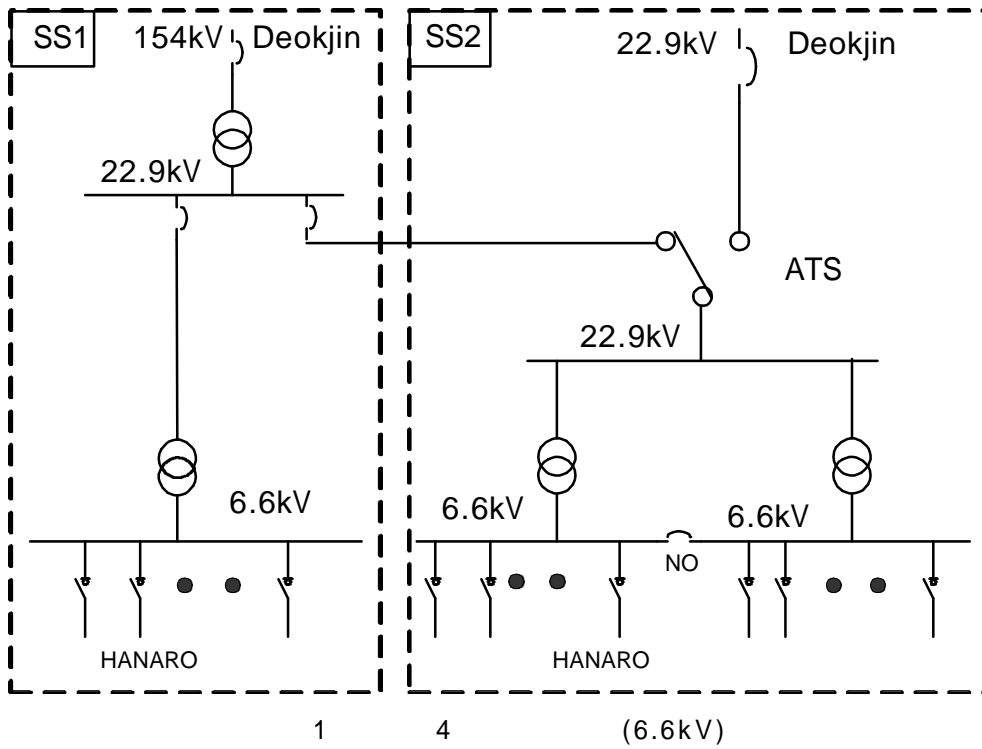
725kW 460V 1 가
 가 가 [1]^{3),4)}
 가 가 가

1995 2 8

가

2002

4



2.

IEEE Standard 1159-1195

1 IEEE Std 1159

1).

1) Transients

2) Short duration variation

1.

(IEEE Std 1159)

Categories	Typical spectral content	Typical duration	Typical Voltage Magnitude
1.0 Transients			
1.1 Impulsive			
1.1.1 Nanosecond	5 ns rise	< 50 ns	
1.1.2 Microsecond	1 μ s rise	50 ns-1 ms	
1.1.3 Millisecond	0.1 ms rise	> 1 ms	
1.2 Oscillatory			
1.2.1 Low frequency	< 5 kHz	0.3-50 ms	0-4 pu
1.2.2 Medium frequency	5-500 kHz	20 μ s	0-8 pu
1.2.3 High frequency	0.5-5 MHz	5 μ s	0-4 pu
2.0 Short duration variation			
2.1 Instantaneous			
2.1.1 Sag		0.5-30 cycles	0.1-0.9 pu
2.1.2 Swell		0.5-30 cycles	1.1-1.8 pu
2.2 Momentary			
2.2.1 Interruption		0.5 cycles-3 s	< 0.1 pu
2.2.2 Sag		30 cycles-3 s	0.1-0.9 pu
2.2.3 Swell		30 cycles-3 s	1.1-1.4 pu
2.3 Temporary			
2.3.1 Interruption		3 s-1 min	< 0.1 pu
2.3.2 Sag		3 s-1 min	0.1-0.9 pu
2.3.3 Swell		3 s-1 min	1.1-1.2 pu
3.0 Long duration variation			
3.1 Interruption, sustained		> 1 min	0.0 pu
3.2 Undervoltages		> 1 min	0.8-0.9 pu
3.3 Overvoltages		> 1 min	1.1-1.2 pu
4.0 Voltage imbalance		Steady state	0.5-2 %
5.0 Waveform distortion		Steady state	
6.0 Voltage fluctuations	< 25Hz	Intermittent	0.1-7%
7.0 Power frequency variations		< 10 s	

- 3) Long duration variation
- 4) Voltage imbalance
- 5) Waveform distortion
- 6) Voltage fluctuation
- 7) Power frequency variation

2.

가
가
1995 2 8
2002
“ ” , “ ”

2 (1995~2002)

1995	13	36	49
1996	3	25	28
1997	12	26	38
1998	13	25	38
1999	17	20	37
2000	18	22	40
2001	17	18	35
2002	14	7	21
	107 (37.4%)	179 (62.6%)	286
	286		

93% 가 19 (95%)가
 2 286
 107 37.3%,
 179 62.7%

2.1. (1995~2002)

20 19
 가
 1995 8 13 6 36
 1 6 5
 가 RPS/RRS
 1996 28 3
 가 2
 가 1
 1997 38 26 10
 12 2
 4 2
 2
 1998 38 13 25
 5 5
 2
 가
 1999 20 17 3
 4
 2
 3
 2000 40 1
 2000 4 1 가
 2001 17 18 35 3
 32 2 가

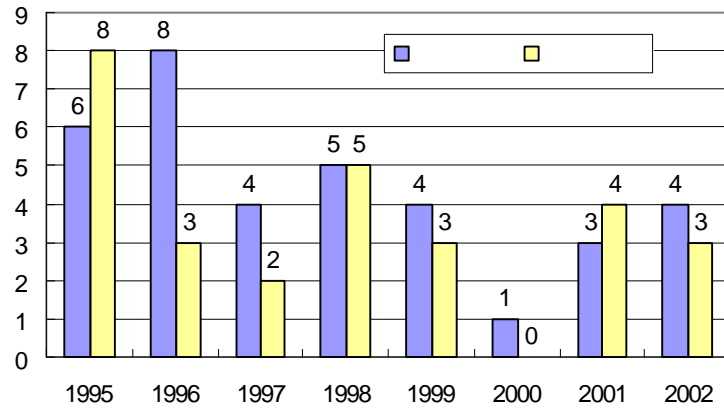
2002 . 3 4 1 1 ,
 14 가 21 2 , 7 , 2 2
 , 1 . 4

2.2. (1995~2002)

3 6 . 22% 63
 28 11
 154kV 가 , 1999 가
 154kV

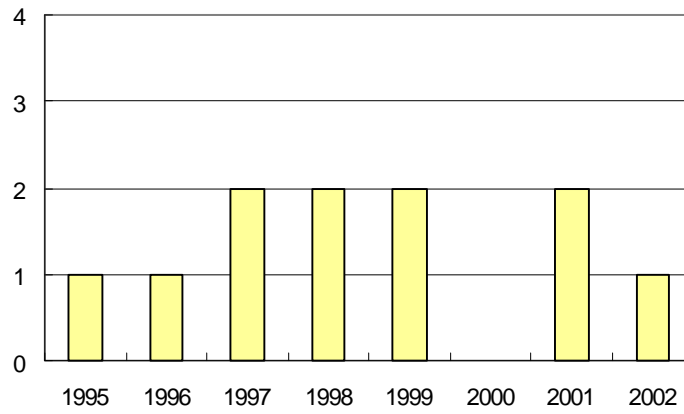
3 (1995~2002)

1995	6	8	1
1996	8	3	1
1997	4	2	2
1998	5	5	2
1999	4	3	2
2000	1	0	0
2001	3	4	2
2002	4	3	1
	35 (55.5%)	28 (44.5%)	11
	63		

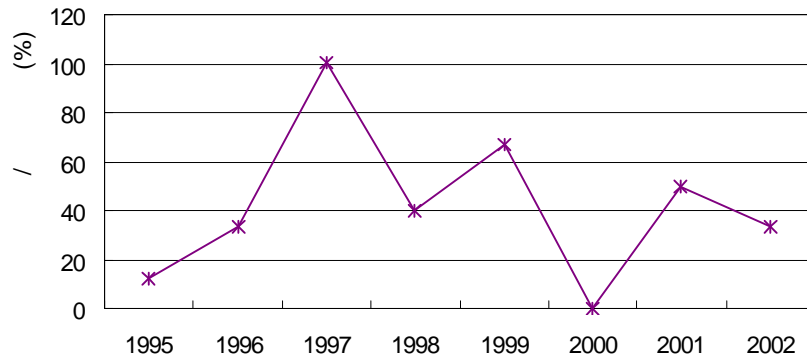


2

(1995~2002)

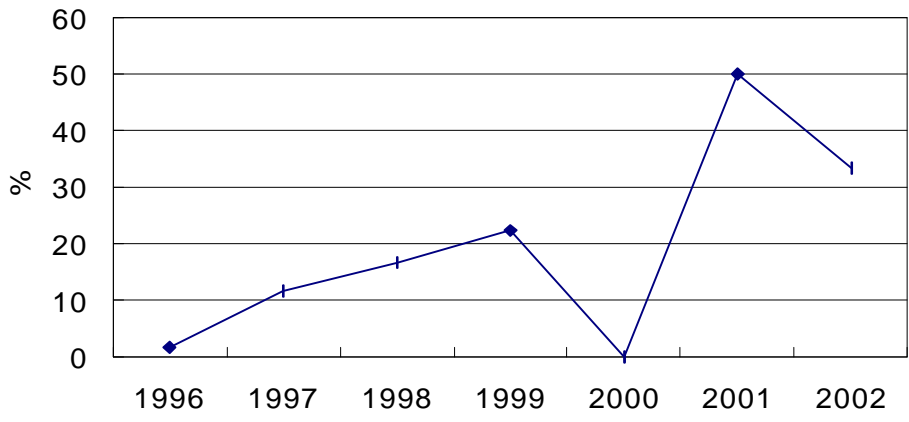


3 4



4

7 4
 2
 가 4 가 40%
 / , 가 가
 9 가



5

2.3.

1995
 4
 가
 25 가
 17 ,
 6 , 10 ,
 8 가

			(%)
		19	17.76
	'	25	23.36
	'	17	15.89
		10	9.35
	()	6	5.61
		5	4.67
		3	2.80
		22	20.56

3.

30%

가
maintenance)

(Electric preventive

4.

- 1) IEEE Standard 1159, IEEE Recommended Practice for Monitoring Electric Power Quality, 1995.
- 2) IEEE Standard 100, IEEE Standard Dictionary of Electrical and Electronics Terms, 1992
- 3) , KAERI/TR-710/1996, KAERI, 1996
- 4) K.H.Lee, H.K.Kim, et al., A Reliability Study on HANARO Class 4 Power Supply Outages, 7th Korea-Japan PSA Workshop, Jeju, May 2002