XA0102806
IAEA-CN-82/21

IMPROVEMENT PROGRAMME OF SAFETY PERFORMANCE INDICATORS (SPIs) IN KOREA

LEE, S. Y.
Korea Institute of Nuclear Safety
P.O. Box. 114, Yu-Sung
Taejon, Republic of Korea
Fax: +82-42-863-3381, Email: K272LSY@KINS.RE.KR

Abstract

KINS has developed and used Safety Performance Indicators (SPIs), which are count based and composed of 10 indicators in 8 areas, to monitor the trend of performance of NPPs in Korea since 1997. However, the limited usage of SPIs and the increasing worldwide interest on SPIs became the motivation of the SPI improvement programme in Korea. Korea is planning to establish plant performance evaluation programme through analysis of SPI and result of inspection. The SPI improvement programme is a part of the plant performance evaluation programme and includes study on performance evaluation areas, indicator categories, selection and development of indicators, redefinition of indicators and introduction of graphical display system.

The selected performance evaluation areas are general performance, reactor safety and radiation safety. Each area will have categories as sub-areas and total six categories are selected. One or two indicators for each category are determined or will be developed to make a set of Safety Performance Indicators. Also graphic display system will be introduced to extend the usage of SPIs.

1. INTRODUCTION

Performance indicators for the quantitative assessment of NPP's operational performance have developed and used by many operating organizations, regulatory bodies, and international organizations as their own purposes. The performance indicators can be used to monitor and to gain perspective on performance and progress of a nuclear power plant. The PIs also provide an indication of the possible need to adjust priorities and resources to achieve improved performance.

The importance and usefulness of performance indicators were recognized also in Korea and SPIs for Korean nuclear power plants were developed through a government-funded project in 1997 by KINS with the cooperation of the Korea Electric Power Corporation (KEPCO). The SPIs, currently used after one-year trial application and modification, are composed of 8 indicators for PWR plants. The SPIs for CANDU reactors are searched separately because CANDU reactors have different characteristics with PWRs and relatively less operating experience than PWRs in Korea.

Korean is planning and studying the establishment of plant performance evaluation programme. This programme will evaluate each operating NPPs in Korea using the analysis of SPIs and inspection results. However, current SPIs are all traditional count-based indicators and no performance goals were set. Also the increasing chances of comparing safety performance among plants or countries and the demand to utilize SPIs for regulatory purpose initiated the introduction of new concept, for example risk concept, into the safety performance indicators and graphic display system. The possibility of regulation policy change to performance-based regulation and increasing demand of public communication tool is also a motivation of the SPI improvement programme.
Currently, the international trends are also seeking the possibilities of expanding the usage of SPIs. For example, the OECD/NEA just started Working Group for developing IPIS (International Performance Indicator System) and US NRC developed and started 'New regulatory oversight programme' (NUREG-1649).

Overall improvement programme and results up to now are presented and also the result of current SPIs are illustrated in Figure 1.

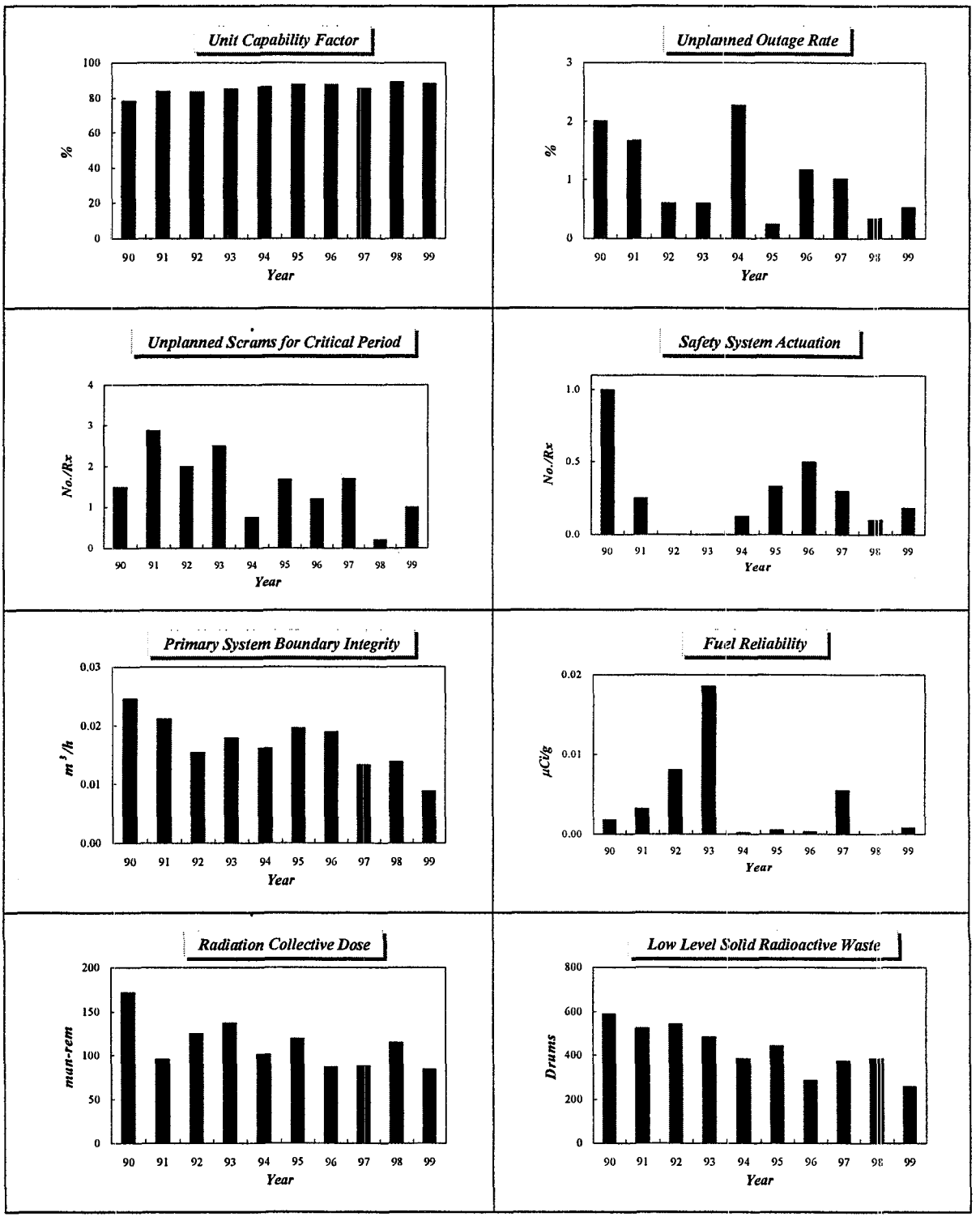

FIG. 1. Average trend of each indicator

2. FRAME WORK OF SPI IMPROVEMENT PROGRAMME

2.1. Safety performance evaluation area and categories

First of all, the areas to be evaluated to measure the safety performance of a plant are determined. The performance evaluation areas are selected based on the final goal of nuclear safety that is to protect public and environment from radiological hazards. Those areas are general performance area, reactor safety area and radiation safety area. The general performance area is not directly related to the safety but can show overall performance which depends on the operation and maintenance.

The reactor safety area can be sub-divided into three categories, integrity of multiple barriers, initiating events and mitigation system. The safety of nuclear plant could be assured when the multiple barriers maintain their integrity. These barriers include fuel, primary coolant, containment and emergency preparedness. Indicators to measure the integrity of each barrier are selected.

Safety performance can also be measured by the occurrence of reportable events and availability of mitigation system. Korean reporting criteria prescribes many reportable events and unplanned reactor scram is one of the important reportable events. Safety Injection system and emergency diesel generator are major accident mitigation systems.

Radiation safety, both on site and off site, is an important area to measure the safety performance of a nuclear power plant.

In summary, the areas and categories for SPIs are as follows;

- general performance area;
  - operation;
  - maintenance;
- reactor safety area;
  - initiating events;
  - multiple barrier;
  - mitigation system;
- radiation safety area;
  - on site radiation safety
  - off site radiation safety.

2.2. Selection of SPIs

Characteristics of SPIs are considered before the selection of appropriate indicators within each performance evaluation area. The characteristics of improved SPIs should be;

- based on current SPIs;
- able to cover safety related areas;
- balanced among indicators;
- balanced reactor types in Korea;
- comparable with other countries or plants;
- based on available and controllable data; and
- possible to communicate with public.

Based on the above characteristics of SPIs and areas and categories for SPIs, most of the current SPIs are adopted and additional SPIs to be developed are determined. Those SPIs adopted from current SPIs are reviewed and some of the SPIs need to be redefined following the new concept of improved SPIs.

Besides the selected SPIs additional SPI candidates are proposed and are under review. Those are unplanned power reduction indicator and number of reportable events in initiator area etc.

2.3. Definition of selected SPIs

2.3.1. General performance area

In this area, there are two categories and one indicator for each category. Unit Capability Factor and Unit Outage Rate were selected as indicators to measure operational and maintenance sub-area under general performance area.

- Operation
  Indicator (UCF): Unit Capability Factor
  UCF = actual electricity generation/design capacity
- Maintenance
  Indicator (UOR): Unit Outage Rate
  UOR = unplanned outage time/ (unplanned outage time + reactor operating time).

2.3.2. Reactor safety area

- Initiating event
  Unplanned Reactor Scram is selected as an indicator representing the initiating events because the unplanned reactor scram is the major event in frequency of report among reportable events.
  Indicator (USR): Unplanned Reactor Scram
  USR = No. Of unplanned reactor scram for 7000 critical hours

Unplanned power reduction and number of reported events are candid indicators in this area.

- Multiple barriers
  All the physical and non-physical barriers are selected in the category of multiple barriers. These are Fuel, Primary Coolant, Containment and Emergency Preparedness.
  Fuel Indicator (FR): Fuel Reliability
  FR = I-131 equivalent activity in primary coolant (same as WANO's)
  Primary Coolant Indicator (PCL): Primary coolant leakage
  PCL = Primary Coolant Leak Rate
  Containment Indicator (CL): under development
  Containment leakage during test is a candid indicator.
  Emergency Preparedness Indicator (EP): under development

Number of findings in the inspection of emergency response facility could be an indicator.

- Mitigation System
  Safety Injection System availability and the availability of Emergency Diesel Generator are selected as indicators for mitigating system. PSA result will be incorporated in these indicators.
  Safety Injection Indicator (SIA): SI system Availability
  SIA = Availability of SI system
  Emergency DG Indicator (DGA): DG availability
  DGA = Availability of EDG.

2.3.3. Radiation Safety Area

Radiation Safety area has two indicators which are on site radiation safety and off site radiation safety.
On-site Radiation Safety Indicator (RCD): Radiation Collective Dose
RCD = Radiation collective dose including sub-contractors
Off-site Radiation Safety Indicator (ORE): under development
ORE = off-site radiological effects
ODCM could be used for this indicator.

Safety Performance Evaluation Area	Category	Indicator	Remark
General	Operation	- Unit Capability Factor	
	Maintenance	- Unplanned Outage Rate	
	Initiator	- Unplanned Reactor Scram	
Reactor Safety	Multiple Barrier	- Fuel Reliability	
		- Primary Coolant Leakage	
		- Containment Leakage	UD*
		- Emergency Preparedness	UD*
	Mitigation System	- SI availability	
		- DG availability	
Radiation Safety	On site radiation safety	- Radiation Collective Dose	UD*
	Off site radiation safety	- Public Dose/Environmental Radiation	

* UD: under development

Table I. SPI summary

2.4. Performance classification and graphical display

The PI improvement programme includes graphical display of SPIs of each plant. All the safety performance will be classified as four levels which are satisfactory, acceptable, attention and unacceptable. The threshold of each level will be determined by using PSA results and statistical method based on database. This graphical display system will make SPIs more easier to evaluate plant safety performance for users and public. Proto-type graphical display form was suggested and under development by computer engineers and web designers.

3. CONCLUSION AND FUTURE WORK

The increasing interest on SPI and changing regulatory environment was the motivation of the SPI improvement programme. The improved SPIs will be based on current SPIs but the concept of whole system will be quite different. Current SPIs were developed on count-base and lack of completeness and comparability limited the utilization of them. They could only give average performance trend and no thresholds for acceptable performance level were established. The improved SPIs will have more completeness and comparability by more comprehensive study and introducing PSA. With the improved SPIs and other regulatory measures the acceptability of safety performance of all NPPs in Korea and appropriate regulatory response could be determined. In addition, the SPIs with graphic display system will serve as a public information tool for easier understanding of safety performance of NPPs.

Once the draft of the improved SPIs and graphical display system is completed, trial use on pilot plant is planned. Any deficiency or unpractical findings will be corrected and modified for actual use. Also additional SPIs will be added if required during trial use or actual use of the new SPIs.

We understand the SPIs are not stand only tools to evaluate safety performance of a plant and may have adverse effects for example operator bias when abused. User manual describing not only the purpose and definition of each SPI but also limitations and adequate usage of SPIs will be prepared.

References

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Operational safety performance indicators for nuclear power plants (IAEA-TECDOC-1141), IAEA, Vienna (2000).

[2] NUCLEAR ENERGY INSTITUTE, Regulatory Assessment Performance Indicator Guideline (NEI 99-02), (1999).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY/NUCLEAR ENERGY AGENCY OF THE ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, Safety Performance Indicators (Proc. Specialist Meeting on Safety Performance Indicators, Madrid, 2000), IAEA/NEA/Ciemat/CSN (2000).

[4] LEE, S., Performance Indicators of Korean Nuclear Power Plants (KINS/AR-729), Taejon (2000).