

Safety Performance Indicators used by the Russian Safety Regulatory Authority in its Practical Activities on Nuclear Power Plant Safety Regulation

A.L.Khazanov

Scientific and Engineering Centre for Nuclear and Radiation Safety, of Nuclear Industrial and Environmental Regulatory Authority of Russia,
Moscow, Russia.

Abstract. The Sixth Department of the Nuclear, Industrial and Environmental Regulatory Authority of Russia, Scientific and Engineering Centre for Nuclear and Radiation Safety process, analyse and use the information on nuclear power plants (NPPs) operational experience for NPPs safety improvement. Safety performance indicators (SPIs), derived from processing of information on operational violations and analysis of annual NPP Safety Reports, are used as tools to determination of trends towards changing of characteristics of operational safety, to assess of effectiveness of corrective measures, to monitor and evaluate of the current operational safety level of NPPs, to regulate NPP safety. This report includes list of the basic SPIs, those used by the Russian safety regulatory authority in regulatory activity. Some of them are absent in list of IAEA-TECDOC-1141 («Operational safety performance indicators for nuclear power plant»).

1. Introduction

Determination and analysis of SPIs are one of the main components of the operational experience feedback. SPI, side by side living PSA (probabilistic safety analysis), have become the basic tool in safety management, for controlling the safety performance of NPP.

Safety performance indicators are intended to:

- identify events and conditions that are precursors to significant degradation and have the potential to cause severe accidents;
- identify and forecast trends in the operational safety status of the NPP;
- identify areas requiring special attention to ensure safe operation of the NPP;
- assess the effectiveness of measures taken to raise of operational safety of the NPP;
- issue of the recommendations to improve of operational safety of the NPP, to regulate NPP safety.

SPI are used by regulator for monitoring and control the current operational safety level of NPPs, for identification degradation of the power units systems and elements and deficiencies in management of NPP Operations. Regulator use this information in regulatory activity, in licensing process.

SPIs are defined in the course of information compiled in NPPs operational violations database processing and submitted in annual NPP Safety Reports that are to be drawn up by NPPs in accordance with the requirements of regulators.

To ensure the use of SPIs effectiveness, comprehensiveness and trustworthiness (reliability, validity) of information about malfunction in operation of NPPs must by provided.

2. Russian safety regulatory authority use following SPI (here are listed the basic SPIs):

2.1. Power utilization indices

- The load factor.
- The availability coefficient.
- Time utilization coefficient.

2.2. State and reliability of the physical protective barriers

- Fuel element reliability index.
- Reactor core cooling circuit leak tightness index
- Results of non-destructive monitoring of metal of equipment and pipes of the primary circuit and of safety-related system*.
- Containment leakage.

2.3. State of the protection systems

- Numerical values of unavailability indices of safety systems.
- Number of failures in safety systems (average value per unit per year).
- Percentage of failures in safety systems discovered by surveillance and testing.
- Number safety systems actuations, including:
 - a). false;
 - b). on requirement;
- Number of incidents with dependent and independent failures in safety systems superimposed on the initial event in each event.*
- Number of dependent and independent failures in safety systems superimposed on the initial event in each event.*

2.4. Operating performance. (Forced power reductions and outages, events, servicing and maintenance, operations organization; compliance with procedures, rules and licensing requirements, Measures to improve operational safety);

- Number of incidents with scrams (average value per unit per year), including:
 - (a) during power operation;
 - (b) false;
 - (c) on requirement;
- Power fluctuation intensity index.
- Number of incidents (average value per unit per year).
- Number of incidents with the violation of the conditions and limits of the safety operation.
- Number of common cause failures.
- Number of repeated failures.
- Number of failures in normal operation systems (average value per unit per year).
- Number of incidents with dependent and independent failures in normal operation systems superimposed on the initial event in each event.*
- Number of dependent and independent failures in normal operation systems superimposed on the initial event in each event.*
- Number of shortcomings of organization NPPs operation, average value per unit per year*:

- (1) non-availability of procedures, deficiencies in procedures;
- (2) deficiencies in operating documents (deficiencies in various operating, repair manuals, regulations);
- (3) documents regulating equipment acceptance for operation after repair, deficiencies associated with repair, work medium, spare parts, spare equipment);
- (4) deficiencies in personnel training;
- (5) low efficiency of corrective action on results of NPP operational events' analysis;
- (6) failure to take measures on elimination of deficiencies found during operation;
- (7) deficiencies in planning, arrangement and execution of activities;
- (8) deficiencies in accident investigation (failure to find root causes of initial events and dependent and independent failures superimposed on the initial event in each event);
- (9) cases of demonstration of insufficient level of safety culture.

- Lists of o deviations from established water chemistry values in the main process circuits of the power unit.
- Technical specification exemptions.
- Number of violations to technical specifications.
- Number of violations of the licensing requirements.
- Exhaustions of the major equipment designed resource index.
- Servicing and maintenance quality index, number of violations in NPP operation caused by failing in safety-related systems tests and maintenance*.
- List of measures adopted from reports of investigation of violation in NNP operation and information on their implementation.
- List of changes to safety system and their servicing showing the reasons for the change.
- List of alterations made to equipment and structures and steps taken to modernize systems and station control.
- Lists of work on phased modernisation of power units to improve safety and reliability planned for the future.
- List of accident training sessions and information on their performance.

2.5. Human performance

- Number of human errors (average value per unit per year), including:
 - a). by personnel categories;
 - b). by error types;.
- Percentage of events due to deficiencies in procedures.
- Percentage of events due to human errors.
- Number of human related incidents during testing, maintenance, or restoration.
- Number of low safety culture cases (average value per unit per year)*.

2.6. Effectiveness of population, environment and personnel radiation protection

- Effluent activity versus allowed limit.
- Number of workers receiving doses above limits.
- Collective radiation exposure.

2.7. Treatment with spent nuclear fuel*

- Filling of spent fuel pool.

2.8. Storage and processing of radioactive waste*

- Filling of liquid radioactive storage tanks.
- Filling of solid radioactive waste stores.

2.9. Status of firefighting protection of power units*

- Information on fires and conflagrations
- List of planned measures to improve fire safety, with timescales and implementation

Symbol (*) designates SPIs those used by the Russian safety regulatory authority, but are not listed in IAEA-TECDOC-1141 («Operational safety performance indicators for nuclear power plant»).