



中国核电技术研究院  
(CNPRI)

## Application of Risk-informed Performance Index in GNPS and LNPS



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# Background

- GNPS and LNPS use unavailability (I0) to control the performance of safety-related system and equipment
- MSPIs replaced the SSUI by NRC from 2006. 4, focused on the system performance by risk-insights :
  - Emergency AC power system
  - High pressure safety injection system
  - Auxiliary feedwater system
  - Residual heat removal system
  - Cooling water support system (includes component cooling water system and service water system)



## MSPI IN GNPS AND LNPS

- PSA development and application in GNPS and LNPS
  - Level I PSA models for GNPS and LNPS had been developed completely in 2004
  - In the past several years, there are many PSA application cases for the two plants in spite there is no firmly policy for PSA application in China
  - Not only the owner but also the authority has realized that risk-informed safety management can help safety management and regulation more efficiently.



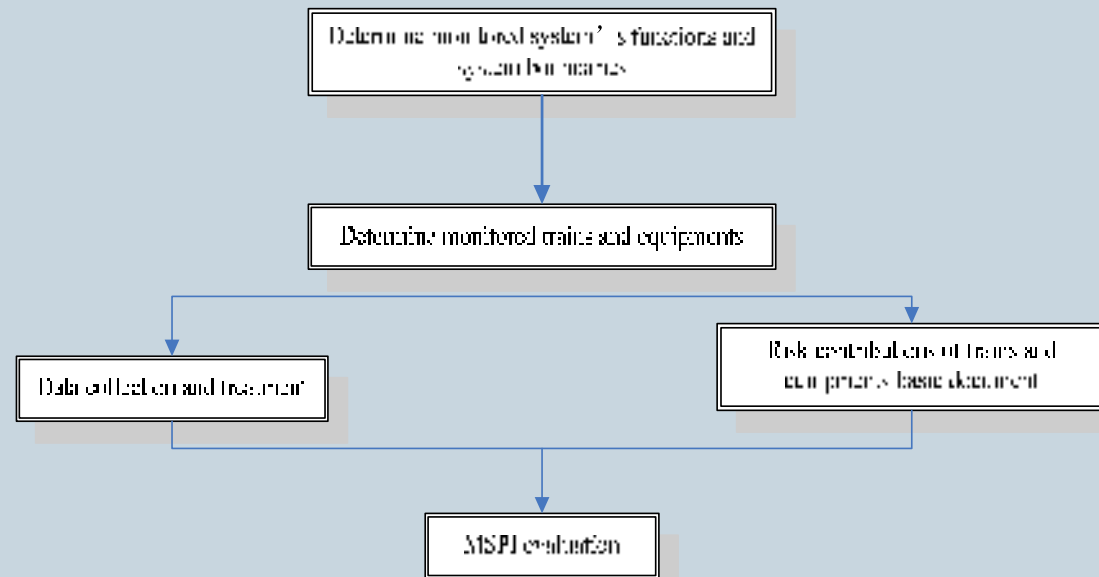
## MSPI in GNPS AND LNPS(2)

- Conditions of GNPS and LNPS
  - 900MW units designed by Framatome
  - A series faults happened in several systems related to defence of prevention or mitigation of loss of offsite power accident
    - auxiliary feed water (ASG),
    - emergency diesel (EDG),
    - auxiliary offsite power (LGR)
    - hydro-test pump turbine generator set (LLS)
  - The CDF contribution of loss of offsite power is more than 20 percent
  - Utility worried about the systems performance
  - MSPI can answer how about the plant safety state under this condition



## MSPI in GNPS AND LNPS(3)

- Process and Data Collection



- The past seven years data of the four systems had been collected



## MSPI in GNPS AND LNPS(4)

- Relative Comparison Baseline
  - MSPI is a relative index
  - No generic baseline data can be used
  - A relative baseline compared with plant itself past is selected
  - MSPI can show the change of the result sensitively



# MSPI in GNPS AND LNPS(5)

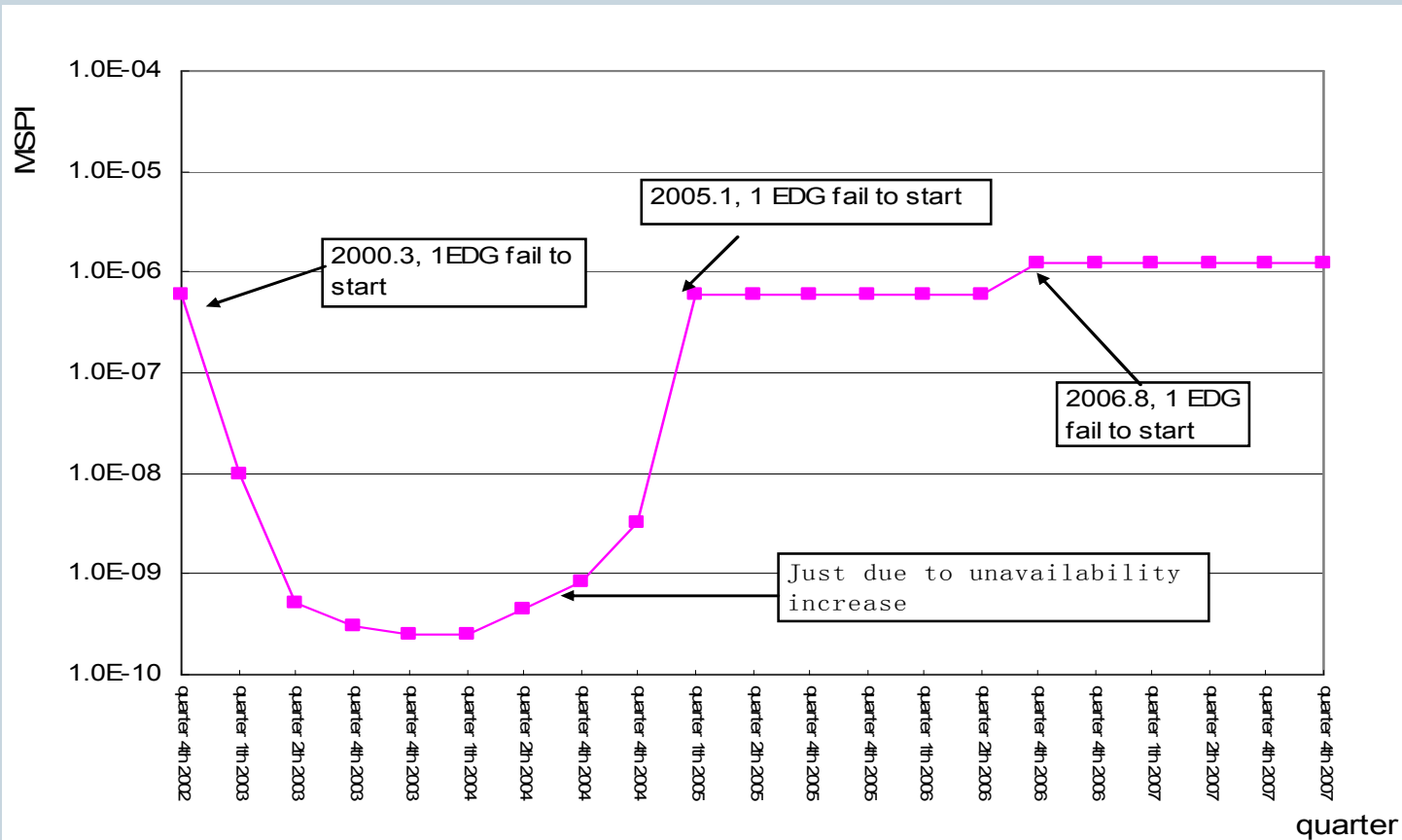


Fig 3-2 1 Unit EDG Relative MSPI of GNPS in 7 Years





## MSPI in GNPS AND LNPS(7)

- Enhance Safety by Risk insights from MSPI
  - (1) Equipment reliability is important, dominant for the risk
  - (2) Different equipment plays different role on system performance and plant safety
  - (3) Different system plays different role on plant safety.



## MSPI in GNPS AND LNPS(8)

**Table 1 Comparison between Unavailability and Fail to start rate**

Cases	Unavailability/Fail to start rate	MSPI contribution
(1) 100h EDG unavailable	4.25E-3	5.40E-8
(2) one time EDG fail to start	2.30E-2	4.94E-7



## MSPI in GNPS AND LNPS(9)

### Table 2 GNPS ASG pumps Birbaum

Equipment	Basic Event in PSA	Event description	Birbaum
ASG001PO	ASG001MOF-FR	001MO motor fail to run	1.45E-05
	ASG001MOF-FS	001MO motor fail to start	1.45E-05
	ASG001POP-FR	001PO pump fail to run	2.09E-05
	ASG001POP-FS	001PO pump fail to start	2.09E-05
ASG002PO	ASG002MOF-FR	002MO motor fail to run	1.52E-05
	ASG002MOF-FS	002MO motor fail to start	1.52E-05
	ASG002POP-FR	002PO pump fail to run	2.18E-05
	ASG002POP-FS	002PO pump fail to start	2.18E-05
ASG003PO	ASG003POP-FR	003PO turbine pump fail to run	1.02E-04
	ASG003POP-FS	003PO turbine pump fail to start	1.02E-04
	ASG001TCN-FR	001TC turbine fail to run	6.41E-05
	ASG001TCN-FS	001TC turbine fail to start	6.41E-05



## MSPI in GNPS AND LNPS(10)

### ● Suggestions

According to the risk-insight from MSPI. Some suggestions to the plants:

- (1) Equipment reliability is the dominant to risk. Use new index like MSPI to replace the I0 index
- (2) Plants must take care the tests not succeed on the first time
- (3) the most important objective of maintenance is finding the root cause and avoiding the re-failure in spite some time sacrifice.



## Conclusions

- The MSPI is a useful tool for index to monitor the whole system performance by using risk information. It can be used for all safety-related systems in principle.
- Using relative comparison baseline maybe let plant finds the performance change more quickly.
- MSPI application can help plant change some unreasonable management policy, and enhance the safety efficiently.
- In China, the authority already realized the reasonability of MSPI in safety regulation and regards the MSPI application practice in GNPS and LNPS as the good practice. China Authority plan to use MSPI as maturely. Now related preparing work is in progress.



**Thank!**

**Questions?**