

Activation Scheme to Use Performance Indicators for the Graded Regulation on Korean NPPs

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Abstract

In this paper, we will provide an activation scheme of using performance indicators for graded regulation on Korean Nuclear Power Plants (NPPs). The safe operation of NPPs is the basic objective of nuclear society. To achieve the object, the direction of the regulation is established to regulate the risk of public health and safety. Therefore, it ' s essential to keep the safety of

plants. However, it's not easy to define the appropriate safety level. So, the requirement of performance indicator establishment and framework establishment for safety management has been increased. Performance indicators can provide quantified safety value numerically. Therefore, we can increase the acceptance and trust of the public for safety of NPPs. Also, it helps predictive regulation through the objective comparison of safety. Moreover, according to the importance of safety, we can allocate the resources effectively and lead an effort for the improvement of safety by comparison among nations and plants. The safety of a plant is affected by not only design but also the quality of operators, appropriate operation, maintenance and test. So, in this paper, we reviewed the application of performance indicators in domestic and foreign countries, and groped for a method to activate the use of performance indicators.

1.

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(Nuclear Regulatory Commission: NRC)
(Reactor Oversight Process: ROP)[1]
()가
NRC PSA
(Risk Based Performance Indicator; RBPI)
RBPI (pilot study) [2].
WANO (World Association of Nuclear Operators)
NRC ROP
[3].
가
가
[3].
RBPI가 [3].
, 1997

2.

2.1

가 1995 1998
[3]. 10 , 2000

8 3,6].

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- PSA 가 PSA , PSA
- Graphic Display Model 가 , 3
- 가 3가 1

5가 11 가 4

4 , 4

PSA

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2.2

ROP[1] . ROP 8 , 17 가

ROP (Significant Determination Process: SDP)

ROP SECY 99 -007[9]

가

NRC 1999 (Risk Based Performance Indicators; RBPI)

2002 1 RBPI pilot study RBPI [11]가

NUREG -1753[2]

3

- RBPI (Mitigating System Performance Indexes: MSPI)
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- /
- RBPI (Significant Determination Process: SDP)

2.2.1

RBPI (Risk Measures) (Core Damage Frequency: CDF)
 (Large Early Release Frequency: LERF)

ROP RBPI ,
 SECY 99-007[9] 2, “ 가 ” RBPI
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- SSC
- NRC가 가
- 가
- ROP
 , ROP 가 RBPI RBPI , RBPI ROP
 가 :
- 가 / /
- 가
- RBPI
- 가 가
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CCF) (accident sequence precursor: ASP) (common cause failure:
 , RBPI . RBPI
 (ASP)

RBPI (LOOP, SGTR, small LOCA) 가
 2 RBPI

- RBPI / :
 RBPI IPE IPE . IPE

(CCDP) 1.0E -6 CDF 1%
3가

, PWR, BWR

SPAR

IPE IPE
PSA Application Guide

1.160

- Fussel -Vesely 0.05

- FV > 0.005

- CDF 5%

(support system)

2 RBPI

	PIs	RBPIs			
Initiating Event	- Unplanned scram, - LONHR -Unplanned reactor power changes	- General transient - LOFW - LOHS			
Mitigating System	- EPS (UA) - RHR (UA) - PWR AFW (UA) HPI (UA) - BWR HPCS/HP (UA) RCIC/IC (UA) - Safety system functional failures	PWR at Power	BWR at Power	Shutdown	Fire
		-EPS (UR&UA) - AFW -MDP(UR&UA) - AFW -TDP(UR&UA) -HPI (UR&UA) - PORV (UR) -RHR (UR&UA) - SWS(UR&UA) - CCW (UR&UA) - AOV (UR) - MOV (UR) - MDP (UR)	- EPS (UR&UA) - HPCS/HPCI(UR&UA) - RCIS/IC(UR&UA) -RHR (UR&UA) - SWS (UR&UA) - AOV (UR) - MOV (UR) - MDP (UR)	- *Time in high, medium, low risk - significant, or early reduced inventory (vented) configurations	None
Barriers	-RCS specific activity -RCS identified leak rate	- *CIV (UR&UA)	- *Drywell spray (MarkI)(UR&UA) - *CIV (Mark III) (UR&UA)	None	None

UA: unavailability, UR: unreliability, *:

2.2.3

RBPI

PSA

(Mitigating System) , MSPI(Mitigating System Performance Index)
NRC [15]. MSPI ROP Mitigating System Performance Indicator
, NEI 2004 7 , NRC
, 2005 가 . MSPI :

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MSPI

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- Birnbaum 가
- 가

3.

가 PSA , PSA 가
 가 PSA , PSA
 , RBPI , PSA
 3 RBPI 3
 SCSS(Sequence Coding Search System, Oak Ridge
 (Licensee Event Reports)) MOR(Monthly Operating Report,
 INEEL) , IPE PSA
 PSA

3 RBPI

	RBPI	
IPE PSA	BWR 18, PWR 22,	/ RBPI
SPAR	NRC CDF	RBPI 가
	NUREG/CR -5500, Vol.1~8	
	1987~ 1995 , NUREG/CR -5750, LOOP NUREG /CR -5496	
EPIX		/
RADS(reliability and availability system)		가
, PSA	Surry/ Grand Gulf PSA, NUMARC 91 -06	RBPI

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4.

4.1

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 RBPI , ROP RBPI 가 . 가 RBPI
 , RBPI 가 , RBPI 가
 , SDP (Periodic Safety Review; PSR)
 ROP, ,

4.2

PSA
 , W/H , , PSA
 , PSA
 , 가
 , MSPI , RBPI
 , ROP MR

5.

• PSA
 , 가
 , (Significant Determination Process: SDP) (Eropean
 Commission) PSA
 , PSA
 , 가 PSA
 , 가 RBPI 가
 , RBPI

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가

RBPI

MSPI

가

가

PSA

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1. NUREG -1649, Reactor Oversight Process, Rev.3, 2000
2. NUREG -1753, Risk-Based Performance Indicators: Results of Phase I Development, NRC, 2002
3. KAERI -TR/2098 -2002 KINS -AR/802
, KINS, 2002
4. Topical Issues No. 5, Safety Performance Indicator, International conference on Topical Issues in Nuclear Safety, 2001
5. Risk -based Safety Performance Indicators for Nuclear Power Plants, SMIRT17, 2003
6. WANO 2001 Performance indicator report, 2002
7. TECDOC -1141, Operational safety performance indicators for nuclear power plants, 2000
8. SECY -02 -0030, SUMMARY REPORT ON NRC'S HISTORICAL EFFORTS TO DEVELOP AND USE PERFORMANCE INDICATORS, 2002
9. SECY -99 -007, Recommendations For Reactor Oversight Process Improvements ", SECY -99 -007, Jan. 8, 1999
10. White Paper, Development of Risk -Based Performance Indicators: Program Overview,
11. ACRS Letter, NRC Program For Risk -Based Analysis of Reactor Operating Experience, 2000
12. S -99, Reporting requirements for operating nuclear power plants, March 2003
13. Rg 1.174, An Approach for Using PRA in Risk -Informed Decisions on Plant Specific Changes to the Licensing Basis, 1998
14. NUMARC 91 -06, Guidelines for industry actions to assess shutdown management, 1991
15. NRC, Regulatory Issue Summary 2002 -14, " Proposed Changes to the Safety System Unavailability Performance Indicators, August 28, 2002.
16. Regulatory Assessment Performance Indicator Guideline, NEI 99 -02, Revision 1, 2000.4