Development of Safety Performance Indicators (SPI) for HANARO

Jong sup, WU
jswu@kaeri.re.kr

HANARO Application Research Center
Korea Atomic Energy Research Institute (KAERI), KOREA

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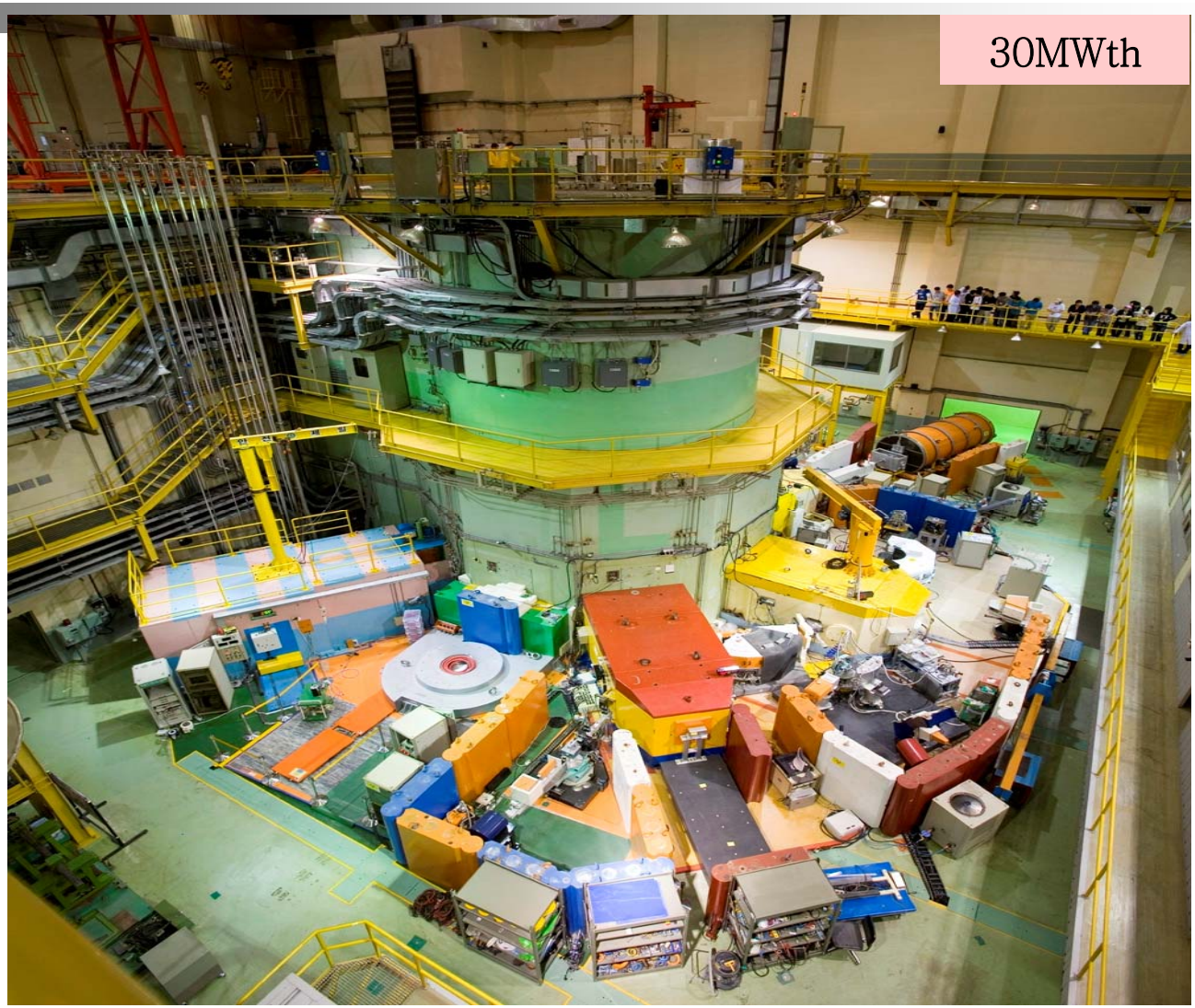
HANARO Reactor Hall



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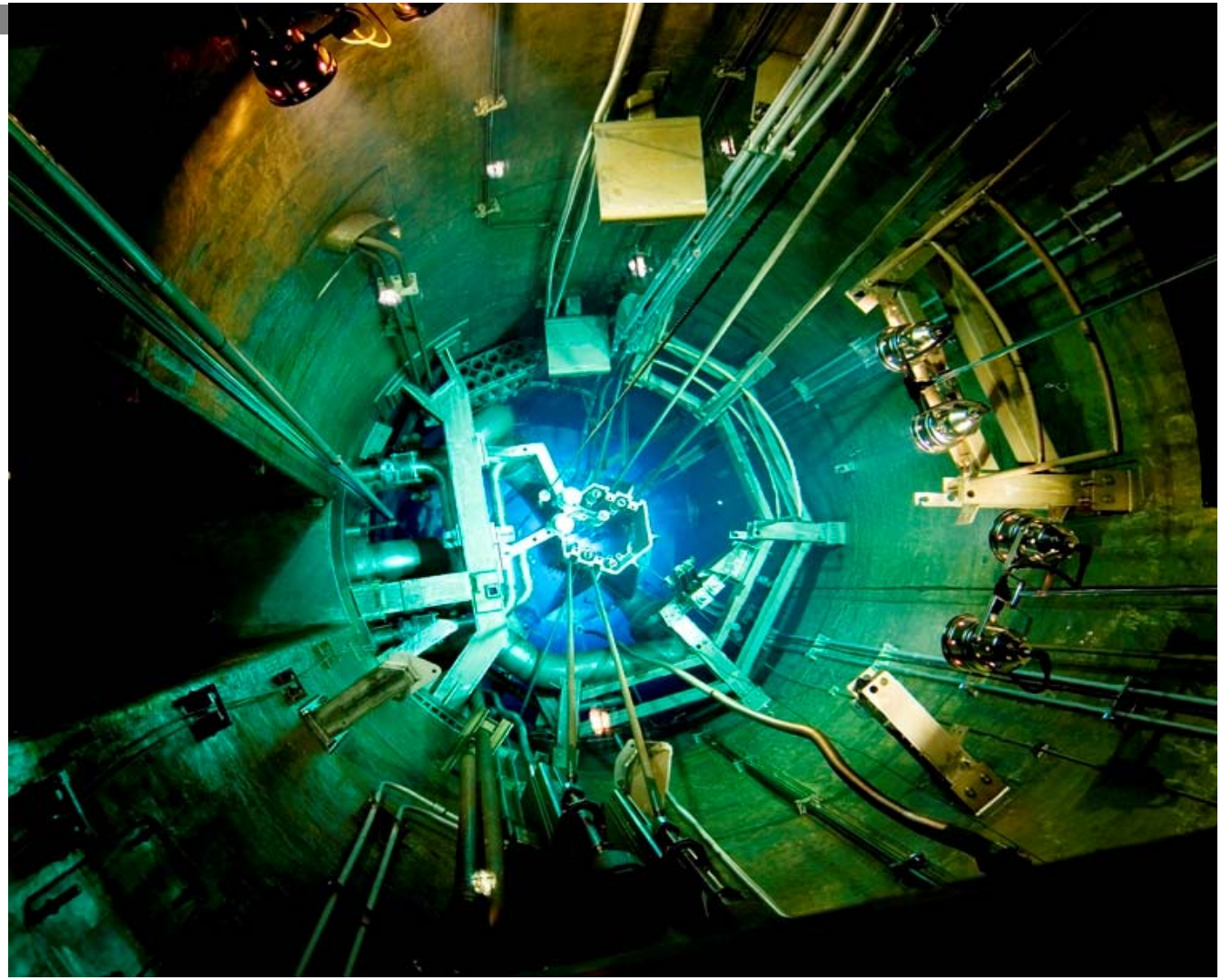
Reactor Pool



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Control Room

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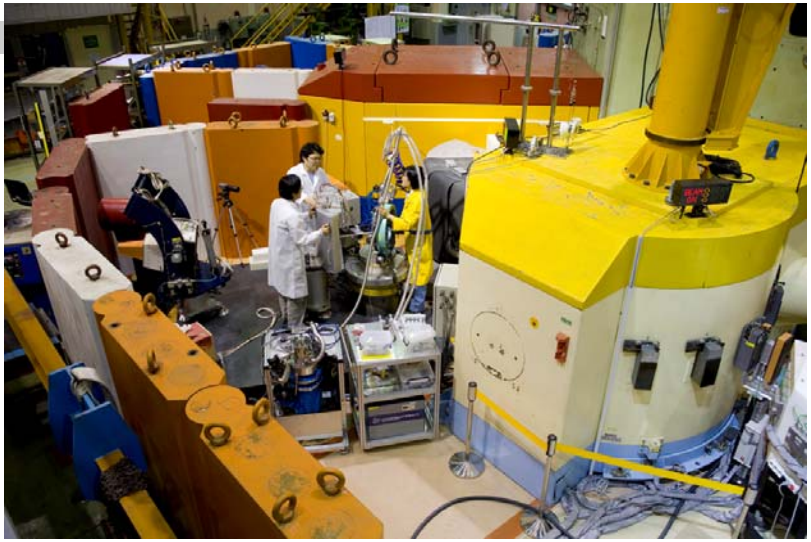
Experimental Facilities



1. Introduction (1/2)

- **The aims of management system for nuclear facilities:**

  1) to improve its safety performance

  2) to foster and support a strong safety culture

- **The management system can be monitored/measured :**

  by an assessment of its operational performance.

- **The operational safety performance indicators help :**

  an organization define and measure a progress with regards to its safety activity performance goals.

1. Introduction (2/2)

- **The elements of the safety performance indicators should be : quantifiable measurements**

- **This year, HANARO tried to develop an operational performance indicator program.**

- **HANARO has made an effort to select its own operational safety performance indicators which are specific to a research reactor operation and its utilization.**

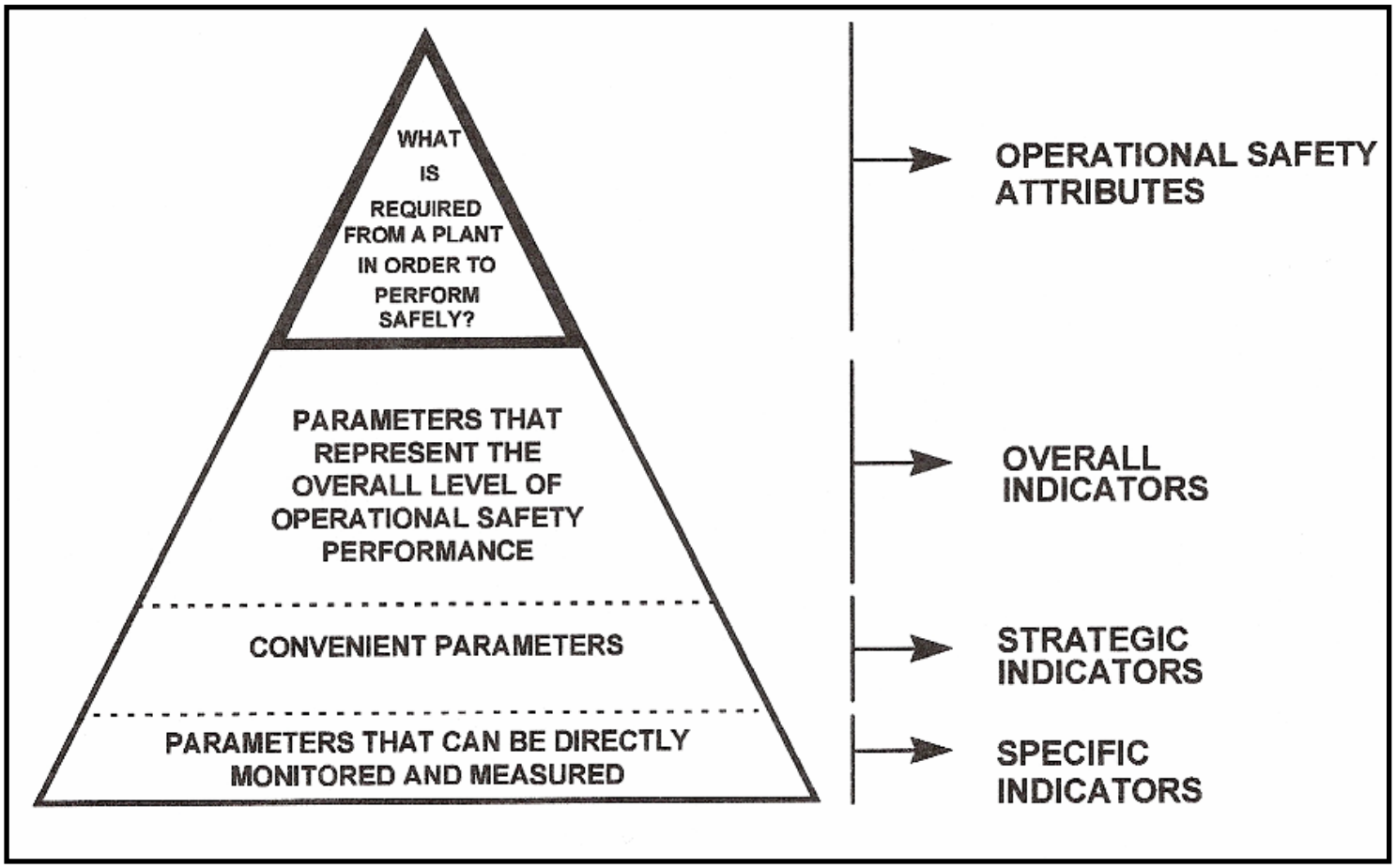
2. Operational safety performance indicators for NPP

- Since 1995, efforts have been directed towards the elaboration of a framework for the establishment of an operational safety performance indicator program.

- IAEA-TECDOC-1141, “Operational safety performance indicators for nuclear power plants” :

  A frame work for an identification of performance indicators which have a relationship to the desired safety attributes

IAEA approach to monitoring NPP's operational safety performance



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NPP Overall Indicators

Attributes (3)	Overall Indicators (8)
Operate Smoothly	Operating Performance
	State of SSC (Structure, Systems and Components)
	Events
Operate with a Low Risk	Challenges to Safety System
	Plant Ability to Respond to a Challenge
	Plant Configuration Risk
Operate with a Positive Safety Attitude	Attitude towards Safety
	Striving for Improvement

3. HANARO
Operational Safety Performance Indicators

- HANARO made an effort to prepare a final draft of operational safety performance program which were specific to a research reactor operation and its utilization.
- The program is based upon the model proposed by the IAEA-TECDOC-1141.
- The three key attributes were maintained except for “the attribute of a safe utilization” for research activities and its application.

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Flow of Indicator Selection

Selection of indicators considering Balanced Scorecard measures

Establishment of specific indicator definition

Establishment of the necessary organizational support

Data collection

Analysis and evaluation of indicators

Management feedback / Preparation of reports

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HANARO's Structure

Hierarchical Structure	Number	***Ref. IAEA***
Safety attributes	4	***3***
Overall indicators	10	***8***
Strategic indicators	22	***21***
Specific indicators	42	***70***

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HANARO - Attributes

Operational Safety Performance Attributes

- **Operate Smoothly**
- **Operate with a Low Risk**
- **Operate with a Positive Safety Attitude**
- **Operate with a Safe Utilization**

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HANARO – Overall Indicators

Attributes	Overall Indicators (10)
Operate Smoothly	Operating Performance
	State of SSC
	Events
Operate with Low Risk	Challenges to Safety System
	Plant Ability to Respond to a Challenge
	Plant Configuration Risk
Operate with a Positive Safety Attitude	Attitude towards Safety
	Striving for Improvement
Operate with a Safe Utilization	State of Experimental Equipment
	User Ability to Respond to a Challenge from Field Work

Specific Indicators for a smooth operation

Overall Indicators	Strategic Indicators	Specific Indicators (13)
Operating Performance	Forced power reductions and outages	No. of forced power reduction and outages due to internal causes
		No. of forced power reduction and outages due to external causes
		Power generation (MWD)
		Operation days
State of SSC (Structures, Systems, and Components)	Corrective NCR (Non Conformance Reports) and WO (work orders) issued	No. of NCR issued
		No. of WO issued
		Ratio of corrective NCR&WO executed to NCR&WO programmed
		No. of pending NCR&WO for more than 3 months
	Material condition	*Conductivity index of cooling water*
		Reflector tank ageing index
	State of the barriers	*Confinement leakage*
Events	Reportable events and incidents	Significant events & incidents due to internal causes
		Significant events & incidents due to external causes

Specific Indicators for an operation with a low risk

Overall Indicators	Strategic Indicators	Specific Indicators (10)
Challenges to Safety Systems	Safety systems actuations	No. of automatic scrams
		No. of demands on RPS, ECCS
Plant Ability to Respond to a Challenge	Safety systems performance	No. of failures in safety systems
	Operator preparedness	No. of hours devoted to training
	Emergency preparedness	Findings during emergency drills
		Findings during emergency plan audits
		No. of hrs devoted to training
		No. of staff receiving training
Plant Configuration Risk	Risk during operation	No. of technical specifications violations
		No. of LOC entries

Specific Indicators for an operation with a positive safety attitude

Overall Indicators	Strategic Indicators	Specific Indicators (13)
Attitude towards safety	Compliance with procedures, rules and licensing requirements	No. of violations of licensing requirements, SAR and technical specifications
		No. of violations of operating procedures
	Attitude towards procedures, policies and rules	*No. of violations found through regulatory body's audits*
	Radiation protection program effectiveness	No. of workers receiving doses above limits
		Corrective radiation exposures
		Effluent activity vs. allowed limit
	Operator Performance	*No. of accidents & events due to operator errors*
	Safety Awareness	% of staff trained in safety management
		Safety culture
		No. of seminars on safety related matters
Striving for improvement	Self-assessment	No. of independent internal QA inspection and audits
		No. of findings from internal QA inspections audits
	Operating experience feedback	No. of events at other facilities that undergo review/analysis

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Specific Indicators for an operation with a safe utilization

Overall Indicators	Strategic Indicators	Specific Indicators (6)
State of experimental equipment	Corrective NCR (Non Conformance Reports)/ WO (work orders) issued	No. of NCR/WO issued
	State of safety barrier	No. of high radiation alarms
	Operating performance	No. of reactor scram due to abnormal condition of experimental equipment
User ability to respond to a challenge from field work	User preparedness	No. of training
	Emergency preparedness	No. of hrs devoted to training on the emergency plan
		No. of findings during internal and external inspections / audits

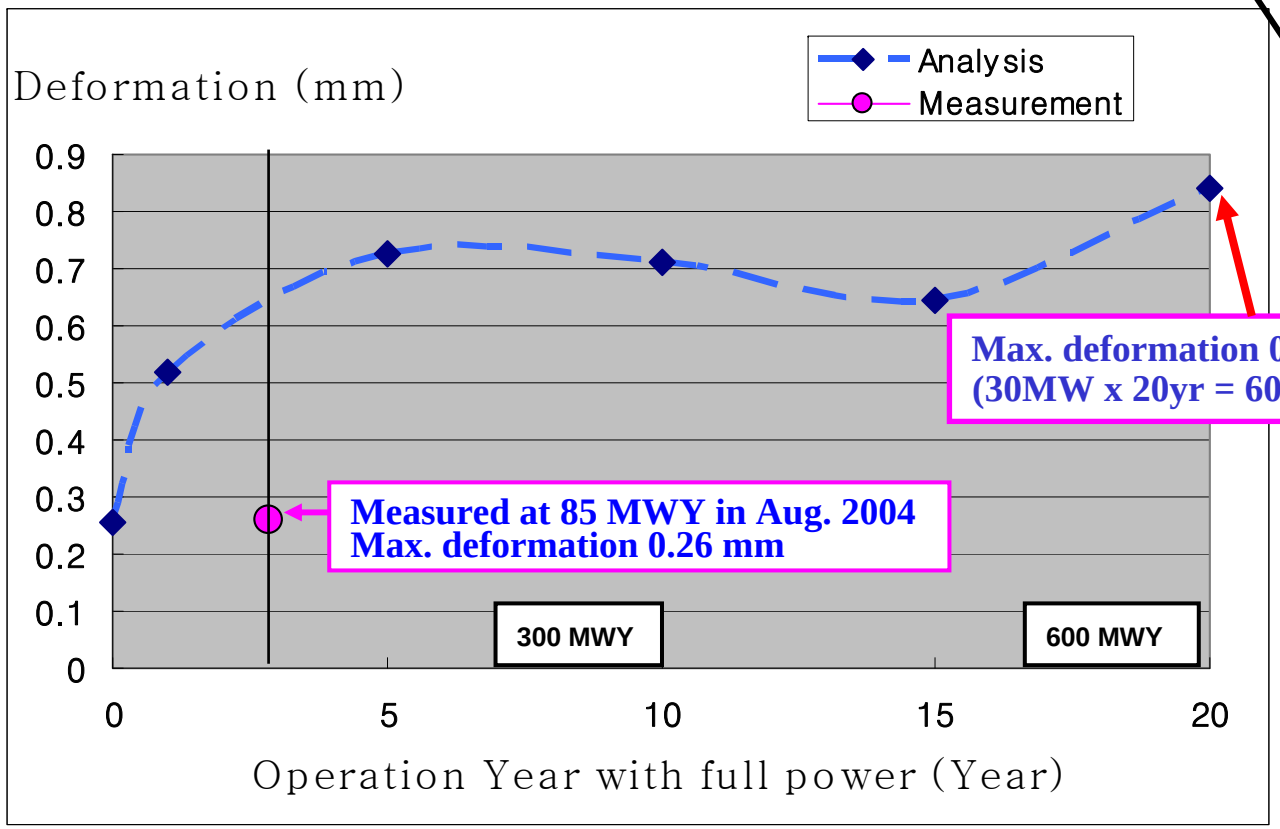
4. Example : Definition of Indicator

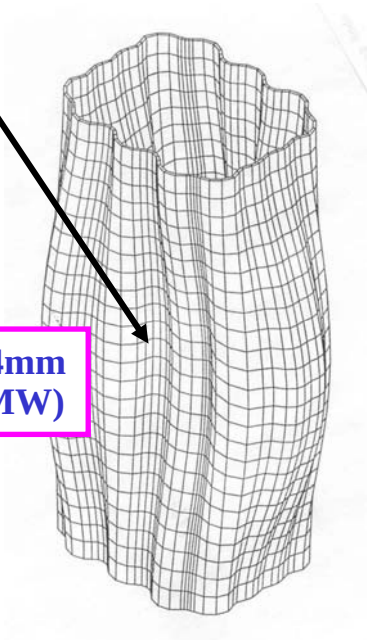
Indicator	Unit	Definition
Power generation	**MWD**	**Reactor operation performance indicator** **Total power generation a year**
Conductivity index of cooling water	**μS/cm**	**Material condition** **Chemistry performance indicator** **Conductivity of primary cooling water (pool water)**
Reflector tank (core)ageing index (refer to figure)	**mm**	**Material condition** **Aging index of Reactor Core Inner shell** **Deviation (mm) from As-built dimension**
Confinement leakage	**m^3/hr**	**State of the barrier** **Air leakage of reactor confinement building** **$\leq$ 600 m^3/hr**

Deformation of Core Inner Shell

by Yeong-Garp Cho, KAERI

Analytic estimation and Measurement Value at Center Point





Reference: B.Leitch, KMRR Creep and Growth Analysis. 37-31200-220-006, 1991

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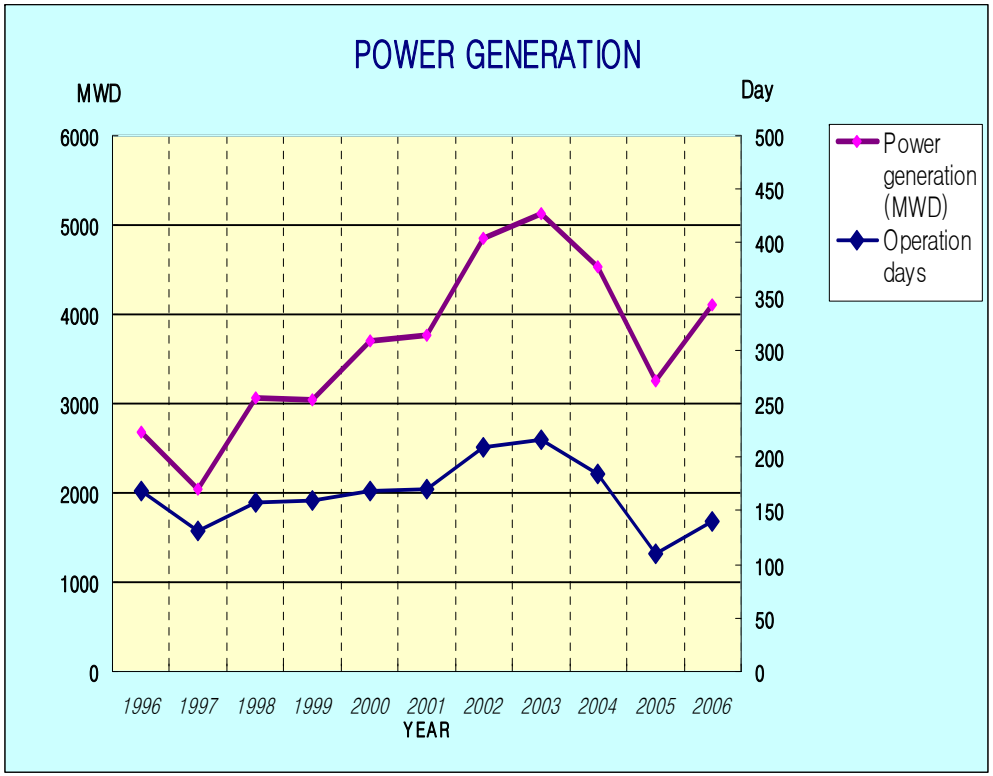
Example : Definition of Indicator

Indicator	Unit	Definition
NCR (Non Conformance Reports)/ WO (work orders) issued	No.	Activities of corrective maintenance NCR for safety system WO for non safety system
High radiation alarms at reactor hall area	No.	Safety barrier of experimental systems at reactor hall area
Reactor scram due to abnormal condition of experimental equipment	No.	Effecting reactor safety Unplanned scrams due to abnormal condition of experimental equipment
Devoted to training on the emergency plan	hr	User preparedness Training of staffs and users, The preparation for emergency cases

Example : Display sheet of an indicator

Plant operates smoothly	Overall indicators	Operating performance	Performance Color:
	Strategic indicators	Forced power reduction and outages	2006
	Specific indicators	0003 Power generation	G/W/Y/R



Year	Anticipated MWD	Actual MWD
1996		2687
1997		2036
1998		3062
1999		3042
2000		3699
2001		3771
2002		4852
2003		5119
2004		4523
2005		3248
2006		4113

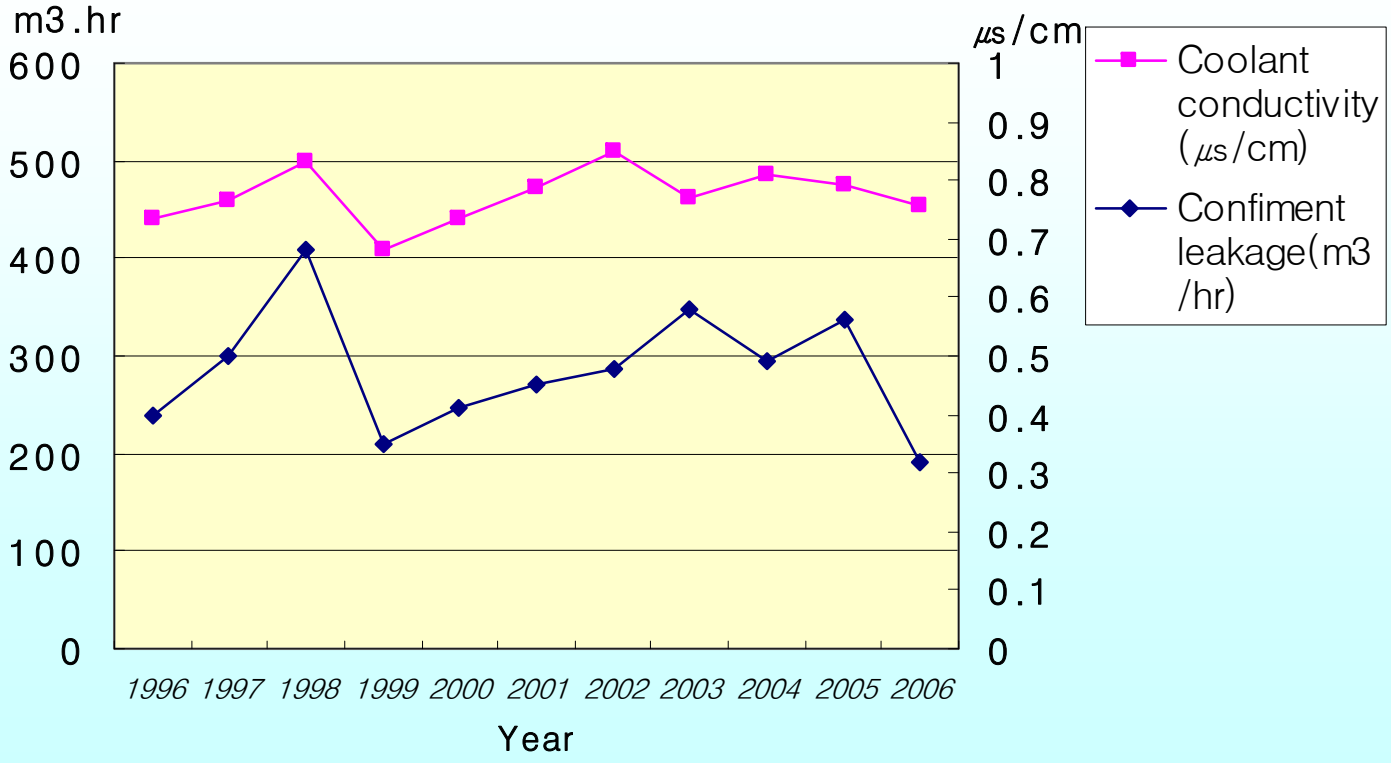
continued

Definition	Unit capability is the maximum power generation that HANARO is capable of supplying for the neutron beams to the users. A high power generation indicates an effective reactor use.	
Goal	It depends on the requirement of the beam users and a program of an audit, inspection and maintenance.	
Data source/ Reference	Operation Records Annual Report of HANARO Operation	
Analysis/ Action		
Remarks	In 2005, 5 weeks of periodic inspection and audit were performed by regulatory body and needed several weeks for maintenance.	
Responsible	HANARO management center	**Analysis by:** - - -

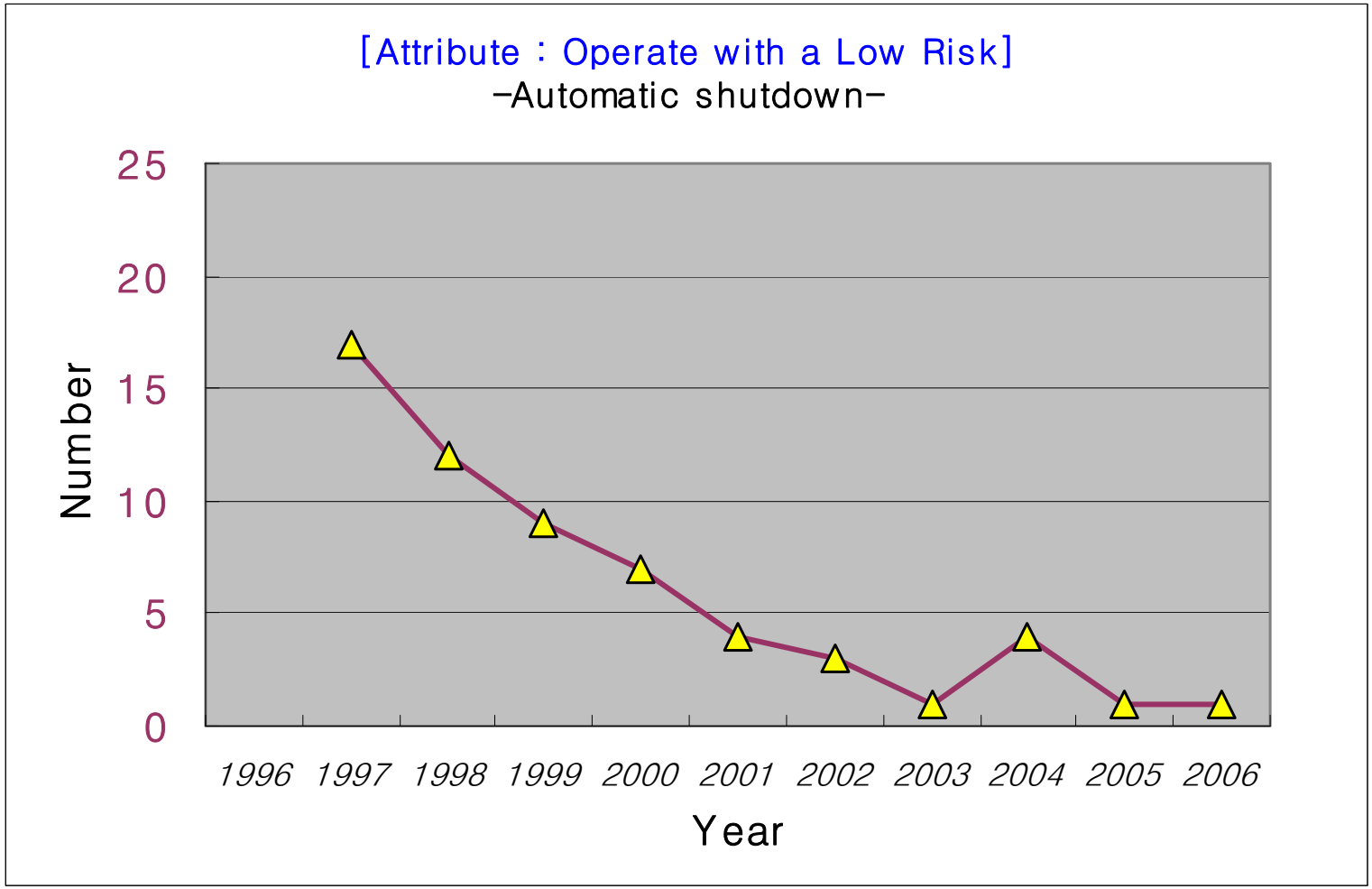
Example – Trend 1

[Attribute : Plant operates smoothly]

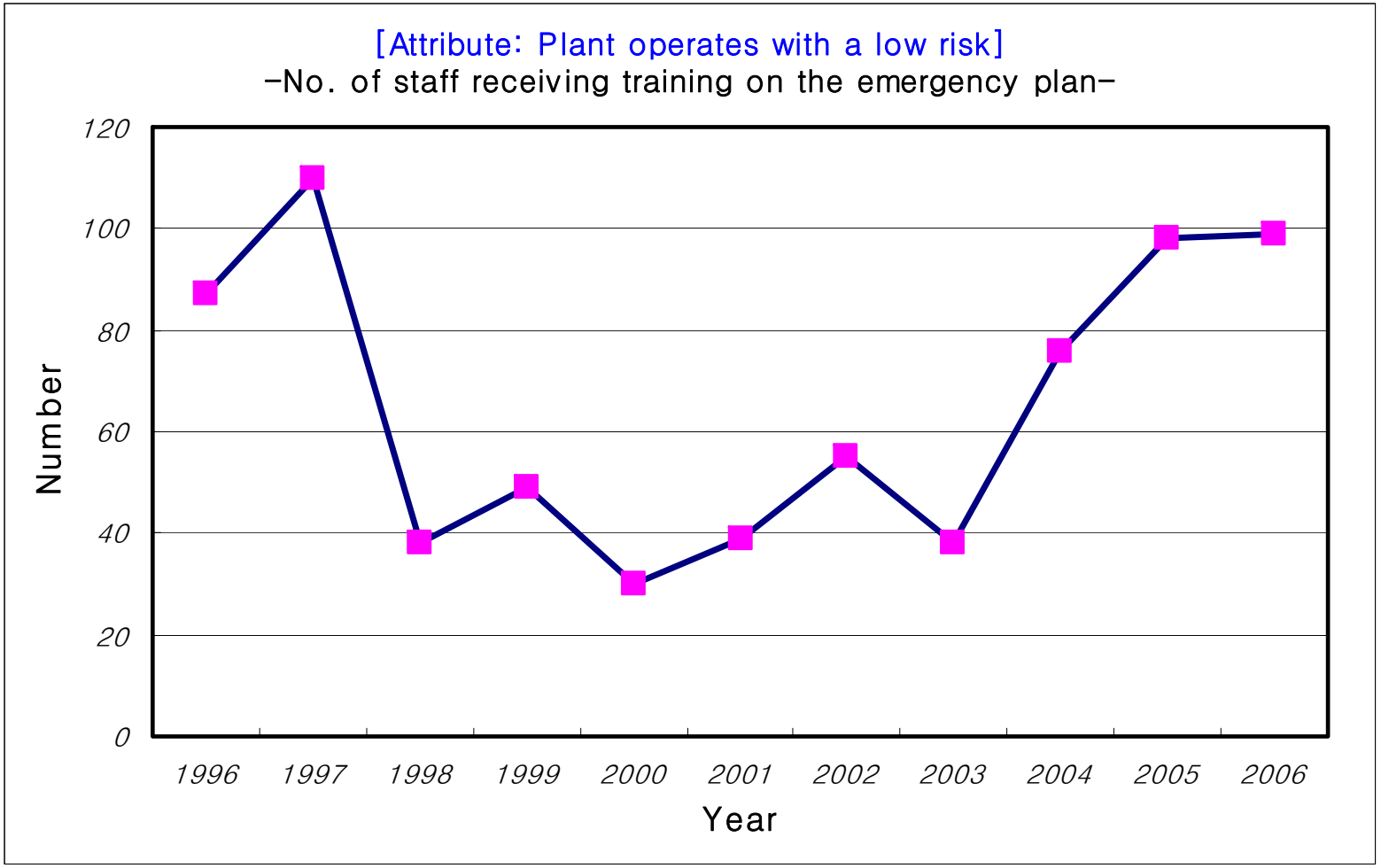
-Conducrivity/Confinement-



Example – Trend 2



Example – Trend 3



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5. Summary (1/3)

- **The proposed IAEA concept and framework for a program to monitor an operational safety performance is considered as a good approach not only for a NPP but also for a research reactor.**
- **HANARO selected 4 safety attributes, 10 overall indicators, 22 strategic indicators and 42 specific indicators for operational safety performance.**
- **This year HANARO started to systematically gather the information on the operation/maintenance data and to study the evaluation method.**

5. Summary (2/3)

- **HANARO does not have a final performance indicator program yet.**

  Some indicators may need to be modified due to a lack of appropriate analysis tools and application experience.

- **Through reviewing these indicators, it is expected to obtain the following information;**
  - **Plant safety attribute**
  - **Safety information, for example, reactor operation status and radiation safety**
  - **Measures necessary to improve the safety management**
  - **Early warning to management for decision making**

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5. Summary (3/3)

- **Next year HANARO will implement this performance indicator program and study the analysis tools.**

- **The HANARO will continuously pursue the trends of the operational safety performance for an effective safety management of a reactor operation and its utilization.**

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HANARO

- THANK YOU -