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NUCLEAR ENERGY AGENCY
COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

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JOINT CSNI/CNRA REPORT ON REGULATORY USES OF SAFETY PERFORMANCE INDICATORS

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McKinsey & Co. – "everything can be measured and what gets measured gets managed"

Albert Einstein – "not everything that can be counted counts and not everything that counts can be counted"

Douglas Adams – The answer to the ultimate question about life, the universe and everything is forty-two (from book "The Hitch Hiker's Guide to the Galaxy")

REGULATORY USES OF SAFETY PERFORMANCE INDICATORS

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), Korea (12th December 1996) and the Slovak Republic (14 December 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consists of 28 OECD Member countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

The NEA Committee on the Safety of Nuclear Installations (CSNI) is an international committee made up of senior scientists and engineers, with broad responsibilities for safety technology and research programmes, and representatives from regulatory authorities. It was set up in 1973 to develop and co-ordinate the activities of the NEA concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations.

The committee's purpose is to foster international co-operation in nuclear safety amongst the OECD member countries. The CSNI's main tasks are to exchange technical information and to promote collaboration between research, development, engineering and regulatory organisations; to review operating experience and the state of knowledge on selected topics of nuclear safety technology and safety assessment; to initiate and conduct programmes to overcome discrepancies, develop improvements and research consensus on technical issues; to promote the coordination of work that serve maintaining competence in the nuclear safety matters, including the establishment of joint undertakings.

The committee shall focus primarily on existing power reactors and other nuclear installations; it shall also consider the safety implications of scientific and technical developments of new reactor designs.

In implementing its programme, the CSNI establishes co-operative mechanisms with NEA's Committee on Nuclear Regulatory Activities (CNRA) responsible for the program of the Agency concerning the regulation, licensing and inspection of nuclear installations with regard to safety. It also co-operates with NEA's Committee on Radiation Protection and Public Health (CRPPH), NEA's Radioactive Waste Management Committee (RWMC) and NEA's Nuclear Science Committee (NSC) on matters of common interest.

COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

The Committee on Nuclear Regulatory Activities (CNRA) of the OECD Nuclear Energy Agency (NEA) is an international committee made up primarily of senior nuclear regulators. It was set up in 1989 as a forum for the exchange of information and experience among regulatory organisations.

The committee is responsible for the programme of the NEA, concerning the regulation, licensing and inspection of nuclear installations with regard to safety. The committee's purpose is to promote cooperation among member countries to feedback the experience to safety improving measures, enhance efficiency and effectiveness in the regulatory process and to maintain adequate infrastructure and competence in the nuclear safety field. The CNRA's main tasks are to review developments which could affect regulatory requirements with the objective of providing members with an understanding of the motivation for new regulatory requirements under consideration and an opportunity to offer suggestions that might improve them or avoid disparities among member countries. In particular, the committee reviews current management strategies and safety management practices and operating experiences at nuclear facilities with a view to disseminating lessons learned.

The committee focuses primarily on existing power reactors and other nuclear installations; it may also consider the regulatory implications of new designs of power reactors and other types of nuclear installations.

In implementing its programme, the CNRA establishes cooperative mechanisms with the Committee on the Safety of Nuclear Installations (CSNI) responsible for the programme of the Agency concerning the technical aspects of the design, construction and operation of nuclear installations. The committee also co-operates with NEA's Committee on Radiation Protection and Public Health (CRPPH) and NEA's Radioactive Waste Management Committee (RWMC) on matters of common interest.

ACKNOWLEDGEMENT

This report has resulted from the work of the CSNI/CNRA Task Group on Safety Performance Indicators during 2002-2005. Consequently, it is fair to express thanks to all the persons who have contributed to the work of the Task Group, and their names are mentioned in the appendices of this report with the description of the work carried out. The report would not have been possible without a significant contribution from some individuals and they deserve to be mentioned separately. Mr. Lennart Carlsson (chairman, SKI), Mr. Yves van den Berghe (AVN), Mrs. Seija Suksi (STUK) and Mr. Patrick Baranowsky (US NRC) all gave their personal constructive effort to work. Mr. John Lyndon Summers greatly contributed to the work and drafting of the final draft versions of the report as a consultant to the NEA. The final version of the report was prepared by Dr. Pekka Pyy and Mrs. Elisabeth Mauny at the OECD Nuclear Energy Agency.

TABLE OF CONTENTS

1. INTRODUCTION

Nuclear regulators monitor closely the safety of the installations under their supervision. They need, in addition to inspection results and other intelligence, indicators to give information about the safety level. In many cases this happens in terms of safety significant parameters, such as the number of scrams or collective dose. Most regulators have in place country-specific programmes on safety performance indicators (SPIs).

The regulatory SPIs are often generated by nuclear power plants (NPPs) themselves or with little additional data collection by the authorities. They are often seen as a cost-effective way to obtain information about the licensee safety performance. In some countries, there also is a growing demand for information about NPP and regulatory performance from stakeholders such as policy makers, parliament, public and media. Such a demand has to be responded to and the information provided needs to be meaningful and understandable to non-experts. Moreover, new regulatory practices such as moving towards risk-informed regulation in some countries emphasize the role of quantitative information.

Consequently, there seems to be a need for a structured and hierarchical SPI system with indicators providing information for different stakeholders and decision situations. Regulators, moreover, have differing national regulatory frameworks, which come about through differing legal systems, legislation and culture. The ways in which SPIs, inspections and other ways to collect information for decision making are used in their regulatory frameworks are influenced by and reflect these differences.

In 1998, the NEA Committee on Nuclear Regulatory Activities (CNRA) began an activity, the objective of which was to advance the discussion on how to enhance and measure regulatory effectiveness in relation to nuclear installations. One of the outcomes of this activity has been establishing two task groups: a CNRA Task Group on Regulatory Effectiveness (TGRE) and the Joint CNRA / CSNI (Committee on the Safety of Nuclear Installations) Task Group of Safety Performance Indicators (SPIs). The latter had previously existed under the CSNI with some different goals for a common indicator system.

This report discusses the work and findings of the Joint CSNI/CNRA Task Group. It takes into account a number of previous, related studies by CNRA, CSNI and the activities of international bodies WANO, IAEA and EU (European Union). A summary of these activities is given in Appendix 5 of this report.

The report is organised as follows. Firstly, the objectives and the scope of the Task Group activities are described. Then, insights generated during the Task Group work are discussed ranging from the policy and framework level to experience with individual indicators. At the end, some necessary cautions are made. Finally, conclusions are presented with recommendations to the CNRA and the CSNI. Several appendices give complete details on the findings of the Task Group work and summarise other related international activities in the field of SPIs.

2. SCOPE AND OBJECTIVES OF THE CSNI/CNRA SPI TASK GROUP

2.1 Objectives

The first objective of the Task Group, when it operated under the CSNI only, was to compile a summary report on plant performance indicators currently being used or being tested by regulatory bodies, to prepare sets of common performance indicators that could be used by each regulatory body and to prepare a summary of the work. The Task Group reported its work in ***NEA/CSNI/R(2001)11 - Summary Report on the Use of Plant Safety Performance Indicators***, and defined six indicators most commonly used by participating regulatory bodies.

After issuing the report, the mandate and goals of the group were revised and the CSNI and CNRA approved new goals in 2002 for the Joint CSNI\CNRA Task Group. Under this new mandate, rather than defining a common indicator system, the Task Group was instructed to establish good practices among regulators especially in data collection on the operational safety of NPPs and in the use of SPIs for decision making. Also, the task was to take into account the observed performance and reliability of main safety functions. The revised objectives are shown in Appendix 1.

2.2 Scope of the Task Group Activities

The Task Group activities consisted of **meetings**, a **workshop** and two **questionnaires** aimed to provide input about the objectives, status, experience and future plans in member countries with SPIs.

The Task Group held six **meetings** in the period 2002-2005. During that time, representatives from Belgium, Canada, Czech Republic, Finland, France, Germany, Hungary, Japan, Korea, Slovak Republic, Slovenia, Spain, Sweden, UK and USA contributed to its work. International agencies: WANO (World Organisation of Nuclear Operators) and IAEA (International Atomic Energy Agency), also provided input. The discussions during the Task Group meetings form an important input to the final report. A complete list of national representatives that have contributed to the work is given in Appendix 2 and a summary of the meeting outcomes in Appendix 5.

In addition to its meetings, the CSNI/CNRA Task Group organised in cooperation with Consejo de Seguridad Nuclear (CSN) a **workshop** on "Regulatory Uses of Safety Performance Indicators". The workshop was held in **Granada, Spain** in May 2004. It was attended by 53 experts from the industry, regulators and technical support organizations in 18 countries. The workshop proceedings were issued as report ***NEA/CNRA/R(2005)3 - Summary and Conclusions of the Joint CNRA/CSNI Workshop on the Regulatory Uses of Safety Performance Indicators.*** Its summary and conclusions provide a brief overview of the developments in the field and the kernel of them is presented as a part of Appendix 5.

As a part of its work, the Task Group also organised **two questionnaires**. The main purpose of the first questionnaire was to collect information from the member countries about the objectives, stakeholders and structure of their SPI systems. In addition, it covered data collection arrangements, information on how indicators are used in regulatory oversight and decision-making and further development projects.

Fourteen countries contributed with information: Belgium, Canada, Czech Republic, Finland, Germany, Hungary, Japan, Korea, Slovakia, Spain, Sweden, Switzerland, UK and USA. The template of the first questionnaire and an extensive summary of the replies are given in Appendix 3.

The Task Group launched a second questionnaire to expand on the findings of the first questionnaire by collecting detailed information on regulatory experience with SPIs. Both generic and indicator-specific experience was sought, including positive and negative insights. The second questionnaire allowed countries to provide precise definitions of the indicators they use for regulatory purposes. It covered experience with processes in place for collecting data, calculating indicators and assessing indicator results. Also, questions about experience and challenges in transforming indicator data to meaningful information for decision-making were included.

Ten countries contributed information: Belgium, Finland, Germany, Hungary, Japan, Korea, Slovenia, Spain, Sweden and USA. The template of this second questionnaire and the summary of the replies are given in Appendix 4.

3. INSIGHTS IN THE USE OF SPIs BY REGULATORY BODIES BASED ON THE WORK OF THE CSNI/CNRA TASK GROUP

3.1 The needs of Regulators

The Task Group, confirmed by other groups whose work is reported in Appendix 5, have reached the firm conclusion that SPIs for themselves have no value unless they are to be used for a specific purpose. There is no merit in designing and delivering SPIs simply for numeric values if their uses are not defined. Also, an indicator giving information for one use may give worthless misleading information for a slightly different use.

The Task Group questionnaires allowed identifying several objectives for **regulators’** safety performance indicator systems. The following table provides an overview:

Table 1. Overview of replies about the objectives for the establishment of a regulatory SPI system (for more information, see Appendix 3 for replies and Appendix 2 for country codes)

Objectives mentioned by countries:	BE	CA	CH	CZ	ES	FI	GB	HU	JP	KR	SE	SK	SL	US
objectively measure safety performance		x		x	x	x	x	x	x	x		x	x	x
to identify timely degradation in safety performance / predict arising problems	x	x	x			x					x		x	
to provide additional insights on plant safety performance	x	x	x	x		x					x			
allows national and international comparison of safety performance					x					x				
provide information on safety performance to congress/parliament		x			x	x							x	x
provide information on safety performance to policy makers/ government		x		x		x			x			x	x	x
provide information on safety performance to industry/licensees		x		x		x		x	x					x
provide information on safety performance to public, news media, …		x		x		x			x	x		x	x	x
to evaluate/develop RB supervision activities						x								
to allocate resources in effective and efficient manner		x		x		x	x	x					x	x
to trigger additional investigations/inspections	x	x	x	x									x	
to rationalize RB enforcement policy/provide basis for regulatory actions		x		x				x					x	x

From these replies the Task Group concluded that the following broad classes of objectives can be identified for SPI systems used by regulatory bodies:

- ***to measure the safety performance of licensees*** – as part of their regulatory oversight - a way of judging safety performance of licensees in concert with inspection, interview, scrutinising documents etc. and as a way of judging whether a licensee's systems for managing safety are effective in attaining good and, in most cases, improving, safety performance (note: some regulators may have no powers to seek improving safety performance);

- ***to improve their own regulatory activities*** – as a tool of helping target their resources (e.g. inspections) in the most effective ways and as a tool of identifying declining, or deficiencies in, safety performance that may warrant investigative or enforcement actions;

- ***to communicate about the safety of NPPs with stakeholders*** – in some countries, there is a growing demand for information about NPP performance from stakeholders such as policy makers, parliament, public and media. Such a demand has to be responded to and the information provided needs to be meaningful and transparent;

- ***to measure their own efficiency and effectiveness*** – safety performance of the NPPs used as a way of deducing regulators' own efficiency and effectiveness - so that they can evaluate the effectiveness of other regulatory tools and identify areas for improving their performance and monitor the effects of changing their regulatory processes (for further discussion see section 3.9); and

- ***to compare safety performance with similar plants (on national or international level)*** – some countries operating similar plants or having similar regulatory frameworks might want to compare safety performance between similar plants.

Only a minority of replies to the questionnaires support the last two classes of objectives.

There is a need to make a clear distinction between the needs of regulators and those of licensees. Licensees want, for example, to measure their performance as part of a safety management system / quality management system, to self-improve, to identify and remedy deficiencies through Licensee Self Assessment (LSA), etc. Generally speaking, licensees seek a continual improvement in performance – both safety performance and commercial performance – and they may act long before the indicators reach values necessitating regulatory intervention.

Utilities also often wish to benchmark with other utilities and to demonstrate to their stakeholders - including the regulators - how safe and efficient they are. As utilities have different needs from regulators, it is accepted that there may be differences in the SPIs they use. Consequently, licensees' SPI systems are likely to be larger and deeper in hierarchy than those of regulators'.

3.2 The influence of the regulatory policy and framework in uses of SPIs

Regulators have differing regulatory frameworks, which come about through differing legal systems, legislation, culture and philosophy. The way in which SPIs fit into their regulatory frameworks reflects these differences. Because of the varied needs of regulators in different countries, and because some regulators use SPIs for other purposes in addition to regulatory oversight, it is hard to draw out commonalities.

Table 2 provides an overview of country replies to the question about the present regulatory uses of SPIs. As seen, there is a scatter in the replies manifesting the different national frameworks but possibly also the fact that the SPI systems are under development.

Table 2. Present regulatory uses of SPIs (See Appendix 2 for country codes)

Used of indicators by Regulators	BE	CA	CH	CZ	DE	ES	FI	GB	HU	JP	KR	SE	SK	SL	US
Development of inspection program based on PI data			x	x			x			x			x		x
Increased RB response when threshold values are crossed			x						x	x			x	x	x
Regulatory action determined by integrated picture (PI combined with other info)	x	x		x			x					x			x
Indicator trending used internally to focus on problematic areas		x		x		x	x							x	x
Regulatory action depending on trend violation and margin to safety		x					x								
Indicators are compared among plants to rank regulatory responses		x				x									
Indicators are compared with those of foreign plants (performance evaluation)						x									
Annual reports with evaluation of safety level of NPPs from PI point of view	x	x		x			x							x	
Indicators are reported to parliament						x								x	
Reporting of selection of indicators to host ministries							x							x	
Selection of indicators are made public (through website, annual report …)			x				x				x				x

3.2.1 Role of SPIs in regulatory oversight - measuring safety performance

All regulators need to closely oversee their licensees' safety performance. Regulators who use SPIs regard them as a useful insight into safety performance and therefore this is for most regulators the most important use of SPIs.

All regulators recognise that SPIs alone are not sufficient to give a complete picture. They are part of a suite of tools used in drawing up a view on whether a licensees' safety performance is acceptable. Using SPIs in regulatory oversight must be part of, and complementary to, a wider range of regulatory activity consisting of such as inspection of plant, investigation of events, assessment and scrutiny of documents, interviewing licensees' staff etc.

3.2.2 Role of SPIs in focussing regulatory activities

For most regulators, their oversight is a feedback loop in which the level of scrutiny and enforcement is "performance informed". Many regulators are using SPIs as a component in identifying areas of poorest performance and highest risk, on which to focus and to prioritise inspections. In all such cases the regulators do not rely only on SPIs but use the information alongside other intelligence to seek areas to be focussed on. Regulators are using such information in several ways, such as:

- *to actively and quickly respond to deteriorating performance with unplanned actions (inspections, investigations);*
- *as input to their long-term planning processes; and*
- *to contribute in triggering enforcement actions and, in some cases, providing evidence for those actions.*

3.2.3 Role of SPIs in communicating with stakeholders

More and more regulators are finding a need to report to external stakeholders, and stakeholders in some countries are requiring more openness and transparency from regulators. Some regulators regard it as a necessity to be completely transparent in their whole regulatory process while others keep part of it confidential. This, again, manifests differences in frameworks and cultures.

There is some variation between regulators in the stakeholders they identify for communication with, and the relative importance of the stakeholders. The Task Group identified the following as stakeholders (Table 3).

Table 3. Stakeholders mentioned in the replies to the questionnaire (See Appendix 2 for country codes)

Stakeholders mentioned by countries:	BE	CA	CH	CZ	DE	ES	FI	GB	HU	JP	KR	SE	SK	SL	US
Public		x		x			x		x	x	x			x	x
RB Policy Makers		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Government		x		x			x						x	x	
Congress/Parliament						x	x		x					x	x
Utility/Licensee	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Inspectors/Assessors	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Other							x								

SPIs constructed for the purpose of monitoring licensees' safety performance may be inappropriate for informing stakeholders and vice versa. In addition, different stakeholders have different needs and it may be that different attributes of SPIs are appropriate to different stakeholder communications. Cases have been mentioned that some stakeholders (e.g. Ministers) may have demands in this respect that might produce difficulties in interpretation and appropriateness.

3.2.4 Use of indicators for international benchmarking

WANO uses SPIs to support international exchange of information and encourage emulation of best industry practices (see Appendix 5). The system depends on a limited set of common indicators with unambiguous definitions and is supported by rigorous guidelines for indicator calculation. It is worth noting that only a few of the WANO indicators are directly related to plant safety.

The Task Group concluded that an international system of SPIs for regulators use is not foreseen as the needs and frameworks are different. Existing indicator definitions have been driven by licensee data available to the regulator, which limits the possibilities for comparison even between similar indicators. Furthermore, SPI systems in member countries are in different stages of development. A common indicator set presupposes an extensive and coordinated system on an international level that would to some extent hinder the possibilities of further improvement and tailoring of SPI systems in member countries.

It is however normal that some regulators may wish to cooperate to share limited parts of their SPIs in order to compare closely similar plants, since they may use complimentary information to explain similarities and differences. Also, regulators should always seek to compare good practices and experience with the development of indicator systems in similar regulatory frameworks.

3.3 Desirable attributes of an SPI system

Desirable attributes for SPIs have been mainly discussed during previous CNRA and CSNI work (Appendix 5). The Task Group notes that the following are the main attributes:

- *There should be a clearly defined, logical relationship to the safety regulators goals and objectives.*
- *The definition of indicators should be clear and precise.*
- *The indicators should be resistive to manipulation, misuse or misunderstanding.*
- *At least some of the SPIs should lead to timely indications of safety degradation.*

Also, at least some SPIs should be useful to reveal latent deficiencies in licensees' systems and processes. However, there is usually a time-lag between a decline in safety and a change in the value of an SPI.

Shortening the lag by use of predictive indicators has been under repeated discussion for years. The degree of lag that is acceptable to allow regulatory actions varies depending on the SPI. A longer lag can generally be tolerated for reporting to stakeholders, planning regulatory activities and deducing effectiveness than, e.g. for monitoring safety system performance. Regulators may try various means to reduce the time-lag by, e.g. decreasing the time period between successive data points, but cost-benefit of such measures always have to be carefully considered.

For the time being, no set of *predictive* indicators has been developed, although e.g. analysis of indicator trends and PSA-related indicators may sometimes be used in that purpose. Some have also referred to *leading indicators* in this context. However, the Task Group discussions, particularly in the Granada workshop, ended up with a considerable uncertainty as to what these terms meant. Consequently, the Task Group leaves the discussion to another forum.

3.4 How SPI systems have been established

As discussed earlier, the extent of the role SPIs have in the regulatory oversight is the result of considering many factors, such as the legislation, culture, regulatory policy and framework, etc. Each regulator needs to find for itself a balance in the use of the various regulatory tools to its disposal., When constructing an SPI system additional factors come into play, as for example: availability of data, needed resources for collecting data or regulatory burden on the licensees, plant performance already covered by inspection programs, additional uses of SPIs (e.g. for communication with stakeholders) etc. For instance, the US NRC makes cost benefit analyses to decide if a particular feature is best monitored by SPIs or inspection plans considering licensees costs as well as their own in the calculation.

Regulators have to decide whether to rely on the licensees SPI system (with proper oversight of it to ensure it is working properly), or to establish a SPI system tailored to their needs. In the latter case, regulators might have an agreement with their licensees to provide the indicator results. Others might decide to collect data and calculate indicators independently from the licensee on the basis of licensee reports (including LERs) and other sources of information (e.g. inspection reports).

No unique way was reported about how to establish a regulatory SPI system. Some regulators try to establish from the start a more or less comprehensive system covering all the safety areas or cornerstones they want to include in their system. Others are gradually bringing into use SPIs, starting with few and adding to them later as they review the system to judge its effectiveness. Seeking completeness need not delay the introduction of a system, as there will be benefits even to partial systems. Some regulators also feel that a smaller set of SPIs, used together with the oversight of a licensee's more comprehensive set of indicators is the most appropriate.

As discussed under 0, some regulators use SPIs for stakeholder communication and report that the selection of indicators can be strongly influenced by the communication element. They are aware of the sensitivity and possibility of the public misinterpreting and comparing plants in inappropriate ways. There is, in such a case, a motivation to restrict the communicated indicators to those that are extremely objective (e.g. radiation doses) and to avoid subjective SPIs (e.g. dealing with licensees' safety management processes). Thus, the issue also arises that it is possible and in many cases even desirable to use different sets of SPIs for communication and regulation.

3.5 Coverage of safety areas or cornerstones by SPI systems

In addition to providing information that has contributed to the discussion above, the Task Group questionnaires sought to identify each of the significant aspects of a licensee's safety performance ("*cornerstones*") and the respondents' coverage of them in their SPI systems.

Most countries have established a hierarchical structure that helps to make more rigorous the process of constructing a system of SPIs. In some countries this approach also reflects the need for indicators at a strategic level as well as at a more operational level. The questionnaires showed that similar SPIs may arise independently of the hierarchy chosen.

In order to allow a presentation of the indicators used in the countries that contributed to the questionnaires, a mapping was performed to two hierarchical structures. The first structure is built on a set of cornerstones of safety performance, while the second corresponds to the structure proposed by the IAEA's Tecdoc-1141 for licensee SPIs, based on attributes of safe operation (Appendix 5). The exercise allows to easily comparing SPI systems in place in different countries including their scope and comprehensiveness.

The results of this mapping exercise are presented in 2 sets of tables. Table 4 and Table 5 provide information on the indicator areas, which are covered by the SPI systems in contributing countries. The tables included in Appendix 3 provide for interested readers more detailed information on the indicators themselves that have been selected for each of these areas.

Table 4. Indicator areas classified according to safety performance cornerstones (See Appendix 2 for country codes)

Indicator areas according to safety areas or cornerstones	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
A Reactor safety													
A1 Events	x	x	x	x	x	x	x	x	x	x	x	x	x
A2 Mitigating systems	x	x	x	x	x	x	x	x	x	x	x	x	x
A3 Barriers integrity	x		x	x		x	x	x	x	x	x	x	x
A4 Material condition and ageing		x				x	x						
B Radiation safety													
B1 Occupational Radiation Safety	x	x	x	x	x	x		x	x	x		x	x
B2 Public Radiation Safety / Environmental risk	x	x	x	x		x		x	x			x	x
C Industrial safety													
C1 Fire safety						x	x	x			x	x	
C2 Occupational safety		x					x	x				x	
D Global plant performance		x			x	x	x	x		x		x	
E Safety Management / Safety related processes													
E1 Human performance	x		x	x	x	x	x	x		x	x	x	
E2 Compliance / Attitude	x	x	x	x		x	x	x		x	x	x	
E3 Operational preparedness		x	x					x				x	
E4 Emergency preparedness		x	x					x	x			x	x
E5 Management of plant modifications	x	x				x		x		x		x	
E6 Maintenance	x	x	x		x	x	x	x		x		x	
E7 Self-assessment			x					x					
E8 Operating experience feedback	x		x				x	x		x		x	
E9 Backlog of safety issues							x					x	
F Physical Protection / Security													x
G Investments						x	x						

This mapping exercise shows that the conversion between both structures for presenting indicators is straightforward. It also allows to identify a few indicator areas that seem not be included in the IAEA Tecdoc-1141 structure. These areas include physical protection/plant security, as well as plant modifications and investments.

Table 5. SPI areas classified according to IAEA Tecdoc-1141 (See Appendix 2 for country codes)

Indicator areas according to IAEA TECDOC-1141 structure	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
Plant operates smoothly													
Operation performance													
Plant capability								x		x		x	
Forced power reductions	x	x		x	x	x	x	x	x	x		x	x
Status of Structures, Systems and Components													
Functionality		x	x			x	x	x		x		x	
Material condition and ageing		x				x	x						
State of barriers	x		x	x		x		x	x	x	x	x	x
Events													
Reportable events	x	x	x	x	x	x	x	x		x	x		
Incidents		x		x		x		x			x		
Plant operates with low risk (deterministic approach)													
Challenges to safety systems													
Actual challenges	x	x	x	x	x	x	x	x	x	x	x	x	x
Potential challenges													
Plant ability to respond to a challenge													
Safety system performance	x	x	x	x	x	x	x	x	x	x	x	x	x
Operator preparedness		x	x					x				x	
Emergency preparedness		x	x					x	x			x	x
Fire protection Programme Effectiveness						x	x	x			x	x	
Plant configuration risk													
Risk during operation			x	x		x	x	x				x	
Risk during shutdown													
Radiation safety													
Radiation protection effectiveness	x	x	x	x	x	x		x	x	x		x	x
Radioactive waste management		x	x					x				x	
Industrial safety													
Work accident rate		x					x	x				x	
Accident severity		x											
Physical Protection													
Plant Security													x
Plant operates with a positive safety attitude													
Attitude towards safety													
Compliance/Attitude to regulations, procedures, policies and rules	x	x	x	x		x	x	x		x	x	x	
Human performance	x		x	x	x	x	x	x		x	x	x	
Backlog of safety related issues							x					x	
Safety awareness			x										
Striving for improvement													
Self-assessment			x					x					
Operating experience feedback	x		x				x	x		x		x	
Plant modifications	x					x		x		x		x	
Investments						x							

Recognising that the definitions of indicators vary between countries, about 17 indicators could be identified as being commonly used by a significant number of regulators. Six regulators, about half of the respondents using a particular indicator, have arbitrarily been taken as the threshold for identifying these indicators. They are identified in the following Table 6.

Table 6. Common indicators according to cornerstone structure (See Appendix 2 for country codes)

	Common indicators according to safety areas or cornerstones	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
A	Reactor safety													
A1	Events													
	Unplanned scrams / RPS actuations	x	x	x	x	x	x	x	x	x	x	x	x	x
	Safety system actuations	x	x	x		x			x			x	x	
	Safety significant events / reportable events	x	x	x	x	x	x	x	x		x	x		
	Unplanned power changes	x	x		x				x	x	x		x	x
A2	Mitigating systems													
	Safety system availability	x	x	x	x		x	x	x	x	x	x	x	x
	Safety system failures	x	x		x	x	x				x	x	x	x
A3	Barriers integrity													
	Fuel reliability (RCS specific activity)	x			x		x		x	x	x	x	x	x
	RCS / Pressure boundary leak rate	x		x			x			x			x	x
	Drywell/ Primary Containment/ Hermetic zone tightness			x	x		x		x	x		x	x	
B	Radiation safety													
B1	Occupational Radiation Safety													
	Radiation exposure to workers - collective dose	x	x	x	x	x	x		x	x	x		x	
B2	Public Radiation Safety / Environmental risk													
	Public dose (calculated dose) / Environmental Radiation		x	x	x		x			x			x	
	Liquid Releases (excluding tritium, tritium releases)	x	x		x		x		x				x	
	Gaseous/air-born releases	x	x	x[1]	x		x		x				x	
E	Safety Management / Safety related processes													
E1	Human performance													
	Events due to human or organisational failure / MTO related events	x			x	x	x		x		x	x	x	
E2	Compliance / Attitude													
	Number of TS violations/deviations/non compliances (TS or L&C)	x		x	x		x	x	x			x	x	
	Number of TS exemptions (temporary changes) (TS or L&C)	x			x		x		x			x	x	
E4	Emergency preparedness													
	Drill participation / training on emergency response		x	x					x	x[2]			x	x

An observation may be made that the indicators that are commonly used by regulators seem to be those which are well-established and using data that are easy to collect or already available within the licensee. They have a clear and direct relationship to safety and responders report that they are "mature" in their systems. Most have a distinct engineering background. They cover *"cornerstones"* such as events, mitigating systems, barrier integrity, worker dose and releases, human performance, compliance with regulations and emergency preparedness.

[1] Used as indicator for fuel integrity

[2] As part of aggregated indicator

The "*cornerstones*" that are not so well served by commonly used indicators include material condition and ageing, fire safety and occupational safety, global plant performance, operational preparedness, licensee self-assessment, operating experience feedback process and plant security.

A selection of insights from experience in member countries with each commonly used indicator is compiled in Appendix 4. It also includes the full country replies to the second questionnaire about the experience with SPIs.

3.6 How regulators collect and process data

3.6.1 Data collection and calculation of indicators

A range of practices was reported by members of the Task Group. These practices may depend on the regulatory framework and the way indicator data are used. Most regulators rely partly on licensees' data and partly on data processed by themselves. Regulators in countries, such as USA and Canada, rely entirely on data produced by licensees. In some countries, there is a formal regulation in place requiring SPIs to be submitted to the regulator, whereas other regulators rely on data supplied voluntarily.

Consideration of data collection leads to the question about the confidence in the information obtained. There are varying reasons why regulators might question data reliability: there may be misunderstandings over definitions and collection schemes may be deficient. The Task Group even discussed intentional manipulation of values. Consequently, if regulators depend on licensee data, they may consider it necessary to verify the data and the systems producing it. Clearly, SPIs cannot contribute to oversight, or any of the other uses, unless regulators have confidence in the information based on which the SPIs are calculated. In spite of this, many countries have reported during the Task Group work and during the Granada workshop that they do not see confidence in data as a problem.

3.6.2 Thresholds and trends

Regulators have two distinct approaches for detecting degrading/improving safety performance and for regulatory decision making:

- *qualitatively, by trending indicator results; and*
- *through identifying instances in crossing predetermined threshold levels.*

The differences seem to arise through differences in regulatory philosophy and the role of indicators in the regulatory oversight process. Some regulators use trends as a trigger to start regulatory investigations into causes of declining performance. Others use thresholds to trigger regulators' attention or action (e.g. increased oversight or enforcement). The former is more frequent amongst the regulators as shown in Table 7.

Table 7. Ways to process and present indicator data (See Appendix 2 for country codes).

	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
Use of thresholds			x					x	x		x	x	x
Use of trends	x	x	x	x	x	x		x		x		x	
Use of colour codes								x	x	x			x

3.6.3 Use of colour codes

Regulators that use thresholds as a tool for assessing safety performance are inclined to use colour codes as well to visualise indicator results and categorise plants. Regulators that want to communicate with stakeholders on plant safety find it convenient to have a coloured coding. Also, some regulators (e.g. Sweden) are using colour codes internally as a visual and helpful representation when planning their activities.

No clear opinion about pros and cons was formed collectively by the Task Group about colour codes. Colour coding was regarded as capable of causing difficulties and confusion amongst regulatory staff, if it is not directly linked to regulatory actions or when the SPI in question is subject to different interpretations. Also, some cultural aspects may play a role in using or averting certain colours. Consequently, there may be other good practices to present indicator results. The regulator in Hungary, for example, uses a visualisation method that shows all the indicators and trends diagrammatically, in a single display.

3.6.4 Aggregation of indicators

There are different ways to aggregate or combine indicator outcomes to inform the regulator and its stakeholders about safety performance of plants.

Mathematical aggregation, in a hierarchical SPI system, of a number of lower-tier indicators into a smaller number of "upper-tier" strategic indicators offers the possibility of simplification when reporting to stakeholders, such as policy makers. However, few regulators use at present such aggregation methods according to the findings of the Task Group. There is a certain danger in the aggregation process because opposite trends of sub-indicators of an aggregated high level indicator could be hidden. Graphical multi-dimensional approaches may also be considered, since regulators mostly combine results of sets of indicators in order to get an integrated picture of specific areas of plant performance.

3.6.5 Review of SPI system

It is appropriate for regulators to periodically review their SPI systems. Certain SPIs may develop plateaux after continuous effort to improve safety performance as measured by these indicators. A further issue is that if the system is fixed and not subject to change it may eventually distort both the behaviour of licensees and regulators as they begin managing the indicators and not safety. This means that, with time, the indicators become less effective in stimulating improvements. One of the findings of the Task Group is that the regulators using SPI systems are, however, aware of this risk and are considering changes (see replies to questionnaires in Appendix 3 and 4 for more details on further projects of development of SPIs) .

Also, in the early stages of introducing an SPI system, it is appropriate to use reviews of the systems as an engine for improvement, particularly for those regulators who are introducing systems gradually. Thus regulators should be prepared to add, delete or amend SPIs as the need arises.

3.7 Indicators of Safety Management, Safety Culture and Attitude towards Safety

Measurement is an integral and essential part of a safety management system (SMS). Licensee organisations need to measure what they are doing in order to assess how effective they are at managing safety and how well they are developing and improving their safety culture. It is generally agreed that looking for indicators for safety culture, human and organisational performance and safety management effectiveness is indispensable to improve demonstration of self-assessment and continuous improvement.

There has been a considerable discussion at the Task Group on the need for regulatory indicators for licensees' safety management and safety culture.

A view has been expressed particularly by utilities at the Granada workshop that indicators of safety management and culture may be seen as belonging to the domain of utility organisation. Consequently, the regulatory bodies may not wish to go too far to that domain except by oversight and inspections. The implication of this is that regulators may wish to oversee that the licensees have safety management systems and processes in place but not to actively use the indicators themselves so as not to interfere with the benefits the licensee gains from them.

Many regulators are interested in using SPIs as part of their monitoring of the SMS and safety culture of licensees. A number of regulators report in the Task Group questionnaire that they have indicators in such areas as human performance, compliance, self-assessment and operating experience feedback. The view from some regulators was that they may have no powers to monitor SMS, but they may monitor the licensee's SPIs. Some regulators, in contrast, report that in their countries there are regulations requiring licensees to have a SMS and thus the regulator is obliged to actively oversee it. Once more, there are variations in country practices, and some regulators believe that they need to have their own measures of licensees' safety culture rather than relying on SPIs provided by licensees. Others believe that only the licensee is placed to be able to make such measurements and regulators have to be careful in closely overseeing them.

No clear agreement has emerged about what the regulators' indicators of safety management and especially safety culture are or even whether such indicators could be developed. Work has been done in Sweden, UK, USA, IAEA and in some other countries and, obviously, further work should take place in the area at least to bring order in the multitude of concepts.

3.8 PSA-related indicators

PSA-related SPIs are indices of risk, initiating event frequency or safety system unavailability. PSA related indicators thus represent an aggregation of operating experience data, and some users call them *risk-informed* indicators, which may be slightly misleading.

There is a considerable amount of work being done in this area. A few PSA-related SPIs are currently being used or tried out in regulators' SPI systems. Examples are:

- Mitigating Systems Performance Index (MSPI) in USA;
- Risk peaks and accumulated risk in Switzerland;
- Risk indicators based on system unavailability and TS exemptions in Slovenia and Finland;
- Core melt index for events in Hungary; and
- Number of precursor events in Belgium and Finland.

Some regulators have reported to the Task Group their aspiration to an increased use of PSA-related indicators. The EU Concerted action on PSA-related SPIs is mentioned in Appendix 5. A view promoted in the concerted action, too, is that indicators that are directly related to risk levels should be sought. The Task Group took no clear stand with regard to the question but the use of PSA-related information seems to be increasing.

Finally it should be mentioned that some countries (e.g. USA) reported that the concept for setting performance thresholds (see section 3.6.2) already included consideration of risk.

3.9 Role of SPIs in improving and demonstrating regulatory effectiveness

The CNRA TGRE conclusions (Appendix 5) identify SPIs as indirect (or outcome) indicators and describe how some regulators use them for their own self-improvement, using models such as Quality Management System (QMS), Balanced Scorecard (Finland) and EFQM (European Foundation for Quality Management model applied e.g. in the UK). There seems to be an increasing tendency within regulatory bodies to want to use SPIs as one basis for informing stakeholders and demonstrating to stakeholders how effective they are in meeting their regulatory goals. TGRE also annotates that, *while indirect indicators can provide information useful for regulatory purposes, they must be treated with great caution in deducing a regulator's effectiveness*, as it is difficult to isolate the contribution of the regulatory body from that of the licensee in achieving safe performance of nuclear installations. The findings of the CSNI/CNRA Task Group are in line with that remark.

4. CAUTIONS

A number of cautions have been identified in the course of the work of the Task Group and in previous work. It is worthwhile to summarise the most important of them:

- *SPIs may not be resistant to temptation of manipulation if, for example, licensees' staff bonuses depend on them or if direct public disclosure or regulatory actions will result from issuance;*
- *when SPIs are used for informing stakeholders and for oversight, there is always a possibility that licensees manage the indicators rather than safety, i.e. focus on the aspects measured rather than also covering those aspects not easily measurable - regulators may not be immune to this either; and*
- *regulators should be aware of the dangers of reacting to small changes in SPIs or any changes in those SPIs that have a high scatter as a result of small samples, e.g. counting small numbers of events.*

Other cautions were already mentioned in various parts of this report and are brought together here for convenience:

- *SPIs are only valuable if they are constructed with a specific objective in mind – different objectives may require different or auxiliary information to be collected;*
- *SPIs constructed for the purpose of monitoring licensees' safety may be inappropriate for informing stakeholders and vice versa – the indicator systems may have to be tailored for multiple purposes;*
- *there is usually a time-lag between a decline in performance and a change in the value of an SPI – trending together with combined use of several SPIs and other findings should lead this lag to be sufficiently short so that actions may be taken before major safety consequences take place;*
- *comparing SPIs internationally between different types of plants, different organisational frameworks and different cultures without add-on information may lead to a biased view of the safety of the compared installations;*
- *opposite trends may be hidden if data is mathematically aggregated to higher level indicators in a hierarchical SPI systems – any aggregation has to be made with care; and*
- *colour codes, though efficient in delivering the message about allowed ranges of SPIs, may cause confusion amongst people who are not fully familiar with their meaning and there may be cultural factors involved in importing such a system from country to country.*

5. CONCLUSIONS AND PROPOSALS TO THE CNRA AND THE CSNI

5.1 Conclusions

Most regulators are using or considering SPIs for a number of objectives: to oversee their licensees' safety performance; to improve their own regulatory activities by focussing their use of resources; to deduce their own efficiency and effectiveness; and to communicate with stakeholders.

All regulators need to oversee their licensees' safety performance. Those regulators who use SPIs regard them as providing useful insights and for some of them this is the most important use of SPIs. However, the SPIs alone are not sufficient to give a complete picture of licensee safety behaviour due to the fact that not all its dimensions are easily measurable. Consequently, the SPIs are part of, and complementary to, a wider range of regulatory activity aiming to find information about the licensee performance. These activities consist of such as inspection of plant, investigation of events, assessment and scrutiny of documents, interviewing licensees' staff etc. Regulatory oversight needs to be comprehensive, but the extent of the role SPIs have in that oversight is the result of considering many factors such as the legislation, culture, regulatory framework, etc. Each regulator needs to find its own balance in the use of these various tools.

The effort and cost of data collection is significant, which is one reason some regulators use licensees' data for their SPIs as much as possible. All regulators participating in the CSNI/CNRA Task Group advise that collecting SPIs for their own sake is a costly and fruitless exercise. There must be clear objectives to SPI information collection, and as the regulators have differing purposes for their SPIs, there also is a variation in the SPIs they use. Thus, a common system for all regulators does not emerge from the work of the CSNI/CNRA Task Group. Despite this fact, there emerges a set of about seventeen SPIs, which are used by almost a half of the regulators responding to the surveys. A remark that must be made, however, is that these seventeen SPIs do not use consistent definitions and consequently do not represent a template for international comparison.

Many regulators are of the opinion that indicators can and should be used in contributing to regulators' judgements on licensees' Safety Culture - also sometimes referred as Safety Climate or Safety Attitude in this context. The same applies to licensees' systems of feedback for self improvement – sometimes referred to Self Assessment, Quality Management and Safety Management Systems. However, there is little consensus on how regulators should oversee these aspects of licensees' safety behaviour and this topic is proposed as one for which CNRA could usefully pursue as future work.

Many regulators see SPIs as a source of information to use in focussing and planning the use of their regulatory resources and helping to provide evidence for enforcement actions. Thus, a practice of "performance informed/based" regulation emerges, which links with and closely parallels "risk informed" regulation. Some regulators are developing their thinking on the incorporation of PSA – related indicators into their suites of SPIs. It is generally agreed that PSA - related indicators can be usefully employed in this way.

Generally, regulators need to be open in their communications with stakeholders and they see SPIs as a vehicle for communicating licensee safety performance. Several regulators have indeed reported that the use of SPIs for stakeholder communication has been a factor in the choice of the SPIs themselves, as they try to ensure that they use no SPIs that might mislead stakeholders. However, some indicators may communicate better to external stakeholders and some others may be more useful in regulatory decision making and oversight. IAEA work is about to begin in the area of SPI communication.

Regulators may in some cases use the SPIs in measuring the effects of their own work, e.g. the effect of changes in their regulatory practice. However, excessive dependence on SPIs in deducing a regulator’s effectiveness should be avoided, as there is a difficulty in isolating the contribution to safety of the regulatory body from that of the licensee. More work obviously needs to be done to bring the work of the CNRA TGRE work and the CSNI/CNRA SPI Task Group to a common conclusion in future.

5.2 Proposals to the CNRA and the CSNI

- Because countries are in various stages of SPI system development and are reviewing their systems as they develop, we recommend a follow-up to monitor and share these developments with a meeting in 2007. An option to update the questionnaires after that should be considered. An integrated follow-up of the CSNI/CNRA Task Group and the CNRA TGRE could lead to mutual benefits.
- Development of valid and informative indicators dealing with barrier integrity (fuel, primary circuit, containment) requires knowledge on structural integrity. Here, follow-up of and a potential co-operation with the CSNI IAGE group are proposed.
- There is little consensus on what needs to be done or how with regard to indicators of safety management and safety culture. A programme is proposed, in collaboration with the CSNI SEGHOF, to explore the indicators in contributing to regulators' judgements in these areas.
- IAEA work is just commencing on the uses of SPIs for communicating with stakeholders. It is recommended that the CNRA encourages regulators to take part in such initiatives in this area, or at least take note of them.
- This report described the CSNI/CNRA Task Group progress over several years of activities during which the national regulatory SPI programmes have slowly emerged. It may be suitable to consider developing it into a green CNRA booklet. However, knowing that many countries were not yet ready to report to the Task Group the possibility to do this in 2007 as a part of the follow-up should be considered.

REFERENCE MATERIAL

In the past, the following CNRA and CSNI reports have been issued discussing various activities relating to safety performance indicators and/or organisational effectiveness:

NEA/CNRA/R(98)3 - Performance Indicators And Combining Assessments To Evaluate The Safety Performance Of Licensees.

NEA/CNRA/R(2001)3 - Improving Nuclear Regulatory Effectiveness

NEA/CNRA/R(2001)4 & 5 - Regulatory Inspection Activities Related To Radiation Protection, Long Shutdowns And Subsequent Restarts, And The Use Of Objective Indicators In Evaluating The Performance Of Plants, Workshop Proceedings, Baltimore, United States, 15-17 May 2000.

NEA/CSNI/R(2001)11 - Summary Report on the Use of Plant Safety Performance Indicators.

NEA/CSNI/R(2002)2& 3 - Specialist Meeting on Safety Performance Indicators, Proceedings, Madrid, Spain, October 17-19 2000.

NEA Publication 04728, Nuclear Regulatory Review of Licensee Self-assessment (LSA). ISBN: 92-64-02132-9. June 2003. 52 pages

NEA Publication 03669, Direct Indicators of Nuclear Regulatory Efficiency and Effectiveness - Pilot Project Results. ISBN: 92-64-02061-6. April 2004. 48 pages

Other bodies have issued reports of interest and some useful ones are listed below:

WANO has its own set of Performance Indicators (PI) for members – see http://www.wano.org.uk.

IAEA Peer Discussion Group (PDRP-4): Assessment of Regulatory Effectiveness

IAEA-Tecdoc-1141 "Operational Safety Performance Indicators For Nuclear Power Plants“.

OECD Environment, Health and Safety Publications – Series on Chemical Accidents No.11

EU concerted action “Approaches and Recommendations for the Application of Safety Performance Indicators for Nuclear Power Plants”

UK Health and Safety Executive “Successful Health and Safety Management” – HSG65

APPENDICES

Appendix 1: Action proposal with the objectives, October 2002

Title	**Task Force to propose good Performance Indicator practices among Regulators**
Objectives and expected products	The objective is to propose good practices in data collection for and use of performance indicators (PIs) in decision making. PIs for the operational safety of NPPs that will take into account observed performance, reliability of main safety functions are relevant for the activity.
Scope /Justification	The task is the continuation of the earlier CSNI/CNRA task force approved in June 2001 with changed goal-settings approved during the CNRA and CSNI meetings in December 2001 and June 2002. Regulators are monitoring closely performance of their plants as for most safety significant parameters, such as scrams or collective dose. They need indicators to evaluate safety of installations. Harmonising practices and spreading information about good ones helps regulators in their task. As much as possible, the proposed practices are built on already existing national systems in order to avoid additional burden to member countries.
Safety significance, use and users of the results	Indicators provide information that could be used to look for differences in safety performance. Understanding differences and similarities in practices helps to develop national indicator systems and to interpret results obtained. The principal users are the regulatory bodies.
Schedule and milestones	1. The task force has continued its activity in 2002 by two meetings (one internal task force workshop). 2. One meeting in spring 2003 (another internal workshop) 3. A CSNI/CNRA workshop at the end of 2003 / 2004 4. Two further working meetings and a report in 2004/2005.
Lead organisation(s)	SKI, Sweden
Participants	11 other countries + IAEA and WANO
Financing (if relevant)	
Requested action	Approval to continue to organise the workshop in 2003/4

Appendix 2. List of participants in Task Group

Dr. Javier YLLERA	IAEA
Mr. Yves VAN DEN BERGHE	Belgium (BE)
Mr. Ken LAFRENIERE	Canada (CA)
Mr. Greg RZENTKOWSKI	Canada (CA)
Mr. Radomir REHACEK	Czech Republic (CZ)
Mr. Marc DE FEU	EU (Belgium)
Mrs. Seija SUKSI	Finland (FI)
Ms. Naoelle MATAHRI	France (FR)
Mr. Didier WATTRELOS	France (FR)
Mr. Thomas FROHMEL	Germany (DE)
Mr. Szabolcs HULLAN	Hungary (HU)
Mr. Laszlo JUHASZ	Hungary (HU)
Mr. Andras TOTH	Hungary (HU)
Mr. Motoo Tominaga	Japan (JP)
Mr. Ken Kawaguchi	Japan (JP)
Mr Chang Wook HUH	Korea (KR)
Dr. Bon Hyun KOO	Korea (KR)
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Mr. Mikulas BENCAT	Slovakia (SK)
Mr. Matjaz FERJANCIC	Slovenia (SL)
Mr. Rodolfo ISASIA GONZALEZ	Spain (ES)
Mr. Enrique MELENDEZ	Spain (ES)
Ms. Elena VERDURAS RUIZ	Spain (ES)
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Mr. Lennart CARLSSON	Sweden (SE)
Mr. Yngve FLODIN	Sweden (SE)
Mr. Herbert DEUTSCHMANN	Switzerland (CH)
Mr. John W. BARTLETT	Great Britain (GB)
Dr. John HIGHTON	Great Britain (GB)
Mr . Richard JONES	Great Britain (GB)
Mr. John Lyndon SUMMERS	Great Britain (GB)
Mr. Patrick BARANOWSKY	USA (US)
Mr. Donald E. HICKMAN	USA (US)
Mr. Christopher HUNTER	USA (US)
Mr. Johann POPP	WANO (Paris)
Mr. Jurgen SCHLEGEL	WANO (Paris)

Appendix 3 – Results of the first questionnaire

3.1 Compilation of the replies (represents mostly the situation in 2003-4)

1. POLICY LEVEL AND FUNDAMENTALS

1.1 What is the rationale for setting up (an) indicator system(s) in your country (by the Regulatory Body (RB) or the nuclear industry)? What are its objectives?

Belgium

Situation up to 2003: In Belgium there is no formal indicator system set up by the Regulatory Body (Federal Safety Agency and its authorized inspection organization AVN) as part of its oversight of licensee performance. The reason for this situation was the belief of AVN management that indicators are not able to provide an accurate picture of licensee safety performance and the fear that licensees might focus their improvement actions mainly on safety areas that are monitored by indicators used by the regulatory body. In practice, an informal limited set of indicators has been used by AVN for many years with the objective to follow certain aspects of operational safety and to trigger additional investigations if needed.

A pilot project was started in 2002 at AVN to explore further the possible use of SPI's in its regulatory oversight process. For an update of this information in 2005 see response to second survey.

The licensees, being member of WANO, implemented the WANO-concept of performance indicators with the objective to benchmark their performance with the performance of NPPs worldwide. In addition the licensees have introduced site-specific indicators, in order to obtain a more balanced view of financial results and overall safety performance and to monitor and improve the performance of the individual organizational entities (operations, maintenance, etc.). In addition, more low-level indicators are used by some organizational entities for strict internal performance evaluation purposes.

Canada

– To give objective measures of safety performance of Canadian Nuclear Power Plant Licensees.
– To have the ability to compare CANDU nationally and internationally.

Ref Board Member Document 98-108 (1998 AECB documentation)

Czech Republic

The PI system was developed to assist SUJB's evaluation of the safety performance of nuclear power plants and to support decision-making process. It is designed to meet the following objectives:

- Accurately and objectively measure plant safety performance
- Allocate Regulatory body inspection resources
- Provide basis for regulatory actions
- Accurately communicate the safety performance to industry and to public (in near future)

Finland

The project to develop a set of indicators for nuclear safety supervision was established by Radiation and Nuclear Safety Authority (STUK) in 1995. Documents published by IAEA and other international organizations were used as examples of concepts and to organize the development project. The goal set for the STUK indicator System was:

- to identify weaknesses at nuclear power plants;
- to evaluate and develop NRR's supervision activities increasing efficiency and effectiveness; and
- to develop co-operation between STUK and stakeholders.

The aim was to develop an extensive system based on the concept of 'Defence in Depth'. After monitoring potential areas initial data collection, data analysis and test calculations were performed and a decision to adopt the indicator system to a managerial tool of the Nuclear Reactor Regulation department (NRR) was made in 1997 to illustrate levels and trends of nuclear power plants' performance and safety in a quantitative manner.

The STUK Indicator System is divided into two main areas: A) Safety of Nuclear Facilities, which describe utilities' safety performance, and B) Regulatory Activities describing STUK's performance. Both of these groups are divided further into three areas, each having from 3 to 7 "cornerstone areas" which contain the individual indicators. At the moment the STUK indicator system consists of about 35 indicators describing plant performance and more than 20 indicators describing regulatory activities.

The areas (layers) of the main area A) Safety of Nuclear Facilities are: I) Safety and quality culture, II) Operational events and III) Structural integrity. Principal subgroup I illustrate the condition of the plant and performance of different functional groups of the plant; as maintenance, operation, radiation protection. Quality management, and attitudes to safety as well. Indicators in the principal subgroup II describe specially operation and the performance of operation unit through events, their risk-significance and direct causes of events. In the third safety performance indicator area, the leaktightness of multiple barriers (fuel, primary circuit, secondary circuit, containment) is monitored.

Indicators of area "A" describe the effectiveness of the regulatory control and those of area "B" the efficiency of STUK's own activities. STUK Indicator System is a complementary tool in the nuclear safety regulation in addition to inspections (basic, specific, Periodic Inspection Programme) and periodic safety reviews. The indicator system has been intended for an information system which different functional sectors and individual inspectors at the department of NRR can utilise in their daily work. Indicators are available in STUK's intranet. Indicator system is applicable for assessing and detecting changes in performance and safety level of NPPs as well as assessing success of the strategy plan for focusing safety reviews and inspections of STUK.

The STUK indicator system has a performance-based approach additionally using risk-based indicators to define a risk level of performance. STUK indicator system is designed to meet the following objectives:

- Additional tool in overall assessment of the safety performance of nuclear power plants in protecting people, society and environment from harmful effects of radiation.

- Quantitative and understandable safety performance information and documentation to STUK, stakeholders, public and media.

- Provide the NRR and licensees with objective indicators to assess level of safety performance and trends, to allocate resources in an effective and efficient manner.

- Identify timely degradation in safety performance.

- Allow STUK to track causes of degradation of safety level and help to perceive areas and extent of deteriorated performance.
- Provide the host ministries (Ministry of Trade and Industry; Ministry of Social Affairs and Health) and governmental agencies with objective information to assist in decision making in energy questions and in assessing the energy policy.

Reference Document: NEA/CNRA/R(2001)5, pp 84-92

The licensees of NPPs are members of WANO and they are implementing WANO-performance indicators to follow-up their performance and to compare performance values worldwide.

Another licensee has developed an indicator system of its own to illustrate nuclear and radiation safety; also some indicators describing the efficiency of some projects and activities are included.

Reference document: NEA/CSNI/R(2002)2, pp. 52-56

Germany

The German utilities are routinely reporting to the WANO the set of “WANO indicators”.

As a response to operational events in German NPPs, whose root causes are supposed to be deficiencies in safety management, the federal regulatory body (BMU) has requested that the utilities develop an “indicator-based safety quality management system”. A proposal for such a system has been developed, and submitted to the regulator, by the utilities. The proposal currently is under review by expert organizations on behalf of the regulator.

As part of these activities a “Performance Indicator Pilot Project” for one specific plant is being performed.

For update of this information in 2005 see response to second survey.

Hungary

The PI system is an integral part of assessment activity of NSD. It is a performance-based approach designed to meet the following objectives:

- Accurately and objectively measure the safety performance of nuclear power plant in protecting the public health and safety
- Provide utility licensees and the NSD with objective indicators to assess safety performance and trends, to rationalize the NSD enforcement policy, and to allocate resources in a effective and efficient manner

Japan

We are now investigating and working to improve the overall inspection system for NPPs in Japan.

“Application of the inspection in compliance with the Performance evaluation”, that is effective to incite and strengthen the licensee’s efforts to improve, is the important item in this activity.

So we are going to introduce the new PI system in order to assist the inspections.

The main purpose of our developing PIs is to provide the program to assess safety performance objectively and reasonably, and as follows.

- Overall Assessment of Safety Performance
- Regulation in compliance with Safety Performance & Significance
- Opened Method for Informing the Public Accountable Explanation

Korea

The SPIs(Safety Performance Indicators) system is established by the RB(MOST/KINS).

SPIs are used

- to monitor the plant safety to investigate the system detrimental to reactor safetyto enhance public confidence in the operational safety and regulationto follow the international trend in PI

Slovakia

The PI system is established by the nuclear industry and the system is following mainly IAEA TECDOC-1141 Operational safety performance indicators for Nuclear power plants, May 2000 and TECDOC-1125 Self-assessment of operational safety for NPP's, December 1999. These TECDOC's are worked out into the internal procedures of nuclear installations.

- Accurately and objectively measure the safety performance of nuclear power plants in protecting the public health and safety
- Provide accurate and understandable safety performance information to the public, news media
- Provide regulatory body with objective indicators to assess safety performance and trends
- Provide government with objective information

Spain

CSN has operated a PI system since 1995. The system is based on the one used by the USNRC before the ROP was started, and therefore was used to compare the performance of Spanish and US plants of similar technology and vintage. The objectives of the Spanish PI system are:

- Track the performance of the Spanish plants
- Provide performance information to the stakeholders, mainly to the Parliament, from which CSN depends, and thereby to the public.

Sweden

The aim with indicators is to provide additional insights to various inspection activities and the yearly integrated safety assessment of each licensee. A SKI pilot project has been in operation for a few years. The set of indicators has been modified as experience has been obtained.

The integrated safety assessment evaluates 15 areas defined in the SKI regulation. It provides input to design of the inspection activities for coming years. It is based on inspection findings and utility performance, where indicators are used to evaluate trends and areas of concern.

Switzerland

Regulatory body: At present the Swiss Federal Nuclear Safety Inspectorate (HSK) is optimising its regulatory oversight activities by introducing an "integrated oversight" system. One important input to this system will be delivered by "Safety Performance Indicators" (SPI). These indicators should allow to monitor changes in the performance of the individual plants and to give an indication of potential arising problems. Based on different sources (literature, international workshops and meetings, discussions, etc.) HSK defined a set of indicators.

In 2003 a test program was agreed with the utilities: The NPPs delivered the SPI data for the period from 1998 to 2002. In 2004 HSK reviewed and assessed the SPI data regarding plausibility of values and trends, relations of values to thresholds, validity, usefulness of the SPI for the annual safety assessment of the plants. The program started with 41 SPIs and, after the test 33 SPIs remained for regular application. The test results were sent to the utilities at the end of 2004.. A decision about the publication of the SPIs is pending.

By the use of indicators HSK intends to have early indications for changing performance in order to support HSK's decisions for e.g. the frequency of inspections.

Improvement of annual safety assessment of the NPP's:

Human and organisational factors as well as risk information are to be included more systematically into a comprehensive oversight process. The key element of the so-called Integrated Oversight approach is a new NPP Safety Assessment System bringing together information from inspections, event reports, periodic reports and safety indicators. This system is based upon the assumption that an NPP is a socio-technical system whose safety depends on human, organisational and plant factors. The importance of all factors is assessed with regard to their impact on defence in depth and specific safety functions. Safety assessment takes into account both formal requirements written down in plant documents and operational experience. Indicators are supposed to be an important source of information on operational experience.

Utilities: They developed their own indicator system (in addition to the WANO indicators) as input for management self-assessment, which was required by the regulatory body. The reference document for their SPI set is IAEA TECDOC-1141; some presentations of them were made to the EU SPI task force.

Utilities and HSK tried to harmonize their indicators in order to reduce burden. A total agreement was not possible but many indicators are common. A special set of the utilities' indicators are the safety culture indicators which are only used inside the plant.

United Kingdom

The context of the United Kingdom Nuclear Installations Inspectorate’s (NII’s) response to this questionnaire is a Safety Performance Indicator (SPI) Pilot Study being conducted with one of our licensees, British Energy. In this Pilot Study British Energy are supplying the NII with SPI data on their seven Advanced Gas-cooled Reactor (AGR) stations (fourteen reactors) and one Pressurised Water Reactor (PWR) on a quarterly basis.

The NII's principal objectives in setting up the Pilot Study were:

1. To obtain objective data on British Energy's safety performance.
2. To use this data to inform the NII Management Team's forward regulatory strategy and associated allocation of resources.

The one year duration of the Pilot Study, together with the availability of historical data for some SPIs, is considered sufficient to reach an informed judgement on whether or not these principal objectives have or can be met. Longer term use of British Energy's SPI data, leading to increased levels of confidence in it, may allow additional objectives to be met. These could include informing regulatory action and providing information to other stakeholders.

A subsidiary benefit of the Pilot Study to the NII is that in setting it up the NII has been able to judge the adequacy of British Energy's *"measuring performance"* element of their health and safety management system [1]. Some of the Pilot Study SPIs are part of British Energy's extensive performance measurement (safety and non safety related) system. Other SPIs have been created at the NII's request for this Pilot Study. In this instance British Energy is collecting the data for the NII.

[1] HSE Books, ISBN 0 7176 1185 X. *Managing for Safety at Nuclear Installations*. First published 1996.

USA

The PI system is an integral part of the Reactor Oversight Process (ROP) established by the NRC. It is a risk-informed, performance-based approach designed to meet the following objectives:

- Accurately and objectively measure the safety performance of nuclear power plants in protecting the public health and safety
- Provide accurate and understandable safety performance information to the public, news media, and other stakeholders
- Provide utility licensees and the NRC with objective indicators to assess safety performance and trends, to rationalize the NRC enforcement policy, and to allocate resources in a effective and efficient manner
- Provide Congress with objective information to assist in performing its oversight and authorization responsibilities

1.2 Identify the different stakeholder groups for the PI system(s) set up in your country (public, congress/parliament, ministries/agencies, RB policy makers, inspectors/assessors, etc) and what influence, if any, do your country's stakeholders have on the construction of your PI system(s)?

Belgium

Stakeholders (check all that apply) ☐ Public ☐ RB Policy Makers ☐ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☒ Other: WANO	The licensee site-specific PI system objectives (stated in 1.1) are adapted to meet the needs of the licensee as stakeholder. The AVN informal PI system objectives are adapted to the needs of the AVN inspectors. WANO and the licensees are stakeholder of the WANO PI-system.

Canada

Stakeholders (check all that apply) ☒ Public ☒ RB Policy Makers ☒ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	To date the indicators have been mainly used internally but results of some indicators are presented at public meetings and licensing hearings. It is through these forums that external stakeholders can influence PI development.

Czech Republic

Stakeholders (check all that apply) ☒ Public ☒ RB Policy Makers ☒ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	The SUJB's PI set was designed during the technical discussion with licensee.

Finland

Stakeholders (check all that apply) ☒ Public ☒ RB Policy Makers ☒ Congress/Parliament/Government ☒ Utility/Licensee ☒ Inspectors/Assessors ☒ Other: Expert groups e.g. Advisory committees of Ministry; Directorate of STUK; Safety commitees of NPPs	Until now the stakeholders have not had any influence on the construction of STUK's indicator system. However, at the moment there are on-going discussions with the licensees to improve the accuracy of some indicators (e.g. maintenance, risk based indicators) by co-operation in data collection and calculation processes. Also development and definition of logical relationships, which were useful for licensees' purposes to avoid overlapping activities, are also under discussions.

Germany

Stakeholders (check all that apply) ☐ Public ☒ RB Policy Makers ☐ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	(Expected stakeholders for the PI system, which is currently under development)

Hungary

Stakeholders (check all that apply) ☒ Public ☒ RB Policy Makers ☒ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	

Japan

Stakeholders (check all that apply) ☒ Public ☒ RB Policy Makers ☐ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	

Korea

Stakeholders (check all that apply) ☒ Public ☒ RB Policy Makers ☐ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	After opening the SPIs in bottom of 2002 through the internet, the stakeholder groups' interest on SPI is increasing continuously.

Slovakia

Stakeholders (Check all that apply) ☒ RB Policy Makers ☒ Government ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	The UJD SR started works on its own PI only this year (2003). All information on PI comes from licensee's reports.

Spain

Stakeholders (check all that apply) ☐ Public ☒ RB Policy Makers ☒ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	CSN reports yearly the results (industry-wide averages) of its PI system to the Parliament.

Sweden

Stakeholders (check all that apply) ☐ Public ☒ RB Policy Makers ☐ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	

Switzerland

Stakeholders (check all that apply) ☐ Public ☒ RB Policy Makers ☐ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	

USA

Stakeholders (check all that apply) ☒ Public ☒ RB Policy Makers ☒ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	The NRC's PI system objectives (stated in 1.1) are adapted to meet the needs of all the stakeholders.

United Kingdom

Stakeholders (check all that apply) ☐ Public ☒ RB Policy Makers ☐ Congress/Parliament ☒ Utility/Licensee ☒ Inspectors/Assessors ☐ Other	The SPIs were selected by a team of NII inspectors working with British Energy, who provided information on their performance measurement system. Additional specialist NII expertise provided input to the SPI selection process in specific technical areas. Data on the Pilot Study SPIs is for internal NII use only, with the exception of consultants employed to advise the NII. In this case appropriate confidentiality arrangements are in place.

2. CURRENT INDICATOR SYSTEM USED

2.1 Please list, in tabular form, the current performance indicators (with hierarchical structure) used in your country. The following information, if applicable, should be included:

- Indicator Areas (e.g. Cornerstones, Safety Areas, Chapters, etc.)
- Indicators (please provide more information if the indicator definition is not obvious)
- Indicator Thresholds or Goals
- Calculation Time Period (e.g. per calendar year, moving time window, etc.)

Belgium

PI – system used by utilities:

The following WANO-indicators have been implemented on all NPP sites (all PWR's): Unit Capability Factor, Unplanned Capability Loss Factor, Unplanned Automatic Scrams per 7000 hours critical, Safety System Performance (HPSI, AFW and Emergency AC power systems), Fuel Reliability, Collective Radiation Exposure and Industrial Safety Accident Rate. (see WANO PI-manual or guidelines). Calculation and reporting is performed quarterly. Yearly goal setting is performed for calendar year averaged values (some plants target worldwide best quartile performance).

The additional indicators are site-specific, calculated on a monthly basis and not documented here in detail. They are not structured in a hierarchical way, but a difference is made between site-wide indicators and organizational entity specific indicators.

At one nuclear site color-coding and trends with respect to the previous month is used to present PI-results to the plant staff. For some indicators goal setting may be applied (e.g. for indicator measuring global unavailability of TS-related safety systems – see also table below).

At the other site only trending is applied (neither thresholds nor goals are applied).

Informal indicators currently used by AVN:

The following indicators are used by AVN (situation up to 2003):

Area	Indicator	Calculation Time Period
Initiating Events	Number of unplanned scrams	Per calendar year
Mitigating Systems	Unavailability rate of safety systems covered by the Technical Specifications (global indicator values for all TS-related safety systems together and for individual systems are available; indicator values are based on the fraction of allowable TS-outage time used for corrective and preventive maintenance interventions)*	Per calendar year
Occupational Radiation Safety	Collective dose	Per calendar year

* This indicator is available for only one site.

Neither thresholds nor goals are used in this system. Only trending is performed in an informal way in order to detect “abnormal” evolutions.

For update of this information in 2005 (indicators followed in pilot program) see response to second survey.

Canada

Please see S-99 appendix A and B Reporting Requirements for Operating NPP
http://www.nuclearsafety.gc.ca/eng/licensees/documents/current_docs.cfm

Czech Republic

List of the SUJB PI set is included in table below. The set covers these areas of NPP operation:

– Significant Events
– Safety Systems Performance
– Barriers Integrity
– Radiation Protection

There are no thresholds and goals, only trends are evaluated.
The set is evaluated annually and the values for last six years are compared.

AREA	Group/ Indicator	*1.1.1 Name of Indicator*	*1.1.2 Definition*	Note
SIGNIFICANT EVENTS	**1.A**	**Reportable / Safety Related Events**		EDU/ETE*
	1.A.1	Number of Reportable Events - RE	Monitors the development of number of reportable events (RE) including its division according to the evaluation of the International Nuclear Event Scale (INES) into significant events (SSE, INES > 0) and the below scale events (BSE, INES = 0). Until 2002 the RE indicator was equal to summary of SSE and BSE.	EDU*
	1.A.1	Number of Safety Related Events - SRE - INES ≥ 0	Monitors the development of the number of safety related events (SRE) including their division according to the evaluation of the International Nuclear Event Scale (INES) into significant events (SSE, INES > 0) and the below scale events (BSE, INES = 0).	ETE*
	1.A.1a	Number of INES Events > 0 - SSE (Safety Significant Events)	Monitors INES Events > 0	
	1.A.1b	Number of INES Events = 0 - BSE (Below Scale Events)	Monitors INES Events = 0	
	1.A.2	Human Factor, Human Factor Index - HF, HFI	The indicator is expressed by the number of the reportable / safety related events with an influence of human factor (HF) and its percentage share (HFI).	EDU/ETE*

SIGNIFICANT EVENTS	**1.B**	**Actuation of the Protection and Limitation Systems**		
	1.B.1	Unplanned Unit Scrams - US	Summarises the total number of automatic unplanned unit scrams (US) (reactor in MODE 1 or 2). The term unplanned means that the scram was not an expected part of the planned test.	
	1.B.2	Unplanned Manual Unit Scrams - USM	Summarises the total number of manual unplanned unit scrams (US) (reactor in MODE 1 or 2). The term unplanned means that the scram was not an expected part of the planned test.	
	1.B.3	Automatic Power Reduction HO-2 / LS (c) - APR2	Indicates the number of unplanned Automatic Power Reduction or Limitations due to actuation of different limitation system functions.	EDU/ETE*
	1.B.4	Automatic Power Reduction HO-3 / LS (a) - APR3		EDU/ETE*
	1.B.5	Automatic Power Limitation HO-4 / LS (b) - APL4		EDU/ETE*
	1.B.6	Control Rod Drop - CRD	Development of the number of control rod drops (CRD).	EDU*
	1.B.6	Limitation System function (d) Actuation – LS(d)	Summarises the total number of automatic unplanned reactor scrams with action of the limitation system function (d) (reactor in MODE 1 or 2). The term "unplanned" means that the scram was not an expected part of the planned test	ETE*
	1.B.7	Limitation System Manual function (d) Actuation – LS(d)	Summarises the total number of manual unplanned reactor scrams with action of the limitation system function (d) (reactor in MODE 1 or 2). The term "unplanned" means that the scram was not an expected part of the planned test	ETE*

SIGNIFICANT EVENTS	**1.D**	*1.1.2.1 Limits and Conditions*		
	1.D.1	Violation of Limits and Conditions - VLC	Summarises violations of the Limits and Conditions (VLC) detected by the Regulatory body or reported to the Regulatory body by the licensee.	
	1.D.2	Number of Actions Induced by L&C Requirements - AILCR	Indicates the number of all commencements of the unit transition to the mode with a higher serial number enforced by the state of parameters of the facility consistent with the requirements of the Limits and Conditions (AILCR).	
	1.D.3	Number of Exemptions from L&C - ELC	Summarises the number of planned and unplanned exemptions from the Limits and Conditions (ELC) approved by the Regulatory body.	
	1.D.4	Drawing of L&C - DLC	Summarises number of hours of drawing of Limits and Conditions in all unit modes (DLC).	

	2.A	**Safety System Unavailability**		
	2.A.1	Safety System Unavailability - SSU	Indicates the site value of unavailability of the "unit – general" safety system (SSU) determined by mean value of unavailability of all monitored safety systems of the site.	
		Safety System Unavailability - SSU_S	Unavailability of particular safety systems (SSU_S) is defined as the ratio of the total time of unavailability of an evaluated safety system to the total time when its availability was required. Unavailability of Diesel Generators, High-Pressure Emergency Core Cooling Systems, Low-Pressure Emergency Core Cooling Systems, Spray Systems, Emergency and Auxiliary Feed-water systems is monitored.	
	2.A.2	Average System Time Unavailability - ASTU	Monitors an average time of unavailability of the "unit – general" safety system at the site (ASTU) that is determined by the ratio of mean time of one unavailability of safety system to the time of a single unavailability permitted by the Limits and Conditions.	
		Average System Time Unavailability - $ASTU_S$	Expresses the system values of ASTU.	
	2.A.3	Frequency of Safety System Unavailability - FSSU	Monitors the total number of unavailabilities of the "unit – general" safety system at the site per thousand hours of required availability (FSSU).	
		Frequency of Safety System Unavailability - $FSSU_S$	Expresses the system values of FSSU.	
	2A.4	Type of SSU - SSU(T)	Indicates the ratio of the total time of unavailability of the "unit – general" safety system four respective reason to the total time when availability of the system was required - SSU(T).	
		Type of SSU_S - $SSU(T)_S$	Expresses the system values of SSU(T).	
	2.A.5	Relative System Type Unavailability - STUR	Indicates the ratio of the total time of unavailability of safety system for respective reason to the total time of unavailability of the system – STUR.	
		Relative System Type Unavailabilities - $STUR_S$	Expresses the system values of STUR.	

SSP	**2.B**	1.1.2.1.1 Failure of Safety Systems		
	2.B.1	Number of Starting Failures - NSF_S	Indicates the number of starting failures of the safety system (NSF), i.e. the state when the respective system on the demand does not achieve nominal performance characteristic or its failure (shutdown) occurs within 30 minutes after its start.	
	2.B.2	Starting Unreliability - SU_S	Expresses the ratio of the number of starting failures to the total number of starts of safety system (starting unreliability - SU) in respective period (so-called Starting unreliability).	
	2.B.3	Number of Running Failures - NRF_S	Indicates the number of running failures of safety system (NRF), i.e. the number of states when failure shut down of respective system, drive, possibly set occurs at nominal performance characteristics for the time exceeding 30 minutes since its starting.	
	2.B.4	Running Unreliability - RU_S	Indicates the ratio of the total number of running failures to the total number of run hours (RU) when its availability is required.	
BARIERS INTEGRITY	**3.A**	**Nuclear Fuel**		
	3.A.1	Fuel Reliability Indicator - FRI	Monitors fuel reliability of particular units through the values of FRI - Fuel reliability indicator. The value 19Bq/g ≥ FRI expresses that reactor core most likely does not contain any steady fuel defects.	
	3.A.2	Number of Leak Fuel Assemblies - NLFA	Indicates the number of leak fuel assemblies (NLFA) that had to be put out of operation due to their inadmissible leakage.	
	3.B	*1.1.2.2 Containment*		
	3.B.1	Results of Periodic Integral Tightness Testing of Units - L_e (Leak)	States the results of Periodic integral tightness testing.	

1.1.2.3 RADIATION PROTECTION	**4.A**	*1.1.2.4 Staff*		
	4.A.1	Collective Effective Dose per Unit - CEDU	Indicates collective effective dose (CED) received by the staff of NPP (including suppliers and visitors) during monitored period, measured by basic film dosimeters and expressed by mean value per unit.	
	4.A.2	Collective Effective Dose - CED	Indicates collective effective dose received by the staff of NPP and suppliers during monitored period, measured by basic film dosimeters.	
	4.A.3	***1.1.2.5 Specific Collective Effective Dose per Capita - CEDC***	Indicates specific collective effective dose received by the staff of NPP and suppliers during monitored period, measured by basic film dosimeters and express by value per one radiation worker.	
	4.A.4	Maximum Individual Effective Dose - MIED	Indicates maximum individual effective dose received by one particular employee of NPP and one particular employee of supplier during monitored period, measured by basic film dosimeters.	
	4.A.5	Number of Workers with Special Decontamination - NWSD	Indicates number of workers (NPP and suppliers) subjected to a special decontamination under medical supervision.	
	4.B	*1.1.2.6 Radioactive Releases*		
	4.B.1	Gaseous Releases - Committed Effective Doses	Indicates the committed effective dose for individual, which arises from radioactive gaseous releases from NPP.	
	4.B.2	Liquid Releases - Committed Effective Doses	Indicates the committed effective dose for individual, which arises from radioactive liquid releases from NPP.	

Note: * - means, that the indicator is specific for nuclear power plant in question, and different indicator is used for the other nuclear power plant or this indicator is not applied at all

ETE - Temelín NPP, EDU - Dukovany NPP

Finland

Safety area **Indicator area**	**A.I Safety and quality culture**				
		Indicator	**Definition**	**Purpose and thresholds or goals**	**Calculation period**
A.I.1 **Failures and their repairs**	**A.I.1a**	Failures of components subject to the Technical Specifications	Number of failures causing unavailability of components specified in Tech. Spec during opreation: • immediate operation restriction from detection of a failure • restriction for operation from start of repair work	Assess the plant lifetime management and the development of the condition of components. No thresholds or limits; followed by trending	quarterly
	A.I.1b	Maintenance of components subject to the Tec[3]h.Spec.	Numbers of failure repairs and preventive maintenance work orders for components defined in the Tech Specs by plant unit.: • volume of maintenance works • number of failure repair work • number of preventive maintenance works • Ratio of preventive maintenance work orders to the sum of failure repair work orders.	Describes the volumes of failure repairs and preventive maintenance and illustrates the condition of the plant and its maintenance strategy. The indicator is used to assess the maintenance strategy executed at the plant. No thresholds or limits; followed by trending	quarterly
	A.I.1c	Repair time of components subject to the Tech. Speci.	Average repair time of failures causing unavailability of components defined in the Tech Specs is followed. With each repair, the time recorded is the time of unavailability. It is calculated from the detection of the failure to the end of repair work, if the failure causes an immediate operation restriction. If the component is operable until the beginning of repair, only the time of the repair work is taken into account.	The indicator shows how quickly failed Tech Spec components are repaired in relation to the repair time allowed in the Tech Specs. The indicator is used to assess the maintenance strategy, resources and effectiveness of the plants. Followed by trending.	quarterly

A.I.1 **Maintenance errors** **Common Cause Failures (CCF)** (available only from Olkiluoto plant)	**A.I.1d**	Common Cause Failures	Number of common cause failures of components or systems defined in Tech Specs	Quality of maintenance: CCFs shall not increase significantly (internal goal).	calendar year
	A.I.1e	Technical, critical CCFs (preventing operation)	Number of technical common cause failures (CCFs) causing unavailability of equipment or systems is followed for all plant systems.	The number of CCFs of a technical origin. A CCF preventing a function refers not only to the failure of a safety system but includes all systems. Thus conclusions on the safety-significance of CCFs are not to be made based on the indicator, but importance of technical CCFs. CCFS of technical origin shall not increase signicantly (internal goal).	calendar year

Safety area **Indicator area**	**A.I Safety and quality culture (cont.)**				
		Indicator	**Definition**	**Purpose and thresholds or goals**	**Calculation period**
	A.I.1.f	Potential CCFs	Number of potential CCFs of technical origin that have no effect on the availability of the equipment or systems but do have a bearing on the reliability of their operation (ageing, wear and tear, corrosion, etc.).	Anticipatory sign for failures, which could develop into a failure preventing the operation of equipment or systems. Followed by trending.	calendar year
A.1.1	**A.I.1g**	Production loss due to failures	Loss of power production caused by failures in relation to rated power (gross).	Significance of failures from the point of view of production. Followed by trending.	quarterly
A.I.2 **Deviations from Tech.Spec.**	**A.I.2.a**	Exemptions from the Technical Specifications	Deviations from the Tech. Spec. granted by STUK	To follow the utilities' activities in accordance with the Tech Specs: compliance with the Tech Specs and identified situations during which it is necessary to deviate from them; of which conclusions can be made as regards the appropriateness of the Tech Specs. The plant should be operated in compliance with Tech. Spec. (Decision of the Council of State and indirect, task goal of NRR).	quarterly
	A.I.2.b	Non-compliances from the Technical Specifications	The number of non-compliances with the Technical Specifications as well as the number of exemptions granted by STUK.		quarterly
A.I.3 **Unavailability of safety systems**	**A.I.3**	**PWR** HPSI (TJ) AFW ((RL) EDG **BWR** HPCS (321/322) AFW (327) EDG	Plant unit specific WANO-indicators	Indicate the unavailability of safety systems; the condition and status of safety systems and development of trends.	quarterly, sliding year and calendar year

A.I.4 **Occupational Radiation safety**	**A.I.4a**	Occupational radiation exposure	Annual collective doses	Success of the plant's ALARA programme. < 2,5 manSv/GWe/unit (average of two years) [Guide YVL 7.9] Loviisa: 1,22 manSv/plant unit Olkiluoto: 2,10 manSv/plant unit	quarterly and calendar year
	A.I.4b	Workers' exposure control effectiveness	Average of the ten highest personal doses	at the same time indicating the effectiveness of the plant's radiation protection unit Compliance with the person limit:: how close the individual occupational doses at the plant are to the limit < 20 mSv/year average over any period of five years or < 50 mSv in any one year (Radiation Decree/1512/1991)	quarterly
A.I.5 **Radioactive releases**	**A.I.5a**	Radioactive releases into atmosphere	Releases of: noble gases (as Kr-87 equivalents) iodine (as I-131 equivalents) aerosols	Release limits are defined in Tech. Spec. Loviisa: < 22 000 TBq; < 22 0 GBq Olkiluoto: < 17 700 TBq; < 114 GBq	quarterly
	A.I.5b	Radioactive releases to water	gamma-activities	Loviisa: < 0,89 TBq Olkiluoto: < 0,296TBq To monitor the amount and trend of radioactive releases and assess factors having a bearing on any changes in them.	quarterly

Safety area / Indicator area	A.I Safety and quality culture (cont.)				
		Indicator	**Definition**	**Purpose and thresholds or goals**	**Calculation period**
	A.I.5c	Calculated dose of the most exposed individual in the vincity of the plant	Dose caused by the measured releases calculated at STUK	< 5 % from the limit value 100 μSv defined in the Decision of the Council of State	quarterly
A.I.6 **Documentation**	**A.I.6**	Keeping plant documentation current. (FSAR, Tech.Spec., emergency, disturbance, operation and maintenance instructions, process flow-charts, Classification documents)	Ratio of plant documents updated by the next refuelling outage to number of documents identified to be need updating because of modifications.	Supervise quality management of utilities and their ability to maintain plant documentation. Internal goal 100 %.	operational cycle
A.I.7 **Investments in facilities**	**A.I.7**	Annual investments to plant maintenance and modifications	Investments on plant maintenance and modification in current value of money improved by the building cost index.	To follow the amount of investments in plant maintenance and their fluctuations.: change in investment policy. Followed by trending.	calendar year

Indicator area / Safety area	A.II Operational events				
		Indicator	**Definition**	**Purpose and threshold or goal**	**Calculation period**
A.II.1 **Number of events** (reported operational events according to Guide YVL 1.5)	**A.II.1a**	Number of special reports	Number of safety significant events	Specified in the Guide YVL 1.5: deviations from Tech.Spec. No thresholds or limits. Followed by trening. Number should not increase signifcantly.	quarterly
	A.II.1b	Number of reactor scrams	Number of unplanned scrams both manual and automatic		quarterly
	A.II.1c	Number of disturbance reports	Number of other kind of disturbances	Specified in the guide YVL 1.5: power reductions > 5 %, turbine trips, stops of PCPs, etc.	quarterly
A.II.2 **Risk significance of events**	**A.II.2a**	Risk-significance of events caused by component unavailability . As the risk measure, an increase in the Conditional Core Damage Probability (CCDP) associated with each event is employed. The indicator is the number of events in each of following category.	Events are grouped into three categories according to their risk-significance (CCDP): • the most risk-significant events (CCDP>1E-7), • other significant events (1E-8<CCDP<1E–7) and • other events (CCDP<1E–8). In addition events in each category are futher divided into three groups: 1) unavailabilities due to component failures, 2) planned unavailabilities and 3) initiating events.	To follow the risk-significance of component unavailabilities and to assess risk-significant initiating events and planned unavailabilities. Special attention is paid to recurring events, CCFs, simultaneously occurring failures and human errors. In addition, an objective in event analysis is to systematically identify signs of deteriorating organisational and safety culture. Division into categories is followed.	half-yearly and yearly
A.II.2 **Risk significance of events**	**A.II.2b**	Risk significance of events (combined risk)	Risk of the safety system unavailability (% of the average annual core damage risk)	CDF < 5 % of the annual severe accident risk	calendar year
	A.II.2c	Risk significance of TS equipment failures	Risk contribution by unavailability of equipments subject to Tech. Spec. (caused by failures)	Duration and significance of unavailability of equipment subject to Tech. Spec.	calendar year

Indicator area / Safety area	A.II Operational events (cont.)				
		Indicator	**Definition**	**Purpose and threshold or goal**	**Calculation period**
	A.2.2d	Risk significance of preventive maintenance of TS equipment	Risk contribution by unavailability of equipments subject to Tech. Spec. (caused by preventive maintenance)	Duration and significance of unavailability of equipment taken of because of preventive maintenance	calendar year
	A.2.2e	Risk significance of exemptions from Tech. Spec.T	Risk contribution by unavailability of equipments subject to Tech. Spec. (caused by exemtions from Tech. Spec.)	Acceptability and risk significance of the exemption order to deviate from Tech. Spec.	calendar year
A.II.3 **Direct causes of events**	**A.II.3a**	Number of events caused by human failures	Direct causes are roughly divided to technical and human failures. Calculated from the event reports delivered to STUK according the guide YVL 1.5	Track changes in direct causes of operational event (mutual judgement)	calendar year
	A.II.3b	Number of events caused by technical factors			calendar year

A.II.4 **Number of fire alarms**	**A.II.4a**	Number of malfunctions	Automated failures	Supervise and track operation of fire alarm system and fire brigades	calendar year
	A.II.4b	Number of real fire alarms	Actual automated alarms		
	A.II.4c	Number of fires	Actual fires		

Safety area **Indicator area**	**A.III Structural integrity**				
		Indicators	**Definition**	**Purpose and thresholds or goals**	**Calculation period**
	Goal: Fuel integrity, integrity of primary and/or secondary circuit and integrity of containment fulfil requirements, and no significant negative changes are seen.				
A.III.1 **Integrity of nuclear fuel**	**A.III.1a**	Primary coolant activity	• Maximum activity concentration level of the primary coolant (I-131 equivalents/LO; I-131 activity/OL) on steady-state operation: • Maximum activity concentration of I-131 during depressurisation while entering shutdown or after reactor scram	The indicators depict fuel integrity and the fuel leakage volume during the operating cycle. The indicators for the shutdown situations also describe the success of the shutdown concerning radiation protection. I-131 activity limits specified in Tech. Spec. Loviisa < 10 MBq/kg (repairing time 1 week) Olkiluoto < 2,2 MBq/kg	quarterly
	A.III.1b	Number of removed fuel bundles due to fuel leakage		There should not be leaking fuel rods in the reactor. If the indication of a fuel leakage during operation is observed (indicators 1) the number leaking fuel rods and size of the leakage is assessed and the leakage is also localised during operation.	operating cycle

Safety area Indicator area	**A.III Structural integrity (cont.)**				
		Indicators	**Definition**	**Purpose and thresholds or goals**	**Calculation period**
A.III.2 **Integrity of primary circuit**	**A.III.2**	**A.III.2a** *Water chemistry conditions*			
		Loviisa	Olkiluoto		
		• WANO chemistry index • A new secondary circuit chemistry index (introduced in 2003)	• WANO chemistry index	To monitor and control primary and secondary circuit integrity. The monitoring is done by indices depicting water chemistry control and by chosen corrosive impurities and corrosion products.	quarterly
		• maximum chloride concentration of the steam generator blow-down (compared with Tech Spec limit)	• maximum chloride concentration of the reactor water (Compared with Tech Spec limit)		quarterly
			• maximum sulphate content of reactor water		quarterly
		A.III.2b *Corrosion products released from the surfaces of the reactor circuit and the secondary circuit into the coolant.*			
		• maximum iron concentration of the primary coolant solid material	• maximum iron concentration in reactor feed water		quarterly
		• maximum iron concentration of secondary circuit feed water.	•		quarterly
		• maximum Co-60 activity concentration of the reactor coolant while bringing the plant to a cold shutdown or after a reactor scram	• maximum Co-60 activity concentration of the reactor coolant while bringing the plant to a cold shutdown or after a reactor scram		quarterly

Safety area / Indicator area	A.III Structural integrity (cont.)				
		Indicators	**Definition**	**Purpose and thresholds or goals**	**Calculation period**
A.III.2 Integrity of primary circuit	**A.III.2**	• **A.III.2c** *Primary circuit leakages at the Olkiluoto plant units*			
		Volume of identified and unidentified leakage	• total volume of identified containment internal leakage (from containment to collection tank 352 T1 of the controlled leakage drain system) and • total volume of unidentified (total volume of leakages into the sump of the controlled floor drainage system, 345 T33) containment internal leakages during the operating cycle, and • highest containment internal leakage volume during the year in relation to the allowed leakage volume in the Tech Specs (outflow water volume of water condensing in the air coolers of the containment cooling system 725/Tech Specs limit).		quarterly
A.III.3 Integrity of containment	**A.III.3a**	Overall leakage of isolation valves compared with the highest allowed overall leak-age of the isolation valves		Track tightness of containment isolation valves	operating cycle
	A.III.3b	Percentage of isolation valves at each plant unit that passed the leakage test at the first attempt		Track tightness of containment isolation valves	operating cycle
	A.III.3c	Overall leakage of containment's entrance and other holes in relation to the highest allowed overall leakage of these holes at each plant unit		Track tightness of penetrations and airlocks	operating cycle

Germany

Currently not applicable

Hungary

Generally represent	SPI	Subindicator	Broadly Accepted	Increased Regulatory Response Band	Required Regulatory Response Band
Operational performance	Unplanned shut downs and power reductions	Power reduction due to internal causes (more than 10%)	<20	20-80	>80
		Capacity factor	>88	80-88	<80
	Maintenance planning	Ratio of work-instructions beyond plan	<20	20-40	>40
		Ratio of planned and real duration of main outages	>0,95	0,8-0,95	<0,8
		Ratio of the preventive and total maintenance	<10%	10-50%	>50%
		Ratio of unsuccessful engineering safety reviews	<2	2-5%	>5%
		Use of stressor cycles	Under proportional part of life time limit	Under TS limit	Out of TS limit
		Ratio of plugged Steam Generator tubes	Under proportional part of life time limit/year	Out of proportional part of life time limit/year	Out of proportional part of life time limit
	State of physical barriers	Leakage in Primary Circle	<5	5-10	<10
		Leakage of the hermetic zone	Good trend	Trend decrease more than 20%/year	TS violation or trend decrease more than 50%/year
	Events	Immediately reportable events	<10/NPP	10-25	>25
		Not immediately reportable events	<70/NPP	70-120	>120
		Number of indirectly reportable events	<250/NPP	250-350	>350
		Events investigations ordered by the HAEA NSD	<4	4-8	>8
Safety systems and equipment	Actual operation of safety systems	ECCS actuations	<2	2-3	>3
		Total number of SCRAMs	<5/NPP	5-8	>8
	Availability	Unavailability detected during tests	<5% unsuccess	5-15% unsuccess.	>15 unsuccess.
		Diesels availability	>95%	85-95%	<85%
		Availability of the pumps	>95%	85-95%	<85%
		Availability of the safety systems	>95%	85-95%	<85%
		Tests of the safety valves	>95%	90-95%	<90%
Preparedness	Operational preparedness	Number of staff with regulatory license	>105%	100-105%	<100%
		Unsuccessful regulatory exams	<2%	2-5%	>5%
	Emergency preparedness	Deficiencies found during emergency exercises	<10 issue/exercise	10-50	>50
		Ratio of participants in ERO trainings	>90%/year	70-90%	<70%
		Deficiencies found during regulatory inspections	<20	20-50	>50

Risk	Operational risk	Number of TecSpecs violations	0	1-5	>5
		Number of occurrences under the effect of TecSpecs	<100	100-200	>200
		Core-melting index caused by the initiating events	<10E-6	<10E-5	>10E-5
	Environmental risk	Airborne radioactive release	<10% of RB Limit	10-50%	>50%
		Liquid radioactive release	<30% of RB Limit	30-65%	>65%
		Solid radioactive waste generated	Low increase	10-50%	High increase
Complying with instructions	Departure from planned state	Number of exemptions from the scope of the TecSpecs	<5	5-25	>25
		Temporary modifications	<30	30-100	>100
		Operating Instructions	<50	50-100	>100
		Number of modifications of the TecSpecs	<5	5-10	>10
	Violation of instructions	Number of TecSpecs violations	0	1-5	>5
		Number of Cancelled Tests	<10 point/unit	10-30	>30
		Number of other violations	0	1-15	>15
	Deviation in the reporting system	Delay of notification of M1 events	0	0-5% delay	>5%
		Delay in Reporting	0	0-5% delay	>5%
		Delay in Investigation	0	0-5% delay	>5%
Human performance	Efficiency of radiation protection program	Case reports connected to radiation protection	<5	5-15	>15
		Dispersion of contamination	<5	5-15	>15
		Work programs at high radiation level (WPHRL)	<5	5-15	>15
	Efficiency of the industrial safety program	Fires	<3	3-10	>10
		Work accident	<5	5-10	>10
	Human Factor	Unsuitable state for work	<50	50-100	>100
		Events due to human failure	<25	25-50	>50
Striving for improvement	Self-assessment	Number of independent internal audits	>95%	70-95%	<70%
		Corrective measures of investigations	<10%	10-40%	>40%
		Corrective measures of quality assurance audits	<10%	10-40%	>40%
	Experience feedback	Recurrent events	<4	4-7	>7

Japan

Our PIs are under development and the detail has not been decided yet.

Korea

Safety Performance Area	Category	Indicator	Thresholds			
			Satisfactory	Acceptable	Attention	Unacceptable
Reactor Safety	Operational Safety	Unplanned Reactor Scram	<0.75	<1.5	<5	>=5
		Unplanned Power Reduction	<1.5	<3	<5	>=5
	Multiple Barrier	Fuel Reliability	< 50% (TS limit)	< 70%	< 100%	=> 100%
		Reactor Coolant Leakage	<50%(TS limit)	< 70%	< 100%	=>100%
		Emergency Preparedness	>90%	>80%	>60%	<=60%
		Containment Reliability	Under developed			
	Mitigation System	SI system Availability	< 0.015	< 0.05	< 0.1	>= 0.1
		EDG system Availability	< 0.025	< 0.05	< 0.1	>= 0.1
		AFW system Availability	< 0.015	< 0.05	< 0.1	>= 0.1
Radiation Safety	On-site	Radiation Collective Dose	< 1 (man· Sv)	< 3	< 5	>= 5
	Off-site	Public Dose/ Environmental Radiation	< 62.5 (μSv)	< 250	< 600	>=600

Slovakia

Safety Area	Indicator	Thresholds
Operation of safety systems	1. Inoperability of safety systems 2. Number of events during tests 3. Failure of safety systems at start 4. Failure of safety systems during operation 5. Spurious activation of safety systems 6. Activation of safety systems on technological requirement	
Significant events	1. Number of events and their rating by INES 2. Number of unplanned automatic SCRAMS 3. Number of fires 4. Number of Technical specification violation 5. Number of temporary Technical specification changes	>INES1 >1 >1
Barriers tightness	1. Containment tightness 2. Fuel reliability	> value defined by Technical specification
Human factors	1. Number of events caused by human factor failure 2. Share of human factor on total events number	

Listed performance indicators are provided by operator to regulatory body. The thresholds are not determined for all indicators. The new project on SPI for regulatory body in cooperation with DTI (GB) has been launched this year.

Reference Document: UJD SR QA Instruction

Spain

- Automatic scrams while reactor critical
- Safety systems actuations
- Significant events
- Safety system failures
- Forced outage rate
- Forced outage rate for 1000 critical hours of critical commercial operation
- Radiation exposure to workers

The data about PIs are obtained for each NPP from LER´s and monthly reports. There is a computer program which obtains the PIs from the data provided by the NPP and those derived from Licensee Events Reports, Special Reports and Monthly Performance Reports. The program calculates trends and deviations as well, so that the behavior for a specific NPP as compared with the rest is easily obtained.

Sweden

Indicator	**Cornerstone**	**Indicator**
Level		
1	**Global**	**Unplanned power reductions**
	Operational	**Availability**
		Collective dose
	Initiating events	**Unplanned Reactor Scrams**
	Events	**Number of reportable events, techn. spec.**
		Number of reportable MTO related events
	Barrier	**Fuel reliability index**
	Mitigating systems	**Unavailability of core cooling systems**
		Unavailability of residual heat removal systems
		Unavailability of diesel generator systems
2	**Strategic MTO**	**Number of MTO causes (11 categories)**
		Number of MTO root causes (9 root causes)
Indicator	**Cornerstone**	**Indicator**

Level			
	Defence in depth	**System unavailability:**	
			Operational control and failure detection (level 2)
			8 system unavailability
			Control over design based events (level 3)
			7 system unavailability
			Control over design based events severe accidents
			2 system unavailability
			Control over accidents (level 4) 8 system unavailability
3	**Maintenance records**	**Number of maintenance activities**	
			- per year
			- per month
	Components with increased maintenance need trends		
New on trial		**Number of recurring events**	
			Preventive vs corrective maintenance
			Set of administrative indicators, MTO
			Number of licensee deviations from regulation

Switzerland

The information below refers to the indicators developed as part of a new PI-project. Existing indicators (WANO), which are published for many years in HSK annual reports (see www.hsk.ch), are mentioned in part 4 of this survey.

The following table gives an overview over the hierarchical structure but does not list the specific safety performance indicators and their thresholds. The calculation time period is mainly one calendar year.

Areas of Supervision	Superordinate Safety Indicators	Strategic SPIs		
Operation	Normal Operation	Not reportable Occurrences	Unplanned Load Reductions	Availability of Safety Systems
	Disturbed Operation	Reportable Occurrences	Initiation Reactor Protection System	Initiation of Safety Systems
	Probabilistic Indicators	Reliability Analyses	Configuration Analyses	
Maintenance	Plant in Operation	Inspection of Safety Systems	Operational Maintenance	
	Plant in Shutdown	Shutdown		
Control of Radioactive Material	Radioactive Releases	Solid Releases	Liquid Releases	Gaseous Releases
	Radiation	Plant	Environment	
	Condition of Barriers	Fuel-Cladding	Pressure Boundary	Drywell/Primary Containment
Safety Culture	Safety Related Behaviour	Promotion of Training	Management	Quality
	Safety Related Behaviour	Human Factors	Event Report Culture	Agreement with Instructions
	Safety Related Behaviour	Emergency Preparedness		
	Striving for Improvement	Independent Check	Evaluation ext. Occurrences	

The next table provides the corresponding specific indicators:

Areas of Supervision	Superordinate Safety Performance Indicators	Specific Safety Performance Indicators		
Operation	Normal Operation	1)Safety Systems: Total time of limited condition of operation (h)		
	Disturbed Operation	2) Number of Reportable events class A&B	3) Number of unplanned Scrams	Number of: 4) triggering of reactor protection system or emergency cooling (without Scram) 5) triggering of Safety Systems by failures of electronic devices 6) triggering of Safety Systems with real system actuation
	Probabilistic Indicators	7) Number of Risk peaks	8) Accumulated risk	
Maintenance	Plant in Operation	9) Number of corrective work orders on safety systems (ss)	10) Number of Work orders derived from functional test on safety systems	
	Plant in Shutdown	11) Number of repair work orders during operation on ss / refuelling time		
Control of Radioactivity	Radioactive Waste	12)Yearly accumulated waste	13) Approved temporary stored waste	
	Radiation	14) Exhaust source related dose	15) Collective dose 16) Collective dose during refuelling	17) Age-dose > 0,2 Sv
	Condition of Barriers	18) Exhaust tech. Spec limit I-131	19) Un-identified & 20) Identified leakage of primary circuit in containment/drywell	21) Sum of leakage during leak-test of Containment valves and 22) penetration
Safety Culture	Safety Related Behaviour	23) Number of dismissals by employees	24) Number of illness days	25) Grade of fulfilment of HSK requirements
	Safety Related Behaviour	26) Number of HSK inspection findings	27) Number of Techn. Spec. violations	
	Safety Related Behaviour	28) Time for training on Emergency Preparedness	29) Number of audit findings/number of Audits	30) Number of in depth analysed external events/ number of action taken
	Striving for Improvement	31) Time for simulator training for shift personnel	32) Training time/ work time for licensed and 33) other personnel	

During the test phase 3 categories of classification were used: good, capable for improvement, unsatisfied.

The real data of 5 year backwards allowed to define realistic thresholds.

Some thresholds are common for all plants e.g. Scrams: threshold for categories: Good: 0 or decreasing trend; capable for improvement:1-4 or stabile trend; unsatisfied:≥5 or increasing trend

Other indicators are plant specific: Example: Safety Systems: Unavailability as Sum of hours of Letter Conditional Operation LCO time: Plants with safety System design n+2 are allowed to make preventive maintenance during operation, the indicator has high values ; other plants with n+1 preventive maintenance is not allowed, therefore the time is much lower.
For some indicators only the trend is of interest. As there are a lot of plant specific thresholds for classification no specific values are described.

For the annual assessment the performance indicators will be used in the following way:

Indicator areas	Indicator sub areas	Indicators
Radiation protection	Radioactive release and waste	The set of indicators will be finalised in autumn 2005.
	Radiation exposure of NPP staff	
Defence in depth	Level 1: Prevention of abnormal operation and failures	
	Level 2: Control of abnormal operation and detection of failures	
	Level 3: Control of accidents within the design basis	
	Level 4: Control of severe plant conditions including prevention of accident progression and mitigation of the consequences of a severe accident	
	Level 5: Mitigation of the radiological consequences of significant external releases of radioactive materials	
Barrier integrity	Fuel matrix and cladding	
	Boundary of the reactor coolant system	
	Containment	
Overall risk	PSA risk measures	
Safety functions	Controlling criticality	
	Cooling the fuel	
	Confining the radioactive material	
	Limiting radioactive exposure	

United Kingdom

General Notes:

1. For the duration of the Pilot Study none of the indicators have thresholds or goals.
2. Unless stated otherwise in the "*Comments*" column data is per month per station. British Energy report the data to the NII on a quarterly basis.

No.	Operational Safety Attribute	Overall Indicator	Strategic Indicator	Specific Indicator	Comments
1.	Smooth operation	Operating performance	Forced power reductions due to internal causes	Forced loss rate	Part of British Energy's performance measurement system. WANO indicator.
2.	Smooth operation	Status of structures, systems and components	Functionality	Routine/defect maintenance ratio	Part of British Energy's performance measurement system. Defined as: PM/(CO + UP + UW) % Where: PM Number of work orders of type "*Planned Maintenance*" completed or finished during the previous 12 months. CO Number of work orders of type "*Corrective*" completed or finished during the previous 12 months. UP Number of work orders of type "*Unplanned Maintenance*" completed or finished during the previous 12 months. UW Number of work orders of type "*Other Work*" completed or finished during the previous 12 months. The SPI is therefore a 12 month rolling average. Its objective is to show that undue reliance is not being placed on corrective, unplanned or "*other*" maintenance. It includes all maintenance, whether safety related or not.
3.	Smooth operation	Status of structures, systems and components	Material condition and ageing	Number of NDT inspections per outage	Created at the NII's request. For this indicator British Energy are to report historical data over about the last 10 years for two stations only. This is because this SPI will only vary slowly with time and the NII wishes to see whether the data can be correlated with the history of the stations selected. The data will be categorised by broad systems (e.g. "*low alloy steel systems*").
4.	Smooth operation	Status of structures, systems and components	Material condition and ageing	Number of significant NDT findings per outage	The comments made for "*Number of NDT Inspections per outage*" apply.

No.	Operational Safety Attribute	Overall Indicator	Strategic Indicator	Specific Indicator	Comments
5.	Smooth operation	Events	Reportable events	LC 7 notifications	Created at the NII's request. Licence Condition (LC) 7 relates to "*Incidents on the Site*".
6.	Smooth operation	Events	Reportable events	HSE's public service agreement indicator	Created at the NII's request. Information provided in Section 2 of http://www.hse.gov.uk/nuclear/pow0506.pdf. NII's work provides a major contribution to the Health and Safety Executive (HSE) public service agreement target to achieve a sustained reduction in the occurrence of precursor incidents in key major hazard industries regulated by HSE over the period 2005-2010. The indicator relates to the NII's contribution to HSE's public service agreement target. Data will be reported by British Energy once a nuclear industry wide definition of this SPI has been agreed. Historical data will also be provided to the beginning of the Pilot Study. The conceptual model is based on Section 5.8 of IAEA-TECDOC-1458.

No.	Operational Safety Attribute	Overall Indicator	Strategic Indicator	Specific Indicator	Comments
7.	Plant operates with low risk	Challenges to safety systems	Actual challenges	Unplanned trip rate	Created at the NII's request. Includes both manual and automatic trips. Per 7000 hours critical.
8.	Plant operates with low risk	Plant ability to respond to a plant challenge	Safety system performance	IOI/TS plant out of service	Part of British Energy's performance measurement system. Defined as the number of Identified Operating Instruction (IOI) or Technical Specification (TS) related plant items out of service identified on a weekly basis and averaged over the period of a month. The NII are still considering the adequacy of this definition.
9.	Plant operates with low risk	Plant ability to respond to a plant challenge	Safety system performance	Safety system unavailability (SSP1)	Part of British Energy's performance measurement system. WANO indicator.
10.	Plant operates with low risk	Plant ability to respond to a plant challenge	Safety system performance	Safety system unavailability (SSP2)	Part of British Energy's performance measurement system. WANO indicator.
11.	Plant operates with low risk	Plant ability to respond to a plant challenge	Safety system performance	Safety system unavailability (SSP5)	Part of British Energy's performance measurement system. WANO indicator.
12.	Plant operates with low risk	Plant ability to respond to a plant challenge	Safety system performance	Amount of time in LCO action condition	Created at the NII's request. Negotiations between the NII and British Energy about this SPI are ongoing. It is unlikely that data will be obtained on it before the end of the Pilot Study.
13.	Plant operates with low risk	Plant ability to respond to a plant challenge	Fire protection programme effectiveness	Minor fires	Part of British Energy's performance measurement system but initially suggested by the NII.
14.	Plant operates with low risk	Plant ability to respond to a plant challenge	Fire protection programme effectiveness	Fire near misses	Part of British Energy's performance measurement system but initially suggested by the NII.
15.	Plant operates with low risk	Plant configuration risk	Risk during operation	Extended unavailability reviews completed	Part of British Energy's performance measurement system. A Technical Specification (TS) time limit may be extended by the completion of an Extended Unavailability Review (EUR). This is the number of EURs completed during a calendar month.

No.	Operational Safety Attribute	Overall Indicator	Strategic Indicator	Specific Indicator	Comments
16.	Plant operates with low risk	Plant configuration risk	Risk during operation	Rolling average risk increase factor	Created at the NII's request. This is for the two AGR stations (four reactors) with risk monitors only. It is per reactor and not per station. It is the ratio between the risk taking into consideration real unavailabilities in post-trip cooling systems and the risk when all post-trip cooling systems are fully available averaged over a calendar month.
17.	Plant operates with low risk	Industrial safety	Work accident rate	Lost time accidents	Part of British Energy's performance measurement system. The number of lost time accidents (taking into account all staff, not just those employed by British Energy) during a calendar month.

No.	Operational Safety Attribute	Overall Indicator	Strategic Indicator	Specific Indicator	Comments
18.	Plant operates with a positive safety attitude	Attitude towards safety	Attitude towards procedures, policies and rules	Percentage of statutory and essential training "*in ticket*"	Part of British Energy's performance measurement system. The purpose of this SPI is to indicate the level of staff that are recorded as competent against statutory or essential tasks within their post or role profile. Statutory training is required by law whilst essential training is that which is determined to be required for the role. The SPI deals with station staff only.
19.	Plant operates with a positive safety attitude	Attitude towards safety	Attitude towards procedures, policies and rules	Technical specification breaches	Part of British Energy's performance measurement system. Negotiations between the NII and British Energy about the definition of this SPI are ongoing. The NII want the total number of technical specification breaches per calendar month, however they are categorised.
20.	Plant operates with a positive safety attitude	Attitude towards safety	Attitude towards procedures, policies and rules	CCR/MCR defects	Part of British Energy's performance measurement system. The number of defects which impair control room indications at the end of the month.
21.	Plant operates with a positive safety attitude	Attitude towards safety	Attitude towards procedures, policies and rules	Operator workarounds	Part of British Energy's performance measurement system. Operator workarounds relate to any plant condition (equipment defect or other) that would require compensatory operator actions in the execution of normal operating procedures, abnormal operating procedures, or emergency operating procedures during transient, abnormal or emergency conditions. The number of identified operator workarounds at the end of the month, excluding workarounds that have been identified as institutionalised workarounds.
22.	Plant operates with a positive safety attitude	Attitude towards safety	Attitude towards procedures, policies and rules	Standing CCR/MCR alarms	Part of British Energy's performance measurement system. The number of standing defective or disabled alarms in the control room at the end of the month.
23.	Plant operates with a positive safety attitude	Attitude towards safety	Attitude towards procedures, policies and rules	Safety docs > 90 days	Part of British Energy's performance measurement system. Safety documents may be associated with isolated plant, extended abnormal conditions or for access control to restricted plant areas. The number of safety documents that have been in existence for an extended period of time (>90 days) at the end of the month.
24.	Plant operates with a positive safety attitude	Attitude towards safety	Attitude towards procedures, policies and rules	Technical advice notes > 30 days	Part of British Energy's performance measurement system. Technical Advice Notes (TANs) provide written advice to operations staff, providing information to raise the awareness and understanding of particularly significant, non-standard operations or operational states. The number of open TANs over 30 days old at the end of the month.

No.	Operational Safety Attribute	Overall Indicator	Strategic Indicator	Specific Indicator	Comments
25.	Plant operates with a positive safety attitude	Attitude towards safety	Attitude towards procedures, policies and rules	Temporary operating procedures/ instructions > 30 days	Part of British Energy's performance measurement system. Temporary operating procedures provide written working level instructions to operations staff for the operation of plant or equipment. The number of open temporary operating procedures/instructions over 30 days old at the end of the month.
26.	Plant operates with a positive safety attitude	Attitude towards safety	Human performance	Employee availability	Part of British Energy's performance measurement system. This indicates the number of full time equivalents employed by British Energy against the location manpower plan at the end of the month. It is a broad indicator of resource availability. Includes all employees on the station payroll.
27.	Plant operates with a positive safety attitude	Attitude towards safety	Backlog of safety related issues	Open safety related defects	Part of British Energy's performance measurement system. The number of open industrial safety related defects at the end of the month. Negotiations between the NII and British Energy about the definition of this SPI are ongoing. The NII want this number plus the number of open safety related plant defects.
28.	Plant operates with a positive safety attitude	Striving for improvement	Operating experience feedback (OEF)	Condition reports initiated	Created at the NII's request. Relates to British Energy's Corrective Action Programme. For each station per month: 1. The total number of Condition Reports raised. 2. The number of "*Significant Adverse Condition*" Condition Reports raised. 3. The number of "*Adverse Condition*" Condition Reports raised. 4. The number of "*Improvement Item*" Condition Reports raised.
29.	Plant operates with a positive safety attitude	Striving for improvement	Operating experience feedback (OEF)	Average age of open SACI	Part of British Energy's performance measurement system. Relates to British Energy's Corrective Action Programme. Reported for each station per month. A SACI is a Significant Adverse Condition Investigation. Shows if SACIs are being completed in a timely manner.
30.	Plant operates with a positive safety attitude	Striving for improvement	Operating experience feedback (OEF)	Root causes	Created at the NII's request. Relates to British Energy's Corrective Action Programme. For each station per month: 1. The number of events with a root cause relating to physical ergonomics. 2. The number of events with a root cause relating to equipment. 3. The number of events with a root cause relating to human performance. 4. The number of events with a root cause relating to organisational.
31.	Plant operates with a positive safety attitude	Striving for improvement	Operating experience feedback (OEF)	Number of British Energy events screened at OpEx screening meeting	Created at the NII's request. This is a central support function indicator not a station specific indicator. Its objective is to provide insight into British Energy's learning from their events.
32.	Plant operates with a positive safety attitude	Striving for improvement	Operating experience feedback (OEF)	Number of non British Energy events screened at OpEx screening meeting	Created at the NII's request. This is a central support function indicator not a station specific indicator. Its objective is to provide insight into British Energy's learning from other organizations events.
33.	Plant operates with a positive safety attitude	Striving for improvement	Operating experience feedback (OEF)	No. of CRs raised as a result of OpEx evaluations	Part of British Energy's performance measurement system. This is a central support function indicator not a station specific indicator. Number of Condition Reports (CRs) raised as a result of OpEx evaluations (routine and mandatory) completed in the reporting month. Its objective is to provide insight into British Energy's learning from events.

USA

Cornerstone	Indicator		Thresholds: Increased Regulatory Response Band	Thresholds: Required Regulatory Response Band	Thresholds: Unacceptable Performance Band
Initiating Events	Unplanned Scrams per 7000 Critical Hours (Automatic and manual scrams during the previous four quarters)		>3.0	>6.0	>25.0
	Unplanned Scrams with a Loss of Normal Heat (over the previous four quarters)		>2.0	>10.0	>20.0
	Unplanned Power Changes per 7000 Critical Hours (over the previous four quarters)		>6.0	N/A	N/A
Mitigating Systems	Safety System Unavailability (avg. of previous 12 quarters)	**All Plants**			
		#2EDG	>2.5%	>5.0%	>10.0%
		>2EDG	>2.5%	>10.0%	>20.0%
		Hydro. Emerg. Power	TBD	TBD	TBD
		BWRs			
		HPCI	>4.0%	>12.0%	>50.0%
		HPCS	>1.5%	>4.0%	>20.0%
		RCIC	>4.0%	>12.0%	>50.0%
		RHR	>1.5%	>5.0%	>10.0%
		PWRs			
		HPSI	>1.5%	>5.0%	>10.0%
		AFW	>2.0%	>6.0%	>12.0%
		RHR	>1.5%	>5.0%	>10.0%
	Safety System Functional Failures (over previous four quarters)	BWRs	>6.0	N/A	N/A
		PWRs	>5.0	N/A	N/A
Barriers *Fuel Cladding*	Reactor Coolant System (RCS) Specific Activity (maximum monthly values, percent of Tech. Spec. limit)		>50.0%	>100.0%	N/A
Reactor Coolant System	RCS Identified Leak Rate (maximum monthly values, percent of Tech. Spec. limit)		>50.0%	>100.0%	N/A
Emergency Preparedness	Drill/Exercise Performance (over previous eight quarters)		<90.0%	<70.0%	N/A
	ERO Drill Participation (percentage of key ERO personnel that have participated in a drill or exercise in the previous eight quarters)		<80.0%	<60.0%	N/A
	Alert and Notification System Reliability (percentage reliability during previous four quarters)		<94.0%	<90.0%	N/A
Occupational Radiation Safety	Occupational Exposure Control Effectiveness (occurrences during previous four quarters)		>2	>5	N/A
Public Radiation Safety	RETS/ODCM Radiological Effluent Occurrence (occurrences during previous four quarters)		>1	>3	N/A
Physical Protection	Protected Area Safety Equipment Performance Index (over a four quarter period)		>0.080	N/A	N/A
	Personnel Screening Program Performance (reportable events during the previous four quarters)		>2	>5	N/A
	Fitness-for-Duty FFD/Personnel Reliability Program Performance (reportable events during the previous four quarters)		>2	>5	N/A

2.2 Why were these Indicator Areas chosen (i.e., basis for choosing particular area)?

Belgium

PI – system used by utilities:

In addition to the site-wide indicators, each organizational entity (operations, maintenance, etc.) had to choose a limited number of safety performance indicators (dependent on the site), for which they could be held directly accountable.

Informal indicators currently used by AVN (situation up to 2003):

The minimal set provides some high level indication of trends in the areas of nuclear safety (initiating events, mitigating systems) and radiation safety (collective dose).

The scope of areas covered has been increased in the pilot PI system, which is due for validation in 2005 (see section 5.1 and response to second survey). Its scope is more in line with SPI systems used by other regulators and depends on availability of reliable data for covering the areas. It is also limited by AVN's mandate as authorised inspection organization.

Canada

The basis for the original indicators were selected from an information survey and literary search (1996 -1998) and a systematic process (Management Oversight and Risk Tree (MORT) analytical tool) to select applicable PIs for measuring the safety of Canadian NPPs.

The Criteria included:

1. Be definable
2. be sensitive to changes in data
3. Show immunity to data manipulation
4. Not be prone to management without showing other effects

Have no negative impact on safe operation

Czech Republic

SUJB has chosen these areas as their monitoring covers most important parts of SUJB's duty concerning supervision of NPPs operation.

Finland

Concept for "Defence of Depth" was used as the base of the SPI structure.

STUK's indicator area A, Nuclear Power Plant Safety, cover the following performance areas:

- Safety and Quality Culture
- Operational Events
- Structural Integrity

Classification into these performance areas (layers) is based on the adoption of the concept of "Defence in Depth".

Reference Document: NEA/CSNI/R(2002)2, pp 114-141

Germany

Currently not applicable

Hungary

Our SPI system covers every main elements of nuclear safety. The tree main areas are:

- Plant operates smoothly
- Plant operates with low risk
- Safety attitude

Japan

We are developing PIs about the Reactor Safety Area.

Korea

MOST/KINS' indicators cover the following performance areas:

- Reactor Safety Area : 3 categories 9 indicators
- Radiation Safety Area : 2 categories 2 indicators

The reactor safety is the most important.

It has been reflected the WANO and USNRC PI systems.

Slovakia

The performance indicators cover the following performance areas:

- Operation of safety systems
- Significant events
- Barriers tightness
- Human factors

The licensee report to regulatory body covers four areas which significantly influent the nuclear safety of nuclear installations.

Reference Document: UJD SR QA Instruction

Spain

The set of performance indicators was selected to match those of the US NRC so that comparisons with similar plants was readily available.

Sweden

High level indicators such as WANO (level 1 SKI grouping) were chosen because they are available at the utility. For SKI use the lower level indicators (SKI group level 2) gives more insights to various safety concerns. The grouping into barrier and defence in depth were chosen to give a broad picture how well the utilities operate and maintain equipment important to safety.

Switzerland

The chosen areas cover the obligations and responsibilities of the HSK oversight. They are more or less in line with the proposals made by the IAEA in the TECTOC 1141. The reduction of burden for data collection was also a criterion. HSK receives comprehensive monthly reports which are a source for some of the indicators.

Reason of choosing indicator (Look at the indicator Number in the SPI table):

1) Shows the ability of the utility to reduce the plant risk by optimising the LCO time.
2) Shows the effort of the utility to eliminate plant weaknesses by a careful use of operating experience.
3) Correlated with the plant risk (activation of reactor protection system by a transient). Also aging aspects are involved.
4) Indication of errors of operating or maintenance personnel and/or aging of electric devices
5) Aging or other reasons of electronical devices
6) The same as 4) but with focus on failed manipulation of personnel
7) All actions or events (every unavailability of a safety component or Scram) which led to a CCDF > 2 E-5. Ability of operator to minimize the plant risk.
8) Sum CCDF of all events (every unavailability of a safety component or Scram). Minimizing plant risk.
9) Indictor of the quality of the maintenance of safety systems.
10) Quality of preventive maintenance of safety systems.
11) Quality of maintenance of safety systems versus time pressure during refuelling.
12) Ability to minimize radioactive waste.
13) Ability to handle waste in the designed form.
14) ALARA.
15) ALARA.
16) ALARA.
17) ALARA.
18) Indicator for fuel reliability and plant risk (radioactive release by leakage).

19) Primary tightness as indicator of ability of utility to cope with leakage problems.
20) Same as 19.
21) Same as 19.
22) Same as 19.
23) Indicator for bad working climate or high work load and/or too inadequate remuneration or recognition.
24) Same as above
25) Indicator for willingness of operator to cooperate with HSK and/or adequacy of personnel resources.
26) Indicator for quality of work respective negative implication of economical constraints.
27) Will of utility to respect the Techn. Specification by adequate effort to prevent violations.
28) Emergency preparedness depends in high degree on training, indicator for emergency fitness
29) Willingness of utility to use the instrument efficient for learning.
30) Willingness of utility to learn from external events.
31) Shift fitness depends highly on training. Indicator for shift fitness to cope with emergencies etc.
32) Additional training of shift personnel on e.g. specific safety issues, shut down safety , self assessment etc.
33) Training of all other personnel as maintenance, engineering etc. at all related areas

For Annual plant safety Assessment:

The indicator areas were chosen so as to get information about all levels of defence in depth, also in the fields of normal operation and prevention of failures and weaknesses.

United Kingdom

In selecting indicator areas and specific indicators the following overall principles were adopted by the NII:

P1. The IAEA SPI framework in [2], which updates the SPI framework in IAEA-TECDOC-1141, was used without modification at the levels of operational safety attributes, overall indicators and strategic indicators.

P2. SPIs were not selected to represent IAEA strategic indicators that the NII considered to already be adequately represented by the NII's existing inspection and assessment programmes. This principle eliminated selection of SPIs to represent "*Emergency Preparedness*", "*Radiation Protection Effectiveness*" and "*Radioactive Waste Management Effectiveness*".

P3. SPIs were not selected to represent IAEA strategic indicators not under the control of British Energy. This principle eliminated selection of SPIs to represent "*Forced Power Reductions due to External Causes*".

P4. SPIs were selected to represent the remaining IAEA strategic indicators. However, if a SPI judged to be adequate to represent a particular IAEA strategic indicator could not be identified, the IAEA strategic indicator was not represented.

P5. Maximum use was made of British Energy's existing performance indicators, to minimise the additional workload on them.

P6. The intent was that the total number of SPIs selected would not exceed approximately thirty to reduce the likelihood of data overload at the NII. This total number of SPIs is quite high but it was considered to be reasonable for a Pilot Study on the basis that a number of the SPIs selected may not prove in practice to be adequate for longer term use by the NII.

These principles were applied during a two day Workshop attended by both the NII and British Energy [British Energy's role was limited to providing information on their performance measurement system]. The following main steps were followed during the Workshop:

S1. Map British Energy's performance indicators relevant to safety onto the IAEA SPI framework.
S2. Map SPIs used by other nuclear utilities and nuclear regulators onto the IAEA SPI framework. Particular sources used were IAEA-TECDOC-1141, Reference [2] and the proceedings of the joint CNRA/CSNI Workshop "*Regulatory uses of Safety Performance Indicators*" (http://www.nea.fr/html/nsd/workshops/pi/programme.html) in Granada.
S3. Consider lessons learnt relating to performance indicators from recent major accidents or events in the nuclear or other industries (particularly the Columbia shuttle disaster (http://caib.nasa.gov/) and Davis-Besse) and if possible select additional SPIs to take these into account.
S4. Brainstorm SPIs to represent IAEA strategic indicators not well represented by steps S1-S3.
S5. Select SPIs for the Pilot Study from the IAEA SPI framework populated with specific indicators from steps S1-S4. Selection was done qualitatively using a majority voting approach.

After the Workshop the Pilot Study SPIs were updated following input from specialist NII expertise in specific technical areas and following a series of meetings between the NII and British Energy.

[2] IAEA-TECDOC-XXX. *Development and Implementation of Safety Performance Indicators at Nuclear Power Plants*. To be published.

USA

NRC's cornerstones cover the following performance areas:

- Reactor Safety
- Radiation Safety
- Physical Protection

These three areas cover the obligations and responsibilities of the NRC. Most of the federal regulations operating NPPs need to acquire and maintain an NRC license are located in 10 CFR Part 50.

Reference Document: NEA/CSNI/R(2002)2, pp 15-16

3. DATA COLLECTION, PI CALCULATION AND REPORTING REQUIREMENTS

3.1 Please answer the following questions regarding indicator data collection:

- Who is responsible for the data collection and/or indicator calculations (licensee/utility and/or RB)?
- To whom and how often is the data reported?
- If the utility/licensee performs the indicator calculations, does the RB perform independent calculations (if not how does the RB ensure the quality of the data and calculations)?

Belgium

Informal indicators currently used by AVN (situation up to 2003):

- The licensees are responsible for data collection and indicator calculations.
- The licensees report gross data for scrams and collective dose to AVN in the frame of their monthly and yearly reports.

There are no reporting requirements for data on safety system unavailability rates. Information on related indicators is collected by the AVN-inspectors in the frame of their routine inspection activities.

For scrams and collective dose, AVN performs independent indicator calculations based on gross data provided by the licensees. AVN does not perform independent verifications of indicators related to safety system unavailability rates.

Data collection in the frame of the new SPI pilot project is mainly done by AVN (on the basis of existing regular utility reports, event reports and inspection results), with the exception of WANO indicators, which are provided directly by the licensees.

Canada

- The licensees are responsible for data collection.
- The licensees are required to report indicator data to the CNSC on a quarterly basis.
- The CNSC verifies completeness and accuracy of the indicators reported by the licensees.

Reference: S-99 Reporting Requirements for NPP

Czech Republic

- The licensees are partly responsible for data collection, as SUJB’s resident inspectors are responsible for other part.
- The licensees are required to report indicator data to the SUJB mostly on a quarterly basis. The precious form, period of the data, which should be reported, is prescribed in SUJB’s decisions.
- The SUJB verifies completeness and accuracy of the data reported by the licensees. Residents are performing calculation.

Finland

- The licensees are responsible for data collection and delivery to RB. In some cases the inspectors perform data selection before calculation. RB (responsible inspector) is responsible for indicator calculation (except WANO-indicators).
- The licensees report data needed in calculation to the NRR on quarterly and/or annual basis in regular reports according to the guide YVL 1.5 or based on personal contacts with nominated inspectors in responsible for individual indicators or in the meetings of utility and RB management. There are some indicators in the system (e.g. CCFs, containment integrity) which are calculated by operation cycle
- The NRR inspects and verifies the data of the indicators reported by the licensees.

Germany

Currently not applicable.

Hungary

- The licensees are responsible for the most part of data collection and indicator calculation.
- NSD also collects data and makes indicator calculation and evaluation.

Japan

Now we are under investigation.

Korea

The data for the SPIs are quarterly provided by the licensees, which are not subjected to legal reporting requirements.

Slovakia

- The licensees are responsible for data collection and indicator calculation.
- The licensees are required to report indicator data to the UJD SR on a quarterly basis.
- The regulatory body does not perform independent calculations

Reference: according to issued license for operation and UJD SR decision 245/2001

Spain

- The licensees send indicator information to the CSN. CSN is responsible for data collection from LERs and monthly reports
- A contractor (the research centre CIEMAT) computes the indicator indices and provides the trending reports
- The yearly report on indicators with conclusions is completed at the CSN.

Sweden

For the time being the licensee collect data for the higher level indicators (e.g WANO) and maintain the database on maintenance records. SKI derives the indicators based on LER:s and calculates unavailabilities.

Switzerland

The utilities have the responsibility for basic data collection.

- The licensees are responsible for data collection and calculation of indicators of their interest.
- The licensees are required to report data and/or indicators of HSK's interest on a periodic (annual) basis.
- The licensees and HSK verify the completeness and accuracy of their indicators. In order to verify the quality of the indicators HSK will perform inspections on a random basis.

For annual plant safety Assessment
Most indicators are collected or calculated by the licensees. Indicators that can be calculated on the basis of information the RB already has are calculated by the RB.

From 2006 onwards the data are supposed to be reported to the RB monthly.

The RB verifies indicators by comparing them with inspection results.

United Kingdom

1. British Energy is responsible for data collection.
2. With the exception of SPIs 3. and 4. British Energy report indicator data to the NII on a quarterly basis. British Energy report data on SPIs 3. and 4. on a yearly basis.
3. It is intended that the NII, or a contractor employed by the NII, will verify on a sample basis the completeness and accuracy of the indicators reported by British Energy. This may occur after the completion of the Pilot Study.

USA

- The licensees are responsible for data collection and indicator calculation.
- The licensees are required to report indicator data to the NRC on a quarterly basis.
- The NRC verifies completeness and accuracy of the indicators reported by the licensees.

Reference: http://www.nrc.gov/NRR/OVERSIGHT/nei_9902rev2.pdf (pp10)

3.2 Please list in the following table which indicators are based on the following information:

- Which PIs are based on regular reports to the RB?
- Which PIs are based on separate reporting requests by the RB?
- Which PIs are based on information from site inspectors and/or site inspections?
- Which PIs are based on maintenance and event data banks?
- Which PIs are based on interviews/personal contacts/meetings?
- Other?

Belgium

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
Collective dose	None	Safety system unavailability rate* * only available for one site	Unplanned scrams (Event data base owned by AVN)	None	None

(Refers to situation up to 2003)

Canada

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
All PIs are based on licensee reports due to the CNSC on a quarterly basis.	None	None	None	None	None

Czech Republic

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
Part of PIs (60%) is based on licensee reports due to the SUJB on a quarterly basis.	None	Part of PIs (40%) is based on information from SI.	Some of that, which are collected by SI.	None	None

Finland

Regular Reports to the RB	Separate Documents submitted to the RB	Information from Site Inspectors and/or Site Inspections	Fault Data or Work Order Records and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other or Comments
A.1.1g; A.1.4a; A.1.5a,b; A.3.1a,b;	A.2.1a; A.2.1a,b,c; A.2.2a,b,c,d; A.2.3a,b; A.3.3a,b,c;	A.1.1a; A.1.1b; A.1.1c A.1.3;	A.1.1a; A.1.1b; A.1.1c A.1.1e; A.1.1f/TVO; A.2.1b; A.1.6;	A.1.1a; A.1.1b; A.1.1c A.1.3; A.1.4b; A.1.7; A.2.4; A.3.1a; A.3.2a; A.3.2b/TVO	A.1.1e & A.1.1f not available from LO; A.1.3: WANO-ind.; A.1.5c calculated by STUK; A.1.6 STUK's plant modification record; A.2.2 CDF calculated at STUK; A.3.2a: WANO-ind.; A.3.2c not available from LO

Germany

Currently not applicable.

Hungary

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
YES	YES	YES	YES	None	None

Japan

Now we are under investigation.

Korea

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
all	-	-	-	-	-

Slovakia

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
All PIs are based on licensee reports due to the UJD SR on a quarterly basis.	None	None	None	None	None

Spain

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
All PIs are based on licensee information submitted to the CSN.	None	None	None	None	None

Sweden

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
Collective dose (to SSI)	SKI Level 1indicators (WANO)		Utility operated	None	None

Switzerland

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
• Exhaust of I-131 limit. • Number of reportable occurrences class A&B. • Collective doses. • Environmental dose. • Lifetime dose > 0,2 Sv until age of 50. • Training. • Amount of untreated waste.	All others	• Result of HSK inspections.	None.	Not fixed.	

For annual plant safety assessment :
A topical list can be presented after autumn 2005

United Kingdom

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
All SPIs except 3. and 4. are based on British Energy reports to the NII on a quarterly basis. British Energy to report SPIs 3. and 4. to the NII once during the Pilot Study.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.

USA

Regular Reports to the RB	Separate Reporting Requests by the RB	Information from Site Inspectors and/or Site Inspections	Maintenance and Event Data Banks	Interviews/ Personal Contacts/Meetings	Other
All Pis are based on licensee reports due to the NRC on a quarterly basis.	None	None	None	None	None

4 HOW ARE INDICATORS USED BY THE REGULATORY AGENCIES

4.1 How are PIs used by the RB in regulatory evaluation (e.g., inspections) and decision processes (provide a brief overview of the general approach and please reference additional documentation that explains in more detail which PIs are related to which kind of evaluation and decision processes)?

Belgium

Situation up to 2003:

The results of the PI-system set up by the licensees are available for the AVN inspectors but are generally not used by them (the unavailability rate of TS-related safety systems is in this respect an exception).

There is no formal process for the use of indicators monitored by AVN. Trending of PI results is within the responsibility of the individual plant inspectors. They may use these data in order to focus their inspection activities on specific areas of interest. Often they are used to investigate licensee activities and to track recurrent problems. They are not used to assess the performance of the licensee in matters of safety.

For update of this information in 2005 see response to second survey.

Canada

General CNSC regulatory philosophy for performance indicators:

Performance indicators will not be used in isolation but combined with other information from staff inspections, event analysis and discussion with licensee. This integrated picture will be used to determine regulatory action.

Performance indicators must not promote any unwanted behaviour from the licensee in order to avoid populating the data. Performance indicators should not be subject to management to affect a desired result. However, if a performance indicator does not reflect licensee practices it should be revised or dropped.

As far as practical, performance indicator definitions should be controlled for meaningful comparison and trending. However interpretations of results and changes to licensee programs will force improvement and evolution of performance indicators.

Czech Republic

The SUJB used the PI set results when evaluating the safety performance of the NPPs and planning new inspection activities.

Finland

- Annual summary reports from the areas A and B with conclusions and evaluation of the safety level of power plants from the indicators point of view are prepared by the administrators of areas for communication with management of NRR and STUK and licensees.
- The annual overall assessment of nuclear power plant safety by inspections (basic, specific, Periodic Inspection Programme) and safety reviews is complemented by the STUK indicator system and reported in the annual report on "Regulatory control of nuclear safety in Finland" to be submitted by to the Ministry of Trade and Industry.
- All SPIs for NPPs are published as appendix of the above mentined annual report, which is available on STUK public website:
- Indicators, which are included as safety objectives of NRR in the annual target plan as well as in the agreement signed yearly between STUK and the Ministry of Social Affairs and Health are reported in annual reports to these "host" ministries.
- The NRR focuses and partially develops its inspection program based on the PI data
- Baseline inspections are always performed even if no SPI deterioration in trends is detected.
- The trends of indicator values, if showing a deteriorated trend during two consecutive years, a need for increased NRR response, e.g., additional inspection or establishment of an investigation team by STUK ([*]) is indicated.
- The NRR's regulating action depends on the trend that has been violated and the margin to safety (limits of Tech.Spec([*] or safety related systems).
- Increased inspection examines the effectiveness of the licensee's actions to correct the deficiency and also if RB's own performance has contributed to the degradation.

[*] *Reference Document: IAEA/NEA/IRS-report number 7494 "Non-compliances with the Technical Specifications and Human-Based Common Cause Failures in Finnish Nuclear Power Plants"*

Germany

Currently not applicable.

Hungary

NSD uses colors (green, yellow, red) to rank the SPI.

Three color-marked evaluator fields were determined for the safety contributors as follows:

- „green": The green field of the safety contributor spreads to the limit deemed appropriate by the authority. The values of the green field considered as reassuring by the authority and further action or increased attention is not deemed to be necessary.
- „yellow": The limits of the warning, yellow field call the attention to the deviation from the desirable values within the regulatory acceptable range. The contributors within the yellow field should be paid increased attention and further actions should be done to avoid the prospective violation of the regulatory limits.
- „red": The lower limit of the red, not acceptable field of the safety contributor is the limit value approved by the authority in different kind of documents - if such value is available –

or in the event of lack of this value such individually determined criterion, in case of in-compliance with that the authority expects the corrective measure of the Licensee or itself initiates corrective measure.

Japan

The regulatory body will use PIs to assist the inspection activities.

Korea

None

Slovakia

- The UJD SR partially develops its inspection plan based on the PI data reported by the licensee
- The threshold values, if stated, indicate a need for UJD SR response (e.g., additional inspection).
- Increased inspection examines the effectiveness of the licensee's actions to correct the deficiency.
- Inspections according to inspection plan are always performed even if no PI thresholds are crossed.
- The UJD SR regulating action depends on the threshold level.

Reference Document: UJD SR Inspection plan

Spain

- The indicator trending is used internally to focus on problematic areas
- Indicators are compared among plants to rank some regulatory responses
- When available, similar indicators are compared with those of plans in other countries to draw conclusions on performance
- Indicators are reported to the Parliament

Sweden

Indicators are on trial use for yearly integrated safety assessment of each licensee. They support the evaluation process. In that respect they contribute and give support for inspection findings and reviews. The integrated safety assessment can change the activities at SKI when needed. However there are no threshold values linked to the SKI response. Colour codes are used for system unavailability with the purpose to alert.

Switzerland

The SPIs are intended to be used for:

- The HSK inspection program (frequency, depth of inspections) will be influenced by the SPI data (other factors also affect the inspection program).
- If threshold values are violated, HSK will strengthen its oversight activities (e.g., additional inspection).
- Baseline inspections are always performed even if no SPI thresholds are violated.
- The HSK's regulatory oversight activities depend on the actual SPIs values and on further investigations (events happened in Switzerland and abroad, insights from research activities, etc.).
- It is foreseen in the frame of the HSK project "integrated oversight" to include selected SPI in the yearly safety assessment of NPPs for the public in the annual report.

An HSK project is on the way to optimize the process for the annual plant safety assessment of the NPPs. Within the project the role of Safety Performance Indicators is under discussion and has still to be defined.

The following operational safety indicators are already used for public information as part of HSK's annual reports. The information below refers to the tables and figures in HSK's annual report 2004: http://www.hsk.ch/english/files/pdf/jabe03_e.pdf:

Table A1	Performance of the Swiss nuclear power plants in 2003
Table A2	Numbers of licensed personnel and grand totals of all personnel in the Swiss nuclear power plants at the end of 2003
Table A3	Classified events in 2003
Table A4a	Summary of the releases of radioactive materials to the environment in 2003 and the resulting calculated individual doses
Table A4b	Releases of the Swiss nuclear power plants in the last 5 years, compared to the release limits
Table A5a	Nuclear power plants: Whole-body doses of occupationally exposed personnel from external irradiation in 2003. Number of persons and average annual dose
Table A5b	Nuclear power plants and research: Whole-body doses of occupationally exposed personnel from external irradiation in 2003. Number of persons and average annual dose
Table A6a	Nuclear power plants: Whole-body doses of occupationally exposed personnel from external irradiation in 2003. Annual collective doses in Person-mSv
Table A6b	Nuclear power plants and research: Whole-body doses of occupationally exposed personnel from external irradiation in 2003. Annual collective doses in Person-mSv
Table A7	Nuclear power plants and research (own and external personnel): Whole-body doses of occupationally exposed personnel from external irradiation in 2003. Number of individuals grouped according to age and sex
Table A8	Nuclear power plants and research: Distribution of hand and foot doses in 2003
Table A9	Nuclear power plants and research: Committed effective dose E50 of occupationally exposed personnel resulting from incorporation in 2003
Table A10a	Nuclear power plants and research: Distribution of total accumulated doses (life-doses) of occupationally exposed own personnel in 2003

This type of information published since many years. The reader of the report may draw conclusions from two types of information:

- Comparison of the Safety Performance of the individual nuclear installations in the respective area and year (e.g. Table A1)
- Comparison of trends in Safety Performance of the individual nuclear installations over a long term period (5 or 10 year) (e.g. Table A4b or Fig A1)

Summary of experience with indicators:

Experience with existing indicators:

- The overall experience with the existing system is seen as very positive.
- Interested readers of the annual report consider the mentioned tables and figures as very valuable. Unexpected trends or values are commented in the textual part. The assessment of the annual safety performance of the plant in the textual part is taking into account the operational safety indicators in a global way (not directly traceable).
- HSK meets the objective of open information of safety issues at NPPs to the public. HSK responds carefully on public questions or critical comments to the report.
- These safety indicators are focused on measurable “hard” facts (mainly doses and releases) but don’t consider the different safety aspects of the defence in depth concept.

New SPI-Project:

Additional safety aspects of the defence in depth concept expressed by safety indicators will be implemented. As the project is just still ongoing, no experience exists.

United Kingdom

A two-day Workshop has been arranged in November 2005, with a principal objective of deciding how the NII will use SPI data in its regulatory activities. To inform this Workshop information is being gathered on how other nuclear regulators, British Energy and other parts of HSE use performance indicator data.

The NII has in place (http://www.hse.gov.uk/nuclear/pow0506.pdf) an Integrated Intervention Strategy (IIS). Currently this includes information from the NII's inspection and assessment activities. How to embed information from SPIs into the IIS will be determined at the Workshop.

USA

- The NRC partially develops its inspection program based on the PI data reported by the licensee (other factors also affect the inspection program).
- The threshold values, if crossed, indicate a need for increased NRC response (e.g., additional inspection).
- Increased inspection examines the effectiveness of the licensee's actions to correct the deficiency.
- Baseline inspections are always performed even if no PI thresholds are crossed.
- The NRC's regulating action depends on the threshold level that has been violated and the margin to safety.

Reference Document: NEA/CSNI/R(2002)2, pp 18-19

5 FUTURE AND CURRENT PILOT PROJECTS/INDICATORS

5.1 Please list any current and future pilot projects/indicators (please reference material that gives detailed information on the project).

Belgium

In 2002 a R&D project has been started at AVN in order to develop a more complete set of indicators to be applied by AVN in the frame of its regulatory oversight activities. Within this R&D project a provisional set of indicators has been defined and a pilot project was started with the objective to assess the usefulness of proposed indicators, the adequateness of proposed definitions, the adequateness of proposed calculation time periods and the feasibility of the data collection process. The R&D project also aims to make proposals for the use of these indicators within AVN's inspection process.

The following areas are covered within this project:

- initiating events (IE)
- safety systems (MS)
- barriers (BI)
- safety related processes (operations, maintenance, plant modifications, operating experience feedback) (PR)
- occupational radiation safety (OR)
- public radiation safety (RE)

Canada

None

Czech Republic

A study is in progress with the aim to include maintenance and operator's feedback indicators in the set.

Finland

- The research ordered by STUK to define safety indicators, which help to review the maintenance quality and its progress also at Loviisa NPP, has been finished. Implementation of an indicator and/or a set of indicators requires commitment of licensee to co-operation, otherwise the workload is too high for RB and the accuracy of possible indicators is not the best possible.
- Improve the accuracy of maintenance quality indicators (A.1.1d – A.1.1f) and risk-based indicators (A.2.2) of Olkiluoto NPP by co-operation with the licensee:
    - define logical relationships useful for RB's and licensees' purposes
    - data selection and calculation to avoid unnecessary burden of both sides

- STUK is considering to include new indicators into its system in areas: Occupational safety, Self-assessment, and Operating experience feedback.
- Use and compliance of indicators in areas of Fire safety and Investments for safety need to be evaluated and indicators need to be developed more informative.
- STUK does not have indicators either in areas Operational preparedness and Emergency preparedness, because inspections of Periodic Inspection Programme cover e.g. areas area as listed in first questionnaire summary table. STUK is going to reassess for needing indicators in these areas.
- Develop an indicator describing the quality of documents supplied by the licensees.
- STUK is going to implement a software system for administration and monitoring (self-assessment) and unified report production. The system will work also on the performance indicator database. In the system considered indicator specifications include also thresholds or limits for acceptability with colour coding.

Germany

PI system (as part of Safety Management system) under development.
For update of this information in 2005 see response to second survey

Hungary

- Develop more risk base indicator.
- Evaluation of the ranking criteria based on our experiences.

Japan

Now we are under investigation.

Korea

Now we are conducting the development work:

- to provide SPI for the containment integrity
- to integrally evaluate the SPI results based on the annual average data as well as on quarterly dataSPI will be improved to provide quantitative indications of both the plant safety and the efficiency of regulatory activities and Web-site will be familiarized with public.

Slovakia

Safety performance indicators – DTI, GB
Reference: project NSP03/S3

Spain

- Feasibility of changing the CSN set of indicators to ROP´s ones
- The indicators now integrate information from the Probabilistic Incident Analyses (Precursor analysis)
- Definition of Risk-Based indicators (similar to ROP)

For update of this information in 2005 see response to second survey

Sweden

A set of indicators has been used last year (situation 2003). Some might be modified for next year and additional indicators will be tested. For trend purpose the indicators will be documented over some years. The documents will be available when they are ready.

Switzerland

Test phase of the SPIs is finished. The SPIs are now being integrated into the Integrated Oversight approach. A new NPP Safety Assessment System will become operational in 2006 (see 1.1).

United Kingdom

WS Atkins are supporting the NII during the British Energy SPI Pilot Study. The three main support activities relate to:

Activity 1. Reviewing how other regulators use SPIs.

Activity 2. Analysing and interpreting the Pilot Study data, suggestions for interventions.
Activity 3. Reviewing the current SPIs.

The third area covers all IAEA strategic indicators but with particular emphasis on:

a) Safety awareness.
b) Self-assessment.
c) Emergency preparedness.
d) Radiation protection effectiveness.

a) and b) are emphasised because the NII could not identify SPIs to adequately represent these IAEA strategic indicators during the British Energy SPI Pilot Study.

c) and d) are emphasised since the NII wishes to consider relaxing overall principle P2 adopted during the Workshop (see the response to Question 2.2).

The intention is to undertake a British Energy SPI Pilot Study Review in a two day Workshop in early 2006. At that Workshop alternative or new SPIs will be available from the WS Atkins Activity 3 review. The intention is that a potentially revised SPI selection from the Pilot Study Review will form the basis for the longer term operation of the NII's SPI system for British Energy.

A SPI Pilot Study is being launched with the UK's other operating reactor licensee, Magnox Electric.

USA

- Mitigating System Performance Index

Reference: *http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/mspi.html*

Appendix 3 – Results of the first questionnaire

3.2 Overview tables of the indicators used by the countries (represents mostly the situation in 2003-4)

On the following pages, first, a table is shown with indicators grouped according to safety cornerstones. After that, a table is presented with a grouping according to the IAEA TECDOC-1141 structure.

I Indicators according to safety areas or cornerstones

Indicators according to safety areas or cornerstones		BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
A	Reactor safety													
A1	Events													
	Challenges of safety systems													
	Unplanned scrams / RPS actuations	x	x	x	x	x	x	x	x	x	x	x	x	x
	Unplanned scrams with LOFW	x												x
	Control rod drops				x									
	Safety system actuations	x	x	x		x			x			x	x	
	Significant events													
	Safety significant events / reportable events	x	x	x	x	x	x	x	x		x	x		
	Reportable events during plant shutdown	x	x											
	Less significant events (disturbance reports, operational failures)				x		x		x					
	Event investigations ordered by RB								x					
	Events caused by technical factors		x				x							
	Events during tests		x									x		
	Number of occurrences/actions under effect of TS (L&C)				x				x					
	Unplanned power changes													
	Unplanned power changes (load reductions, automatic reactor power transients, forced outages)	x	x		x				x	x	x		x	x
	Risk-based indicators													
	Core-melting index caused by initiating events / Risk significance of events (combined risk)	x					x		x					
	Number of risk peaks			x										
	Accumulated risk			x										

		BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
A2	Mitigating systems													
	Safety system availability													
	Safety system availability / unavailability/ inoperability (includes AC power/EDG)	x	x	x	x		x	x	x	x	x	x	x	x
	TS plant out of service							x						
	Amount of time in LCO action condition							x						
	LCO index												x	
	Extended unavailability reviews completed							x						
	Safety system failures													
	Failure of components subject to TS						x				x			
	Safety system functional failures (loss of more than 1 redundancy)	x	x			x							x	x
	Failure of safety systems at start		x		x						x	x		
	Failure of safety systems during operation		x		x						x	x		
	Number of CCFs (potential / actual) (technical critical/technical potential)						x				x			
	Emergency diesel generator reliability (start+ run)	x	x											
	Risk-based indicators													
	Mitigating System Performance Index													x
	Risk indicator connected to preventive maintenance of TS equipment						x						x	
	Risk indicator connected to TS equipment failures						x						x	
	Risk indicator connected to TS exemptions						x						x	
	Number of events in different risk categories (CCDP >= or <= certain value)						x							
	Rolling average risk increase factor							x						
A3	Barriers integrity													
	Integrity of fuel													
	Fuel reliability (RCS specif. activity)	x			x		x		x	x	x	x	x	x
	Number of removed fuel bundles due to leakage				x		x						x	
	Integrity of reactor coolant system													
	RCS / Pressure boundary leak rate	x		x			x			x			x	x
	Primary leakage events								x					
	RCS isolation valves tightness												x	
	Use of stressor cycles								x					
	Ratio of plugged SG tubes								x					
	Integrity of containment													
	Drywell/ Primary Containment/ Hermetic zone tightness			x	x		x		x	x		x	x	

	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
A4 Material condition and ageing													
Chemistry indexes (primary circuit/ secondary circuit)		x				x							
Corrosion products released from surfaces of reactor circuit and secondary circuit						x							
Number of NDT inspections per outage							x						
Number of significant NDT findings per outage							x						
B Radiation safety													
B1 Occupational Radiation Safety													
Radiation exposure to workers - collective dose	x	x	x	x	x	x		x	x	x		x	
Radiation exposure to workers - average dose			x	x									
Radiation exposure to workers - maximum dose/average of 10 highest doses				x		x							
Radiation exposure to workers - number of worker exposues within specific dose ranges												x	
Number of workers subjected to special decontamination		x		x								x	
Dispersion of contamination								x				x	
Work programs at high radiation level								x					
Occupational Exposure Control Effectiveness / Radiation occurrence index/ Occurrences related to TS		x						x				x	x
B2 Public Radiation Safety / Environmental risk													
Public dose (calculated dose) / Environmental Radiation		x	x	x		x			x			x	
Liquid Releases (excluding tritium, tritium releases)	x	x		x		x		x				x	
Gaseous/air-born releases	x	x	x	x		x		x				x	
Radiological Effluent Occurrences	x												x
Solid Releases / Solid waste generated		x	x					x				x	
C Industrial safety													
C1 Fire safety													
Number of malfunctions of fire alarms (non-activation, false alarms)						x						x	
Number of real fire alarms						x						x	
Number of fires						x	x	x			x	x	
C2 Occupational safety													
Number of work accidents / Accident frequency / Index of industrial safety / Lost time accidents		x					x	x				x	
Accident severity rate		x											

		BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
D	Global plant performance													
	Forced outage rate/ Unplanned capability loss / Production loss due to failures / Forced loss rate		x			x	x	x			x			
	Capacity factor/ Unit capability factor								x		x		x	
E	Safety Management / Safety related processes													
E1	Human performance													
	Events due to human or organisational failure / MTO related events	x			x	x	x		x		x	x	x	
	Human-based CCFs (actual/potential)						x				x		x	
	Human based maintenance failures (total number)						x							
	Number of MTO causes (strategic - upper level)										x			
	Number of MTO root causes (specific - lower level)										x			
	Set of administrative indicators (MTO)										x			
	Actual and potential events (near misses) due to procedure deficiencies												x	
	Number of dismissals by employees			x										
	Number of illness days / Employee availability			x				x						
	Unsuitable state for work (number of occurrences)								x					
E2	Compliance / Attitude													
	Number of TS violations/deviations/non compliances (TS or L&C)	x		x	x		x	x	x			x	x	
	Licensee deviations from regulations/ Non-compliance index / Violation of license conditions		x						x		x		x	
	Number of TS exemptions (temporary changes) (TS or L&C)	x			x		x		x			x	x	
	Number of TS modifications								x					
	Number of RB-inspection findings			x										
	Grade of fulfillment of RB-requirements			x										
	Number of cancelled /missed mandatory tests		x						x					
	Percentage of statutory and esssential training "in ticket"							x						
	Main Control Room defects							x						
	Operator workarounds							x						
	Standing control room alarms							x						
	Safety documents > 90 days							x						
	Technical advice notes > 30 days							x						
	Temporary operating instructions		x					x	x					

	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
E3 Operational preparedness													
Number of staff with regulatory licence		x						x				x	
Unsuccesfull regulatory exams/ average examination results (written, full-scope simulator)		x						x				x	
Operator training		x	x										
Training of other NPP personnel			x										
E4 Emergency preparedness									x[4]				
Drill/exercise performance		x											x
Drill participation / training on emergency response		x	x					x				x	x
Alert and notification system reliability		x											x
Emergency response resources completion index		x											
Deficiencies found during emergency exercises		x						x					
Deficiencies found during regulatory inspections		x						x					
E5 Management of plant modifications													
Change control index (temporary changes) / Temporary modifications		x						x				x	
Number of modifications needing regulatory approval												x	
Events caused by deficiency in modif. manag. process	x									x		x	
Keeping plant documentation current						x						x	
E6 Maintenance													
Number of corrective work orders on safety systems			x			x							
Number of maintenance activities										x			
Ratio of preventive vs total / corrective maintenance (routine/defect maintenance ratio)		x				x	x	x		x			
Ratio of work orders beyond plan								x				x	
Ratio of planned and real duration of outages								x					
Ratio of unsuccesful engineering safety reviews								x					
Repair time of TS-components						x							
Components with increased maintenance need trends										x			
Unsuccessful testing index												x	
Safety system surveillance index												x	
Events caused by maintenance deficiencies (errors and lack of maintenance)	x				x					x			
E7 Self-assessment													
Independent checks / internal audits			x					x					
Corrective measures of QA audits								x					

4 Aggregated indicator

		BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
E8	Operating experience feedback													
	Condition reports initiated							x						
	Number of licensee events screened at OpEx meeting							x						
	Number of condition reports raised as result of OpEx evaluations							x						
	Event RCA performed by plant												x	
	Evaluation of external occurrences			x				x					x	
	Delay in notification of events								x					
	Delay in reporting of events								x					
	Delay in investigation of events / Average age of open investigations							x	x					
	Delayed corrective measures								x					
	Recurring events	x							x		x		x	
	Root causes							x						
E9	Backlog of safety issues													
	Number of safety issues treated by plant												x	
	Number of safety evaluations made by plant (screening, analysis, modifications not in time)												x	
	Open safety related defects							x						
F	Physical Protection / Security													
	Protected Area Safety Equipment Performance Index													x
	Personnel Screening Program Performance													x
	Fitness-for-Duty/Personnel Reliability Program Performance													x
G	Investments													
	Annual investments to plant maintenance and modifications						x							

II Indicators grouped according to TECDOC-1141

Indicators according to IAEA TECDOC-1141 structure	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
Plant operates smoothly													
Operation performance													
Plant capability													
Capacity factor/ Unit capability factor								x		x		x	
Ratio of planned and real duration of outages								x					
Forced power reductions													
Forced outage rate/ Unplanned capability loss / Production loss due to failures / Forced loss rate		x			x	x	x			x			
Unplanned power changes (load reductions, automatic reactor power transients, forced outages)	x	x		x				x	x	x		x	x
Status of Structures, Systems and Components													
Functionality													
Number of corrective work orders on safety systems			x			x							
Number of maintenance activities										x			
Ratio of preventive vs total / corrective maintenance (routine/defect maintenance ratio)		x				x	x	x		x			
Ratio of work orders beyond plan								x				x	
Components with increased maintenance need trends										x			
Unsuccessful testing index												x	
Material condition and ageing													
Chemistry indexes (primary circuit/ secondary circuit)		x				x							
Corrosion products released from surfaces of reactor circuit and secondary circuit						x							
Number of NDT inspections per outage							x						
Number of significant NDT findings per outage							x						
State of barriers													
Fuel reliability (RCS specif. activity)	x			x		x		x	x	x	x	x	x
Number of removed fuel bundles due to leakage				x		x						x	
RCS / Pressure boundary leak rate	x		x			x			x			x	x
RCS isolation valves tightness												x	
Primary leakage events								x					
Use of stressor cycles								x					
Ratio of plugged SG tubes								x					
Drywell/ Primary Containment/ Hermetic zone tightness			x	x		x		x	x		x	x	

	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
Events													
Reportable events													
Safety significant events / reportable events	x	x	x	x	x	x	x	x		x	x		
Reportable events during plant shutdown	x	x											
Event investigations ordered by RB								x					
Core-melting index caused by initiating events / Risk significance of events	x					x		x					
Incidents													
Less significant events (disturbance reports, operational failures)				x		x		x					
Events caused by technical factors		x				x							
Events during tests		x									x		
Plant operates with low risk (deterministic approach)													
Challenges to safety systems													
Actual challenges													
Unplanned scrams / RPS actuations	x	x	x	x	x	x	x	x	x	x	x	x	x
Unplanned scrams with LOFW	x												x
Control rod drops				x									
Safety system actuations	x	x	x		x			x			x	x	
Potential challenges													
Plant ability to respond to a plant challange													
Safety system performance													
Safety system availability / unavailability/ inoperability (includes AC power/EDG)	x	x	x	x		x	x	x	x	x	x	x	x
Mitigating System Performance Index													x
TS plant out of service							x						
Amount of time in LCO action condition							x						
LCO index												x	
Failure of components subject to TS						x				x			
Safety system functional failures (loss of more than 1 redundancy)	x	x			x							x	x
Failure of safety systems at start		x		x						x	x		
Failure of safety systems during operation		x		x						x	x		
Number of CCFs (potential / actual) (technical critical/technical potential)						x				x			
Emergency diesel generator reliability (start+ run)	x	x											
Safety system surveillance index												x	
Number of events in different risk categories (CCDP >= or <= certain value)	x					x							

	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
Operator preparedness													
Number of staff with regulatory licence		x						x				x	
Unsuccesfull regulatory exams/ average examination results (written, full-scope simulator)		x						x				x	
Operator training		x	x										
Training of other NPP personnel			x										
Emergency preparedness									x[5]				
drill/exercise performance		x											x
drill participation / training on emergency response		x	x					x				x	x
alert and notification system reliability		x											x
emergency response resources completion index		x											
deficiencies found during emergency exercises		x						x					
deficiencies found during regulatory inspections		x						x					
Fire protection Programme Effectiveness													
Number of malfunctions of fire alarms (non-activation, false alarms)						x						x	
Number of real fire alarms						x						x	
Number of fires						x	x	x			x	x	
Plant configuration risk													
Risk during operation													
Number of occurrences/actions under effect of TS (L&C)				x				x					
Number of risk peaks			x										
Accumulated risk			x										
Rolling average risk increase factor							x						
Risk indicator connected to TS equipment failures						x						x	
Risk indicator connected to preventive maintenance of TS equipment						x						x	
Risk indicator connected to TS exemptions						x						x	
Repair time of TS-components						x							
Extended unavailability reviews completed							x						
Risk during shutdown													

[5] Aggregated indicator

	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
Radiation safety													
Radiation protection effectiveness													
Radiation exposure to workers - collective dose	x	x	x	x	x	x		x	x	x		x	
Radiation exposure to workers - average dose			x	x									
Radiation exposure to workers -maximum dose/average of 10 highest doses				x		x							
Radiation exposure to workers - number of worker exposues within specific dose ranges												x	
Number of workers subjected to special decontamination		x		x								x	
Dispersion of contamination								x				x	
Work programs at high radiation level								x					
Occupational Exposure Control Effectiveness / Radiation occurrence index/ Occurrences related to TS		x						x				x	x
Public dose (calculated dose) / Environmental Radiation		x	x	x		x			x			x	
Liquid Releases (excluding tritium, tritium releases)	x	x		x		x		x				x	
Gaseous/air-born releases	x	x	x	x		x		x				x	
Radiological Effluent Occurrences	x												x
Radioactive waste management													
Solid Releases / Solid waste generated		x	x					x				x	
Industrial safety													
Work accident rate													
Number of work accidents / Accident frequency / Index of industrial safety / Lost time accidents		x					x	x				x	
Accident severity													
Accident severity rate		x											
Physical Protection													
Plant Security													
Protected Area Safety Equipment Performance Index													x
Personnel Screening Program Performance													x
Fitness-for-Duty/Personnel Reliability Program Performance													x

	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
Plant operates with a positive safety attitude													
Attitude towards safety													
Compliance/Attitude to regulations, procedures, policies and rules													
Number of TS violations/deviations/non compliances (TS or L&C)	x		x	x		x	x	x			x	x	
Licensee deviations from regulations/ Non-compliance index / Violation of license conditions		x						x		x		x	
Number of TS exemptions (temporary changes) (TS or L&C)	x			x		x		x			x	x	
Number of RB-inspection findings			x										
Number of cancelled /missed mandatory tests		x						x					
Change control index (temporary changes) / Temporary modifications		x						x				x	
Percentage of statutory and essential training "in ticket"							x						
Main Control Room defects							x						
Operator workarounds							x						
Standing control room alarms							x						
Safety documents > 90 days							x						
Technical advice notes > 30 days							x						
Temporary operating instructions		x					x	x					
Human performance													
Events due to human or organisational failure / MTO related events	x			x	x	x		x		x	x	x	
Human-based CCFs (actual/potential)						x				x		x	
Human based maintenance failures (total number)						x							
Events caused by maintenance deficiencies	x				x					x			
Number of MTO causes (strategic - upper level)										x			
Number of MTO root causes (specific - lower level)										x			
Set of administrative indicators (MTO)										x			
Actual and potential events (near misses) due to procedure deficiencies												x	
Number of dismissals by employees			x										
Number of illness days / Employee availability			x				x						
Unsuitable state for work (number of occurrences)								x					
Backlog of safety related issues													
Number of safety issues treated by plant												x	
Number of safety evaluations made by plant (screening, analysis, modifications not in time)												x	
Open safety related defects							x						
Safety awareness													
Grade of fulfillment of RB-requirements			x										

	BE	CA	CH	CZ	ES	FI	GB	HU	KR	SE	SK	SL	US
Striving for improvement													
Self-assessment													
Independent checks / internal audits			x					x					
Corrective measures of QA audits								x					
Ratio of unsuccesful engineering safety reviews								x					
Operating experience feedback													
Condition reports initiated							x						
Number of licensee events screened at OpEx meeting							x						
Number of condition reports raised as result of OpEx evaluations							x						
Event RCA performed by plant												x	
Evaluation of external occurrences			x				x					x	
Delay in notification of events								x					
Delay in reporting of events								x					
Delay in investigation of events / Average age of open investigations							x	x					
Corrective measures of investigations								x					
Recurring events	x							x		x		x	
Root causes							x						
Plant modifications													
Number of TS modifications								x					
Number of modifications needing regulatory approval												x	
Events caused by deficiency in modification management process	x									x		x	
Keeping plant documentation current						x						x	
Investments													
Annual investments to plant maintenance and modifications						x							

Appendix 4 – Compilation of the replies to the second questionnaire (Represents the situation in 2004-5)

4.1 Selection of insights from experience with commonly used indicators

The information in this appendix is drawn from the country responses, provided in detail in appendix 4.2.

SELECTION OF INSIGHTS FROM EXPERIENCE WITH "COMMONLY USED" INDICATORS

Area A1: Events

Indicator: Unplanned scrams

- Indicator of initiating event frequency and indicative of underlying operational problems (BE; FI). Safety significance of scram events may however vary. (BE)
- Possibility of manipulation of indicator counting only automatic scrams is recognized (SE6); both manual and automatic scrams are counted together to avoid manipulation of the indicator (BE).
- Different indicator results between utility and regulator may occur due to different interpretations of source data (CZ) or slight differences in definitions (BE[7]).
- Normalisation on critical hours to compare between plants (SE). The normalisation process may create false indications if the number of critical hours is too small (rate indicators can produce misleadingly high values when the denominator is small) (KR).
- With few exceptions, no immediate regulatory action has been taken in the past on the basis of event related indicators. Regulatory actions have been limited to raising regulatory concern in discussions with licensees about negative trends. (BE)

Supplemental information:

- Separate tracking of subcategory of scrams with loss of normal feedwater (BE, US).
- Separate indicator on control rod drops (to track specific VVER 440 operational problem) in CZ.

Indicator: Safety system actuations

- It has been experienced that event reporting by the licensees has not been sufficiently reliable and coherent between licensees to support this indicator (BE).
- Although the safety impact of (spurious) safety system actuations might vary from rather innocent to quite challenging for plant operators and plant equipment, they could all be indicative of poor testing or operational practices. On the basis of collected data for the last 8 years, there is however some doubt about the usefulness of this indicator. The appropriateness of this indicator and its definition has to be reviewed. (BE)

[6] in WANO indicator only automatic scrams are included in order to encourage manual actions that may be taken to mitigate consequences of transients

[7] Belgian utilities don't count scrams in mode 2 (< 5% PN)

Indicator: Safety significant events / Reportable events

- Differences between countries in reporting criteria for events (internal regulatory screening criteria in BE and ES, formal regulatory reporting criteria in HU, CZ) may result in non-comparable indicator results.
- Reliability of indicator depends a lot on robustness of data collection system (BE).
- Inconsistencies in reporting practices between plants and changes of reporting practices/criteria over time may lead to non-comparable and difficult to trend results (BE).
- Covers wide variety of event categories and regulatory assessment needs to take this into consideration (not all reportable events have comparable significance to plant safety) (BE).
- Information is confirmed from Licensees' event reports (LERs) required by Guide YVL 1.5. Sometimes discussion is needed on the interpretation of the reporting criteria. (FI)
- Licensees are not spontaneously submitting a special report even if the criteria set in YVL guide are realised, because the number of special reports may have negative effects to their profit (FI).
- This indicator on reportable events has mainly the role of a warning signal.(FI; BE)

Supplemental information:

- Separate indicator to track reportable events specific to plant shutdown modes (BE).

Further developments:

- Solutions to design improved indicators that consider impact on plant safety and risk (use of CCDP calculation, applying significance determination methods similar to INES, …). (BE, FI)

Indicator: Unplanned power changes

- Problems may occur in interpretation of what is "forced" or "unplanned" power reduction; additional guidance needed for interpretation of definition (BE).
- Assessment of PI results requires careful consideration of reasons for power reduction and plant design characteristics (BE).
- Unclear relationship with plant safety; benefit still to be confirmed (BE).
- Different indicator results between utility and regulator may occur due to different interpretations of source data (CZ).
- It has been experienced that event reporting by the licensees (i.e. by LERs) has not been sufficiently reliable and coherent between licensees to support these indicators (FI).
- These events mainly have the role of a warning signal. (FI)

Area A2: Mitigating systems

Indicator: Safety system availability/unavailability

- Similarity between countries in systems monitored by this indicator (systems such as LPSI, EDG, spray system, RHRS may or may not be included).
- Regulatory action on degraded safety performance (according to this indicator) has proven to be successful in increasing licensee awareness (BE).
- Use of this type of indicators has proven to be a valuable input in yearly overall assessment by RB of plants and their organisations (SE).
- Presentation of indicator results needs to be adjusted to different stakeholders (SE).

- Indicator measures availability of safety systems but not reliability; this limits the usefulness of this indicator (BE).
- Station averaged values for EDG availability (allowed for by WANO) may conceal problems at specific units (BE, FI).
- Quarterly updating of indicators has revealed deficiencies in the availability of these safety systems and also in the maintenance practices in managing the unavailability of safety trains. There have been deficiencies in licensees' practices in interpreting the unavailability of parallel trains and in calculation of WANO-indicators. In the work order practices there was observed delay in returning work orders after repairs. (FI)
- Indicators allow at the same time to evaluate the average technical safety state of the plant and the operational practices (maintenance, periodic testing), which impact the operability of safety systems. (FI)
- Indicator with strong focus on safety (SE).
- Selection of systems in WANO-indicators may differ between plants, which makes these indicators less useful than other WANO-indicators for direct comparisons between plants (SE).
- These indicators presuppose trustworthy LER reporting (SE).
- Differing points of view between licensees and regulators experienced on number of redundant trains (SE).
- Even if reliability of single indicators may be questionable, aggregation of indicators may provide sufficient information for regulatory assessment and action (SE).
- Some significant safety problems may not be detected by this type of indicator (e.g. detachment of thermal sleeves of SI system) (KR).

Supplemental information:

- Separate indicator for measuring EDG reliability (start + loading reliability) but not supported by reliable data collection process (BE).
- Additional indicators for measuring failures of safety systems at start and during operation to cover reliability aspect (CZ).
- Separate indicator tracking number of failures of systems/components subject to TS (SE).
- Additional level 2 indicators monitoring safety system performance based on LER, including larger number of safety systems (SE).

Further developments:

- Possibility for further increase of number of monitored safety systems in order to enable calculation of unavailability of safety functions is assessed in SE.
- Consideration of risk contributions of safety systems in calculating indicator (SE).
- Implementation of MSPI indicator (covering unavailability and reliability in risk-informed way) will replace conventional unavailability indicators in US.

Indicator: Safety system failures

- Reliability of indicator strongly depending on internal reporting process (not supported by LERs) (BE)
- Failure of safety systems may be difficult to detect, if failures don't take place in front-line components (ES)

Area A3: Barriers integrity

Indicator: Fuel reliability (RCS specific activity)

- Usefulness of indicator is questioned in SE (measuring methods differ between plants, exceeding WANO-threshold for fuel defect is not always sign of actual fuel leak and actual fuel integrity breaches do not always result in values higher than WANO-threshold).
- Present TS-limits are based on design basis accident hypotheses and orders of magnitudes above experienced activity levels. Therefore there is limited licensee and regulatory action during a cycle that experiences significant fuel damage. (BE)
- Routine chemical analysis of reactor coolant and related experience allows quick identification of developing fuel damage; trends in primary activity are correlated with iodine (airborne) releases (BE).
- Indicator has lost its meaning in some cases when it showed zero values for a long time (CZ).
- On the bases of activity measurements compared to old data and related knowledge about the size of the previous leakage and/or the number of leaking fuel rods the inspector can immediately evaluate the scale of the fuel leakage and actions required during normal operation or shutdown. The indicators for the shutdown situations also describe the success of the shutdown concerning radiation protection. (FI).
- Difference in definitions of indicators used by regulators makes comparison between countries of plant performance related to fuel integrity difficult (this is less the case in WANO PI system).

Supplemental information:

- Some countries use number of leaking fuel elements (as discovered at end of cycle by fuel assembly sipping tests) as additional indicator (SL, FI).

Further developments:

- Counting of failed/replaced fuel pins in SE.

Indicator: RCS/ Pressure boundary leakage

- Data collection process by internal reporting of data by inspectors proven to be less reliable (BE).
- RCS leakage rate measurement may be affected by primary to secondary leakage (leak rate stability and measurement uncertainty issues), which complicates interpretation of indicator values (BE).
- More indication of quality of maintenance on equipment connected to primary circuit and operational tolerance of leakage than real indicator on integrity of second barrier (BE).
- Indicator is not sensitive to developing RCS pressure boundary leaks (see also Davis Besse experience) (BE).
- Seen as lagging and not risk-informed indicator (BE).
- Difficulty to design indicator in CZ as leakage is assessed but not directly measured by licensee.

Supplemental information:

- Additional indicators on second barrier in use:
    - RCS component cycles as limited by TS and Ratio of plugged SG tubes in HU
    - RCS isolation valve leakage in SL
    - Chemistry indicators in FI

Indicator: Containment tightness

- Little experience in most countries with this indicator: just being developed in Slovenia and Korea. Mature indicator in FI.
- Used to supervise containment degradation and not to provide exact measure of containment integrity due to limited precision of yearly applied measuring method (SL).
- Differing approaches between plants for implementation of 10CFR50 appendix J type B and type C test requirements and for calculating total containment leakage have hindered development of indicator in BE.

Area B1: Occupational Radiation Safety

Indicator: Radiation exposure to workers - Collective dose

- Use of this indicator by licensees (and operating experience feedback) has resulted in the past in significant reductions of collective dose but in the last 5 years saturation is taking place (BE).
- This indicator can be seen as an indicator of quality of design, operations and maintenance. It is also indirect measure of breaches in barriers (fuel and primary circuit) (SE).
- On-line regulatory assessment of plant performance currently based on maximum and collective dose resulting from outages instead of on PI, which follows collective dose per calendar year (BE).
- The reporting threshold of collective radiation dose has been exceeded at Finnish nuclear power plant units in connection to long duration service outages, when the most extensive maintenance jobs and inspections are conducted. The longer annual maintenance outages take place at the Loviisa power plant every four years. Because of this sequence the Loviisa power plant has begun to monitor the four-year sliding average of collective occupational radiation dose by plant unit.(FI)

Supplemental information:

- Additional indicators in CZ monitor **collective effective dose per capita** and **maximum individual effective dose.**
- An additional indicator in SL monitors the **number of workers receiving a yearly exposure below, between and above fixed thresholds** (1 mSv and 20 mSv).
- In the US an indicator measuring **occupational exposure control effectiveness** (based on occurrences of control deficiencies) monitors the area of occupational radiation safety.
- In FI also **average of 10 highest doses** is followed as indicator. The average of the ten highest doses indicates how close to the 20 mSv dose limit the individual occupational doses at the plants are, indicating the effectiveness of the plant’s radiation protection unit;

Further developments:

- Development of indicator for events characterised by occupational exposure control deficiencies has been considered in BE, but postponed because of lack of a licensee data collection process supporting such indicator.

Area B2: Public radiation safety / Environmental risk

Indicator: Public dose

- Aggregated type of indicator that may be used instead of monitoring separately all types of gaseous and liquid releases. Will replace indicators on releases, which are however maintained as sub-indicators. (CZ)

- The doses for both plant units have been less than 0.05% of the 100 microSv limit established in the Government Resolution (395/1991). Thus there have not been any reason for increased regulatory actions.(FI)
- The calculated dose due to releases to the most exposed individual in the vicinity of the plant describe the success of the plant's ALARA programme and radiation protection unit (or other unit at the plant responsible for controlling releases) and operation as well.(FI)

Indicator: Liquid releases

- Liquid releases are (with exception for tritium) several orders of magnitude below legal limits which makes assessment of indicator based on comparison with legal limits of limited use and regulatory action in case of negative trend difficult (BE)
- Legal limits are based on rolling time windows (13-week and 52-week releases), which makes comparison of indicator with such legal limits difficult (unless indicators is calculated and assessed weekly) (BE)
- Useful to put current releases into historic perspective and to monitor deviating plant performance (comparison of yearly releases between plants) (BE)
- Trending of liquid tritium releases is of very limited use as this type of release is to large extent dependent on generated power (BE)
- Radioactive releases into the environment from the Loviisa and Olkiluoto nuclear power plants have been small and well below the set limits. (FI)

Indicator: Gaseous/ air born releases

- Gaseous releases are several orders of magnitude below legal limits which makes assessment of indicator based on comparison with legal limits of limited use and regulatory action in case of negative trend difficult (BE)
- Legal limits are based on rolling time windows (13-week and 52-week releases), which makes comparison of indicator with such legal limits difficult (unless indicators is calculated and assessed weekly) (BE)
- Trending of gaseous tritium releases is of very limited use as this type of release is to large extent dependent on generated power (BE)
- Monitoring of releases on smaller time scale than 1 year is not considered useful for assessing global plant performance as timing of releases will depend largely on timing of specific plant activities (such as treatment of effluents) (BE)
- Useful to put current releases into historic perspective and to monitor deviating plant performance (comparison of yearly releases between plants) (BE)
- Radioactive releases into the environment from the Loviisa and Olkiluoto nuclear power plants have been small and well below the set limits. (FI)
- Trends in noble gas and iodine releases are to a large extent coinciding with cases of power operation with fuel defects (see also indicator on fuel reliability) (BE); The figures show easily the interdependence between iodine releases and fuel leaks. (FI)

Area E1: Human performance

Indicator: Events due to human or organizational failure/ MTO related events

- Wide variance of indicator definitions between countries related to availability of data.
- Adequate aggregation of cause-based sub-indicators can give regulator useful information about human performance (ES).
- Events caused by human or organisational failures mainly have the role of a warning signal.(FI).
- It has been experienced that event reporting by the licensees has not been sufficiently reliable to support this indicator. (FI); Obtaining reliable information on human and organisational failures, related to LERs, is a difficult and time-consuming process (ES, SE); Regulator depends on willingness of licensees to report human errors and on transparency of provided information (SL);
- SKI is presently relatively confident of quality and coverage of MTO[8]-information in LERs (SE).
- These indicators are not mature yet for the establishment of fixed thresholds related to subsequent regulatory actions. Aggregated, the indicators provide however SKI with enough information which, together with other findings (for example from plant inspections) might result in regulatory action(s). The use of the MTO-related indicators has proven to be a valuable input in the yearly overall assessment by SKI of the Swedish plants and their organisations. (SE)

Supplemental information:

- SKI's MTO-indicators build on a hierarchical system with two levels, the strategic level and the specific or lower level. This hierarchical structure has proven to be suitable for achieving one of the key goals of SKI performance indicator system, namely the unambiguous identification of MTO-related issues at some plant(s) deserving closer regulatory attention. (SE)
- STUK also uses actual and potential human based CCFs as indicators in this area (FI).

Further developments:

- Additional indicator for trending human errors of contractors should be included as outsourcing of activities is in progress. (CZ)
- Development of indicators based on human error induced events and on human factor related causes still being assessed. Questions on robustness of data collection process and statistical relevance of data still to be solved. (BE)
- Depending on the stakeholders, different methods for presenting indicator results will be evaluated. (SE)

Area E2 : Compliance / attitude

Indicator: TS violations/ TS non-compliances

- Experience has shown that licensees are not always reporting TS violations in a consistent and rigorous way. The robustness of this indicator depends to a large extent on the alertness of resident inspectors to detect deviations from TS. (BE)
- The intention of this indicator is to monitor the effectiveness of plant programs that support the development of safety culture. Due to questions on the robustness of the indicator it is still premature to consider regulatory action on the basis of this indicator. Furthermore not all TS-violations are intentional or deliberate and not all are considered to have significant safety impact. If the data collection process for the indicator on TS violations can be made robust, it is believed that this indicator can be a simple and useful tool for monitoring safe behaviour of plant staff

[8] MTO = Man, Technology, Organisation

(mainly operating staff). It should however be complemented with other observations in order to assess safe behaviour and safety culture. (BE)

- If TS-violations are also considered as reportable/significant events double counting of this type of events will occur (in this indicator and in separate indicator on reportable events) (BE).

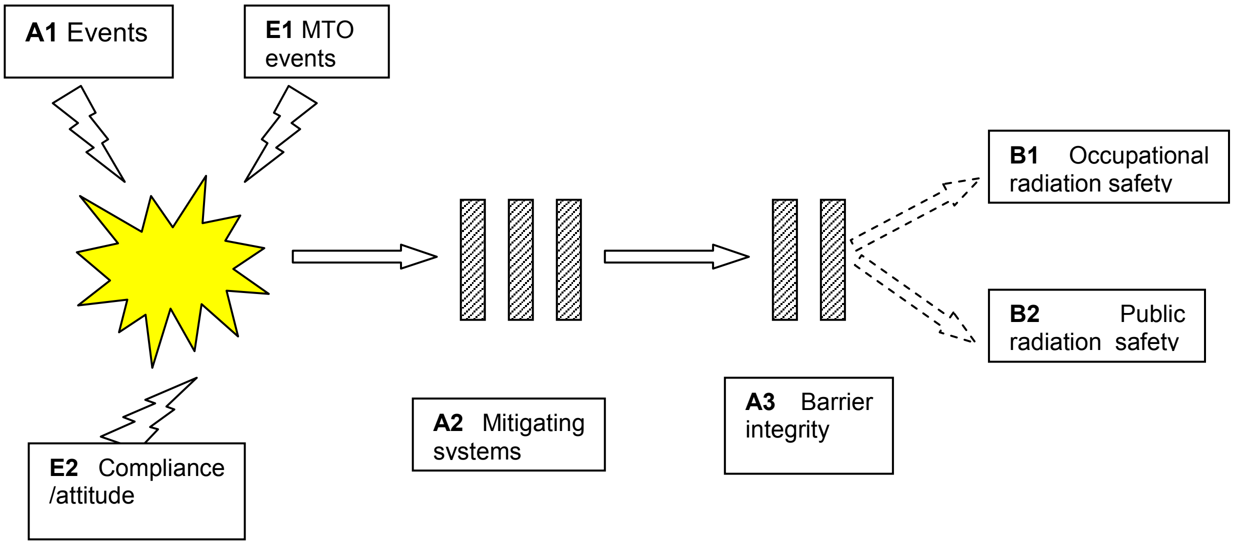
Supplemental information:

- Additional indicators on number of **violations of licensing conditions** in HU and number of **License deviations from regulations** in SL.
- TS violations and TS exemptions are considered to be low-level type of indicators, which are preferably aggregated or combined with other data for assessment of plant safety performance and implementation of safety policies. (BE)
- TS violations and TS exemptions are considered to be "low level" indicators. They belong to the first principal group "Quality and Safety Culture, but are very closely connected to the second principal subgroup "Operational events" in STUK's indicator system. Risk significance of deviations and exemptions is calculated by PSA. These indicators are more aggregated/combined with above mentioned indicator data for assessment of operation than other indicators of subgroup I (failures of TS components and systems and their repairs; production loss due to failures; unavailability of safety systems) for assessment of plant performance. (FI)
- TS violations and TS exemptions illustrate safety attitude of the plant; their willingness to obey rules and orders, and can be indicative of underlying operational deficiencies. (FI)

Indicator: TS exemptions (temporary changes)

- The purpose of this indicator is to monitor plant capability to comply with TS. Requests for TS exemptions are carefully reviewed by AVN before they are granted. The number of TS exemption requests depends to some extent on plant design, age of Technical Specifications, planned plant modification projects and licensee safety management policies. The assessment of this indicator needs to take all these parameters into consideration. Experience has shown however that licensee safety management policy has a significant effect on the number and trend of TS exemption requests submitted to AVN. (BE)
- Over the years the difference between so called planned and unplanned exemptions were revealed so the cases for different kind of exemptions are collected separately. (CZ)
- The assessment of the indicator on TS exemptions does not interfere with the granting process of TS exemptions itself (BE).

Selection of insights from experience with "commonly used" indicators



A1 Events - Unplanned scrams (>) - Safety system actuation (<) - Safety significant events/reportable events (≥) - Unplanned power changes (<)	**B1 Occupational radiation safety** - Radiation exposure to workers – Collective dose (>)
A2 Mitigating systems - Safety system availability/unavailability (>) - Safety system failures (≥)	**B2 Public radiation safety / Environmental risk** - Public dose (>) - Liquid releases (≥) - Gaseous / Airborne releases (≥)
A3 Barriers integrity - Fuel reliability – RCS specific activity (≥) - RCS / Pressure boundary leakage (≥) - Containment tightness (≥)	**E1 Human performance** - Events due to human failure / MTO events (>)
Symbols: > Reliable / useful indicator ≥ Useful indicator / needs improvement < Not seen as reliable / To be reviewed-assessed	 **E2 Compliance / Attitude** - TS violations / Non compliance (≥) - Exemptions (≥)

Appendix 4 – Compilation of the replies to the second questionnaire (Represents the situation in 2004-5)

4.2 Compilation of the experience with all used indicators

The information provided in this appendix is divided into generic information, which is applicable to the whole SPI system, and information that is specific for each safety area or cornerstone.

Template:

Country/Regulatory Organisation

Indicator Area: *Mention indicator area as listed in first questionnaire summary table.*

Performance Indicator(s) in use:

List indicators currently in use in the above-mentioned indicator area. Provide indicator definitions.

Provide an indication of the maturity of each indicator, according to the following scale: 1 = "proposed or just being put into service", 2 = "in service for a short time and still being assessed" and 3 = "mature, fully in service and assessed".

Assessment of indicator results:

Mention how indicator data are assessed (e.g. through use of thresholds or trending of indicator).

If thresholds are used, provide information how the thresholds for safety performance have been established.

Mention useful experience with colour coding of these indicators (if applicable).

Discussion:

Provide discussion on:
- experience and challenges in collecting the data
- experience and challenges in calculating indicators
- experience and challenges in transforming the indicator data to meaningful information for decision making
- whether these indicators are seen as leading or lagging indicators
- to what extent these indicators are risk-informed
- limitations and benefits of current indicators

Discussion on challenges should include problems related to needed resources, if applicable.

Are there any pitfalls worthwhile to be mentioned?

Supplemental Information:

Any supplemental information which might include:
- how these indicators fit into a hierarchical system of indicators (are they considered to be strategic or lower level indicators?)
- what aggregation principles are applied (if applicable)
- to what extent these indicators are communicated to stakeholders
- related studies

etc.

Performance Indicator(s) under development:

List indicators under development or considered for further development within this area, the rationale for developing these indicators and the expected benefits.

This section may include indicators, which are already followed in the frame of a pilot project. If useful experience and conclusions are already available from such pilot project, please provide this information in the sections above (please mention in that case that the experience is related to a pilot project).

Country Inputs:

Generic information:

Belgium/AVN

Indicator Area: Generic

Assessment of indicator results:

Performance indicators have, for the moment, no high importance in the regulatory approaches applied by AVN. Assessment of the safety performance of the licensees is mainly achieved by a rigorous program of inspections including 2-weekly systematic inspection at each plant and complemented by specific inspections, in response to abnormal events, and by thematic inspection covering, with varying periodicity depending on the area of interest, most safety significant plant activities and processes. Inspections are mainly performed by plant-dedicated inspectors, which are expected to have a good picture of the safety performance of their plant, and are sometimes supported by HQ experts for specific fields (e.g.neutronics, fire protection, radiation protection, emergency planning, operating experience feedback etc.). Monthly and yearly summaries of the most important inspection findings allow having an executive view on plant safety performance.

Furthermore there has been, up to now, a lack of external pressure to AVN for the development and use of indicators within this regulatory frame. The development of indicators has however come more and more into fashion, mainly by the current views on how to establish management systems.

AVN has started to gain experience in developing indicators for monitoring the efficiency of its own processes (so-called direct indicators) as part of its quality management system (ISO 9001-2000 certified). Also the NPP utilities are slowly developing their own indicators for monitoring their processes and this approach is encouraged by AVN. International developments in the use of indicators by regulatory bodies, with the purpose to assess licensee performance, has been observed and AVN did not want to stay too much behind these developments. In order to gain experience in this field, it has been decided to set up a pilot PI project for Belgian plants and to participate as well on the international level (mainly through the NEA). The objectives of this pilot project were to identify a set of indicators that could be sustained with minimal resources, without increasing at the same time regulatory burden to the licensees (in fact AVN is only working as a support to the Safety Authorities and has no regulatory power to enforce reporting requirements, including on PI-data, to the licensees) and make proposals for an approach that would integrate the use of these indicators in the current overall safety assessment process of AVN.

Taking into account the current regulatory background and inspection practices it is not expected that the performance indicators will, in the foreseeable future, take an important role in AVNs oversight of safe plant performance. However it might play some supporting role in the yearly-performed exercises to produce an overall view on plant safety performance, supplementing the executive views based on inspection findings, which may to some extent be biased.

Within this frame, it has been decided that the development of warning thresholds for degrading or unacceptable performance is for the moment not an issue and that trending of indicator results might be sufficient.

Discussion:

Experience and challenges in collecting the data:

Due to the background for the development of a PI-system mentioned above and taking into account that, at the time of start of the PI pilot project, the use of PI-systems at the licensees (with the exception of the WANO-indicators) was only slowly developing, it was decided that AVN should be self-supporting in collecting the necessary data and calculating the indicators (with minimal effort). A further deliberate constraint was that each selected indicator should be supportable with data for all Belgian plants. This situation involved some important constraints on the type of data that could be used to support the PI-system and explains the initial choices made in the PI selection process.

Experience with the current set of indicators will show if these constraints should be maintained.

Discussion (continued):

Experience and challenges in calculating indicators:

For the moment, data collection is performed on a regular basis and indicators are calculated on a yearly basis by one AVN staff member, which is responsible for the PI pilot project. This is a temporary solution, which has been adopted to assure the success of the project in terms of obtaining short-term PI-results.

A wide involvement of plant inspectors (or other AVN experts) in collecting data and calculating indicators, which are not (yet) convinced of the need to have such a PI system, has been avoided in order not to delay the implementation of the project. The drawback of this approach is that additional effort will be needed to gain recognition, within AVNs inspection department, of the potential contributions of the PI-system to their work. An important involvement of the plant inspectors in the efforts related to the assessment of the indicator results should help to achieve this objective.

Supplemental Information:

Although the indicators, which are being assessed within the frame of the pilot project, are clearly not all situated at the same level, the definition of a clear hierarchical structure that supports the whole set of indicators has not been considered yet. This is mainly due to the fact that

- the number of indicators is still rather limited (less than 25)
- assessment of indicator results does not lead directly to regulatory action
- there is no need to communicate indicator results to external stakeholders (Safety Authority, public, …).

The indicators are mainly used for internal purposes. Furthermore AVN is, as regulatory organisation working in support of the Nuclear Safety Authority, submitted to limitations of confidentiality with regard to information received through its regulatory activities.

For the same reasons aggregation of indicators has not been considered yet.

Czech Republic/SUJB

Indicator Area: *Generic.*

Performance Indicator(s) in use:

The State Office for Nuclear Safety executes the state administration and supervision of the utilisation of nuclear power and ionising radiation in order to assure achieving a required safety level. As the focus of execution of the supervision consists in the evaluation and assessment of activities related to nuclear safety and their results, the State Office for Nuclear Safety annually evaluates an achieved level of nuclear safety of operation of NPs by means of Safety Performance Indicators.

The set consists of about 30 indicators in following areas:

A1 Events, A2 Mitigating Systems, A3 Barriers Integrity, B1 Occupational Radiation Safety, B2 Public Radiation Safety, E1 Human Performance, E2 Compliance.

Assessment of indicator results:

The results of Safety Performance Indicators are used as auxiliary tool for evaluation of the level of nuclear safety, to reveal the weak areas of NPP`s operation, arguments for SUJB`s positions.

The evaluation results of Safety Performance Indicators are presented in the form of graphs for six years period. The graphs mostly represent site yearly values in the form of sum totals or averages of the unit values. Only for Safety System Unavailability, the indicated values are also at the level of the systems and for Barriers Integrity at the unit level.

Mainly the trends of indicators are assessed. The Czech specific thresholds have not been established and so the proposal for colour coding of indicators has been prepared based on US NRS thresholds where it was possible.

Discussion:

Experience and challenges in collecting the data:

It has been SUJB`s intention since the beginning of SUJB use of SPIs to be as independent in needed data collecting as possible. Nowadays about 40% of raw data is collected by resident inspectors the rest is provided by licensee. The submitted data by licensee are subject of regular inspections performed by resident inspectors.

Experience and challenges in calculating indicators:

All the calculations are performed by SUJB staff, mainly resident inspectors. The spreadsheet applications are used for the calculation.

Whether these indicators are seen as leading or lagging indicators:

The whole set of SPIs is created just by lagging indicators.

Supplemental Information:

The set includes indicators and sub indicators which support the indicators and provide some more detailed information in dedicated area.

The results of SPIs and action taken in connection with the results assessment are communicated to licensee, government and general public.

Finland/STUK

Indicator Area: Generic

Assessment of indicator results:

The annual overall assessment of nuclear power plant safety by inspections (basic, specific, Periodic Inspection Programme) and safety reviews is complemented by the STUK indicator system. The system indicators can be used to illustrate that certain safety factors under scrutiny have remained at a desired level or to gain insight into their possible changes and trends in the short and the long run.

Indicator results are used for focusing and optimising NRR's resources and for focusing safety reviews and inspections of NRR's Periodic Inspection Programme. Declining trends indicate a possible need to enhance the performance and organisational operation of the plants and STUK's regulatory effort in those areas. If a declining trend of one or more indicators is detected the causes are clarified and needs for focusing NRR's supervision activities are evaluated. Even the effectiveness of actions commenced based on indicator results can be monitored by means of these indicators.

Indicators are numbers, ratios, percentages and amounts of interesting matters or parameters that can be monitored and measured and were found suitable for regulatory purposes. No specific action or threshold limits have been defined for the indicators. Rather, the aim is to recognise trends in the safety-significant functions of a nuclear power plant or STUK as early as possible. The limit values set in the legislation, in the YVL guides and in the Technical Specifications (Tech Specs) of the plants, as well as the target values contained in the objectives of the department of Nuclear Reactor Regulation (NRR), will be applied where available.

The NRR has assigned persons responsible for the supply of indicator data as well as for their calculation and assessment the results and on trend analysis.

Administrator of the system collects indicator data/results, update excel-files of data and graphs, collect data to power point-presentations (Finnish and English) and word report (quarterly in Finnish/yearly in Finnish and English) with conclusions on the condition of indicator areas and sub-group areas. Abnormal or deviating results are discussed immediately with the person in responsible for the indicator, who confirms the result from the licensee. Next these observations are discussed on the department level in a department meeting (held biweekly) or in a supervision meeting (held on two months interval). Graphs, presentations and reports are available on department's public disk. On the updating of the data (quarterly) is informed to the management of department (directors, management support, office heads, persons in responsible). Indicators are also in STUK's intranet. New data (graphs) are taken into intranet half-yearly, which is informed to the whole department and also to the department of Nuclear Waste and Material Regulation and the Director General as well.

After the completion of the annual summary, the conclusions presented in the report concerning indicator results, as well as their justifications, are reviewed with the people responsible for the indicators and the management of NRR and STUK in a joint meeting. The indicator results are presented to the whole NRR staff in a common departmental meeting. Issues discussed in these meetings include factors affecting the results of the indicators showing a deteriorating trend, the reasons behind the figures and measures to discontinue the trend. In these meetings it is also decided on actions required, as; evaluating in more detail the development of the indicators, directing the focus of the periodic inspection programme, and asking the plant for an explanation. STUK's event investigation has once been launched on the bases of deteriorating trend of indicators. Increased inspection examines the effectiveness of the licensee's actions to correct the deficiency and also if STUK's own performance has contributed to the degradation.

The Indicator system is used for assessing success of strategy plan and for focusing safety review and inspection programme of NRR. Other goals of the indicator system are to be an information system, develop co-operation between STUK and stakeholders and use for public information.

Discussion:

Development of indicator system:

- Documents published by the IAEA and OECD/NEA were a useful tool to get familiarised with the concept of an indicator system as well as to organise the development project.
- The limited number of existing data sources restricted the possibilities for determination of specific indicators. This should be noted at an early stage of the project.
- The areas to be monitored may be examined on a theoretical basis, whereas the specific indicators should not be nominated before getting familiarised with the data sources.

Data collection:

- Data needed for the calculation of indicators related to the safety of nuclear installations is gathered mainly from the regular reports (daily, quarterly, annual reports) submitted by the licensees. Regulations related to the reporting requirements are given in the Guide YVL 1.5 concerning licensee reporting to STUK. In connection of the renewal of the guide in 2003 especially needs concerning data collection for indicators were taken into account.
- There are still some indicators for which the data required is not formally reported to the regulator. These are mostly related to the failure data indicators.
- A periodic assessment of the SPI system is performed regularly. Last time it was conducted in 2003. There was need for improvement especially in working processes for data collection and updating indicators to integrate the work as an essential part of supervision of nuclear safety. Also defitions of some specific indicators had to be changed to improve their reliability and usefullness. in NRR's supervision of nuclear safety and in its sub-processes.
- The indicators in accordance with the new definitions were calculated retrospectively over the previous few years to gain a base for comparison with the 2004 indicator values when they were first time implemented.
- The acceptability and usefulness of the indicator system within the regulatory body could be improved by taking into account needs and opinions of the staff. Participation of the staff in the data collection and analysis in the implementation phase should improve the commitment throughout the organisation. Resident inspectors are in key role in collecting and verifying data for many indicators.

Discussion: (continued)

Calculation of indicators:

- The review period of the indicators relating to the safety of nuclear facilities has until present been a calendar year but in some cases also an operating cycle from the beginning of the refuelling outage to the beginning of the next refuelling outage. The indicators relating to the regulatory activities have been determined every calendar year. On the bases of the reassessment of the indicator system and of the frequency of the overall assessment of nuclear safety performed by NRR the decision to update indicators and to make assessments about trending quarterly was made.
- Updating and reporting periods for individual indicators should be assessed and fixed: calendar year/operating cycle and the frequency of intermediate reviews.
- The responsible person should calculate indicator values themselves and evaluate indicators against the following targets: practicality, relevance to NPP safety/regulatory activities, absence of negative impacts, accuracy.

Transforming indicator data to meaningful information for decision-making:

- The Indicator system has been intended as a tool which inspectors and different functional sectors within NRR can utilise in their daily work. Indicators describing the safety of nuclear installations are used as a background material for the discussions between regulatory and licensee management, and also for focusing of regulatory investigations, inspections and safety assessment.
- Interpretation of the results should be carried out carefully. The focus of the analysis should lie on the trends and reasons for changes instead of numbers.
- Indicators should be considered as complementary tool in addition to inspections and safety reviews.
- Information system for indicator data, graphs and interpretations, where reports and presentations could be inquired, would be a useful tool and prevent overlapping work on every organisation level.

Supplemental Information:

Hierarchical system:

The STUK Indicator System is divided in two principal groups that are the safety of nuclear facilities (A) and the regulatory activities (B). Indicators for describing the safety of nuclear facilities can also be utilised to assess effectiveness of STUK, from regulator's point of view "outcome " of activities. These indicators are also called indirect indicators because these reflect mostly the achievements of the operating organisations, but STUK can also make some contribution on them.

Consideration of the group "Safety of nuclear facilities" is divided into 3 sub-groups based on the concept of "Defence in Depth". The areas (layers) under consideration are: Safety and quality culture, Operational events and Structural integrity. Indicator group concerning "Regulatory activities" is also divided into 3 sub-groups: Working processes, Resource management and Regeneration and ability of work. So far, these are mainly used to follow fulfilment of QA requirements of STUK. Combination of results and findings of indicators from the two principal groups offer an interesting and useful tool for the management to observe and guide STUK's activities.

The principal groups A, "Safety of nuclear facilities" and B, "Regulatory activities" of the STUK Indicator System are divided into sub-groups and further into indicator areas, which are presented in the table 1.

Table 1. Structure of the STUK indicator system: principal groups, sub-groups, and indicator areas.

A. Safety of nuclear facilities	B. Regulatory activities
A.I Safety and quality culture A.I.1 Failures and their repairs A.I.2 Number of deviations from Tech Spec A.I.3 Unavailability of safety systems A.I.4 Occupational radiation safety A.I.5 Radioactive releases A.I.6 Keeping plant documentation current A.I.7 Improvement and investments	**B.I Working processes** B.I.1 Fulfilment of outcome targets B.I.2 Timely decision making B.I.3 Maintenance of regulations B.I.4 Implementation of inspection programme B.I.5 Steering of contracted safety research B.I.6 Actions in abnormal situations
A.II Operational events A.II.1 Number of events A.II.2 Risk significance of events A.II.3 Direct causes of events A.II.4 Number of fire alarms	**B.II Resource management** B.II.1 Resources for regulatory oversight of nuclear safety B.II.2 Distribution of workload
A.III Structural integrity A.III.1 Fuel integrity A.III.2 Primary / secondary circuit integrity A.III.3 Containment	**B.III Regeneration and ability to work** B.III.1 Maintenance of YTV Quality Manual B.III.2 Execution of development projects B.III.3 Execution of training programme B.III.4 Work satisfaction B.III.5 Compliance with values

Communication to stakeholders:

A summary report about results and trends is prepared by the administrator of the system in the beginning of each year. This report is utilised in an annual overall assessment of NPPs' safety made by the management of NRR and used in discussions with utilities. The indicator report is attached to "the Annual Report on Regulatory Control of Nuclear Safety in Finland" submitted to the ministry of Trade and Industry and other stakeholder. The annual report is available for public on STUK website. All indicators are also available in STUK's intranet.

Summary report with conclusions about indicator results is presented to the licensees before publishing the annual report, because conclusions based on indicators have not been discussed with licensees in earlier phase as observations made in inspections and recommendations/suggestions given in inspection protocolls or -reports.

One goal in the beginning of the development project was to use indicators also for public information. Until last years STUK was considering to select subset of indicators for public information. Now all SPIs are published as an appendix of the annual report, which is available on STUK public website. Only positive feedback has been received on that; not from individuals of the public but from some professionals or expert groups.

Results have been presented in international workshops and meetings of OECD/NEA "Joint Tasks Force on SPIs of NPPs", Working Group of Inspection Practices, VVER Forum, and meetings with other regulatory bodies e.g. SKI (Sweden).

Performance Indicator(s) under development:

STUK is going to implement a software system for administration and monitoring (self-assessment) and unified report production. The system will work also on the performance indicator database. In the system considered indicator specifications include also thresholds or limits for acceptability with colour coding.

STUK is considering to include new indicators into its system in areas: Occupational safety, Self-assessment, and Operating experience feedback. Use and compliance of indicators in areas of Fire safety and Investments for safety need to be evaluated and indicators need to be developed more informative.

STUK does not have indicators either in areas Operational preparedness and Emergency preparedness, because inspections of Periodic Inspection Programme cover e.g. areas area as listed in first questionnaire summary table. STUK is going to reassess for needing indicators in these areas.

Germany/Federal and State Authorities

Indicator Area: Generic

There is no indicator area determined up to now. Current status and developments in Germany are described below.

Performance Indicator(s) under development:

Current status and developments on the use of PI´s in regulatory processes in Germany:

In Germany a large number of data on the results of radiation protection (e.g. discharge of radioactive material with air and water, resulting radiation exposure) and of plant operation of NPP (e.g. unplanned reactor scrams, reportable events according to mode of and consequences on operation, unavailability data) are used to demonstrate the plants safety status und operational processes.

Single data sets, e.g. mode and number of fuel damages or damage indications on passive components, are permantly recorded and used in order to get indications to specific systematic deficiencies of safety design or operational procedures. However, presently the systematic and direct use of performance indicators is not practice in the frame of the continuous supervision and decision making process of the regulatory body.

In the following a short overview is given about ongoing acitivities and developments for implementation of SPI sets in German NPP´s and in regulatory processes.

Over the last years, a number of reportable events occurred, the root causes of which were identified as significant deficiencies in safety management of German NPP´s. Therefore, all operators of NPPs as well as the federal and state authorities started acitivities aiming to implement comprehensive and more effective safety management systems including the use of indicators.

In the middle of the year 2004 the BMU published fundamental requirements on safety managements systems comprising SPI for quantitative evaluation of safety related processes and process results. Relevant international standards, nuclear rules and recommendations, e.g. EN ISO 9000:2000 ff, IAEA NS-G-2.4 and INSAG 13, were applied. More detailed requirements related to important elements of safety management systems and the process-oriented approach are in development. On behalf of BMU the focus of the work regarding SPI is directed on the development of generic specifications for the elaboration of safety objectives and targets, methods for the verification of completeness and effectiveness of indicators for the assessment of the safety management from a safety point of view.

In parallel to these activities, according to the requirement of BMU and state authorities to implement a comprehensive safety management at all German NPPs, a common concept of the operators for optimizing their safety management systems was developed. It describes suitable elements and necessary tools of safety management as well as indicators in addition to already existing management tools, such as audits, reviews, self-assessment instruments etc. but it is not strictly process-oriented. The proposed indicator set is intended for medium-term trend monitoring and is not suitable for early warning in case of decreasing safety performance. The concept is intended as basis guidance for the NPPs in developing specific systems.

Further ongoing acitivities in this area are single projects for developing a plant specific integrated management system taking into account existing management systems. These include safety management and are based on management, core and support process models and indicator evaluation. It is planned to derive suitable indicators at the level of the safety-relevant process steps in order to measure fullfillment or deviations of process objectives at an early stage. These licensee projects are scheduled to be operable by middle of 2005 with the implementation of all plant-specific processes at three sites.

In general, first experiences have shown following key facts and findings:

- Measuring the achievments of the specified objectives in an adequate manner at a very early stage, especially in case of decreasing performance, can only be attained if performance measurement and control are carried out in time at the level of processes and sub processes.
- The respective indicators must be based on the measurements of the results of the processes and sub processes.
- For each individual objective a measurement (indicator) has to be defined that allows an objective judgement on the achievement of the objective. Indicators alone often do not allow a clear judgement wether a process is running smoothly or performs below target levels. It is necessary to evaluate them by means of an engineering judgement. A „traffic light“ presentation of indicators seems to be too simplified.
- For an effective evaluation, control and improvement of the processes and their results quantitative indicators are required and an appropriate concept for monitoring must be developed, taking already existing tools into consideration, such as audits and reviews.

HUNGARY/HAEA NSD

Indicator Area: Generic

Assessment of indicator results:

The Nuclear Safety Directorate of the Hungarian Atomic Energy Authority evaluates the operational safety performance yearly. Indicator results are assessed yearly by color coding and trending. The safety performance indicators are quantitative indicators with thresholds. The performance expressible by numbers– as the result of the evaluation applying the tools of engineering and safety judgment – in many cases only in comparison with the similar performance indicators of the previous years.

NSD evaluates the safety performance contributors to particularly determined criteria and fits them evaluation color codes in accordance with the followings:

- "green": The green field of the safety contributor spreads to the limit deemed appropriate by the authority. The values of the green field are considered as reassuring by the authority, the appropriate reserve is ensured in comparison with the regulatory requirements or with the possible declared regulatory limits, and further action or increased attention is not deemed to be necessary.
- "yellow": The limits of the warning, yellow field call the attention to the deviation from the desirable values within the regulatory acceptable range. In order to prevent the prospective violation of the regulatory limits the authority pays increased attention to the contributors falling into the yellow field.
- "red": The safety contributor within the red field is not acceptable. The lower limit of the red field is the limit value approved by the authority in different kind of documents – if such value is available – or in the event of lack of this value such individually determined criterion, in case of in-compliance with which the authority expects the corrective measure of the licensee or itself initiates corrective measure.

Supplemental Information:

- The hierarchical system of indicators is based on the IAEA TECDOC
- The SPIs and the evaluation of trends are a main part of the annual evaluation of the performance of Paks NPP. The results were discussed on top managers meeting in the last 2 years.
- HAEA NSD has been collecting data and assessing SPIs since 2001. In the middle of 2005 based on the result and of the first 3 years experiences the indicator system will be reviewed.

Japan/METI(NISA)

Indicator Area: Generic

Performance Indicator(s) under development:

Our PIs are still under development and the detail has not been decided yet.

This will be dependent on the deliberation result of our committee (*) about the framework and the determination of directivity of an inspection system.

(*)"The Subcommittee on Appropriateness of Inspection on Policy"(One of advisory groups for NISA(Nuclear and Industrial Safety Agency)

The situation has not changed from the time of the first questionnaire.

Korea/MOST(Ministry of Science and Technology), KINS(Korea Institute of Nuclear Safety)

Indicator Area: Generic

Performance Indicator(s) in use:

2 Areas : Reactor Safety, Radiation Safety
5 Categories: Operational Safety, Multiple Barrier, Safety System, On-Site Radiation Safety, Off-Site Radiation Safety
11 PIs

Assessment of indicator results:

- the utility reports the values of indicator including the raw data of each PIs to the regulatory body
- each indicator data is assessed through the use of thresholds and is color coded to represent its safety performance level

Discussion:

Experience/challenge in collecting the data:
- the utility prepares and submits performance data including the raw data of each PIs to the regulatory body quarterly and there is no notable difficulties in collecting data

Experience/challenge in calculating indicators:
- the utility calculates and reports the PI values to the regulatory body
- the regulatory body assesses them and determines the grade of the PIs
- owing to the LER documents and resident inspection, the data seems to be reliable

Experience/challenge in transforming the indicator data to meaningful information for decision making:
- the indicator data is not used for the regulatory decision making yet

Whether these indicators are seen as leading or lagging indicators:
- the indicators are thought to be lagging indicators but also has some features of leading indicators

To what extent these indicators are risk -informed:
- the indicators are not risk-informed

Limitations and benefits of current indicators:
- the current system of SPI is only composed of 11 PIs and so it is simple but cannot touch the wide spectrum of plant safety important areas

Are there any pitfalls worthwhile to be mentioned:
- there were a few important events which have not affected the specific indicator but have affected the safety of that indicator and vice versa, for examples see area A1 and A2.

Supplemental Information:

- the following is the hierarchical form of the SPI system

Area(Overall indicator)	Category (Strategic indicator)	Specific Indicator
Reactor Safety	Operational Safety	Unplanned Reactor Scram
		Unplanned Power Reduction
	Multiple Barriers	Fuel Reliability
		Reactor Coolant Leakage
		Containment Reliability
		Emergency Preparedness
	Safety System	SI System Availability
		Emergency DG Availability
		AFW System Availability
Radiation Safety	On-site Radiation Safety	Radiation Collective Dose
	Off-site Radiation Safety	Public Dose/Environmental Radiation

- MOST/KINS opens the results of SPIs on the web site(the address is http://opis.kins.re.kr) in each quarter and publish annual report.
- MOST/KINS communicate with the stakeholders thru the web site and also distribute the report to them

Slovenia/SNSA

Indicator Area: Generic.

Assessment of indicator results:

Since the new "Act on Protection Against Ionising Radiation and Nuclear Safety" came into force in 2002, new regulation "Monitoring Safety of Ionising and Nuclear Facilities" that will supersede the one from 1981 is in preparation (see "Discussion" bellow). SNSA (regulatory body) has started to develop its own set of performance indicators (PI) that would satisfies regulatory needs. First inputs were collected from IAEA-TECDOC-1141 and other national reports, i.e. international praxis. In the scope of Phare Project SI/RA/03 in January 2004 SNSA hosted experts from Belgium and Finland. The goal of the workshop to determine the set of PI that would meet regulatory needs was achieved and SNSA began to develop its own internal procedure. At the moment the preparation of procedure is in the final stage as well as agreements with the plant about selected set of PI. The aim is namely not only to expand plant safety evaluation through PI but also not to put unnecessary burden on plant by asking for too much additional data.

SNSA informed inspection approach that will include trending of indicators is in preparation phase.

With regard to SNSA internal PI procedure, most of PI have proposed threshold that would trigger regulatory action in the case of exceeding it (lagging indicators) as well as evaluation of trend (leading indicators). Trend limits are set to presume the eventual rise/fall of linear correlation for the next period, taking into account last 4 data inputs.

PI data collection includes not only PI values but also additional data that shortly explain background of PI value itself. These explanations are valuable inputs for operation and event data base.

The plant also followed international praxis and established in 1995 its own "Plant Performance Monitoring Program". The Program was upgraded in 2003 and include about 87 indicators. Next to mentioned program plant started in 2001 with System Health Report, using colour coding for systems availability when thresholds are crossed. In 2003 the pilot project "Reactor Oversight Process (ROP)", following US approach has started. The SNSA has been acquainted upon requests with programs and PI definitions.

SNSA PI approach is still in the stage of development, therefore set of PI, definitions and absolute/trending values as presented below are subject to change. For the time being the assessment of PI has not triggered any significant SNSA action yet.

Discussion:

experience and challenges in collecting the data:

Some of plant's PI are requested by regulation from 1981 and since then have been submitted to SNSA (yearly: collective radiation exposure; monthly: unplanned scrams, time availability factor, capacity factor, electrical energy production…). With regard to later SNSA decrees, the plant also report additional PI, such as radioactive releases, radioactive waste inventory and emergency preparedness.

Next to mentioned PI, requested by the legislation, plant's annual reports "Performance Indicators" from 1991 on include WANO indicators as well as some ex WANO indicators and other PI that are presented only for the purpose of continuity of plant performance monitoring i.e. not to lose track of information from previous years. Another source of PI are plant's "Annual Report". The mentioned reports are only submitted to SNSA and are not subject to approval.

The plant collects data for PI. Specific PI information/data are submitted to SNSA upon request.

experience and challenges in calculating indicators:

Plant PI definitions as well as formulas for calculating PI are known to SNSA. At the time ROP pilot project started, only 14 out of 18 indicators were available. Due to fact that US approach can not be completely applied in Slovenia, some of the ROP indicators may never be collected and evaluated in Slovenia.

to what extent these indicators are risk-informed:

Monthly reports of on-line maintenance supported by PSA evaluation are submitted to SNSA.

Supplemental Information:

to what extent these indicators are communicated to stakeholders:

Most of PI are presented in the SNSA annual report to government. With regard to legislation all data are public and are available at SNSA upon request. Nevertheless, only few of PI are presented on SNSA web site.

Spain/CSN

Indicator Area: Generic

Performance Indicator(s) in use:

At the moment CSN is using the PI´s system previous to NRC´s ROP. The current Spanish indicators are the following :

- Automatic Scrams while Critical
- Safety Systems Actuations
- Significant Events
- Safety System Failures
- Forced Outage Rate
- Equipment Forced Outages per 1000 Commercial Critical Hours
- Collective Radiation Exposure
- Cause Codes

Assessment of indicator results:

Only trends analysis is used for indicators assessment. Thresholds or colour coding are not used in the assessment

Discussion:

experience and challenges in collecting the data:

Data are obtained by CSN mainly from Licensing Event Reports; Special Reports and Monthly Operating Reports.

Performance Indicator(s) under development:

Current status and development on the use of PIs in the regulatory processes in Spain

After analysis of the relevant international experience, the Spanish nuclear regulatory authority, CSN, has decided to adopt a methodology similar to ROP for the inspection and control of Spanish NPPs.

This task was not intended to be a mere translation of the methodology from its original English into the Spanish language, but to make a detailed adaptation of the elements in the ROP to the Spanish situation. The following activities were foreseen:

- Analysis of the ROP to understand its foundations and the possible dependencies on other nuclear regulatory system of the US NRC. To this end, documentation had to be extensively reviewed, and a summary report was made addressing these issues.
- Identification of modifications to ROP in order to take advantage of the Spanish experience or to adapt the ROP to the Spanish regulatory system. In this respect, discuss, for each element in the ROP, the modifications deemed necessary in the Spanish framework. Among those, the following topics have been reviewed:
    (1) Definition of the performance indicators and the thresholds for regulatory actuation
    (2) Base inspection program and the procedures thereof
    (3) Methodology for categorisation of findings
    (4) Methodology for discovering, analysing and solving performance problems
    (5) Corrective actions programme
- Conduct a pilot experience with all Spanish nuclear power plants for assessment of the methodology. Given the experience already gathered in the USA and in other countries, restricted pilot exercises involving fewer plants are not considered necessary. The tasks included the assessment of any proposed changes in the methodology, and proposals for the final implementation.
- Develop a procedure to assess the importance for safety of trespassing the thresholds in each category.

After a detailed analysis of the ROP and the Spanish regulatory experience, the ROP scheme was found to be well suited for the Spanish regulatory framework in the strategic performance area of Reactor Safety. In particular the cornerstones ***Initiating Events, Mitigation System and Barrier Integrity***. For the indicators included in these strategic areas, thresholds will be also the same as the established by NRC; colour coding will be used also for them.

The existence of different regulations in the US and in Spain, with well settled practices in Spain, affect specially the cornerstones of ***Occupational and Public Radiation Safety, Emergency Preparedness and Physical Protection***, which need more deep work to convert to the Spanish situation.

In the ***Occupational and Public Radiation Safety*** cornerstones, no new indicators are proposed. The existing ones are conceptually applicable, although some modifications are needed in order to include current CSN regulatory activities, that are not part of the US NRC ROP, as well as the necessary adaptation to Spanish legislation.

Some regulatory activities presently in effect in Spain, and that do not have a counterpart in the current ROP, have to be included within the scope of the future Spanish oversight process. Such are for instance the specific legal provisions for the radiological protection of contractor workers (radiological passbook, registration of contractor companies, education training). An specific Significance Determination Process (SDP) is being developed for these activities.

Moreover, the regulatory activities in Spain related to the oversight of the application of the ALARA principles have a wider scope than their counterpart in the ROP. This more ample oversight process must also be incorporated to a future ROP system, not to loose current well-established regulatory practices.

Although the nature and definition of the ROP indicators for Radiation Safety are considered to correctly reflect the Spanish regulatory system and practices, the details of the Spanish regulation have been taken into account. Special care has to be taken in the definition of the thresholds, since this is likely to be a sensitive point from the public opinion viewpoint. This is also the case for the Radiation Protection of the environment which, in Spain, is conducted by evaluation of the ***Environment Radiological Surveillance Plan***, a programme that every facility has to maintain according to Spanish regulations. In this matter, there may be also need for some development in the indicators and inspection system.

The difference in regulations in the USA and in Spain in ***Emergency preparedness*** issues, suggests some changes in the structure. A significant point is made that the oversight process should not affect the relations between CSN and other national or local organisations involved in the management of the emergency.

The different level of responsibility between Spanish and US NPPs in the emergency management area requires some changes in the definition of two of the indicators proposed in the ROP and the substitution of a third one. Accordingly, some changes will be introduced in the applicable thresholds.

The proposal also includes changes in the base inspection program as proposed in the ROP, which would eliminate one of the inspections, and induce the corresponding changes in the SDP. The changes would imply a larger involvement of the resident inspectors in the associated inspections and in the following and assessment of the emergency drills.

Due to on-going work in the ***security area*** in Spain and its applicable regulations, ROP can at present only be applied partially in this field. An ***Integrated Security Model*** *for NPPs* has recently been designed, and is at the last phase of implementation. This is a dual model in which one part refers to the internal security within the NPPs, of which the responsibility remains with the licensee. The other part refers to the external security system, in which, by national regulations, the national security police forces bear the responsibility. ROP can only be applied to the first part. Since this model is still pending final agreement by all parties, the implementation of the ROP shall be postponed until the model is proved to be effective.

Two of the US NRC ROP indicators in this area could be dropped from the Spanish system; an analysis has to be made in order to resolve and in any case to avoid their conflict with Spanish regulations concerning personal rights. The rest of the indicators, related to technological and operations aspects of the Security cornerstone, are applicable in Spain with no or very few modifications.

In the framework of the Integrated Model referred to above, an initial set of inspections is being made in order to test its adequate implementation. After the testing, a base inspection programme based on the ROP structure will be established.

The communication programme should only be put in practice after an initial period when all technical aspects have been solved, the procedures have been reviewed, and the possible difficulties cleared up.

The elements of the ***communication plan*** are, like those of the ROP, a Web-based information system for the public, and periodical meetings in which the public will be informed by CSN and by licensees of the oversight process.

The information to be included in the web-based information system will be restricted in order not to include the security aspects in detail, although clear indications of the way it is followed should be given. The possibility of including the comments from the licensee along with the results of the SDP of the inspection programme and the results of the indicator system has also been suggested. This way, any discrepancies will be shown up for the consideration of the general public.

There are also some concerns and recommendations regarding the time during which the colour code should remain at levels upper than green and on the convenience of restricting the actual inspection reports for public knowledge.

Finally, ***Cross-cutting issues*** show high variability in the comparison of actual practices by the US NRC and CSN: In some respects, as for instance, inspections to operator re-qualifications, practices are very similar. Other aspects are treated differently, for example, US NRC putting more emphasis on the inspection to programmes dealing with personnel involvement or treatment of strikes in NPPs.

The larger differences arise in the inspections within the broad field of ***Organisation and Human Factors Programmes***; those include inspections to

- Organisation and Human Factors, including the inspection to the Safety Culture programmes at NPPs
- Integrated Management Systems, including inspections to the organisation at the utilities for management of the investments in safety.
- Management of the organisational changes.

Lack of a detailed set of indicators for these issues and of a consistent Significance Determination Process precludes their immediate use within the ROP structure. Given the relatively early state in the implementation of on-going activities in this field, a delay in the final implementation has been proposed.

The timetable for the implementation of the Performance Indicator System based on the ROP is as follows:

- A Pilot Program for all NPP´s Spanish plants will be established lasting from beginning of July 2005 until the end of 2005.
- The PIs Program should be in operation from January 2006 on.

The idea is to adhere to the benefits of the new ROP indicator system in a way consistent with inspection activities, yet retaining the information obtained with the old PI system.

Sweden/SKI

Indicator Area: WANO indicators (generic)

Assessment of indicator results:
The resulting indicator values for the Swedish nuclear power plants are presented in graphs for a 5-year period. Data for the BWR- and PWR-collectives are included for comparison. The type of graph used, a combined bar and curve chart, is considered to give the best representation of the data. As a guide when evaluating the results, explanations are provided for individual indicator values that deviate significantly from normal levels.

Discussion:

Safety Indicators (SI) have been in regular use in the Swedish nuclear industry since the early 90ies. The selection of SIs varies from one utility to another, but is typically based on a combination of WANO Performance Indicators (PI) and indicators defined by the user.

In the SKI indicator system, 6 of the WANO PIs are used as high level (Level 1) indicators: Collective Radiation Exposure (CRE), Fuel Reliability Index (FRI), Safety System Performance (SP1/2/5), Unplanned Automatic Scrams (UA7), Unit Capability Factor (UCF) and Unplanned Capability Loss Factor (UCL).

General comments on WANO PIs:
- WANO PIs are used worldwide and proven by the industry for a long period of time.
- Precise PI definitions facilitate comparison of plant performances.
- Dependencies exist between PIs, i.e. an increase in UCL causes UCF to decrease.

United States/NRC

Indicator Area: Generic

Assessment of indicator results (answers in this section are applicable to all indicators):

All performance indicators are calculated on a quarterly basis and compared with established thresholds/colors. Each threshold/color represents varying amount of regulatory involvement (See Table 1).

Table 8: PI Thresholds/Colors and Associated Actions

Color	**NRC Action**
Green	No additional regulatory response (i.e., maintain baseline inspection)
White	Increased regulatory response (e.g., increased inspection)
Yellow	Required regulatory response
Red	Unacceptable performance band

The concept for setting performance thresholds included consideration of risk and regulatory response to different levels of licensee performance. Thresholds were established so that sufficient margin exists between nominal performance bands to allow licensee initiatives to correct performance problems before reaching escalated regulatory involvement, and sufficient margin exists to allow for both NRC and licensee diagnostic, and corrective actions to be effectuated in response to declining performance. Thresholds have been established sufficiently above the point of unsafe plant operation to allow the NRC sufficient opportunity to take appropriate action to preclude operation in this condition.

Note: certain indicators have thresholds that are plant specific (e.g., safety system unavailability).

Discussion (answers in this section are applicable to all indicators):

Experience/challenge in collecting the data: The licensee collects the data and calculates all performance indicators. NRC inspects the licensee calculations to ensure completeness and accuracy.

Experience/challenges in calculating indicators: Licensees have spreadsheets to calculate PIs. Quality assurance was performed on software prior to use.

Experience/challenge in transforming the indicator data to meaningful information for decision-making: The PIs with their thresholds provide the basis for nominal or increased regulatory action (e.g., inspection).

Leading or lagging indicators: All PIs are lagging indicators.

To what extent are these indicators risk-informed: These indicators themselves are not risk informed. However, the thresholds account for increases in risk. PRA models were used to develop risk intervals approximately an order of magnitude of ΔCDF/year between each threshold.

Limitations/benefits of current indicators: The PI system is an integral part of the Reactor Oversight Process (ROP) established by the NRC. It is a risk-informed, performance-based approach designed to meet the following objectives:

- Accurately and objectively measure the safety performance of nuclear power plants in protecting the public health and safety
- Provide accurate and understandable safety performance information to the public, news media, and other stakeholders
- Provide utility licensees and the NRC with objective indicators to assess safety performance and trends, to rationalize the NRC enforcement policy, and to allocate resources in a effective and efficient manner
- Provide Congress with objective information to assist in performing its oversight and authorization responsibilities

Cornerstone: Reactor Safety
Information related to indicator area A1 (Events):

Belgium/AVN

Indicator Area: A1 Events

Performance Indicator(s) in use:

1. Unplanned scrams + Unplanned scrams per 7000 critical hours
   Definition = The number of unplanned scrams, both manual and automatic, (while critical per 7000 hours) during previous calendar year.
   Maturity = 2 to 3 (the number of unplanned scrams has been trended for many years, trending of number of scrams normalised on the basis of critical hours has only been started as part of a pilot project)
2. Unplanned scrams with loss of normal heat removal
   Definition = The number of unplanned scrams while critical, both manual and automatic, during the previous calendar year, that were either caused by or involved a loss of the normal heat removal path prior to establishing reactor conditions that allow use of the plant's normal long term heat removal systems.
   Maturity = 2
   note: normal heat removal path = main condenser + main feedwater system + steam generators + turbine bypass back to condenser (case of PWRs)
3. Reportable events
   Definition = The total number of reportable events during the previous calendar year.
   Maturity = 2
4. Reportable events during plant shutdown
   Definition = The number of reportable events during the previous calendar year, which occurred during plant shutdown and were relevant for this plant condition.
   Maturity = 2
5. Spurious safety system actuations
   Definition = The number of events during the previous calendar year, related to a spurious safety system actuation.
   Maturity = 2
6. Forced power reductions per 7000 critical hours
   Definition = The number of forced changes in reactor power of greater than 20% of full-power, during the previous calendar year, per 7000 hours of critical operation excluding manual and automatic scrams.
   Maturity = 2

Assessment of indicator results:
Indicator results are assessed yearly by trending. No thresholds for unacceptable plant performance or for increased regulatory attention have been defined yet.

Discussion:

Experience and challenges in collecting the data:

Data collection is mainly done on the basis of AVN inspection reports (information confirmed by LERs if available). For indicator 6 it is crosschecked on the basis of monthly plant reports. It has been experienced that event reporting by the licensees (i.e. by LERs) has not been sufficiently reliable and coherent between licensees to support these indicators, especially for indicators 3 to 5 as indicated above.

Data collection is straightforward with exceptions for

- indicator 2, which requires some expert assessment on the impact of the event on the operability of the normal heat removal path and
- indicators 3 and 4, which are not supported by the present official event reporting requirements as stipulated in the Technical Specifications document; in stead AVN has established criteria for internal reporting by inspectors of off-normal occurrences.

Indicators 3 to 5: Although necessary precautions have been taken within the working process of AVN to make the data collection system as robust as possible (by definition of internal reporting criteria and independent reading by an expert of the inspection reports), the system still depends to some extent on the willingness of the licensees to notify off-normal occurrences to AVN, the ability of plant inspectors to detect off-normal occurrences themselves and their willingness to fill in an additional reporting form (in addition to normal inspection reports). Sometimes also discussion is needed on the interpretation of the reporting criteria.

Experience and challenges in transforming indicator data to meaningful information for decision making:

Indicator 1 provides an indication of initiating event frequency. Indicators 3 and 4 are aggregated type of indicators covering a wide variety of events including initiating events (e.g. scrams, important power transients, safety system actuations), condition events (e.g. failure of safety systems, fire or flooding in safety area…), TS violations, events involving significant dose or uncontrolled release etc. and regulatory decision making needs consideration of the contributing elements to this indicator. It has mainly the role of a warning signal. With few exceptions, no immediate regulatory action has been taken in the past on the basis of indicators 1 to 5. Regulatory actions have been limited to raising regulatory concern in discussions with licensees about negative trends (especially with regard to indicators 1, 3 and 5).

The intention of indicator 6 is to monitor significant power reductions and shutdowns (excluding scrams) forced by plant internal reasons. They include automatic power reduction transients and manual power reductions or shutdowns following technical problems at the plant facility. Assessment of indicator results requires careful consideration of the reasons behind the forced power reductions, which may be manifold. The number of power transients may also depend to some extent on plant design characteristics (e.g. number of turbines). High indicator values may also result from a significantly reduced number of critical hours during the calendar year under consideration because of prolonged plant shutdowns following an important technical problem. Up to now, no regulatory action has been taken on the basis of this indicator. The direct relationship between this type of indicator and plant safety is unclear. Only a fraction of the events monitored by this indicator is also covered by the indicator on reportable events (depends on cause of power reduction).

Leading or lagging indicators?: The indicators are understood to be lagging indicators (although the concept of leading and lagging indicators needs clarification).

To what extent risk-informed?: They are not risk-informed (with a possible exception for indicator 2, which tries to single out scrams which are more risk significant than uncomplicated scrams).

Limitations and benefits of current indicators:

The safety significance of the events counted by the above indicators may vary considerably and therefore simple counting of events, without consideration of their impact on plant safety, may provide a wrong indication.

Discussion:(continued)

Indicators 1: Although one might argue that a scram is not a safety significant event by itself, it should be considered as an initiating event, which challenges safety systems, and large scram rates could be indicative of underlying operational deficiencies.

Indicator 2: In developing this indicator consideration has been given to the question of a differentiated “scram counting”, taking into account additional event characteristics such as reduced heat removal capability. On the basis of data collected for the last 12 years it has been noticed that scrams involving loss of normal heat removal path occur rather seldomly. In addition all Belgian plants are provided with additional safety systems, which are designed for coping with external events and provide an additional independent heat sink for reactor cooling, and therefore it is believed that scrams with loss of cooling capability by the normal heat removal path have limited additional risk with regard to scrams where normal heat removal path remains operable. For these reasons it is under consideration not to continue this indicator. Furthermore, if systematic precursor-analysis would be performed, the impact on core damage probability of such events (and others) could be taken into account in an overall aggregated indicator on safety significant events.

Indicator 5: Real challenges to safety systems (with the exception of reactor scrams and the auxiliary feed water system, which is systematically started after a scram in most plants) are rather infrequent and it was not believed that a useful indicator could be derived from them. However untimely actuation of safety systems (i.e. in frame of testing activities) occured more frequently in the past. Although the safety impact of such actuations might vary from rather innocent to quite challenging for plant operators and plant equipment, they could all be indicative of poor testing or operational practices. On the basis of collected data for the last 8 years, there is however some doubt about the usefulness of this indicator. The appropriateness of this indicator and its definition has still to be assessed.

The benefit of indicator 6 is still to be determined. Clearly it cannot be used as a stand-alone indication of plant performance but should be combined with other indications.

Supplemental Information:

Although these indicators, with exception for indicator 1, are considered to be “low level” indicators, no hierarchical system of indicators has been established yet. These low-level indicators are preferably aggregated / combined with other indicator data for assessment of plant performance. Aggregation principles have still to be examined.

Performance Indicator(s) under development:

Taking into account the limitations mentioned above, AVN is considering to improve the set of indicators by building an indicator on the combination of both the number of INES > 0 events and on the number of precursor events (CCDP > 1E-06). The reliability of the event screening process for precursor analysis at AVN needs to be confirmed. The INES-evaluation of events is performed by the licensees and reviewed/confirmed by AVN.

Czech Republic/SUJB

Indicator Area: *A1 Events*

Performance Indicator(s) in use:

1. Unplanned Automatic/Manual Scrams
   Definition = total number of automatic/manual unplanned scrams (US) (reactor in MODE 1 or 2). The term unplanned means that the scram was not an expected part of the planned test.
   Maturity = 3
2. Unplanned Automatic Load Reduction
   Definition = total number of unplanned automatic power reductions due to actuation of different limitation system functions.
   Maturity = 3
3. Control Rod Drop
   Definition = total number of control rod drops
   Maturity = 3
4. Reportable Events
   Definition = total number of reportable events
   Maturity = 2
5. Number of actions under effect of TS
   Definition = number of all commencements of the unit transition to the mode with a higher serial number enforced by the state of parameters of the facility consistent with the requirements of the Limits and Conditions.
   Maturity = 2

Assessment of indicator results:

The trends of unit and site values of Indicators are assessed yearly.

Discussion:

- *All the data for these indicators are collected by SUJB staff through inspection activities and from regular reports submitted by licensee. The "independence" of SUJB in collecting these data leads sometime to final different indicator results comparing the values of indicators gained by licensee. The correct number must be then found through new review of the source documents and by discussion with licensee.*
- *Indicator 3 was introduced to set to monitor one of operational problems specific for NPP with VVER 440 type reactor very in the beginning. The results of indicator 3 clearly have showed the aging of system and innovations made. Indicator 5 is still assessed from readability point of view.*
- *All these indicators are seen as lagging indicators and not risk-informed.*

Supplemental Information:

- *The master indicator for this area is Indicator 4. The other give supporting more detailed information about scrams, load reductions, rod drops and actions powered required by L&C. The indicators are not aggregated.*

Performance Indicator(s) under development:

Indicator *safety system actuation* or *spurious activation* is again under consideration. There was already one for monitoring of these actuations in the past, but due to low values of indicator (mostly 0) it was excluded from the set.

Finland/STUK

Indicator Area: A1 Events

Performance Indicator(s) in use:

Number of events

Definition: As the indicators, the numbers of events reported in accordance with Guide YVL 1.5 (events warranting a special report, scrams and operational transients) are followed.

1. Unplanned scrams
   Definition = The number of unplanned scrams, both manual and automatic
   Maturity = 3 (the number of unplanned scrams has been trended for many years)
2. Reportable events
   Definition = The number of reportable events
   Maturity = 3 (the number of reportable events has been trended for many years)
3. Special reports
   Definition = The number of events warranting a special report. Such special situations are incidents, observations, deficiencies, and problems if they have importance to the nuclear safety of the plant, to the plant personnel or to the radiation safety of plant's environment.
   Maturity = 3
4. Reports on operational transients
   Definition = The number of significant disturbances which have lead to a forced power decrease of the reactor or generator or other major disturbances in the operation of the plant or its systems.
   Maturity = 3
5. Direct causes of events (*look also at E1*)

   Definition = As the indicators, the direct causes of events reported in accordance with Guide YVL 1.5 are followed. The event causes are divided into technical failures and erroneous operational and maintenance actions (non-technical, human errors).

   Maturity = 3

Assessment of indicator results:

Purpose of these indicators is to follow the number of events important for safety, and to follow the immediate causes of reported events (technical and non-technical).

Indicator results are assessed quarterly and yearly by trending.

No thresholds for unacceptable plant performance or for increased regulatory attention have been defined yet. The number of events in each category is compared to the average numbers of previous years.

Risk significance of events is calculated by PSA (STUK's indicators A.II.2).

Discussion:

Experience and challenges in collecting the data and calculating indicators:

Source of data = The data for the indicators is obtained from STUK's document administration system (YTD) and/or the events follow-up table kept by TUR (STUK/NRR's office responsible for the supervision of operation of plants) at the moment of occurrence or by the notification of the plant about the event. Information is confirmed from Licensees' event reports (LERs) required by Guide YVL 1.5. Sometimes discussion is needed on the interpretation of the reporting criteria.

For indicator 1 are calculated all reactor scrams, also those which have occurred < 5 %, where an automatic protective function has triggered. Reactor scrams on low power (< 5%) are not necessarily reported according YVL 1.5.

It has been experienced that event reporting by the licensees (i.e. by LERs) has not been sufficiently reliable and coherent between licensees to support these indicators, especially for indicator 3 but also for indicator 4.

Data collection is straightforward with exceptions for

- indicator 1, which requires some expert assessment on the impact of the event on the operability of the protective functions
- indicator 3, licensees are not spontaneously submitting a special report even if the criteria set in YVL guide are realised, because the number of special reports may have negative effects to their profit
- indicator 4, the criteria in YVL guide are quite general and licensees interpretation of the significance of an event is often dismissive and they prefer sending a memorandum or a clarification instead of an official report.
- indicator 5, the underlying causes of most events are human based. By this indicator are followed the immediate causes of events if they are technical failures or human origin.

Experience and challenges in transforming indicator data to meaningful information for decision making:

Indicator 1 provides an indication of initiating event frequency. Indicators 2, 3 and 4 are aggregated type of indicators covering a wide variety of events including initiating events (e.g. scrams, important power transients, incidents launching safety functions); defects and degradation of systems and components (e.g. leakage of several fuel rods, primary circuit, or containment, failure of safety systems,), TS violations, incidents related to radiation safety (uncontrolled radioactive leakage inside the plant, significant dose or uncontrolled release). external incidents (flooding, fire or explosion at the plant site) etc. These events mainly have the role of a warning signal.

"Non-technical causes" denote failures caused by erroneous operational and maintenance actions. The indicator may be descriptive of an organisation's operation

Some immediate regulatory action has been taken on the basis of indicators 1 to 4 combined with INES classification of events. Regulatory actions have then initiated at several levels. E.g. the number of reportable events (disturbances, TS deviations) was noticed to be increased in short period at another power plat in Finland. The number of INES class 1 events was also exceptionally high. Discussions with the licensee management were started immediately. Decision was sent to the licensee asking clarification on the increasing trend of events. Improvement of safety culture in the NPP's operation was highlighted.

Leading or lagging indicators?: The indicators are understood to be lagging indicators, but can also be regarded leading: increasing number of low-level events can be a sign about underlying generic deficiencies in operation or wider within the organisation.

To what extent risk-informed?: They are not risk-informed (with a possible exception for indicator 1). Risk significance of events is followed by PSA based indicators.

Limitations and benefits of current indicators:

The safety significance of the events counted by the above indicators may vary considerably. Therefore the risk significance indicators provide precious and necessary information of their impact on plant safety.

Indicators 1: Large scram rate could be indicative of underlying operational deficiencies.

Indicators 2, 3 and 4: These events mainly have the role of a warning signal.

Supplemental Information:

These indicators, with exception for indicator 1, are considered to be "low level" indicators. They belong to the second principal group "Operational events" in STUK's indicator system. Risk significance of events is calculated by PSA. These PSA-based indicators of STUK's indicator system belong to the same principal subgroup (II) as number and direct causes of events.

These event indicators are aggregated/combined with other indicator data (deviations from TS; unavailability of safety systems; failures of TS components and systems and their repairs; production loss due to failures) for assessment of plant performance.

Performance Indicator(s) under development:

In connection of renewal of the Guide YVL 1.5 also other less significant events were required to be reported to STUK. The risk significance of these events (Conditional Core Damage Probability) is CCDP < 1E-08. As the number of these very low level events are given for attention to STUK it could be possible to include this group of events into STUK's indicator system. Appropriateness of this new indicator will be assessed in connection of the next periodic assessment of indicator system.

Hungary/HAEA NSD

Indicator Area: A1 Events

Performance Indicator(s) in use:

1. Unplanned scrams / RPS actuations

Definition = Tracing the changing of the number of events entail with automatic SCRAMs and manual SCRAMs
Maturity = 2

*2. S*afety system actuations

Definition = Tracing the events initiating the operation of the emergency core cooling systems (ECCS)
Maturity = 2

3. Significant/reportable events

Definition = (Immediately) Reported events regarding 1.25 guideline M1 for each unit and for the NPP
Maturity = 2

4. Less significant events (disturbance reports)

Definition = Number of events reported based on the 1.24 guideline (in quarterly report)
Maturity = 2

5. Event investigations ordered by RB

Definition = Event investigation ordered by the HAEA NSD, in case of events that was not reported previously by the NPP but has any safety aspect.
Maturity = 2

6. Number of actions under the effect of TecSpecs

Definition = Number of deviations determined during the investigation of the reportable and indirectly reportable events, declared as occurrence under the effect of the TecSpecs .
Maturity = 2

7. Unplanned power reductions

Definition = Measuring the influence and the number of shut downs and more then 10% power reductions occurring due to internal incidents during the operation of the unit.
Maturity = 2

8. Core-melting index caused by the initiating events

Definition = Core damage frequency according to the PSA level 1 (operational)

Value and trend of the core damage frequency calculated according to the PSA level 1
Maturity = 2

Assessment of indicator results:

*1. Green: < 3 operation/NPP*year*
*Yellow: 3-5 operation/NPP*year*
*Red: > 5 operation/NPP*year*

*2. Green: < 1 operation/unit*year*
*Yellow: 1-3 operation/unit*year*
*Red: > 3 operation/unit*year*

*3. Green: < 10 event/year*NPP or the trend is degrading with max. 10 %.*
*Yellow: 10-25 event/year*NPP, or the trend is degrading with 10-50 %-al*
*Red > 25 event/year*NPP, or the trend is degrading with > 50 %*

*4. Green: max. 250 events/year*NPP and the trend is changing with < 10 %*
*Yellow: 250-350 events/ year*NPP, or the trend is changing with 10-50 %.*
*Red > 350 events/year*NPP, or the trend is changing with > 50 %.*

5. Green: < 4 events/year
Yellow 4-8 events/year
Red > 8 events/year

6. Green: < 100 event/unit/year
Yellow: 100-200 event/unit/year
Red: > 200 event/unit/year

7. Green: , < 3 events / NPP
Yellow: 3-8 events / NPP
Red: < 8 events / NPP

8. Green: CDF < 10^{-5} 1/year and the trend does not decline
Yellow: CDF < 10^{-5} 1/year but the trend declines
Red: CDF > 10^{-5} 1/year

Korea/MOST(Ministry of Science and Technology), KINS(Korea Institute of Nuclear Safety)

Indicator Area: .A1 Events

Performance Indicator(s) in use:

1. Unplanned Reactor Scram(URS)
   Definition : Number of unplanned reactor scram during actual critical hours per possible critical hours
   Maturity : 3

2. Unplanned Power Reduction(UPR)
   Definition : Number of unplanned power reduction during actual critical hours per possible critical hours
   Maturity : 3

Assessment of indicator results:

See also generic information.
The following is the threshold and grade of each indicator:

Indicator	Thresholds(Quarterly)			
	Excellent (green)	Good (cyan)	Normal (yellow)	Warning (orange)
Unplanned Reactor Scram	< 0.75	< 1.5	< 5	≥ 5
Unplanned Power Reduction	< 1.5	< 3	< 5	≥ 5

Discussion:

<u>Are there any pitfalls worthwhile to be mentioned:</u>
- there were a few important events which have not affected the specific indicator but have affected the safety of that indicator and vice versa, for example,
  - whereas one reactor scram usually made the indicator graded to "good" grade but one reactor scram just after annual overhaul made the URS indicator graded to "normal" grade due to a short critical hours

Slovenia/SNSA

Indicator Area: A1 Events.

Performance Indicator(s) in use:

1. Unplanned scrams

Definition: number of unplanned scrams per calendar year. Manual and automatic scrams are presented separately.
Maturity: 3

2. Unplanned load reductions

Definition: number of unplanned automatic or manual load reductions for more than 10 % of rated power and for more than 4 hours.
Maturity: 3

3. Safety system actuation

Definition: number of unplanned safety system actuation, separately for Residual Heat Removal, Safety Injection, Diesel Generator, Containment Spray and Auxiliary Feedwater and Reactor Protection System.
Maturity: 3 for system SI, 1 for systems RPS, RHR, DG, CI and AF

Assessment of indicator results:

1. Unplanned scrams

Threshold: 3 (referenced to ∆CDF)
Trend value: 3

2. Unplanned load reductions

Threshold: 10
Trend value: 13

3. Safety system actuation

Threshold: 2 for each safety system separately / 5 for all safety systems together (referenced to plant reports)

Trend value: 2,7 for each safety system separately / 6,7 for all safety systems together

Discussion:

experience and challenges in collecting the data:

Data collecting is performed by plant. Additional information shall be reported regarding PI :

3. Safety system actuation: date, duration of actuation, plant MODE, cause of actuation (proper/false signal, equipment failure…)

Spain/CSN

Performance Indicator in use:

1. Automatic Scrams while Critical
Definition: Number of unplanned automatic scrams that occurred while the reactor was critical.
Maturity=3

2. Safety Systems Actuations
Definition: Manual or automatic actuations of the logic or equipment of either certain Emergency Core Cooling Systems (ECCS) or, in response to an actual low voltage on a vital bus, the Emergency AC Power System.

In determining which events should be counted by this indicator, only the following system actuations are be considered:

- For PWRs. High Pressure Injection System, Low Pressure Injection System (LPS), and Safety Injection Tanks
- For BWRs. High Pressure Coolant Injection System, Low Pressure Coolant Injection System, High Pressure Core Spray System and Low Pressure Core Spray System. Actuations of the Reactor Core Isolation Cooling System are not counted.

Maturity=3

3. Significant Events
Definition: Events considered under this category are those identified by the Incident Revision Panel (IRP) through a detailed screening process, according to deterministic and probabilistic criteria.
IRP consists of representatives from nine CSN technical areas more involved in NPP operation, and is chaired by the Head of the Area of Operational Experience and Training.
The Panel meets monthly to assure systematic treatment of all events in Spanish NPPs.

The types of deterministic criteria are the following:

- Degradation of important safety equipment.
- Unexpected plant response to a transient
- Degradation of fuel integrity, primary coolant pressure boundary or important associated structures.
- Scram with complication.
- Unplanned release of radioactivity
- Operation outside the limits of the Technical Specifications.
- Other (i.e. Events or recurring incidents that represent ineffective corrective actions, or a deficiency in the plant hardware or administrative programs).

Events can be further classified as SE if, according to probabilistic criteria, conditional core damage (CCDP) probability is higher than 10 E-4.

Assessment of indicator results:

See generic information.

Performance Indicator(s) under development:

Those of the NRC´s ROP, but with the idea to retain also these PIs.

Sweden/SKI

Indicator Area: A1 Events

Performance Indicator(s) in use:
WANO Unplanned Automatic Scrams Per 7000 Hours Critical (UA7).

The WANO Performance Indicator UA7 (Unplanned Automatic Scrams Per 7000 Hours Critical) provides a measure of the level of reactor safety through the number of transients resulting in automatic scrams. To achieve comparable numbers between different plants the number of scrams is weighed against 7000 hours of operation at critical reactor. Only automatic scrams are included in order to encourage manual actions that may be taken to mitigate consequences of transients. Scrams that are part of a planned test are not included.

The detailed descriptions for the indicator can be obtained in the WANO Guidelines.

Assessment of indicator results:

See generic information related to WANO indicators.

Discussion:

Comments on Unplanned Automatic Scrams Per 7000 Hours Critical (UA7): Manipulation of indicator values is possible, although probably not very common, by initiating scrams manually in situations when automatic scrams are impending.

United States/NRC

Indicator Area: A1 Initiating Events

Performance Indicator(s) in use:

The indicators include:

1. Unplanned (Automatic and Manual) Scrams Per 7,000 Critical Hours: The number of unplanned scrams during the previous four quarters, both manual and automatic, while critical per 7,000 hours.
2. Scrams With a Loss of Normal Heat Removal Per 12 Quarters: The number of unplanned scrams while critical, both manual and automatic, during the previous 12 quarters that were either caused by or involved a loss of the normal heat removal path prior to establishing reactor conditions that allow use of the plant's normal long term heat removal systems.
3. Unplanned Power Changes per 7,000 Critical Hours: The number of unplanned changes in reactor power of greater than 20% of full-power, per 7,000 hours of critical operation excluding manual and automatic scrams.

ALL THREE INDICATORS ARE AT A MATURITY LEVEL OF 3.

Assessment of indicator results:

See generic information.

Performance Indicator(s) under development:

NONE AT THIS TIME.

Information related to indicator area A2 (Mitigating Systems):

Belgium/AVN

Indicator Area: A2 Mitigating systems

Performance Indicator(s) in use:

1. High pressure safety injection system unavailability
   Definition = Fraction of time the high pressure safety injection trains are not able to perform their intended function, due to planned and unplanned unavailability, including fault exposure unavailability hours resulting from train failure. The indicator value is an averaged value over the number of safety trains and calculated for the whole calendar year (based on quarterly values of WANO indicator).
   Maturity = 2
2. Auxiliary feedwater system unavailability
   Definition = Fraction of time the auxiliary feedwater system trains are not able to perform their intended function, due to planned and unplanned unavailability, including fault exposure unavailability hours resulting from train failure. The indicator value is an averaged value over the number of safety trains and calculated for the whole calendar year (based on quarterly values of WANO indicator).
   Maturity = 2
3. Emergency AC power unavailability
   Definition = Fraction of time the emergency AC power trains are not able to perform their intended function, due to planned and unplanned unavailability, including fault exposure unavailability hours resulting from train failure. The indicator value is an averaged value over the number of safety trains and calculated for the whole calendar year (based on quarterly values of WANO indicator).
   Maturity = 2
4. Safety System Functional Failures
   Definition = The number of events or conditions, reported in AVNs incident data base, that prevented or could have prevented the fulfilment of the safety function of structures or systems in the previous calendar year.
   Maturity = 2
5. Emergency diesel generator reliability
   Definition = The unit average value of the individual EDG reliabilities for the calendar year under consideration. The individual EDG reliabilities are defined as the sum of EDG start reliability (failures to start) and EDG loading reliability (failures to load).
   Maturity = 2

Assessment of indicator results:
Indicator results are assessed yearly by trending. No thresholds for acceptable/unacceptable plant performance or for increased regulatory attention have been defined yet.

Discussion:

Experience and challenges in collecting the data:

For indicators 1 to 3, AVN is able to obtain data from the utilities (= quarterly WANO indicator values; for indicator 3 only station values are reported to WANO, which averages EDG performance over units of different vintage).
For indicator 4 an independent registration by AVN of occurrences is needed, as this indicator is not supported by a utility data collection process. The reliability of this indicator depends on the reliability of the AVN internal reporting system of events (see for discussion area A1).
For indicator 5, although a specific data collection process is required and is in place, no reliable data has been obtained from the utilities so far.
Experience and challenges in transforming indicator data to meaningful information for decision making:

Indicators 1 to 3:
The intention of these indicators is to monitor the readiness of important safety systems to perform their safety function in response to off-normal events or accidents. The indicators also indirectly monitor the effectiveness of operation and maintenance practices in managing the unavailability of safety trains.

Discussion (continued):
In the past (i.e. in the late 80's) AVN has collected, for many years, data on the availability of a wide selection of safety systems (including safety injection, auxiliary feedwater and EDGs, but also covering other important systems, including bunkerised emergency systems for coping with external events such as plane crash, explosions etc.). The objective of this effort was to draw licensee attention to high safety system unavailability rates due to a non-optimised tagging and maintenance planning practice. This data collection process has been stopped more than 10 years ago, when this specific objective had been reached and the utilities had taken action to correct the situation (the data collection effort was also too resource demanding for the AVN inspectors). In the mean time the licensees have put in place the industry-wide WANO-indicators and some additional station-specific indicators to monitor safety system availability.

Leading or lagging indicators?: The indicators are understood to be lagging indicators (although the concept of leading and lagging indicators needs clarification).

To what extent risk-informed?: They are not risk-informed.

Limitations and benefits of current indicators:

Indicators 1 to 3 are believed to be significant indicators, as they allow at the same time to evaluate the average technical safety state of the plant and the operational practices (such as maintenance, testing), which impact the operability of safety systems. They are rather simple to calculate, but do not provide a full picture of safety system reliability (failure rate on demand, when running). This is especially true for emergency diesel generator (EDG) start reliability.
Indicator 3: WANO provides the possibility to the utilities to report only station values for this indicator, even when the monitored EDG are dedicated to single plant units. This station level averaging may conceal problems at specific plant units.

Supplemental Information:

Although these indicators are considered to be "high level" indicators, no hierarchical system of indicators has been established yet.

Performance Indicator(s) under development:
No additional indicators are considered for the moment.

Czech Republic/SUJB

Indicator Area: A2 Mitigating Systems

Performance Indicator(s) in use:

1. Safety System Unavailability
   Definition = the ratio of the total time of unavailability of an evaluated safety system to the total time when its availability was required. Unavailability of Diesel Generators, High-Pressure Emergency Core Cooling Systems, Low-Pressure Emergency Core Cooling Systems, Spray Systems, Emergency and Auxiliary Feed-water systems is monitored.
   Maturity = 3
2. Failure of Safety System at Start
   Definition = the number of failures at start of the safety system, i.e. the state when the respective system on the demand does not achieve nominal performance characteristic or its failure (shutdown) occurs within 30 minutes after its start. Diesel Generators, High-Pressure Emergency Core Cooling Systems, Low-Pressure Emergency Core Cooling Systems, Spray Systems, Emergency Feed-water systems are monitored.
   Maturity = 3
3. Failure of Safety System during Operation
   Definition = the number of failures during operation of safety system, i.e. the number of states when failure shut down of respective system, drive, possibly set occurs at nominal performance characteristics for the time exceeding 30 minutes since its starting. Diesel Generators, High-Pressure Emergency Core Cooling Systems, Low-Pressure Emergency Core Cooling Systems, Spray Systems, Emergency Feed-water systems are monitored.
   Maturity = 3

Assessment of indicator results:

Safety systems are evaluated individually for unit and site. Trends of the Indicators values are assessed yearly.

Discussion:

- *The raw data for Indicator 1 are provided by licensee, the data for indicator 2 and 3 are collected by SUJB staff from licensee reports about safety systems tests.*
- *Though the collecting of data for Indicators 2 and 3 is more complicated the calculation of Indicator 1 is otherwise. The indicator 1 is at some level identical to such WANO indicator just so called "estimated unavailable hours" were neglected and the experience have not showed any significant values differences.*
- *All these indicators are seen as lagging indicators and not risk-informed.*

Finland/STUK

Indicator Area: A2 Mitigating Systems

Performance Indicator(s) in use:

Unavailability of safety systems (WANO indicators)

1. High pressure safety injection system (PWR) / Containment spray system (BWR) unavailability
   Definition = Fraction of time the high pressure safety injection/containment spray trains are not able to perform their intended function, due to planned and unplanned unavailability, including fault exposure unavailability hours resulting from train failure. The indicator value is an averaged value over the number of safety trains and calculated for the whole calendar year (based on quarterly values of WANO indicator).
   Maturity = 3
2. Auxiliary feedwater system unavailability
   Definition = Fraction of time the auxiliary feedwater system trains are not able to perform their intended function, due to planned and unplanned unavailability, including fault exposure unavailability hours resulting from train failure. The indicator value is an averaged value over the number of safety trains and calculated for the whole calendar year (based on quarterly values of WANO indicator).
   Maturity = 3
3. Emergency diesel generator unavailability
   Definition = Fraction of time the emergency AC power trains are not able to perform their intended function, due to planned and unplanned unavailability, including fault exposure unavailability hours resulting from train failure. The indicator value is an averaged value over the number of safety trains and calculated for the whole calendar year (based on quarterly values of WANO indicator).
   Maturity = 3

Annual plant criticality hours are the availability requirement for the high pressure safety injection system, containment spray system, and auxiliary feedwater systems, and the requirement for emergency diesel generators is continuous - i.e. annual operating hours.

Assessment of indicator results:

Indicator results are assessed quarterly and yearly by trending. No thresholds for acceptable/unacceptable plant performance have been defined, but degradation in trending is enough for increased regulatory attention.

Purpose of indicator is to indicate the unavailability of safety systems; the condition and status of safety systems and their development can be monitored by means of the indicator.

Discussion:

Experience and challenges in collecting the data and calculating indicators:

The data for the indicators is collected from the utilities. Licensee representatives submit the necessary data to the resident inspectors or other relevant person in charge in STUK.

Quarterly and yearly WANO indicator values of indicators 1 and 2 are received separately for plant units, and for indicator 3 only plant values, which averages EDG performance of different units.

The other licensee in Finland has given the values of the sliding last 12 months instead of quarterly values, which averages systems' performance over 12 months period. The management of YTO is going to take this disadvantage under discussion with the licensee for improvement.

Experience and challenges in transforming indicator data to meaningful information for decision making:

Quarterly updating of indicators has revealed deficiencies in the availability of these safety systems and also in the maintenance practices in managing the unavailability of safety trains. There have been deficiencies in licensees' practices in interpreting unavailabilities of parallel trains and in calculation of WANO-indicators. In the work order practices there was observed delay in returning work orders after repairs.

Leading or lagging indicators?: The indicators are understood to be lagging indicators.

To what extent risk-informed?: They are not risk-informed.

Limitations and benefits of current indicators:

Indicators 1 to 3 allow at the same time to evaluate the average technical safety state of the plant and the operational practices (maintenance, periodic testing), which impact the operability of safety systems.

Indicator 3: WANO provides the possibility to the utilities to report only station values for this indicator, even when the monitored EDG are dedicated to single plant units. This station level averaging may conceal problems at specific plant units.

Supplemental Information:

These WANO indicators are included in STUK indicator system into principal subgroup I "Quality and Safety Culture". In addition these indicators describe the condition and status of safety systems and their development they can also used to assess the maintenance strategy executed at the plant, its effectiveness and recourses as well.

These indicators are considered to be "low level" indicators.

Indicators are assessed together with several indicators of STUK's indicator system, as: failures of TS components and systems and their repairs; power loss due to failures; maintenance of components subject to TS, number of events; and risk significance of events.

Performance Indicator(s) under development:

Not any at the moment.

Performance Indicator(s) in use:

PSA-based Indicators (1)

Plant specific PSA -models are used for calculation of risk-significance of safety system unavailability, which is followed as the indicators. Tracking is plant unit –specific. The indicator is the combined risk of follow-up areas. The follow-up areas to be tracked are as follows:

a) risk significance of Tech. Spec. equipment failures

b) risk significance of preventive maintenance of Tech. Spec. equipment

c) risk significance of exemptions from Tech. Spec.

Each indicator is given as the annual sum of conditional core damage frequency contributions from respective type of unavailability, divided by the average annual core damage frequency from the PSA study. Each sum contains all respective unavailability that reduce the reliability of some safety function, and thus cause a temporary risk increase above the basic risk level. Basic risk level prevails when no deviations from faultless plant condition are known to exist.

Maturity = 3

Assessment of indicator results:

The indicators follow the risk-significance of Tech Spec component unavailabilities and monitor the duration of planned isolations and preventive maintenances.

Indicators are calculated yearly. There are not significant annual change in the nature and amount or risk importance of events. Trends are not followed if the risk stays low, because conservative assumptions and simplifications make the comparison difficult.

STUK's permanent objective is that the condition of components having a bearing on the accident risk of nuclear facilities stays so good that the risk-significance of nuclear power plant component failures, preventive maintenance and non-compliance with the Tech Specs is less than 5% of basic-level severe accident annual risk. The combined risk of follow-up areas is copared to the internal target value of 5 % at the all four Finnish nuclear power units. In the case of remarkable increase in the risk (individual event, operating area, combined risk) the causes of the increase are studied in detail.

Discussion:

Transforming indicator data to meaningful information for decision making:

- One should recognise that the basic risk level already contains the risk contribution from majority of the aforementioned events that reduce the safety systems reliability. At a plant performing properly, a low indicator value demonstrates that the risk contributors which can be measured have a minor impact to the total risk. The majority of risk comes from infrequent significant initiators such as LOCAs, loss of offsite power etc.
- While developing the risk based indicators, one should be aware of the limitations of PSA such as completeness problem, modelling uncertainty, shortages in human error analysis and CCF analysis etc., which result in uncertainty into the PSA figures. These uncertainties however are found rather insignificant as concerns the use of indicators. The main problem within the PSA based indicators is that some issues are difficult or even impossible to model with the current PSA-model. Hence it is required that a sophisticated Living PSA system including extensive and detailed system models, with a well established data collection and processing system to provide plant specific data, and an efficient, user friendly PSA code are available. If these conditions are met, the determination of PSA based indicators is quite straightforward.
- Among the individual indicators, the risk importance of exemptions from the Technical Specifications and of preventive maintenance are the most straightforward ones. Most of the deviations in the process are modelled with PSA-programs. Indicators describing the risk importance of failures are also applicable in most cases but all devices are not modelled in detail.

Supplemental Information:

These indicators are considered to be “high level” indicators. They belong to the second principal group “Operational events” in STUK’s indicator system. These PSA indicators are aggregated/combined with other indicator data (deviations from TS; unavailability of safety systems; failures of TS components and systems and their repairs; preventive maintenance of TS components; production loss due to failures) for assessment of plant performance.

Performance Indicator(s) under development:

Calculation of the aforementioned indicators was planned not to be continued as such for indicators because of the complicated interdependence of basic risk level. To identify the most significant risk sources in operation new safety performance indicators were introduced in 2003 to represent the risk-importance of events (look at next table).

INES classification of events is not used in STUK indicator system, because of IAEA’s instructions to use INES class only for public information. The importance of events is covered by the use of risk based indicators.

Performance Indicator(s) in use:

PSA-based Indicators (2)

Definition

As the indicators, the risk-significance of events caused by component unavailability is followed. As the risk measure, an increase in the Conditional Core Damage Probability (CCDP) associated with each event is employed. events are grouped into three categories according to their risk-significance (CCDP):

- the most risk-significant events (CCDP>1E-7),
- other significant events (1E-8<CCDP<1E–7) and
- other events (CCDP<1E–8).

The indicator is the number of events in each category. In addition Events in each category are futher divided into three groups:

1) unavailabilities due to component failures, 2) planned unavailabilities and 3) initiating events.

Unavailabilities caused by work for which STUK has granted exemption orders are in group 2. Possible non-compliances with the Tech Specs are in group 1, if they can be utilised for this indicator (look at the risk indicators in previous table). Non-compliances with the Tech Specs are dealt with under STUK's indicator A.I.2.

Maturity = 2

Assessment of indicator results:

Purpose of indicator is to follow the risk-significance of component unavailabilities and to assess risk-significant initiating events and planned unavailabilities. Special attention is paid to recurring events, CCFs, simultaneously occurring failures and human errors. In addition, an objective in event analysis is to systematically identify signs of deteriorating organisational and safety culture.

The indicators are calculated twice a year.

N.B.! Calculations for the Loviisa plant are based on an internal-initiating-event model, making them indicative only of a trend.

Discussion:

Data for the calculation of the indicators are collected from utility reports and applications for exemption orders.

Experience and challenges in transforming the indicator data to meaningful information for decision making

- look at previous table (PSA-based indicators (1))

Leading or lagging indicators? *These indicators are lagging indicators.*

To what extent these indicators are risk-informed? *They are risk-informed indicators.*

Supplemental Information:

These indicators are considered to be "high level" indicators. They belong to the second principal group "Operational events" in STUK's indicator system. These PSA indicators are aggregated/combined with other indicator data (deviations from TS; unavailability of safety systems; failures of TS components and systems and their repairs; preventive maintenance of TS components; production loss due to failures) for assessment of plant performance.

Performance Indicator(s) under development:
These indicators were planned to replace the risk indicators of combined risk of Tech. Spec. equipment failures, preventive maintenance of Tech. Spec. equipment, and of exemptions from Tech. Spec. In 2004 only these new risk indicators were reported accordingly. For the present both type of risk indicators will be calculated and reported half-yearly.

Hungary/HAEA NSD

Indicator Area: A2 Mitigating system

Performance Indicator(s) in use:

1. Safety system availability

Definition = Tracing the unavailability of each train of the safety systems due to maintenance and failures.

BRÁi=(1-BÜKi)*100 %, BRÁi – availability of the safety system, BÜKi– unavailability time ratio of the safety system, BÜKi=(TÜIi+NÜIi+BÜIi)/ÜKI/Ái, TÜIi – planned unavailability time, NÜIi – unplanned unavailability time, BÜIi – estimated unavailability time, ÜKI – expected availability time of the safety system, Ái – number of trains

Maturity = 2

Assessment of indicator results:

1. Green: > 95 %
Yellow: 85-95 %
Red: < 85 %

Korea/MOST(Ministry of Science and Technology), KINS(Korea Institute of Nuclear Safety)

Indicator Area: A2 Mitigating Systems

Performance Indicator(s) in use:

1. Safety Injection System Availability(SI)
   Definition : Unavailability of SI system(unavailable hours to the hours which SI system is required)
   Maturity : 3

2. Emergency Diesel Generator Availability(EDG)
   Definition : Unavailability of DG system(unavailable hours to the hours which DG system is required)
   Maturity : 3

3. Auxiliary Feedwater System Availability(AFW)
   Definition : Unavailability of AFW system(unavailable hours to the hours which AFW system is required)
   Maturity : 3

Assessment of indicator results:

See also generic information.
The following is the threshold and grade of each indicator:

Indicator	Thresholds(Quarterly)			
	Excellent (green)	Good (cyan)	Normal (yellow)	Warning (orange)
SI System Availability	< 0.015	< 0.05	< 0.1	≥ 0.1
EDG System Availability	< 0.025	< 0.05	< 0.1	≥ 0.1
AFW System Availability	< 0.015	< 0.05	< 0.1	≥ 0.1

Discussion:

<u>Are there any pitfalls worthwhile to be mentioned:</u>

- there were a few important events which have not affected the specific indicator but have affected the safety of that indicator and vice versa, for example,
  - the detachment of the thermal sleeves of SI system has a bad effect on the SI system but the SI indicator was graded to "excellent" and thus it was downgraded to "good" thru the discussion between the utility and the regulatory body

See also generic information.

Slovenia/SNSA

Indicator Area: A2 Mitigating Systems

Performance Indicator(s) in use:

1. Safety system availability

Definition: WANO definition that include next to Safety Injection, Diesel Generator and Auxiliary Feedwater availability also Residual Heat Removal system.

Maturity: 3 for SI, DG and AF, 1 for RHR

2. Safety system functional failures

Definition: number of events or conditions that (could) prevent safety system to perform its function.
Maturity: 1

3. Risk significance of TS equipment failure

Definition: monthly contribution to CDP due to TS equipment failures.

Maturity: 1

4. Risk significance of TS equipment on-line maintenance

Definition: monthly contribution to CDP due to TS equipment on-line maintenance that include: preventive maintenance / predictive maintenance / surveillance testing / calibration / realisation of modification.
Maturity: 2

Assessment of indicator results:

1. Safety system availability

Threshold: 0,005 (quarter of the INPO goal for SI and AF)
Trend value: 0,01 (half of the INPO goal for SI and AF)

2. Safety system functional failures

Threshold: 2 for each safety system separately / 5 for all safety systems together
Trend value: 2,7 for each safety system separately / 6,7 for all safety systems together

3. Risk significance of TS equipment failure

Threshold: $8{,}3\cdot 10^{-8}$ (referenced to yearly CDP = $1\cdot 10^{-6}$)
Trend value: $1{,}1\cdot 10^{-7}$e

4. Risk significance of TS equipment on-line maintenance

Threshold: $2{,}5\cdot 10^{-6}$ (referenced to weekly CDP = $6\cdot 10^{-7}$)
Trend value: $3{,}3\cdot 10^{-6}$

Discussion:

experience and challenges in collecting the data:
Data collecting is performed by plant. Additional information shall be reported regarding PI:

1. Safety system availability: date, duration of unavailability (planned, unplanned, undiscovered), unavailable system/component, plant MODE, unavailability description

2. Safety system functional failures: date, plant MODE, failure discovery (walkdown, test), failure description

3. Risk significance of TS equipment failure: date, duration of TS equipment inoperable, system/component inoperable

4. Risk significance of TS equipment on-line maintenance: date, duration of a TS equipment inoperable, system/component inoperable

experience and challenges in calculating indicators

4. Risk significance of TS equipment on-line maintenance:
For the last 2 years plant has submited to SNSA weekly reports of preventive maintenance activities. SNSA standpoint is that mentioned reports are inadequate. The reports do not take into consideration predictive maintenance, modifications and calibrations, while the plant PSA baseline model already include surveillance testing. SNSA stand is, that CDP should be calculated and evidently presented for each of previously mentioned activity separately. The surveillance testing should not be included into PSA baseline model. By this means, in correlation with evaluated impact of TS equipment failure and TS equipment exemptions, precise CDP could be defined for each moment of plant operation and shutdown.

Spain/CSN

Indicator Area: *A 2Mitigating Systems*

Performance Indicator(s) in use:

Safety System Failure
Definition: Any event or condition that could prevent the fulfilment of the safety function of structures or systems needed for:

- Reactor shutdown and maintenance in safety shutdown condition.
- Residual heat removal
- Accident consequences mitigation

In general the Safety Systems included in this indicators are those required by each plant's Technical Specifications.

If a system consists of multiple redundant subsystems or trains, failure of all trains constitutes a safety system failure. Failure of one out of two or more trains is not counted as a safety system failure.

The major Safety System groups included in this indicator are: Auxiliary/Emergency Feedwater System, Combustible Gas Control Systems, Essential Service Water System, Isolation Condenser System, Reactor Core Isolation Cooling System, Standby Liquid Control System, Ultimate Cooling Water System, Component Cooling Water System, Spent Fuel Systems, Fire Detection/Suppression System, Accident Monitoring Instrumentation, Reactor Trip Instrumentation, Engineering Safety Futures Instrumentation, Containment and Containment isolation, Low Temperature/Overpressure Protection, Recirculation Pump Instrumentation, Essential Compressed Air System, Main Steam isolation Valves, Primary Reactor System, Residual Heat removal System, Safety and Relief Valves, Control Room Emergency Ventilation System, Emergency Core Cooling System, Emergency AC/DC Power System Group and Anticipated Transient without Scrams Mitigation System Actuation Circuitry (AMSAC).

Maturity: 3

Assessment of indicator results:

See generic information

Discussion:

From a practical point of view, in some cases the failure of a safety system may be difficult to detect, if it did not take place in a front-line component, such as for instance when it occurs in an isolation valve in a sample line that does not close on containment isolation signal.

Performance Indicator(s) under development:

Those of the NRC´s ROP, but with the idea to retain also this PI

Sweden/SKI

Indicator Area: A2 Mitigating systems

Performance Indicator(s) in use:
WANO Safety System Performance (SP1/2/5)

The WANO Performance Indicators SP1, SP2, SP5 indicate how well some important safety systems are capable of performing their safety function during operational occurrences and accidents. The indicator includes three sub indicators which cover a system or a group of systems within the safety functions: High Pressure Safety Injection, Residual Heat Removal (BWR)/Auxiliary Feed water (PWR) and Emergency AC Power. Indicator values are calculated, for each sub indicator, as unavailable time divided by the number of system trains.

The detailed descriptions for various reactor types can be obtained in the WANO Guidelines.

Assessment of indicator results:

See generic information related to WANO indicators

Discussion:

Comments on Safety System Performance (SP1/2/5):
Safety System Performance is an indicator with a strong focus on safety. The selection of systems that are monitored may differ even when reactors of the same type are compared. Thus, systems monitored differ also between Swedish reactors at different sites. This makes the SP1/2/5 indicator less useful than the other WANO indicators for direct comparisons between plants (nationally and internationally).

Supplemental Information:

Safety system performance is also monitored as a Level 2 indicator in the SKI system. This indicator is based on the LER reporting, and includes a large number of safety systems (see below).

Performance Indicator(s) in use:

The indicators include:

- Safety system unavailability
- Number of safety system functional failures (failures on demand/during operation and during tests)
- Number of failures of systems/components subject to TS
- Unavailability of emergency diesel generators
- Number of CCF (occurred and potential CCF are identified and listed, but not yet trended)

Calculation of system unavailability:

$$\mathbf{Q}\text{sys} = \frac{\mathbf{t}\text{sys}}{\mathbf{T} \times \mathbf{n}} \times \mathbf{f}\text{sys} \times \mathbf{f}\text{credit}$$

tsys = Unavailable hours (depends on component)
T = Time for critical reactor or calendar time
n = Number of subdivisions / redundant components
fsys = Constant, 0 or 1, indicating the influence on the system of a component unavailability
fcredit = Constant (1, 0,1 or 0,01) indicating the possibility for fast, simpler and supported corrective actions.

The systems monitored have been selected to indicate how well the systems operate regarding the defence in depth levels 2 to 4 (INSAG). Together they give a picture of unavailability of the various defence in depth levels.

The indicator is in use (maturity level 3) but depending on the stakeholders different methods to present the result will be evaluated.

Assessment of indicator results:

The indicators are assessed quarterly by use of signal diagrams (unavailability levels are E-1, E-2 and E-3) and colour coding (green, yellow and red) for the different unavailability estimates. The thresholds are only used for colour coding and without specific significance, yet, for eventual actions by SKI. The colour coding is primarily used for providing a fast overview/trending of the indicators.

Discussion:

Experience/challenge in collecting the data: The data being solely based on LERs, the robustness and accuracy of the indicators presuppose a highly trustworthy LER reporting in regard to both coverage and quality. SKI has underlined this to the licensees. SKI is presently confident, on the whole, of the licensees LER reporting.

Experience/challenges in calculating indicators: The indicators are based on transparent calculations. This pertains especially to utilised time values considering the monitoring (continuous or not) of the failed component and the fulfilment or not of the single failure criterion. This relates also to the possibility for fast, simple and procedure supported corrective action.
The number of redundant trains has for several of the studied systems proven to be not so easy to agree upon (degree of redundancy of the control system and control rod indication, of the automatic depressurisation system in BWR in view of different functional modes, of the activity monitoring system, etc).

Experience/challenge in transforming the indicator data to meaningful information for decision making: The indicator is not mature yet for the establishment of fixed thresholds related to subsequent regulatory actions. Aggregated, the indicators provide however SKI with enough information which, together with other findings (for example from plant inspections) might result in regulatory action(s).
The presentation of signal diagrams needs to be adjusted for different stakeholders.

Leading or lagging indicators? The indicators coupled to safety system unavailability are lagging indicators. It could be that the indicators are leading if they represent the organisations ability to prevent/minimize system unavailability.

To what extent are these indicators risk-informed? These indicators are not risk-informed.

Limitations/benefits of current indicators: The use of the system unavailability indicator has proven to be a valuable input in the yearly overall assessment by SKI of the Swedish plants and their organisations.

Supplemental Information:

Being considered as strategic indicators, the indicators coupled to safety system unavailability fit into the hierarchy of indicators chosen as overall structure by SKI.

Although the interpretation of some of these indicators might not be straightforward nor always informative, SKI still judges the overall picture given by the relatively large set of indicators especially valuable. This also fulfils the original intention SKI had concerning a robust safety performance indicator system, namely that even if each one of the indicators can not fully be relied upon, the aggregated information obtained from the evaluation of the whole set of indicators provides a well grounded base for decisions.

Performance Indicator(s) under development:
SKI is assessing the possibility to increase the number of systems actually followed in order to be able to combine all the systems needed for the calculation of the unavailability of the plant main safety functions, thus allowing SKI to monitor and assess for each plant the operational strength of these functions. This issue is presently matter for internal discussions within SKI, and the licensees will be involved later this year.

It could also be used for system risk-informed contributions.

United States/NRC

Indicator Area: A2 Mitigating systems

Performance Indicator(s) in use:

The indicators include:

1. Safety System Unavailability (over previous 12 quarters): The average of the individual train unavailabilities in the system. Train unavailability is the ratio of the hours the train is unavailable to the number of hours the train is required to be able to perform its intended safety function.
2. Safety System Functional Failures (over previous 4 quarters): The number of events or conditions that prevented, or could have prevented, the fulfilment of the safety function of structures or systems in the previous four quarters.

The system unavailability is determined for each reporting quarter as follows:

a. Train unavailability during previous 12 quarters:

$$\frac{\text{(planned unavailable hrs)+(unplanned unavailable hrs)+(fault exposure hrs)-(effective reset hrs)}}{\text{(hours train required during the previous 12 quarters)}}$$

b. System unavailability is the sum of the train unavailabilities divided by the number of system trains.

The safety system functional failure PI is the unit number of failures over the previous 4 quarters.

Both indicators are at a maturity level of 3.

Assessment of indicator results:

All performance indicators are calculated on a quarterly basis and compared with established thresholds/colors representing the percentage of system unavailability and/or number of safety system functional failures. See also generic information.

Performance Indicator(s) under development:

- The NRC and industry have reached consensus on the remaining technical issues and are moving forward with proposed MSPI implementation target date of 2006.
- Joint NRC-industry MSPI PRA task force was created to address the PRA requirements and standards needed before MSPI can be implemented.
- With the help of the experience gained from the pilot effort, four lead plants are producing the documentation and completing the PRA inputs required for MSPI implementation.
- The NRC and industry are in the process of completing the technical guidance for MSPI and developing a communication plan for implementation.
- In the upcoming months, the industry will provide multiple training workshops for all plants.

Information related to indicator area A3 (Barriers Integrity):

Belgium/AVN

Indicator Area: A3 Barriers integrity

Performance Indicator(s) in use:

1. Reactor coolant system specific activity
   Definition = WANO PWR fuel reliability indicator = the steady-state primary coolant iodine-131 activity (in Bq/g), corrected for the tramp uranium contribution and power level, and normalized to a common purification rate (quarterly values).
   Maturity = 2

2. Reactor coolant system leakage
   Definition = Total RCS leakage in kg/h (weekly or 2-weekly representative values).
   Maturity = 2

Assessment of indicator results:

RCS specific activity (dose-equivalent I-131) and RCS leakage (RCPB leakage, RCS identified leakage, RCS non-identified leakage, leakage to steam generators and RC pump seal leakage) are subject to Technical Specification limits and periodically monitored by the licensees (typical: daily surveillance of global RCS leakage and 3-daily surveillance of global RCS activity).

These approximate indications of RCS activity (based on total gamma measurements) and RCS total leakage values are for the moment routinely monitored by AVN plant inspectors during their periodic inspection visits (weekly or 2-weekly).

The above-mentioned indicators, which correspond to slightly different data (indicator definitions differ from TS parameters), are intended to be assessed by longer-term trending.

Discussion:

Experience and challenges in collecting the data:

Indicator 1: Indicator data are directly obtained from the licensees. Indicator 2: Plant inspectors collect RCS total leakage data during periodic inspection visits and document these data in their inspection reports. On the basis of 2 years of experience it has been shown that this data collection and internal reporting process is less reliable (data are not always obtained or documented).
Experience and challenges in transforming indicator data to meaningful information for decision making:

Indicator 1: Experience has shown that even in cases of significant fuel damage (corresponding with iodine-131 activities up to 1000 Bq/g) there is limited licensee action (additional analysis to identify possible extent of damage) and regulatory action on increasing RCS specific activity during the running cycle. Plant shutdown criteria are based on TS-values, which are related to the hypotheses of the analysis of radiological consequences of design basis accidents, and are orders of magnitudes above normally experienced values. Furthermore other parameters from routine chemical analysis of the reactor coolant are available to licensees and plant inspectors to identify developing fuel damage (no need to wait for quarterly WANO-indicator).

Indicator 2: Data received on RCS total leakage (periodically measured values rather than maximum values in a given period) are routinely assessed by AVN inspectors in the frame of their routine inspections. Assessment and regulatory action on the basis of longer-term trends in (average) leakage data is not (yet) common practice. Licensee actions are mostly triggered by sudden significant increases in detected leak rate (or by direct evidence of increased leakage in containment e.g. on the basis of collected condensate on reactor building cooling batteries or in containment sump).Furthermore total RCS leakage includes primary to secondary leakage, which makes interpretation more difficult for plants with known but not necessarily stable steam generator leakage (the latter is also assessed by specific “measurement” methods, which are affected by uncertainty).

Leading or lagging indicators?: The indicators are understood to be lagging indicators (although the concept of leading and lagging indicators needs clarification).

To what extent risk-informed?: The indicators are not risk-informed.

Discussion (continued):

Limitations and benefits of current indicators:

The benefits of both indicators (in the frame of an overall assessment of plant safety) need still to be assessed.

Indicator 1: The analysis of data covered by indicator 1 is not really needed and helpful to be aware of developing fuel damage problems (it comes too late). The indicator has mainly “historic” value.

Indicator 2: Average levels and trends of RCS total leakage (in the absence of primary to secondary leakage) could be more an indication of the quality of maintenance on equipment connected to the primary circuit (such as valves) and of operational tolerance of primary leaks, than a real indicator for the integrity of the second barrier (as precursor to LOCA). Licensee actions (and inspector reactions) are more initiated by sudden increases in RCS leakage than by increasing trends. Furthermore a developing reactor coolant pressure boundary leakage, which is not allowed by TS but is not directly measurable, could be concealed by different origins of leakage (see Davis Besse).

See also “experience and challenges in transforming data to meaningful information”.

Supplemental Information:

The status of these indicators (high/low level) has still to be determined.

Performance Indicator(s) under development:

In the set-up of the PI pilot program, it was intended to develop also an indicator for the integrity of the 3rd barrier (containment integrity). All plants follow formally 10CFR50 appendix J requirements for testing of containment tightness (with the exception of type A tests, which are only performed every 10 years in Belgian plants). Due to differing approaches between plants for the implementation of surveillance requirements related to type B and type C testing (as found measurements of containment penetration leakage at the end of a operating cycle at some plants versus as left leakage testing before start-up after an outage and after necessary repair on containment valves at other plants and different degrees of conservatism in global leakage estimation), it has been decided to postpone the implementation of this indicator.

Czech Republic/SUJB

Indicator Area: A3 Barriers Integrity.

Performance Indicator(s) in use:

1. Fuel Reliability Index – FRI
   Definition = WANO definition
   Maturity = 3
2. Number of Leaky Fuel Assemblies
   Definition = the number of leak fuel assemblies that had to be put out of operation due to their inadmissible leakage.
   Maturity = 3
3. Containment Tightness Testing
   Definition = results of Periodic integral tightness testing.
   Maturity = 3

Assessment of indicator results:

Trends of the Indicators values are assessed yearly.

The monthly values of indicator 1 are trended during the fuel cycle.

Discussion:

- *The raw data for Indicator 1 are provided by licensee, the data for indicator 2 and 3 are collected by SUJB staff from licensee reports about safety systems tests.*
- *Indicator 1 has lost its meaning in some cases as showed zero values for long term. This is done by sampling and analyzing methods used at NPPs and also by threshold value 4 Bq/l.*
- *All these indicators are seen as lagging indicators and not risk-informed.*

Supplemental Information:

- *Indicator 2 is supplemental to indicator 1.*

Performance Indicator(s) under development:

It is SUJB intention to include to this group indicator for primary circuits leaks. The problem is to decide by which quantities the leak or tightness could be characterized as the leak is by licensee assessed but not directly measured.

Finland/STUK

Indicator Area: *A3 Barriers integrity.*

Performance Indicator(s) in use:

Fuel integrity

1. Reactor coolant system specific activity

Definitions = As the indicators, the parameters below are followed by plant units:

- the maximum activity concentration level of the primary coolant (Loviisa: as I 131 equivalent; Olkiluoto: I-131 only)
  Maturity = 3 (followed several years)
- the peak value of maximum activity concentration on even, steady-state operation (Loviisa: the sum of the iodine isotope activity concentrations in hot standby, start-up state or power operation; Olkiluoto: I-131 activity in power operation). The maximum values are compared with the Tech Spec limit in a graphic presentation;
  Maturity = 2 (new indicator)
- the maximum activity concentration of I-131 during depressurisation while entering shutdown or after reactor scram.
  Maturity = 2 (new indicator)

2. Number of leaking fuel rod bundles removed from the reactor
   Definition = the number of leaking fuel rod bundles that release of radionuclides from the fuel element as discovered by in-core sipping control and removed from the reactor yearly and averaged over the previous 3 calendar years.
   Maturity = 3 (followed several years)

Assessment of indicator results:

Trends of indicators 1 are followed and assed quarterly and yearly. The values are compared to TS limit values. The indicators depict fuel integrity and the fuel leakage volume during the operating cycle.

The number of leaking fuel bundles is available mainly after annual maintenance outages, during which the leaking fuel bundle is sought by the in-core sipping and the bundle identified leaking removed from the reactor.

1. *Reactor coolant system specific activity*

- the maximum activity concentration level of the primary coolant
  Loviisa: I 131 equivalent; TS limit value = 100 MBq/m^3.
  Olkiluoto: I-131 only; TS limit value = 2,2 GBq/m^3.
- the peak value of maximum activity concentration on even, steady-state operation (Loviisa: the sum of the iodine isotope activity concentrations in hot standby, start-up state or power operation; Olkiluoto: I-131 activity in power operation).
  The maximum values are compared with the Tech Spec limit in a graphic presentation; TS limit values: Loviisa 100 MBq/m^3 and Olkiluoto 2,2 GBq/m^3.

- the maximum activity concentration of I-131 during depressurisation while entering shutdown or after reactor scram.

2. *Number of leaking fuel rod bundles removed from the reactor*

- There should not be leaking fuel rods in the reactor. If the indication of a fuel leakage during operation is observed (indicators 1) the number leaking fuel rods and size of the leakage is assessed and the leakage is also localised during operation.

Discussion:

Experience and challenges in collecting the data:

Data for the indicators is obtained from the utilities' quarterly reports (reactor operation and fuel behaviour). The licensees submit the indicator values concerning maximum activity concentrations directly to the person in charge of the indicator at STUK.

In practice the person in responsible receives the activity data directly from licensee, because there is inaccuracy in numbers taken from graphs in the reports.

As a result of the intermediate assessment of the STUK indicator system conducted in 2003, it was decided to adopt some new indicators, to specify the definitions of certain specific indicators for improving their reliability and to find ways of enhancing the indicator process.

As new unit-specific indicators for fuel integrity, the below parameters of primary coolant activity were decided to be followed:

- *The maximum activity concentration level of iodine on even, steady-state operation during the monitoring period. As regards the Loviisa plant, it means the sum of the iodine isotope activity concentrations as I-131 equivalents in hot standby, start-up state or power operation. With regard to the Olkiluoto plant, the indicator is the mere I-131 activity concentration in power operation. The maximum values are compared with the Tech Spec limit in a graphic presentation.*
- *The maximum activity concentration of I-131 during depressurisation while entering shutdown or after reactor scram*

In addition to the old parameters which were:

- *The maximum activity concentration on even, steady-state operation as I-131 equivalents (kBq/m3) (Olkiluoto; I-131 only), and*
- *The number of leaking fuel rod bundles removed from the reactor in each annual maintenance outage.*

Experience and challenges in calculating indicators:

The indicators determined according the new definitions introduced of the beginning of 2004 and were calculated retrospectively over the previous few years (from 1999) to gain a base for comparison with the 2004 indicator values. There is not so much experience yet on the use and usability of these indicators.

Experience and challenges in transforming the indicator data to meaningful information for decision making:

The new indicators are thought to be useful for inspectors in their daily work when a fuel leakage indication is observed to tell "How much is much". On the bases of activity measurements compared to old data and related knowledge about the size of the previous leakage and/or the number of leaking fuel rods the inspector can immediately evaluate the scale of the fuel leakage and actions required during normal operation or shutdown. The indicators for the shutdown situations also describe the success of the shutdown concerning radiation protection.

Leading or lagging indicators? *These indicators are lagging.*

To what extent these indicators are risk-informed? *These indicators are not risk-informed.*

Limitations and benefits of current indicators:

The benefits of new indicators (in the frame of an yearly overall assessment of plant safety) need still to be assessed and usefulness of indicators compared to resources required for data collection, producing graphs and reporting, and assessment of figures as well.

Supplemental Information:

In the safety performance indicator area, the leaktightness of multiple barriers (fuel, primary circuit, secondary circuit, containment) is monitored. The objective is that leaktightness complies with the requirements and deteriorating trends are neither allowed, as assessed according to STUK's safety performance indicators.

Indicators are assessed together with radioactive releases into atmosphere (indicators I.5) of STUK indicator system.

The data for new indicators were first time collected for the year 2004 and presented with the data of few previous years to licensees before publishing them in annual report 2004. The number of leaking fuel bundles removed yearly from reactor is an old indicator, but this rose up discussions about the amount of fuel leakages. At the other power plant, where leaking fuel was observed nearly every year, was established a group to clarify the occurrence of fuel leakages.

Performance Indicator(s) in use:

Primary and secondary circuit integrity

1. *The water chemistry indicators*

Definitions:

Water chemistry conditions: corrosive impurities

- International chemistry performance indices used by the utilities (WANO indicators)
  Maturity = 3 (followed several years)
- A new secondary circuit chemistry index for PWR.
  Maturity = 3 (new, but followed by the plant several years)
- Maximum chloride concentration of the steam generator blow-down at PWR (Loviisa) and the maximum chloride concentration of reactor water at BWR (Olkiluoto) during operation compared with the Tech Spec limit in the monitoring period.
  Maturity = 2 (new indicator even though followed routinely by the plant)
- At BWR (Olkiluoto) the maximum sulphate content of reactor water on even, steady-state operation
  Maturity = 2 (new indicator even though followed routinely by the plant)

2. *Corrosion products in the coolant of the reactor circuit and the secondary circuit the coolant*:

PWR (Loviisa)

- the iron concentration of the primary coolant solid material
  Maturity = 2 (new indicator)
- the iron concentration of the secondary circuit feed water (maximum values of the monitoring period)
  Maturity = 2 (new indicator)

BWR (Olkiluoto)

- the iron concentration of reactor water (maximum value of the monitoring period)
  Maturity = 2 (new indicator)

PWR & BWR

- the maximum Co-60 activity concentration of the reactor coolant while bringing the plant to a cold shutdown or after a reactor scram
  Maturity = 2 (new indicator)

3. *Primary circuit leakages at BWR (Olkiluoto plant units)*:

- total volume (m3) of identified leakages during operation cycle (from containment to collection tank 352 T1 of the controlled leakage drain system), and
- total volume of unidentified (leakages into the sump of the controlled floor drainage system, 345 T33) containment internal leakages during the operating cycle, and
- highest containment internal leakage volume during the year in relation to the allowed leakage volume in the Tech Specs (outflow water volume of water condensing in the air coolers of the containment cooling system 725/Tech Specs limit).
  Maturity = 3 (followed several years as indicators)

Assessment of indicator results:

Indicator results are assessed quarterly and yearly by trending.

Purpose of indicators is to monitor and control primary and secondary circuit integrity. The monitoring is done by indices depicting water chemistry control and by chosen corrosive impurities and corrosion products, and at Olkiluoto units following primary circuit leakages.

Discussion:

Experience and challenges in collecting the data and calculating indicators:

The licensees submit indicators describing the water chemistry control to the respective responsible person at STUK. The concentration levels of corrosive substances and corrosion products are obtained from quarterly reports submitted by licensees.

The licensee submits the leakage amounts of Olkiluoto plant units to the person in responsible at STUK (resident inspector).

The WANO chemistry index of the Olkiluoto plant is affected by the chloride and sulphate concentrations of the reactor water and the iron concentration in the feed water. The calculation method of WANO chemistry index was revised in 1999 resulting that the index for PWRs was not describing for a Loviisa plant type VVER type facility, where was commissioned a new chemistry index, which observes corrosive impurities and contents of corrosion products in steam generator blow-down and feed water. For steam generator blow-down, the calculation includes the chloride, sulphate and sodium concentrations and acid conductivity; for feed water, it includes the iron, copper and oxygen concentrations. The indices for both plants only cover the aforementioned values during power operation.

As a result of the intermediate assessment of the STUK indicator system conducted in 2003, it was decided to adopt some new indicators, to specify the definitions of certain specific indicators for improving their reliability and to find ways of enhancing the indicator process.

In addition to the international chemistry indices and the earlier mentioned new chemistry index for VVER secondary circuit chemistry, the following other new unit-specific indicators for primary and secondary circuit integrity were introduced:

As indicators of corrosive impurities: The maximum chloride concentration of the steam generator blow down (PWR/Loviisa) and the reactor water (BWR/Olkiluoto) compared with the Tech Spec limit is followed in the monitoring period. At the BWR/Olkiluoto plant the maximum sulphate concentration of reactor water is followed as well.

As indicators of corrosion products released from the surfaces of the reactor circuit and the secondary circuit into the coolant: For the PWR/Loviisa plant, the iron concentration of the primary coolant solid material and the secondary circuit feed water (maximum value of the monitoring period) are followed. For BWR/Olkiluoto plant, the iron concentration of the reactor water (maximum value of the monitoring period) is followed. In addition, the maximum Co-60 activity concentration of the reactor coolant while bringing the plant to a cold shutdown is followed for both plants.

Leading or lagging indicators? *These indicators are lagging.*

To what extent these indicators are risk-informed? *These indicators are not risk-informed.*

Limitations and benefits of current indicators: *The benefits of new indicators (in the frame of an yearly overall assessment of plant safety) need still to be assessed and usefulness of indicators compared to resources required for data collection, producing graphs and reporting, and assessment of figures as well.*

Supplemental Information:

In the safety performance indicator area, the leaktightness of multiple barriers (fuel, primary circuit, secondary circuit, containment) is monitored. The objective is that leaktightness complies with the requirements and deteriorating trends are neither allowed, as assessed according to STUK's safety performance indicators.

The data for new indicators were first time collected for the year 2004 and presented with the data of few previous years to licensees before publishing them in annual report 2004.

Performance Indicator(s) under development:

The indicators describing the volume of primary circuit leakages are under study and development for Loviisa plant units. The benefit of these indicators is obvious.

Performance Indicator(s) in use:

Containment integrity

Definitions

- overall as-found leakage of outer isolation valves compared with the highest allowed overall leakage of the outer isolation valves
- percentage of isolation valves tested during the year in question at each plant unit that passed the leakage test at first attempt (i.e. as-found leakage smaller than acceptance criteria of valve and no consecutive exceeding of the so-called attention criteria of a valve without repair)
- combined leakage rate of containment penetrations and airlocks in relation to their highest allowed overall leakage at each plant unit. The combined leakage rate at Olkiluoto includes leakages in personnel airlocks, the maintenance dome and the containment dome. In Loviisa the combined leakage rate is comprised of the leakage test results from personnel airlocks, the material airlock, the cable penetrations of inspection equipment, the containment maintenance ventilation systems (TL23), the main steam piping (RA) and the feed water system (RL) penetrations; the seals of blind-flanged penetrations of ice-filling pipes are also included.

  Maturity = 3

Assessment of indicator results:

Indicators are assessed yearly by trending and absolute values are compared to the highest allowed overall leakages. The leaktightness data is available after annual maintenance outages, during which the isolation valves are tested.

Purpose of indicator is to follow the integrity of the containment isolation valves, penetrations and air locks.

Discussion:

Experience and challenges in collecting the data

Data is extracted from the utilities' leaktightness test reports submitted by the licensee to STUK for information within three months of the completion of annual maintenance. STUK calculates the overall as-found leakages, since the reports give total leakages as they are at the end of an annual maintenance outage (i.e. after completion of repairs and re-testing).

Leading or lagging indicators? *These indicators are lagging.*

To what extent these indicators are risk-informed? *These indicators are not risk-informed.*

Supplemental Information:

In the safety performance indicator area, the leaktightness of multiple barriers (fuel, primary circuit, secondary circuit, containment) is monitored. The objective is that leaktightness complies with the requirements and deteriorating trends are neither allowed, as assessed according to STUK's safety performance indicators.

Hungary/HAEA NSD

Indicator Area: A3 Barrier integrity

Performance Indicator(s) in use:

1. Fuel reliability

Definition = Tracing the compactness of the cladding of the fuel pins, as the state of the 2nd barrier that prevents the dispersion of the radioactive materials

Stationer I-131 and I-134 activity of the primary cooling water (Bq/g) corrected to the uranium contamination of the surface and normed to the water cleaning rate. ÜAM=[(A131)N-K(A134)N] *[(Ln/LHGR)*(100/Po)]1,5, (A131)N and (A134)N – I-131 and I-134 average stationer activity*

Maturity = 2

2 . Primary leakage

Definition = Tracing the incidents entail with the failure of the integrity of the primary circuit, Incidents entail with the failure of the primary circuit - as pressure boundary - like water leakage; with special regard to the number of water leakages during refueling

Maturity = 2

3 Use of stressor cycles

Definition = Tracing the use of cycle numbers limited by TS

CSZM= min (Ei) Ei – relative rate of use of cycle numbers
Ei = ((Max-Sum)/T)/(Max/30)
Max – maximum permitted cycle number
Sum – total number of cycle numbers of the all previous campaigns
(Max-Sum)/T – maximum estimated cycle number for the following campaigns (T=30 - number of the actual campaign)
(Max/30) – a part of the permitted maximum cycle number concerning to one year
A: use of average cycle number permitted for one operational year (%)
B: Use of permitted cycle number calculated for the past operating period.

Maturity = 2

4. Ratio of plugged Steam Generator tubes

Definition = A: Ratio of the use of tube number, which could be plugged as average by based on the 30-year (informatively 50-year) operating lifetime of the steam generators. B: Ratio of permitted plugging calculated for the past operating period.

Maturity = 2

5. Leakage of the hermetic zone

Definition = Characterization of the integrity of the hermetic zone based on the results of the integral leakage tests

Maturity = 2

Assessment of indicator results:

*1 Green: A < 3,7 * 105 Bq/kg*
*Yellow: A = 3,7 * 105 Bq/kg - 3,7 * 107 Bq/*
*Red: A > 3,7 * 107 Bq/kg*

*2 Green: < 5 incidents/unit*year*
*Yellow: 5-10 incidents/unit*year*
*Red: > 10 incidents/unit*year*

3 Green: The number of stressor cycles has not reached the time proportional part calculated based on the limitation prescribed by the TS
Yellow: The cycle number exceeds the time proportional value, but does not exceed the limit prescribed by the TS
Red: The cycle number exceeds the TS limit

*4. Green: The ratio of the plugged tubes does not exceed the ratio of tubes, which could be plugged by the calculation for one year (0,33%/year'18 tube/year) and for the time-proportional number ended by the given year (18*finished campaign)*
Yellow: It exceeds the ratio calculated for one year, but the time proportional for the last operating time
Red: The number of plugged tubes exceeds the value of time proportional number

5. Green: The trend is improving, stagnating or degrading with maximum 20 % and the TS limit is not violated
Yellow: The trend is degrading with 20-50%, but the TS limit is not violated
Red: The TS limit is reached or the trend is degrading more than 50 %

Korea/MOST(Ministry of Science and Technology), KINS(Korea Institute of Nuclear Safety)

Indicator Area: .A3 Barriers integrity

Performance Indicator(s) in use:

1. Fuel Reliability(FR)
   Definition : Ratio of the maximum value of Iodine-131 equivalent activity in reactor coolant to the limit of Technical Specification

   Maturity : 3

2. Reactor Coolant Leakage(RCL)
   Definition : Ratio of the maximum value of reactor coolant leakage rate to the limit of Technical Specification
   Maturity : 3

3. Containment Reliability(CR)
   Definition : Ratio of the maximum leak rate(sum of ILRT(70%) and LLRT(30%)) to the limit of Technical Specification (ILRT = integral leak rate tests; LLRT = local leak rate tests)
   Maturity : 1

Assessment of indicator results:

See also generic information.
The following is the threshold and grade of each indicator:

Indicator	Thresholds(Quarterly)			
	Excellent (green)	Good (cyan)	Normal (yellow)	Warning (orange)
Fuel Reliability	< 50% (T/S limit)	< 70%	< 100%	≥ 100%
Reactor Coolant Leakage	< 50%(T/S limit)	< 70%	< 100%	≥ 100%
Containment Reliability	> 90%(T/S limit)	> 80%	> 60%	≤ 60%

Discussion:

The Containment Reliability (CR) indicator is just being developed and is planned to be applied in the first quarter of 2005 for the first time.The thresholds are based on the limits in the Technical Specification.

For the other indicators see generic information.

Slovenia/SNSA

Indicator Area: A3 Barriers Integrity

Performance Indicator(s) in use:

1. Fuel reliability indicator

Definition: WANO – steady state reactor coolant I-131 activity, corrected for the tramp uranium contribution and normalised to a common purification rate and linear heat generation rate.

Maturity: 3

2. Number of leaking fuel elements

Definition: number of damaged discharged or partially spent fuel elements that result in release of radioactive products outside the fuel element as discovered by in-mast sipping control.
Maturity: 3

3. RCS leakage

Definition: percentage of identified and unidentified monthly RCS leakage with regard to TS limits.

Maturity: 2 (data is part of inspection reports, but never presented as PI)

4. Containment leakage

Definition: percentage of containment leakage with regard to permissible 2 % of containment volume per day as tested once per year at plant full power.

Maturity: 1

5. RCS isolation valve leakage

Definition: average percentage per fuel cycle of all RCS isolation valves with regard to TS limits. RCS isolation valve testing is required by TS: once per 18 months / if the plant was in cold shutdown for 7 days or more and testing has not been performed for 9 months / following maintenance, repair or replacement works / following manual or automatic action or flow through valve.

Maturity: 1

Assessment of indicator results:

1. Fuel reliability indicator

Threshold: $5 \cdot 10^{-4}$ Ci/m^3 (minimum value that can be measured)

3. RCS leakage

Threshold: 80 %

Trend value: 108 %

4. Containment leakage

Threshold: 100 %

Trend value: 135 %

5. RCS isolation valve leakage

Threshold: 80 %

Trend value: 110 %

Discussion:

experience and challenges in collecting the data:

Data collecting is performed by plant. Additional information shall be reported regarding PI:

5. RCS isolation valve leakage : isolation valve number, leakage volume

experience and challenges in transforming the indicator data to meaningful information for decision making:

4. Containment leakage

Design leakage 0,2 % of containment volume per day shall be tested every 10 years considering design pressure. Intermediate yearly tests on full power shall be performed with lower containment internal pressure, therefore due to test realization and results processing, higher acceptable limits are set. Function of presented containment leakage PI is to supervise containment degradation over the years and not to verify the integrity of the third barrier.

Sweden/SKI

Indicator Area: A3 Barriers integrity

Performance Indicator(s) in use:

WANO Fuel Reliability (FRI).

The WANO Performance Indicator Fuel Reliability (FRI) monitors how well fuel integrity is maintained. Damaged/leaking fuel shows a break of the first barrier to prevent releases of radioactivity to the environment. It also increases doses to personnel as well as operational costs. Increased activity levels in the coolant indicate fuel damage. WANO sets limits for FRI, different for PWRs and BWRs, above which there is a high probability for fuel damage.

The detailed descriptions on calculating this indicator for various reactor types can be obtained in the WANO Guidelines.

Assessment of indicator results:

See generic information related to WANO indicators.

Discussion:

Comments on Fuel Reliability Index (FRI):

The usefulness of the indicator is questioned. Comparing values between plants at different sites is difficult as measurement methods vary. Exceeding the WANO limits is not always a sign of actual fuel damage/fuel leaks, and on the other hand, actual fuel integrity breaches do not always result in measured values higher than the WANO limits.

Performance Indicator(s) under development:

Additional indicators monitoring performance of containment and primary system integrity are under discussion for the SKI indicator system.

United States/NRC

Indicator Area: A3 Barriers Integrity

Performance Indicator(s) in use:

The indicators include:

1. Reactor Coolant System (RCS) Specific Activity: The maximum monthly RCS activity in micro-Curies per gram (µCi/gm) dose equivalent Iodine-131 per the technical specifications, and expressed as a percentage of the technical specification limit. Those plants whose technical specifications are based on micro-curies per gram (µCi/gm) total Iodine should use that measurement.
2. Reactor Coolant System Leakage: The maximum RCS identified leakage in gallons per minute each month per the technical specifications and expressed as a percentage of the technical specification limit.

Both indicators are at a maturity level of 3.

Calculation formulas:

a. $\frac{\text{The maximum monthly value of calculated activity}}{\text{Technical Specification limit}} \times 100$

b. $\frac{\text{The maximum monthly value of identified leakage}}{\text{Technical Specification limiting value}} \times 100$

Assessment of indicator results:

See generic information.

Performance Indicator(s) under development:

None at this time.

Cornerstone: Radiation safety
Information related to indicator area B1 (Occupational Radiation Safety):

Belgium/AVN

Indicator Area: B1 Occupational Radiation Safety

Performance Indicator(s) in use:

Collective radiation dose
Definition = The annual collective whole body dose, received by individuals at the unit level and at station level, during the previous calendar year and averaged over the previous 3 calendar years.
Maturity = 3

Assessment of indicator results:

Indicator results are assessed yearly by trending of yearly doses and 3-year average trends. The latter is needed to take account of the fact that at some plants 18-month cycles are in place (collective doses in calendar years without plant outage are significantly lower than with a plant outage).

No thresholds for unacceptable plant performance or for increased regulatory attention have been defined.

Discussion:

Experience and challenges in collecting the data: Data are collected via the annual reports of the licensees. Due to late publishing of these reports, indicator data for the calendar year under consideration are generally only available 6 months after the end of that year.
Experience and challenges in transforming indicator data to meaningful information for decision making:

This indicator allows monitoring the effectiveness of ALARA policies in place to limit radiation dose to individuals (plant staff, contractors, consultants, visitors etc.) working at the site.

The current (regulatory) practice is to limit the assessment to maximum and collective doses, which have been received during the major plant outages for maintenance and fuel reloading. Data on these latter doses, which are an important fraction of total calendar-year dose, are more quickly available.

Leading or lagging indicators?: The indicators are considered to be lagging indicators.

To what extent risk-informed?: This notion does not apply to this type of indicator (radiation risk versus core melt risk).

Limitations and benefits of current indicators: Systematic assessment of this indicator and related experience feedback by the licensees has allowed them to significantly reduce collective radiation dose to workers over the last 12 years. Further reduction has however come to a standstill in the last 5 years (saturation effect). Comparison of plant performance between plants allows however still to single out the less-performing plants.

Supplemental Information:

This indicator is believed to be a “high level” indicator.

Information is provided to the public on the aggregated value of average collective dose per unit (for both NPP sites combined) through the AVN annual reports.

Performance Indicator(s) under development:

During the set-up of the PI pilot program in 2001, it was intended to develop also an indicator for events characterised by an occupational exposure control deficiency. The purpose of this indicator would have been to monitor the control of access to and of work activities within radiological-significant areas of the plant and occurrences involving degradation or failure of radiation safety barriers that result in readily identifiable unintended dose. Such indicator could be an answer to the saturating character of the indicator based on collective dose. However at the moment there are no licensee data collection processes in place that would support this indicator and independent data collection by AVN-inspectors was considered to be an unachievable goal. Therefore the development of this indicator has been postponed.

Czech Republic/SUJB

Indicator Area: B1 Occupational Radiation Safety

Performance Indicator(s) in use:

1. Collective Effective Dose
   Definition = collective effective dose received by the staff of NPP and suppliers during monitored period, measured by basic film dosimeters.
   Maturity = 3
2. Specific Collective Effective Dose per Capita
   Definition = collective effective dose received by the staff of NPP and suppliers during monitored period, measured by basic film dosimeters and express by value per one radiation worker.
   Maturity = 2
3. Maximum Individual Effective Dose
   Definition = maximum individual effective dose received by one particular employee of NPP and one particular employee of suppliers during monitored period, measured by basic film dosimeters.
   Maturity = 2
4. Number of Workers with Special Decontamination
   Definition = number of workers (NPP and suppliers) subjected to a special decontamination under medical supervision.
   Maturity = 2

Assessment of indicator results:

Trends of the Indicators values are assessed yearly.

Discussion:

- *The data and values of indicators are provided by licensee to SUJB. Some of data are verified by SUJB independent measurement.*
- *All these indicators are seen as lagging indicators and not risk-informed.*

Supplemental Information:

- *Indicator 2 and 3 are supplemental to indicator 1.*

Finland/STUK

Indicator Area: B1 Occupational Radiation Safety

Performance Indicator(s) in use:

1. Collective radiation dose
2. Average of ten highest doses

   Definitions = As the indicators, collective radiation exposure by plant site (and plant units) is followed as well as the average of the ten highest yearly radiation exposures.
   Maturity = 3

Assessment of indicator results:

Indicators are assessed quarterly and yearly both by trending and personal doses are compared to the dose limits set in legislation for individual occupational doses (when calculated the average of ten highest doses). The compliance of plant unit's collective dose averaged over two successive years with the YVL guides calculatory threshold is followed yearly.

Personal dose limit = the effective dose for a worker from radiation work $\leq$ 20 mSv/year average over any period of five years or $\leq$ 50 mSv in any one year (Radiation Decree/1512/1991)

YVL Guide's (7.9) calculatory threshold value, 2.5 manSv per one gigawatt of net electrical power, for one plant unit's collective dose averaged over two successive years means:

- collective radiation dose of 1.22 manSv for one Loviisa plant unit
- collective radiation dose of 2.10 manSv for one Olkiluoto plant unit.

Discussion:

Experience and challenges in collecting the data and calculating indicators:

The data on collective radiation exposure is obtained from quarterly and annual reports by the person in responsible in NRR's office Radiation protection (SÄT). The data on individual radiation doses is obtained from the national dose register.

Experience and challenges in transforming the indicator data to meaningful information for decision making:

If at one plant unit the collective occupational radiation dose average over two successive years exceeds 2.5 manSv per one GW of net electrical power, the utility is to report the causes of this to STUK, and any measures possibly required to improve radiation safety (Guide YVL 7.9).

The reporting threshold of collective radiation dose has been exceeded at Finnish nuclear power plant units in connection of long duration servise outages, when the most extensive maintenance jobs and inspections are conducted. The longer annual maintenance outages take place at the Loviisa power plant every four years. Because of this sequence the Loviisa power plant has begun to monitor the four-year sliding average of collective occupational radiation dose by plant unit.

Leading or lagging indicators? *These indicators are lagging.*

To what extent these indicators are risk-informed? *These indicators are not risk-informed.*

Supplemental Information:

These indicators are included in STUK's indicator system into the principal subgroup I "Quality and Safety Culture". The collective radiation doses describe the success of the plant's ALARA programme. The average of the ten highest doses indicates how close to the 20 mSv dose limit the individual occupational doses at the plants are, indicating the effectiveness of the plant's radiation protection unit.

These indicators are considered to be "low level" indicators.
Indicators are assessed together with radiactive release indicators (STUK's indicators I.5; B2) aggregated with other indicators of STUK's indicator system belonging to the principal subgroup I illustrating the condition of the plant and performance of different functional groups at the plant; such as functioning of the maintenance unit (failures and their repairs, unavailability of saty systems), safety attitude of operation (non-compliance with the TS), performance of operation unit (events and their causes, risk significance of events), currency of plant documentation, and investments for improvement and safety.

Performance Indicator(s) under development:
Not any in this area.

Hungary/HAEA NSD

Indicator Area: B1 Occupational Radiation Safety

Performance Indicator(s) in use:

1. Collective dose

Definition = Annual sum of the external exposure of the entire personnel of the plant and the dose measured by the operative dosimeters.
Maturity = 2

2. Dispersion of contamination

Definition = Number of premises qualified into higher category than its original at least for one campaign based on its radiation conditions, plus number of hot spots discovered by measurements after shutdown for main outage.
Annual points of discovered hot spots in the controlled zone (1 point) and premise trans-qualifications according to radiation conditions (5 points) for each unit summarized for the plant.
Maturity = 2

3 Work programs/orders at high radiation level (WPHRL)

Definition = Number of WPHRLs for each unit summarized for the plant.
Maturity = 2

Assessment of indicator results:

*1. Green: < 2000 personnel*mSv*
*Yellow: 2000-3000 personnel*mSv*
*Red: > 3000 personnel*mSv*

2. Green: < 40 points/year
Yellow: 40-120 points/year
Red: > 120 points/year

3. Green: < 15 WPHR/year
Yellow: 15-30 WPHR/year
Red: > 30 WPHR/year

Korea/MOST(Ministry of Science and Technology), KINS(Korea Institute of Nuclear Safety)

Indicator Area: . B1 Occupational Radiation Safety

Performance Indicator(s) in use:

1. Radiation Collective Dose(RCD)

Definition : Total unit(NPP) whole body collective radiation exposure during an evaluation period
Maturity : 3

Assessment of indicator results:

See also generic information.
The following is the threshold and grade of the indicator:

Indicator	Thresholds(Quarterly)			
	Excellent (green)	Good (cyan)	Normal (yellow)	Warning (orange)
Radiation Collective Dose	< 1 (man· Sv)	< 3	< 5	≥ 5

Discussion:

See generic information.

Slovenia/SNSA

Indicator Area: B1 Occupational radiation safety

Performance Indicator(s) in use:

1. Number of workers subjected to special decontamination and unplanned personnel exposure

Definition:

– number of internal and external radioactive contamination of workers and visitors with regard to limits set in the national regulations.
– number of unplanned personnel exposure with regard to work order predicted exposure.

Maturity: 1

2. Collective dose

Definition: WANO
Maturity: 3

3. Radiation exposure to workers

Definition: number of yearly exposure of workers, contractors and visitors with regard to dose: below 1 mSv / 1 mSv … 20 mSv / above 20 mSv
Maturity: 3

4. Dispersion of contamination

Definition: ratio of exposure and contaminated area to entire radiological controlled area with regard to low, medium and high level of exposure and contamination
Maturity: 1

Assessment of indicator results:

2. Collective dose

Threshold: 650 mSv

Trend value: 880 mSv

Spain/CSN

Indicator Area: *B1 Occupational radiation safety*

Performance Indicator(s) in use:

Collective radiation exposure
Definition: Total radiation dose accumulated by unit personnel. In sites with two units, which reported site total doses, individual unit values are the half of this total dose.
Maturity=3

Assessment of indicator results:

See generic information

Sweden/SKI

Indicator Area: B1 Occupational Radiation safety

Performance Indicator(s) in use:

WANO Collective Radiation Exposure (CRE).

The WANO CRE (Collective Radiation Exposure) monitors the efficiency of measures taken to minimise the exposure to plant personnel. CRE is defined as the total external and internal whole body dose to employees, hired personnel and visitors.

The detailed descriptions for the indicator can be obtained in the WANO Guidelines.

Assessment of indicator results:

See generic information related to WANO indicators.

Discussion:

Comments on WANO Collective Radiation Exposure:

CRE can be seen as an indicator of quality in design, operations and maintenance. It is also an indirect measure of breaches in the barriers Fuel and Primary system.

Information related to indicator area B2 (Public Radiation Safety / Environmental Risk):

Belgium/AVN

Indicator Area: B2 Public Radiation Safety / Environmental risk

Performance Indicator(s) in use:

1. Radiological effluent occurrences
   Definition = The number of radiological effluent release occurrences in the previous calendar year (at site level). (Radiological effluent release occurrence = any gaseous or liquid release, that exceeds TS limits)
   Maturity = 2
2. Gaseous releases (separate indicators for noble gasses, iodine, aerosols and tritium)
   Definition = Total noble gas release in TBq (Xe-133 equivalent), iodine release in MBq (I-131 equivalent), aerosol release in MBq (Cs equivalent) and gaseous tritium release in MBq/GWhe (normalised value) during the previous calendar year (at site level).
   Maturity = 2
3. Liquid effluents (separate indicators for tritium and other nuclides)
   Definition = Normalised value of total liquid release of tritium in Bq/GWhe and total liquid release of all nuclides (except tritium) during the previous calendar year (at site level).
   Maturity = 2

Assessment of indicator results:
Unacceptable levels for gaseous and liquid releases are expressed by TS limits on instantaneous activity (concentration) and cumulative activities released. In terms of total activities released to the environment, current levels of gaseous and liquid releases are (with the exception of liquid tritium releases) 1 to 3 orders of magnitude below allowed TS limits. There are very few historic records of cases where TS limits have been exceeded (limited to cases of exceeding instantaneous activity limits). Furthermore TS limits for cumulative activity releases are applicable to rolling time windows of 13 weeks and 52 weeks and have to be monitored by the licensees themselves (reported to the Safety Authorities in monthly reports).

Therefore additional assessment and trending of indicator results against threshold values is not performed. Overall trending of plant performance on calendar year basis and comparison between plants/sites is preferred.

Discussion:

Experience and challenges in collecting the data:

Indicator 1: Events which involve exceeding of TS limits for liquid and gaseous releases have to be notified to the Safety Authorities and AVN and are recorded in AVNs incident database.
Indicator 2 and 3: Release data are provided by the licensees in monthly reports.
Experience and challenges in transforming indicator data to meaningful information for decision making:

Because current levels of activity release are only a small fraction of allowed limits, it is rather hard to make a regulatory case even when increasing trends in release data are noticed or when performance of a specific site is below that of other sites. Furthermore trends in noble gas and iodine releases are to a large extent coinciding with cases of power operation with defective fuel.

Leading or lagging indicators?: The indicators are considered to be lagging indicators.

To what extent risk-informed?: This notion does not apply to this type of indicator (radiation risk versus core melt risk).

Limitations and benefits of current indicators:

Indicator 1: Because of the very limited number of cases recorded in plant history, this indicator is believed to be of limited value.
Indicators 2 and 3: Mainly useful to put current release records into historic perspective and to monitor deviating plant performance. Trending of gaseous and liquid releases of tritium is of very limited value as these data are to a large extent dependent on power generated by the plants.

Supplemental Information:

The status (low/high level) of these indicators should still be defined.
These indicators are not communicated to external stakeholders.

Performance Indicator(s) under development:

No additional indicators are considered for development within this area.

Czech Republic/SUJB

Indicator Area: B2 Public Radiation Safety / Environmental risk

Performance Indicator(s) in use:

1. Gaseous/Liquid Releases - Committed Effective Doses from Gaseous/Liquid Releases
   Definition = the committed effective dose for individual, which arises from radioactive gaseous/liquid releases from NPP.
   Maturity = 2 - 3

Assessment of indicator results:

The trends of yearly indicators values are assed and compare with limiting values given by Limits and Condition which are differed for site and releases.

Discussion:

- *The data and values of indicators are provided by licensee to SUJB. Some of data are verified by SUJB independent measurement. The releases of noble gases, iodine, aerosols and liquid tritium and corrosion and fission products are monitored.*
- *For many years were public radiation safety monitored by the absolute or relative values of selected releases as gaseous and liquid as well. Indicators directly connected with releases are considering as maturity 3. This policy was changed several years ago and the "new" indicators where the committed effective dose is trended are still assessed from correctness point of view.*
- *The indicators are seen as lagging indicators and not risk-informed.*

Supplemental Information:

The master indicators are committed effective doses now and the direct releases are just supplemental indicators to them.

Finland/STUK

Indicator Area: B2 Public Radiation Safety / Environmental risk

Performance Indicator(s) in use:

Public dose (calculated dose)/Environmental risk

Definition = the calculated dose due to releases to the most exposed individual in the vicinity of the plant
Maturity = 3

Assessment of indicator results:

Indicator is assessed quarterly and yearly by trending. The annual calculated dose is compared to the objective value, which is less than 1% of limit of the 100 microSv limit established in the Government Resolution (395/1991).

Discussion:

Experience and challenges in collecting the data and calculating indicators:

Data for radioactice releases is collected from the quarterly and annual reports of the utilities. STUK's Research and Environmental Surveillance Department (TKO) calculates the dose for the most exposed person in the plant vicinity and submits it to the person in charge of this indicator.

Experience and challenges in transforming the indicator data to meaningful information for decision making:

The doses for both plant units have been less than 0.05% of the 100 microSv limit established in the Government Resolution (395/1991). Thus there have not been any reason for increased regulatory actions.

Leading or lagging indicators? *These indicators are lagging.*

To what extent these indicators are risk-informed? *These indicators are not risk-informed.*

Supplemental Information:
These indicators are included in STUK indicator system into principal subgroup I “Quality and Safety Culture”. The calculated dose due to releases to the most exposed individual in the vicinity of the plant describe the success of the plant’s ALARA programme and radiation protection unit (or other unit at the plant responsible for controlling releases) and operation as well.

These indicators are considered to be “low level” indicators eventhough they tell about the success of protecting people in the vincity of power plants from npps’ detrimental effects to health.

Indicators are calculated on the bases of radiactive releases and assessed together with these release indicators. They are aggregated with other indicators of STUK’s indicator system belonging to the principal subgroup I illustrating the condition of the plant and performance of different functional groups of the plant; such as functioning of the maintenance unit (failures and their repairs, unavailability of safety systems), safety attitude of operation (non-compliance with the TS), performance of operation unit (events and their causes, risk significance of events), success of radiation protection (occupational doses), currency of plant documentation, and investments for improvement and safety.

Performance Indicator(s) under development:
Not any in this area.

Performance Indicator(s) in use:

Gaseous / air-born releases

Definition = Radiactive releases into atmosphere

- noble gas releases
- iodine isotope releases
- aerosol releases
  Maturity = 3

Liquid releases (excluding tritium)

Definition = Gamma active liquid releases into sea
Maturity = 3

Assessment of indicator results:

The amount and trend of radioactive releases are assessed quarterly and yearly, and assess factors having a bearing on any changes in them.

The limit values = annual limits in TS:

Noble gas releases into atmosphere: Loviisa npp = 2,2E+16 Bq; Olkiluoto npp = 1,77E+16 Bq
Iodine isotope releases into atmosphere: Loviisa npp =2,20 E+11 Bq; Olkiluoto npp = 1,14E+11 Bq
Gamma activity of liquid releases: Loviisa npp = 8,90E+11 Bq; Olkiluoto npp = 2,96E+11 Bq

Discussion:

Experience and challenges in collecting the data: *Data for the indicators is collected by the person in resposible from NRR’s office Radiation Protection (SÄT) from the quarterly and annual reports of the utilities.*

Experience and challenges in transforming the indicator data to meaningful information for decision making

Radioactive releases into the environment from the Loviisa and Olkiluoto nuclear power plants have been small and well below the set limits.

Leading or lagging indicators? *These indicators are lagging.*

To what extent these indicators are risk-informed? *These indicators are not risk-informed.*

Supplemental Information:
Gaseous fission products, noble gases and iodine isotopes originate in leaking fuel rods; in the minute amounts of uranium left on the outer surfaces on fuel cladding during fuel fabrication; and in reactor surface contamination from earlier fuel leaks. At both Loviisa and Olkiluoto the numbers of fuel leaks have been very small. The figures show easily the interdependence between iodine releases and fuel leaks (A2; STUK's indicators A.III.1).

These indicators are considered to be "low level" indicators eventhough they tell about the success of proteting people from npps' detrimental effects to health. Indicators are used to calculate the dose of the most exposed individual in the vincity of the plant.

Indicators are aggregated with other indicators of STUK's indicator system belongin to the principal subgroup I illustrating the condition of the plant and performance of several functional groups at plant, such as functioning of the maintenance unit (failures and their repairs, unavailability of saty systems), safety attitude of operation (non-compliance with the TS), performance of operation unit (events and their causes, risk significance of events), success of radiation protection (occupational doses), currency of plant documentation, and investments for improvement and safety.

Performance Indicator(s) under development:

Not any in this area.

Hungary/HAEA NSD

Indicator Area: B2 Public Radiation Safety / Environmental Risk

Performance Indicator(s) in use:

1. Solid radioactive waste generated

Definition = Annual sum of the low and medium activity radioactive wastes, the annual accumulated quantity of the high activity radioactive wastes.

Maturity = 2

2. Liquid radioactive release

Definition = The releases shall be summarized for the whole year type by type and shall be compared to the regulatory limits.

Maturity = 2

3 Gaseous release

Definition = Sum of annual release for noble gas, strontium, radioiodine and radioactive aerosols.

Maturity = 2

Assessment of indicator results:

1. Green: increase of the annual quantity of the wastes < 10%
Yellow: increase of the annual quantity of the wastes in a certain year <50%, or 10-50% during more years
Red: increase of the quantity of the wastes >50%

2. Green < 30 % of the regulatory limit
Yellow: declining trend 30-65 % of the regulatory limit
Red: > 65% of the regulatory limit

3. Green < 10 %of regulatory limit
Yellow: declining trend 10-45 % of the regulatory limit
Red: > 45% of the regulatory limit

Korea/MOST(Ministry of Science and Technology), KINS(Korea Institute of Nuclear Safety)

Indicator Area: . B2 Public Radiation Safety / Environmental Risk

Performance Indicator(s) in use:
1. Public Dose/Environmental Radiation(PD/ER)

Definition : Total public exposure dose to the number of unit(NPP) in site
Maturity : 3

Assessment of indicator results:

See also generic information.
The following is the threshold and grade of the indicator:

Indicator	Thresholds(Quarterly)			
	Excellent (green)	Good (cyan)	Normal (yellow)	Warning (orange)
Public Dose/Environmental Radiation	< 62.5 (μSv)	< 250	< 600	≥ 600

Discussion:

See generic information.

Slovenia/SNSA

Indicator Area: B2 Public radiation safety / environmental risk

Performance Indicator(s) in use:

1. Calculated public dose

Definition: theoretical calculated dose of the most exposed citizen who lived in the plant vicinity.

Maturity: 1

2. Solid waste generated

Definition: yearly increase of volume of medium and high radioactive solid waste and level of their contamination as measured on December 31.

Maturity: 3

3. Liquid releases

Definition: monthly activity of liquid releases without tritium.

Maturity: 3

Performance Indicator(s) in use:

4. Activity of tritium releases

Definition: monthly activity of tritium releases

Maturity: 3

5. Gaseous releases

Definition: monthly activity of noble gases (equivalent Xe-133), iodine (equivalent I-131) and air-borne releases

Maturity: 3

Assessment of indicator results:

1. Calculated public dose

Threshold: 0,8 mSv (80 % of legal limit)

Trend value: 1,1 mSv

2. Solid waste generated

Threshold: 45 m^3

Trend value: 60 m^3

No limits regarding level of contamination

3. Liquid releases

Threshold: 16,66 GBq (referenced to regulatory limit)

Trend value: 22,5 GBq

4. Tritium releases

Threshold: 1,66 TBq (referenced to regulatory limit)

Trend value: 2,25 TBq

5. Gaseous releases

Threshold: 9,16 TBq (noble gases), 1,54 GBq (iodine and air-borne gases) (referenced to regulatory limit)

Trend value: 12,4 TBq (noble gases), 2,1 GBq (iodine and air-borne gases)

Cornerstone: Industrial Safety
Information related to indicator area C1 (Fire Safety):

Finland/STUK

Indicator Area: *C1 Fire safety.*

Performance Indicator(s) in use:

Number of fire alarms

Definition = the numbers of fire alarms: 1) alarms caused by failures; 2) actual automated alarms and 3) actual fires
Maturity = 2

Assessment of indicator results:

Data is collected and assessed half-yearly by trending.

There are not set any thresholds for these indicators, but the target is that there should not be fires at nuclear power plants because of their possible serious consequencies.

Purpose of indicator is to follow the effectiveness of fire detection and alarm system at the nuclear power plants.

Discussion:

Experience and challenges in collecting the data and calculating indicators:

The data for the indicators is collected from the utilities. The licensees submit the data needed for the indicators to the person responsible at STUK.

The data should be easily got from the system recording automated fire alarms and promptly supplied to STUK. - There have been delays in the data supply. This may be related to the resources at STUK in the area of active fire protection.

Experience and challenges in transforming the indicator data to meaningful information for decision making:

Because the condition of fire detection and alarm system is directly related to fire insurance fees, plants spontaneously invest on them and systems are modernised at both Finnish power plants. Requirements for fire protection arrangements and active fire protection are given in STUK's Guide YVL 4.3.
The methods to use these indicator results need to be evaluated.

Leading or lagging indicators? *These indicators are lagging.*

To what extent these indicators are risk-informed? *These indicators are not risk-informed.*

Supplemental Information:

These indicators are included in STUK indicator system into principal subgroup II “Operational events” together with number of events (A1; STUK II.1), direct causes of events (A1, STUK II.3) and risk-significance of events (A4; STUK II.2).

These indicators are considered to be “low level” indicators eventhough fire safety is at high importance in the safety of power plants. Alarms caused by failures and actual automated alarms illustrate the condition of fire detection and alarm system and effectiveness of fire protection unit to response on them so that actual fires are avoided.

Performance Indicator(s) under development:

Use and compliance of these indicators need still to be evaluated.

Hungary/HAEA NSD

Indicator Area: C1 Fire Safety

Performance Indicator(s) in use:

1. Number of Fires

Definition = Number of fires reported to the regulator according to the Guidelines 1.25 and 1.24.

Maturity = 2

Assessment of indicator results:

1. Green: < 3 fire/year
Yellow: 3-10 fire/year
Red: > 10 fire/year

Slovenia/SNSA

Indicator Area: C1 Fire safety

Performance Indicator(s) in use:

1. Fire alarms non-activation

Definition: number of fire alarms malfunction, i.e. alarm was not activated although at least one of conditions (smoke, temperature, testing signal) was present.
Maturity: 1

2. Fire alarms false activation

Definition: number of fire alarms malfunction, i.e. alarm was activated although none of conditions (smoke, temperature, testing signal) was present.
Maturity: 1

3. Real fire alarms

Definition: number of justifiable fire alarms due to actual fire or due to consequences of technological process/internal events (smoke caused by welding, grinding, smoking…).
Maturity: 3

4. Number of fires

Definition: number of actual fires.
Maturity: 3

Information related to indicator area C2 (Occupational Safety):

Finland/STUK

Indicator Area: *Occupational safety*

Performance Indicator(s) in use:

STUK has not yet included work accidents into its indicators sytem, because supervision belongs for other authorities responsible for industrial safety.

Discussion:

Licensees make reports or memorandums on serious work accidents and supply them for information to STUK and they are discussed in seminars or in meetings between STUK and licencee management. Less serious work accidents are not reported. Mostly they have happened during maintenance outages and STUK's inspectors on-site have reported them futher to STUK/NRR department.

STUK has been under impression that there are very few work accidents at Finnish nuclear power plants as compared internationally or to other conventional industries. Lately this feeling has met opposite information from power plants. There was also a fatal work accident in another Finnish nuclear power plant one year ago.

The report made by the plant on the fatal accident in electrical work during the annual maintenance is not included in any of the event reporting categories mentioned in the guide YVL 1.5 (A1; STUK indicator II.1).

Performance Indicator(s) under development:

STUK is considering including indicator(s) of this area into its indicator system.

Hungary/HAEA NSD

Indicator Area: C2 Occupational safety

Performance Indicator(s) in use:

1. Number of work accidents

Definition = Annual number of works accidents healing over 3 days in the plant.

Maturity = 2

Assessment of indicator results:

1. Green: < 5 accident/year
Yellow: 5-20 accident/year
Red: > 20 accident/year

Slovenia/SNSA

Indicator Area: C2 Occupational safety

Performance Indicator(s) in use:

1. Index of industrial safety
Definition: WANO.
Maturity: 3

Assessment of indicator results:

1. Index of industrial safety
Threshold: 0,3 (INPO goal)
Trend value: 0,4

Information related to indicator area D (Global Plant Performance):

Finland/STUK

Indicator Area: *D Global plant performance*

Performance Indicator(s) in use:

Production loss due to failures

Definition = Loss of power production caused by failures in relation to rated power (gross). Maturity = 3

Assessment of indicator results:

Indicator results are assessed quarterly and yearly by trending. No thresholds for acceptable/unacceptable plant performance have been defined, but degradation in trending is enough for increased regulatory attention.

Purpose of indicator is to follow the significance of failures from the point of view of production.

Discussion:

Experience and challenges in collecting the data:

Data for the indicator is collected from annual and quarterly reports submitted by utilities.

Leading or lagging indicators?: The indicators are understood to be lagging indicators, but quarterly updating and related inspections increase its effectiveness and usefulness making it more leading.

To what extent risk-informed?: Indicator is not risk-informed.

Supplemental Information:

Indicator is aggregated in STUK's indicator system to area A.I.1 Failures and their repairs together with specific indicators failures, maintenance and repair time of components subject to Technical Specifications (look also at indicators in areas *A2 Mitigating systems* and *E6 maintenance*). The indicator area in question (A.I.1) is included in STUK indicator system into principal subgroup I "Quality and Safety Culture". These indicators describe the condition of TS components and systems and its development. They can also be used to assess the maintenance strategy executed at the plant, its effectiveness and recourses.

This indicator is considered to be a "low level" indicator.

This indicator is assessed together also with other indicators of STUK's indicator system, as: number of events; risk significance of events, and WANO-indicators.

Performance Indicator(s) under development:

Not any at the moment.

Hungary/HAEA NSD

Indicator Area: D Global plant performance

Performance Indicator(s) in use:

1. Capacity factor

Definition = Contributor aims at the measurement of the smooth operation

RÁ=(EME-NTK) / EME where RÁ – capacity factor EME – electrical power could be generated theoretically NTK – unplanned outages (due to internal causes) EME=KO*NT KO – number of critical hours, NT – nominal power

Maturity = 2

Assessment of indicator results:

1. Green: , > 88 % / NPP
Yellow: 80-88 % / NPP
Red: < 80 % / NPP

Slovenia/SNSA

Indicator Area: D Global plant performance

Performance Indicator(s) in use:

1. Unit capability factor
Definition: WANO
Maturity: 3

Assessment of indicator results:

1. Unit capability factor
Threshold: 90 %
Trend value: 67 %

Spain/CSN

Indicator Area: D Global plant performance

Performance Indicator in use:
1. Forced outages
Definition: Those required to be initiated no later than the end of the weekend following the discovery of an off-normal condition. It is defined as the number of forced outage hours divided by the sum of unit service hours (i.e., generator on-line hours) and forced outage hours.
Maturity: 3

2. Equipment Forced Outages per 1000 Commercial Critical Hours
Definition: Number of forced outages caused by equipment failures per 1000 critical hours of commercial reactor operation. It is the inverse of the mean time between forced outages caused by equipment failures. The inverse number was adopted to facilitate calculation and display.

Maturity: 3

Assessment of indicator results:

See generic information.

Performance Indicator(s) under development:

Those of the NRC´s ROP, but with the idea to retain also these PIs.

Sweden/SKI

Indicator Area: D Global plant performance

Performance Indicator(s) in use:

1. WANO **Unit Capability Factor** (UCF).

The WANO UCF (Unit Capability Factor) is an overall monitor of the level of operations and maintenance of the plant. UCF is calculated as the available energy during the period divided by a reference level for the energy generation during the same period, expressed as a percentage. The reference level is the energy that could have been produced at full power considering the given circumstances. Planned as well as unplanned energy losses are included in the calculations.

2. WANO **Unplanned Capability Loss Factor** (UCL).
The WANO UCL (Unplanned Capability Loss Factor) is an overall monitor of the effectiveness on maintenance programme and working routines to keep high availability. UCL is calculated as the ratio between unplanned energy losses in the period and a reference level for energy production in the same period expressed in percentage.

The detailed descriptions for the indicators can be obtained in the WANO Guidelines.

Assessment of indicator results:

See generic information related to WANO indicators.

Discussion:

Comments on WANO Unit Capability Factor (UCF):

This indicator does not provide a direct measure on safety, but a broad measure on quality in operations and maintenance of the plant.

Comments on WANO Unplanned Capability Loss Factor (UCL):

This indicator does not provide a direct measure on safety, but on the efficiency of surveillance and condition monitoring.

Performance Indicator(s) under development:

WANO has introduced another performance indicator within this indicator area, the Forced Loss Rate (FLR). This PI is similar to the Unplanned Capability Loss Factor, but only considers losses during operation, not losses when starting up after outages. FLR may be considered as a complement to UCL and UCF in the SKI indicator system.

Cornerstone: Safety Management
Information related to indicator area E1 (Human performance):

Belgium/AVN

Indicator Area: E1 Human performance

Performance Indicator(s) in use:

No indicators on human performance have been included for the moment in the pilot set under investigation.

Performance Indicator(s) under development:

A separate tracking of human factor related events has been started on the basis of a systematic assessment of the events that are recorded in AVNs incident database. Furthermore these “human error induced” events are categorised according to human or organisational factor related root causes. It is however too soon to draw definite conclusions if these data could support the development of additional indicators in this area. Questions about the robustness of the data collection process and the statistical relevance of the data need to be solved first.

Czech Republic/SUJB

Indicator Area: E1 Human Performance

Performance Indicator(s) in use:

1. Human Factor + Human Factor Index
   Definition = the number of the reportable events with an influence of human factor (only licensee staff) and its percentage share.
   Maturity = 2

Assessment of indicator results:

Trend of the Indicator values is assessed yearly.

Discussion:

- *The data for these indicators are collected by SUJB staff through inspection activities and from regular reports submitted by licensee.*
- *The indicators are seen as lagging indicators and not risk-informed.*

Performance Indicator(s) under development:

As these indicators monitor only human failure of licensee personal the similar for the human failures of contractors should included as outsourcing of activities at NPP is in progress.

Finland/STUK

Indicator Area: E1 Human Performance

Performance Indicator(s) in use:

Events due to human or organisational failure - Direct causes of events (*look also at A1 Events, indicator 5*)

Definition = As the indicators, the direct causes of events reported in accordance with Guide YVL 1.5 are followed. The event causes are divided into technical failures and erroneous operational and maintenance actions (non-technical, human errors).
Maturity = 3

Assessment of indicator results:

Purpose of these indicators is to follow the immediate causes of reported events (technical and non-technical).

Indicator results are assessed quarterly and yearly by trending.

No thresholds have been defined, but increasing trend in the number of events caused by human or organisational failures is trigger for increased regulatory attention.

The number of events is followed by indicators *A1* (*1-4*), events caused by technical failures *(A1.5)* and risk significance of events is calculated by PSA (see area *A2*).

Discussion:

Experience and challenges in collecting the data and calculating indicators:

The data for the indicators is obtained from from Licensees' event reports (LERs) required by Guide YVL 1.5. Sometimes discussion is needed on the interpretation of the reporting criteria and causes of events.

It has been experienced that event reporting by the licensees (i.e. by LERs) has not been sufficiently reliable to support this indicator. The underlying causes of most events are human based. By this indicator is followed the immediate causes of events weather they are technical failures or human origin.

Experience and challenges in transforming indicator data to meaningful information for decision making:

"Non-technical causes" denote failures caused by erroneous operational and maintenance actions. The indicator may be descriptive of an organisation's operation.

Some immediate regulatory action has been taken on the basis of indicators A1.1-4 combined with INES classification of events. INES class can be upgraded on the bases of accumulation of human errors. Regulatory actions have then initiated at several levels.

Leading or lagging indicators?: The indicator is understood to be lagging, but can also be regarded leading: increasing number of low-level events with human and organisational causes can be a sign about underlying generic deficiencies in operation or wider within the organisation.

To what extent risk-informed?: They are not risk-informed.

Limitations and benefits of current indicators: Events caused by human or organisational failures mainly have the role of a warning signal.

Supplemental Information:

This indicator belongs to the second principal group "Operational events" in STUK's indicator system. Risk significance of events is calculated by PSA, but human factors cannot be taken into account in calculation.

These event indicators are aggregated/combined with other indicator data (deviations from TS; failures of TS components and systems and their repairs; production loss due to failures; and unavailability of safety systems) for assessment of plant and organisation's performance.

Performance Indicator(s) under development:

Not any at the moment.

Performance Indicator(s) in use:

Human based CCFs (actual/potential)- Indicators based on plant specific fault data statistics

1. Common cause failures preventing operation

Definition = As the indicator, the number of non-technical common cause failures (CCFs) causing unavailability of equipment or systems is followed for all plant systems. Maturity = 2

2. Potential common cause failures

Definition = The indicator is the number of potential CCFs of non-technical origin that have no effect on the availability of the equipment or systems but do have a bearing on the reliability of their operation. Maturity = 2

Assessment of indicator results:

Indicator results are assessed yearly by trending. No thresholds for acceptable/unacceptable plant performance have been defined, but degradation in trending is enough for increased regulatory attention.

Purpose of indicator = To follow the quality of maintenance. The indicator is an anticipatory sign for failures that could have developed into a failure preventing the operation of equipment or systems.

Discussion:

Experience and challenges in collecting the data and calculating indicators:

Data for the indicators is collected from the failure databases of the utilities. So far, only the indicator for the Olkiluoto plant has been available. The licensee has submitted the data in Excel files from which CCFs have been analysed. A corresponding procedure will be established for the Loviisa plant (the study into CCFs has already copleted).

Experience and challenges in transforming the indicator data to meaningful information for decision making:

The increased number of human based common caused failures (at Olkiluoto plant) together with the increased number of non-compliances from Tech Spech (at Olkiluoto and Loviisa plants) trigged STUK's investigation in the beginning of implementation of the indicator (in 2000) to find out if there are any generic reasons for degrading trends.

Leading or lagging indicators?: The indicators are understood to be lagging indicators.

To what extent risk-informed?: They are not risk-informed.

Supplemental Information:

Look also at *A2 Mitigating systems: CCs of Tech Spech components* and *E6 Maintenance: Technical CCs*

Performance Indicator(s) under development:

Implementation of the indicator at Loviisa nuclear power plant.

Performance Indicator(s) in use:
Human based maintenance failures (total number)

On the bases of STUK's experience useful indicators can also be extracted from failure data records, such as indicators for the common cause failures and the quality of maintenance. The analysis of common cause failures was based on a method jointly developed by STUK and VTT (STUK's main contractor for nuclear safety re-search). The idea was to examine the usability of fault data records in calculation and screening of different types of failures. These indicators have been developed and defined only for Olkiluoto nuclear power plant so far. The indicators are simply the numbers of different failure types.

The screening of the plant specific fault data covered years 1995-1996 (about 2800 cases). Failures at Loviisa NPP are currently have been analysed in a project contracted to VTT.

Assessment of indicator results:

Indicator results are assessed yearly by trending. No thresholds for acceptable/unacceptable plant performance have been defined, but degradation in trending is enough for increased regulatory attention.

Purpose of indicator = To follow the quality of maintenance. For more information look at *E6 Maintenance*

Hungary/HAEA NSD

Indicator Area: E1 Human Performance

Performance Indicator(s) in use:

Unsuitable state for work

Definition = the sum of unsuitable states for work, the number of dismissed employees and the number of forbidden external employees.

Maturity = 2

Assessment of indicator results:

Green: < 20 case/year
Yellow: 20-50 case/year
Red: > 50 case/year

Slovenia/SNSA

Indicator Area: E1 Human performance

Performance Indicator(s) in use:

1. Events due to human failure

Definition: number of events due to human failure, caused by

– wilful unconsideration of procedures

– other human failures, such as inadequate communication, self-control, use of proper tools, qualification, tiredness, slip…

Maturity: 2 (plant annual reports present only number without detailed description/explanation)

2. Events due to common cause

Definition: number of events due to common cause, commenced by inappropriate maintenance

Maturity: 1

3. Events due to procedure deficiencies

Definition: number of events due to procedure deficiencies, with regard to:

– actual events

– near-misses events that could lead to unsuitable action.

Maturity: 1

Assessment of indicator results:

1. Events due to human failure

Threshold: 5
Trend value: 7

2. Events due to common cause

Threshold: 5
Trend value: 7

3. Events due to procedure deficiencies

Threshold: 5 (actual events), 10 (near-misses events)
Trend value: 7 (actual events), 14 (near-misses events)

Discussion:

experience and challenges in collecting the data:
Data collecting is performed by plant. Additional information shall be reported regarding PI:

1. Events due to human failure: date, description of human failure
2. Events due to common cause: date, description of common cause failure
3. Events due to procedure deficiencies: date, description of procedure deficiency

Spain/CSN

Indicator Area: *.* E1 Human performance

Performance Indicator(s) in use:

CSN does not have a specific indicator in this area. We have some sub-indicators included in a broad indicator category (Cause codes), that with the adequate aggregation can give us information about events due to human and organisational failure.

Assessment of indicator results:

See generic information

Discussion:

Experience and challenges in transforming the indicator data to meaningful information for decision making: Although data are collected from all LERS, in the majority of the cases data are obtained from a detailed analysis of the event, asking the plant and using information provided by resident inspectors. This aspect makes it very difficult, in some cases, to obtain reliable information about events caused by human or/and organisational failures.

Leading or lagging indicators?: These indicators could be considered as leading because they give us information abut weaknesses and problems in the organization.

Supplemental Information:

Cause codes are intended to identify possible deficiencies in six programmatic categories, most of them related with management, organization and safety culture (MOSC). These categories are: .

- Administrative Control Problems
- Licensed Operator Errors
- Other Personnel Errors
- Maintenance Problems
- Design/Construction, installation, fabrication Problems (Only related to MOSC when there are human errors in design modifications)
- Miscellaneous (Not related to MOSC. It is used for spurious or one-time failures of electronic piece-parts and failures due to meteorological conditions).

Sweden/SKI

Indicator Area: E1 Human performance

Performance Indicator(s) in use:
The indicators include:

- MTO related events (events subject to TS) and their causes
- Human based CCFs (occurred and potential human based CCFs are identified and listed but not yet trended)
- Number of MTO causes
- Number of MTO root causes
- Set of administrative indicators

SKI's MTO-indicators build on a hierarchical system with two levels, the strategic level and the specific level. This architecture corresponds to the two level structure of the so-called MTO-database, which contains since 1994 a classification of the MTO-related Swedish LERs and scrams. The MTO-database structure has presently 11 MTO causal categories and almost 80 MTO root cause categories.

The upper level of the MTO-database relates to the causal categories of the plant events, while the lower level pertains to the root causes of the same events. This signifies that SKI's strategic MTO-indicators are linked to the event causal categories, while SKI's specific MTO-indicators are linked to the event root causes.

The indicator is in use (maturity level 3) but depending on the stakeholders different methods to present the result will be evaluated.

Assessment of indicator results:

The indicators are assessed quarterly by use of signal diagrams (levels are one LER, two, respectively three or more MTO related LERs per unit and quarter) and colour coding (green, yellow and red) for the different levels. The thresholds are only used for colour coding and without specific significance, yet, for eventual actions by SKI. The colour coding is primarily used for providing a fast overview/trending of the indicators.

Dominating MTO causes/root causes are quarterly trended for each unit and each plant.

Discussion:

Experience/challenge in collecting the data: The data being solely based on LERs, the robustness and accuracy of the indicators presuppose a highly trustworthy LER reporting in regard to both coverage and quality. SKI has underlined this to the licensees. SKI is presently confident, on the whole, of the licensees LER reporting.

Quality assurance of the MTO database: Although obvious, the task of assuring a high quality of the MTO database is not simple, due to the somewhat poor description of the event sequence and its causes in several of the MTO-related LERs. This weakness has resulted, and still results, in the need to have contact with the concerned unit specialists in order to obtain full clarification of some of the events reported and their underlying causes. During these discussions, agreement is reached as to the classification of the events and their causes.

Experience/challenges in calculating indicators: The indicators are based on simple calculations and these latter do not result in any specific challenge or difficulty.

Experience/challenge in transforming the indicator data to meaningful information for decision making: The indicator is not mature yet for the establishment of fixed thresholds related to subsequent regulatory actions. Aggregated, the indicators provide however SKI with enough information which, together with other findings (for example from plant inspections) might result in regulatory action(s).
The presentation of signal diagrams needs to be adjusted for different stakeholders.

Leading or lagging indicators? The indicators coupled to MTO-indicators are lagging indicators. It could be that the indicators are leading if they represent the organisations ability to prevent/minimize plant events, and especially MTO related events.

To what extent are these indicators risk-informed? These indicators are not risk-informed.

Limitations/benefits of current indicators: The use of the MTO-related indicators has proven to be a valuable input in the yearly overall assessment by SKI of the Swedish plants and their organisations.

Supplemental Information:

The hierarchical structure, with two levels, of the MTO-indicators has proven to be suitable for achieving one of the key goals of SKI performance indicator system, namely the unambiguous identification of MTO-related issues at some plant(s) deserving closer regulatory attention. Such identification is often confirmed by, or confirms, the results from other regulatory activities, as plant reviews and so-called directed inspections. MTO-indicators can exhibit significant differences between two units of the same plant, thus pinpointing plant/unit specific MTO-related issues to focus upon in the regulator's activities.
Viewed and used as a complement to the results of inspection activities, the MTO-indicators have gained more and more recognition among especially SKI's plant inspectors. The use of the MTO- indicators has proven to be a valuable input in the yearly overall assessment by SKI of the Swedish plants and the organisation of the licensees.

Although the interpretation of some of these indicators might not be straightforward, SKI still judges the overall picture given by the relatively large set of indicators especially valuable. This also fulfils the original intention SKI had concerning a robust safety performance indicator system, namely that even if each one of the indicators can not fully be relied upon, the aggregated information obtained from the evaluation of the whole set of indicators provides a well grounded base for decisions.

Performance Indicator(s) under development:

SKI is not planning to make change in the present set/structure of the MTO-indicators.

Information related to indicator area E2 (Compliance):

Belgium/AVN

Indicator Area: E2 Compliance

Performance Indicator(s) in use:

1. Technical Specification violations
   Definition = The number of reported events during the previous calendar year, which involved a violation against the plants TS (at unit level).
   Maturity = 2
2. Exemptions to Technical Specifications
   Definition = The number of TS exemptions granted by AVN during the previous calendar year.
   Maturity = 2

Assessment of indicator results:

Indicator results are assessed yearly by trending. No thresholds for unacceptable plant performance or for increased regulatory attention have been defined.

The assessment of the indicator on TS exemptions does not interfere with the granting process of TS exemptions itself.

Discussion:

Experience and challenges in collecting the data:

TS violations: Data collection is mainly done on the basis of AVN inspection reports and to a lesser extent on the basis of assessment of LERs. Experience has shown that licensees are not always reporting TS violations in a consistent and rigorous way. The robustness of this indicator depends to a large extent on the alertness of AVN inspectors to detect deviations from TS (see also discussion related to area A1 – TS violations are considered to be a specific category of reportable events) and on the PI-coordinator to correct deficient internal reporting when needed.

TS exemptions: Collecting data is straightforward by counting the number of TS exemptions granted to each plant per calendar year (exemptions to TS are documented in official letters to the licensee).
Experience and challenges in transforming indicator data to meaningful information for decision making:

TS violations: The intention of this indicator is to monitor the effectiveness of plant programs that support the development and the maintaining of safety culture through the number of violations against the Technical Specifications. Due to remaining questions on the robustness of the indicator it is still premature to consider regulatory decision making on the basis of this indicator alone. Furthermore not all TS-violations are intentional or deliberate and not all are considered to have significant safety impact.

TS exemptions: The purpose of this indicator is to monitor plant capability to comply with TS requirements through the number of TS exemptions requested by the plant and granted by AVN.

Requests for TS exemptions are carefully reviewed by AVN before they are granted. The number of TS exemption requests depends to some extent on plant design, age of Technical Specifications, planned plant modification projects and licensee safety management policies. The assessment of this indicator needs to take all these parameters into consideration. Experience has shown however that licensee safety management policy has a significant effect on the number and trend of TS exemption requests submitted to AVN.

Leading or lagging indicators?: These indicators are understood to be rather leading than lagging (depending on definitions of this concept).

To what extent risk-informed?: These indicators are not risk-informed (most TS-violations monitored by this indicator have in fact a low impact on plant risk; the risk significance of granted TS exemptions is in most cases very low or zero).

Limitations and benefits of current indicators: If the data collection process for the indicator on TS violations can be made robust, it is believed that this indicator can be a simple and useful tool for monitoring safe behaviour of plant staff (mainly operating staff). It should however be complemented with other observations in order to come to conclusions about the level of safe behaviour and safety culture at the different plants.

Supplemental Information:

This indicator is considered to be a low-level type of indicator, which is preferably aggregated/combined with other data for assessment of plant safety performance and implementation of safety policies.

Aggregation principles have still to be examined.

Safety significant TS-violations might also be counted by other indicators under consideration, which would be rather high-level type of indicators – see PIs under development in area A1(Events).

Performance Indicator(s) under development:

No additional indicators in this area are considered for development at the moment.

Czech Republic/SUJB

Indicator Area: E2 Compliance

Performance Indicator(s) in use:

1. Violation of Limits and Conditions (L&C)
   Definition = the number of violations of the Limits and Conditions detected by the Regulatory body or reported to the Regulatory body by the licensee.
   Maturity = 3
2. Number of Exemptions from L&C
   Definition = the number of planned/unplanned exemptions from the Limits and Conditions approved by the Regulatory body.
   Maturity = 3

Assessment of indicator results:

Trends of the Indicators values are assessed yearly.

Discussion:

- *The data for these indicators are collected by SUJB staff through inspection activities and from regular reports submitted by licensee.*
- *During the years the difference between so called planned and unplanned exemption were revealed so the cases for different kind of exemptions collected separately.*
- *All the indicators are seen as lagging indicators and not risk-informed.*

Finland/STUK

Indicator Area: E2 Compliance

Performance Indicator(s) in use:

Exemptions and deviations (violations/not compliances) from the Technical Specifications

Definition = The number of non-compliances with the Tech Specs as well as the number of exemptions granted by STUK.
Maturity = 3

Assessment of indicator results:

Indicator results are assessed quarterly and yearly by trending.

Permanent goal in agreement between STUK and Ministry is that plants should be operated in accordance with requirements of Tech Spec. No thresholds for unacceptable plant performance or for increased regulatory attention have been defined, but increased number of deviations or exemption applications/orders is enough for increased regulatory attention.

Risk significance of events/deviations and suggested deviations from Tech Spec is calculated by PSA (STUK's indicators II.2; A4 Operational risk / Probalistic indicators).

Purpose of indicator is to follow the utilities' activities in accordance with the Tech Specs: compliance with the Tech Specs and identified situations during which it is necessary to deviate from them; of which conclusions can be made as regards the appropriateness of the Tech Specs.

Discussion:

Experience and challenges in collecting the data:

Data for the indicators are collected from applications for exemption orders and from event reports.

Experience and challenges in transforming the indicator data to meaningful information for decision making:

STUK's event investigation was lauched in 2000 based on increased number of deviations from Tech Spec at the both nuclear power plants in Finland. Generic and common causes were studied.

Whether these indicators are seen as leading or lagging indicators: *These indicators are considered to be lagging.*

To what extent these indicators are risk-informed: *They are not risk-informed eventhough the consequencies are calculated by PSA.*

Supplemental Information:

These indicators are considered to be "low level" indicators. They belong to the first principal group "Quality ans Safety Culture, but are very closely connected to the second principal subgroup "Operational events" in STUK's indicator system. Risk significance of deviations and exemptions is calculated by PSA.

These indicators are more aggregated/combined with above mentioned indicator data) for assessment of operation than other indicators of subgroup I (failures of TS components and systems and their repairs; production loss due to failures; unavailability of safety systems) for assessment of plant performance.

These indicators illustrate safety attitude of the plant; their willingness to obey rules and orders, and can be be indicative of underlying operational deficiencies**.**

Performance Indicator(s) under development:

Not any at the moment

Hungary/HAEA NSD

Indicator Area: *.* E2 Compliance

Performance Indicator(s) in use:

1. Number of L&C exemptions

Definition = Number of temporary exemptions from the requirements of the *L&C* licensed by the authority, apart from that the subject of the current case is to be reviewed in the future.
Maturity = 2

2. Number of L&C violations

Definition = Number of deviations declared as TecSpecs violations during the investigation of the reportable events.
Maturity = 2

3. Violations of the licensing conditions

Definition = Number of violations of legal requirements, of violation of obligations prescribed in regulatory decisions, of violations of deadlines of the obligations prescribed in regulatory decisions and administrative letters.
Maturity = 2

Assessment of indicator results:

1. Green: < 5 exemptions/year
Yellow: 5-25 exemptions/year
Red: >25 exemptions/year

2. Green: 0 event/unit/year
Yellow: 1-5 event/unit/year
Red: > 5 events/unitt/year

3. Green: 0 case/year
Yellow: 1-15 case/year
Red: > 15 case/year

Slovenia/SNSA

Indicator Area: E2 Compliance

Performance Indicator(s) in use:

1. Number of TS violations
Definition: number of TS (LCO and SR) violations.
Maturity: 3

2. Number of TS exemptions
Definition: number of TS exemptions as permitted by regulatory body.
Maturity: 3

3. Licensee deviations from regulations
Definition: number of licensee deviations from regulations (legislation and regulatory body decrees).
Maturity: 3

4. Risk significance of TS equipment exemptions
Definition: monthly contribution to CDP due to TS equipment exemptions that were approved by SNSA.
Maturity: 1

Assessment of indicator results:

2. Number of TS exemptions
Threshold: 2
Trend value: 3

4. Risk significance of TS equipment exemptions
Threshold: $8{,}3 \cdot 10^{-8}$ (referenced to yearly CDP = $1 \cdot 10^{-6}$)
Trend value: $1{,}1 \cdot 10^{-7}$

Discussion:

experience and challenges in collecting the data:
Data collecting is performed by plant. Additional information shall be reported regarding PI:

4. Risk significance of TS equipment exemptions: date, duration of TS equipment inoperable, system/component inoperable

Information related to indicator area E3 (Operational Preparedness):

Finland/STUK

Indicator Area: E3 Operational preparedness

Performance Indicator(s) in use:

There are no indicators in STUK's indicator system in this area. Supervision of below mentioned items/areas:

Number of staff with regulatory licence
Unsuccessful regulatory exams/ average examination results (written, full-scope simulator)
Operator training / Promotion of training
Training of other NPP personnel

belong to other inspections of STUK as; licensing of staff and several inspections of Periodic Inspection programme including also specific inspection for training.

Performance Indicator(s) under development:
Not any at the moment.

Hungary/HAEA NSD

Indicator Area: E3 Operational preparedness

Performance Indicator(s) in use:

1. Number of staff with regulatory licence
Definition = Tracing the availability of the number of staff necessary for occupying the duties required regulatory authorization exam

Ratio of the valid regulatory authorization exams with reference to professionals and to the NPP and of the number of staff prescribed in TS without the staff working only in day-shift
Maturity = 2

2. Unsuccessful regulatory exams

Definition = Tracing of the preparedness for the exams necessary to pass in front of the regulatory body

STHA=(STH/ÖH)*100%, STHA - ratio of the unsuccessful regulatory exams, STH – number of unsuccessful regulatory exams, ÖH – total number of regulatory exams

Maturity = 2

Assessment of indicator results:

1. Green: > 105 %
Yellow: 100-105 %
Red: < 100 %

2. Green: < 2 %
Yellow: 2-5 %
Red: > 5 %

Slovenia/SNSA

Indicator Area: E3 Operational preparedness

Performance Indicator(s) in use:

1. Operator exams

Definition:

– average written exam result

– average result on plant full scope simulator, including: first acquirement of licence / prolongation of licence / continual training of reactor and main operator

– number of reactor and main operator licence holders

Maturity: 1

Discussion:

experience and challenges in collecting the data:
Data collecting is performed by plant. Additional information shall be reported regarding PI:

1. Operator exams: significant topics that have major contribution to exam/simulator result decrease

Information related to indicator area E4 (Emergency Preparedness):

Finland/STUK

Indicator Area: E4 Emergency Preparedness

Performance Indicator(s) in use:

There are not indicators in STUK's indicator system in this area. Supervision of below mentioned items/areas:

Drill/exercise performance
Drill participation / training on emergency response
Alert and notification system reliability
Emergency response resources completion index
Deficiencies found during emergency exercises
Deficiencies found during regulatory inspections

belong under the specific inspection STUK's Periodic Inspection Programme.

Performance Indicator(s) under development:
Not any at the moment.

Hungary/HAEA NSD

Indicator Area: E4 Emergency preparedness

Performance Indicator(s) in use:

1. Deficiencies found during regulatory inspections

Definition = Total number of deficiencies recorded during on-site regulatory inspection of ER trainings, exercises and during the review of the Emergency Plan

Maturity = 2

2. Drill participation

Definition = Ratio of the number of staff participating in ER theoretical and practical trainings during one year and of the number of the whole staff of the NPP.

Maturity = 2

Assessment of indicator results:

1. Green: < 20 deficiencies/year
Yellow: 20-50 deficiencies/year
Red: > 50 deficiencies/year

2. Green: > 90 %/year
Yellow: 70-90 %/year
Red: < 70 %/year

Korea/MOST(Ministry of Science and Technology), KINS(Korea Institute of Nuclear Safety)

Indicator Area: .E4 Emergency Preparedness

Performance Indicator(s) in use:

1. Emergency Preparedness (EP)
   Definition: Combination of emergency exercise, training of emergency personnel, facility reliability and response capability
   Maturity: 3

Assessment of indicator results:

See also generic information.
The following is the threshold and grade of the indicator:

Indicator	Thresholds(Quarterly)			
	Excellent (green)	Good (cyan)	Normal (yellow)	Warning (orange)
Emergency Preparedness	> 90%	> 80%	> 60%	≤ 60%

Discussion:
See generic information.

Slovenia/SNSA

Indicator Area: E4 Emergency preparedness

Performance Indicator(s) in use:

1. Emergency response organisation drill

Definition: percentage of intervention staff with regard to announced event scale that was present on plant during the exercise or real event within/after 1 hour for last 8 alarms.

Maturity: 1

2. Staff training

Definition: ratio of personnel that attend emergency preparedness training to all personnel that shall attend training. Emergency preparedness training include basic training (first task appointment), plant yearly training, common 3-years training and plant support organisation yearly training. Staff involved in training are: shift crew, technical support centre, operating support centre, offsite support centre.

Maturity: 1

Assessment of indicator results:

1. Emergency response organisation drill
Threshold: 70 % inside 1 hour, 90 % after 1 hour
Trend value: 52 % inside 1 hour, 67 % after 1 hour

2. Staff training
Threshold: 0,9
Trend value: 0,67

Information related to indicator area E5 (Management of plant modifications):

Belgium/AVN

Indicator Area: E5 Management of plant modifications

Performance Indicator(s) in use:

Events caused by modification process deficiencies
Definition = The number of reported events during the previous calendar year, for which a deficiency in the process of management of modifications was identified as one of the contributing or root causes.
Maturity = 2

Assessment of indicator results:

Indicator results are assessed yearly by trending. No thresholds for unacceptable plant performance or for increased regulatory attention have been defined.

The assessment of this indicator is complemented by inspector experience in the handling of applications for plant modification by the licensees.

Discussion:

Experience and challenges in collecting the data:

All reportable events, which are registered in AVN's incident database, are screened for root causes indicating deficiencies in the modification management process. The robustness of indicator data collection depends on the reliability of the event reporting system (see area A1) and the quality of the incident analysis.

Experience and challenges in transforming indicator data to meaningful information for decision making:

The purpose of the indicator is to monitor the performance of the modification management process at the licensees. As the indicator is only built on reportable events, for which a certain threshold related to safety impact exists, it might be that the indicator is not showing a correct picture and it is certainly not showing a complete picture of the quality of this process. Therefore the validity of the indicator results should be crosschecked and completed by additional inspection efforts focussing on the plant modification management process and by inspector experience in treating plant modification applications submitted by the licensees.

Leading or lagging indicators?: This indicator is considered to be a leading indicator.

To what extent risk-informed?: The indicator is not risk-informed (risk significance might vary depending on the nature of the modification process deficiency).

Limitations and benefits of current indicators: The main limitations reside probably in the fact that the indicator is only capturing "top events" and that its scope is narrowed to modification-induced events. Its real benefit needs still to be investigated.

Supplemental Information:

This indicator is considered to be a low-level type of indicator, which is preferably aggregated/combined with other indicator data for assessment of plant safety performance (aggregation with indicators in the area G1 – maintenance might be appropriate). Aggregation principles have still to be examined.

Performance Indicator(s) under development:

No additional indicators in this area are considered for development at the moment.

Finland/STUK

Indicator Area: E5 Management of Plant Modifications

Performance Indicator(s) in use:

Keeping plant documentation current

Definition = This indicator area follows the need to update documents and their realisation by the start-up following the next annual maintenance. The documents to be followed-up are: the Technical Specifications, the Final Safety Analysis Report (FSAR), safety classification documents and diagrams, PSA documentation, operation and maintenance procedures, emergency and disturbance instructions, and process flow-charts. The ratio of the number of implemented document revisions to the number of identified document revisions is followed.
Maturity = 3

Assessment of indicator results:

The indicator is updated once a year after maintenance outages. Reasults are assessed against the recorded needs for updating of plant documentation. The priority is to follow the realisation of these plans but also trending of indicator is followed.

Purpose of indicator is to follow plant quality management and the ability to maintain plant documentation.

Discussion:

Experience and challenges in collecting the data:

The data for the indicator calculation is obtained from STUK's plant modifications register (but also inspection at plant is needed).

Experience and challenges in calculating indicators:

Identification of document amendments and revisions pertaining to modifications at the Loviisa plant is mostly by pre-inspection documents and training notices. In addition, a list of necessary changes to the operating manual maintained at the Loviisa plant is used in the identification of amendments and revisions. The indicator for the Olkiluoto plant is based on the modification project control system (PH2), which includes control forms (AV forms) describing the need to update modification documents and its realisation. In addition, STUK reviews the realisation of document amendments and revisions in the main control rooms of both plants.

The updating situation of document revisions needed after plant modifications (entered into register) in 2004 was 86% for the Loviisa units and 100% for the Olkiluoto units by the start-up after annual maintenance. The indicator does not yet include revisions to documents that need to be updated by the next annual maintenance. The corresponding figures for 2002 were 96% at Loviisa and 86% at Olkiluoto. These figures include revisions to all documents under surveillance. The improved result at Olkiluoto is mainly due to the fact that few safety-significant or extensive modification operations were conducted there in 2004. The monitoring of the realisation of document revisions needed in 2004 focused on Olkiluoto 1 because no significant (monitored) modification work was conducted at Olkiluoto 2.

Teollisuuden Voima Oy has improved the use of AV forms by including the updates of safety classification documents and diagrams. In the previous year the estimate regarding these documents and diagrams was based on an assessment by the person in charge of the indicator. In addition, the somewhat insufficient information of the AV forms had to be made more specific by the Olkiluoto plant modifications planning unit, since a review based only on the AV forms would have yielded a significantly weak result for Olkiluoto.

As regards the Loviisa power plant, the result can be considered reasonable, although more deviations were detected than in the previous years; in general, the procedures used by the Loviisa plant to update the operations manual, the Tech Specs and the PI figures has proved effective. It needs to be mentioned that at Loviisa, unlike Olkiluoto, final, approved instructions are introduced at start-up instead of hand-written versions of instructions and PI figures. The assessment has also been made against these final instructions.

Supplemental Information:

These indicators are considered to be “low level” indicators.

These indicators are included in STUK’s indicator system into the principal subgroup I “Quality and Safety Culture”.

Other indicators of STUK’s indicator system belongin to the principal subgroup I illustrate the condition of the plant and performance of different functional groups at the plant; such as functioning of the maintenance unit (failures and their repairs, unavailability of saty systems), safety attitude of operation (non-compliance with the TS), performance of operation unit (events and their causes, risk significance of events), performance of radiation protection unit (doses and releases) and Investments on plant maintenance and modification.

Performance Indicator(s) under development:
Not any at the moment.

Hungary/HAEA NSD

Indicator Area: *.* E5 Management of plant modifications

Performance Indicator(s) in use:

1. Number of modifications of the L&C

Definition = Number of licensed modifications of the L&C related to the current year based on the issued licences. During recording the modifications belonging to independent chapter identifier in the table of contents of the L&C are to be ranked as one modification.

Maturity = 2

2. Temporary modifications

Definition = Number of temporary modifications and changes. The temporary modifications and changes include the establishment of a state departing from the content of the valid operating documents in order to produce the necessary conditions for the operation of the systems, structures and components of the following fields: mechanical technology, electricity, instrumentation, computer technology and radiation protection.

Maturity = 2

3. Temporary Operating Instructions

Definition = Number of the temporary operating instructions. Temporary Operating Instruction: such operations that are written for the operating personnel, which have to be executed differently from the content of the operating documents, or whose results require a state or parameter to be set and kept differently from the content of the operating documents.

Maturity = 2

Assessment of indicator results:

1. Green: < 5 modification/plant/year
Yellow: 5-10 modification/plant/year
Red: > 10 modification/plant/year

2. Green: < 30 modification/plant/year
Yellow: 30-100 modification/plant/year
Red: > 100 modification/plant/year

3. Green: < 50 modification/plant/year
Yellow: 50-100 modification/plant/year
Red: > 100 modification/plant/year

Slovenia/SNSA

Indicator Area: E5 Management of plant modifications

Performance Indicator(s) in use:

1. Temporary modification

Definition: number of temporary modification that remain in force less than 6 months and more than 6 months.

Maturity: 1

2. Modification approved by regulatory body

Definition: number of modifications for which shall prior to implementation be obtained:

– written confirmation from regulatory body,
– permit/decree from regulatory body

Maturity: 3

3. Events due to implemented modifications

Definition: number of events due to implemented temporary or permanent modifications. Events that could happened even if the modification would not be performed are not considered.

Maturity: 1

4. Keeping plant documentation current

Definition: number of non-updated documents with regard to safety related / quality related / non-safety related / plant programs documents.

Maturity: 2

Assessment of indicator results:

1. Temporary modification

Threshold: 30

Trend value: 40

3. Events due to implemented modifications

Threshold: 3

Trend value: 4

4. Keeping plant documentation current

Threshold: 0 (safety related), 5 (quality related / non-safety related), 3 (plant programs)

Trend value: 7 (quality related / non-safety related), 4 (plant programs)

Discussion:

experience and challenges in collecting the data:
Data collecting is performed by plant. Additional information shall be reported regarding PI:

3. Events due to implemented modifications: date, identification of modification, of procedure deficiency

Sweden/SKI

Indicator Area: E5 Management of plant modifications

Performance Indicator in use:

The indicator is included in SKI MTO-indicators, indicator area E (Human Performance). All comments provided for the MTO-indicators apply for management of change.

The indicator is in use (maturity level 3) but depending on the stakeholders different methods to present the result will be evaluated.

Information related to indicator area E6 (Maintenance):

Belgium/AVN

Indicator Area: E6 Maintenance

Performance Indicator(s) in use:

Events caused by maintenance deficiencies
Definition = The number of reported events during the previous calendar year, for which a maintenance deficiency was identified as a contributing or root cause (maintenance deficiency = poor maintenance, maintenance errors or lack of maintenance). (at unit and site level)
Maturity = 2

Assessment of indicator results:

Indicator results are assessed yearly by trending. No thresholds for unacceptable plant performance or for increased regulatory attention have been defined.

Discussion:

Experience and challenges in collecting the data:

All reportable events, which are registered in AVN's incident database, are screened for root causes indicating deficiencies of maintenance. The robustness of indicator data collection depends on the reliability of the event reporting system (see area A1) and the quality of the incident analysis.

Experience and challenges in transforming indicator data to meaningful information for decision making:

The purpose of the indicator is to monitor the quality of maintenance of safety related equipment, through the occurrence of reportable events. As the indicator is only built on reportable events, for which a certain threshold related to safety impact exists, it might be that the indicator is not showing a correct picture of the quality of maintenance at the plants. In fact most failures of (safety) equipment, discovered during qualification and routine tests, are treated as low-level events and repaired without necessarily performing a root cause analysis of the equipment failure. Therefore the validity of the indicator results should be crosschecked by additional inspection efforts focussing on the plant maintenance process.
In addition equipment failures due to maintenance errors, covered by this type of data collection, are in many cases latent failures, which means that the error is related to varying points of time in the past, which are not necessarily corresponding to the time window (calendar year) the indicator is referring to.

Leading or lagging indicators?: This indicator is considered to be a leading indicator.

To what extent risk-informed?: The indicator is not risk-informed (risk significance might vary depending on the nature and extent of the maintenance deficiencies).

Limitations and benefits of current indicators: The main limitations reside in the fact that the indicator is only capturing "top events". Its real benefit needs still to be investigated.

Supplemental Information:

This indicator is considered to be a low-level type of indicator, which is preferably aggregated/combined with other indicator data for assessment of plant safety performance (aggregation with indicators in the area G3 – management of change might be appropriate). Aggregation principles have still to be examined.

Performance Indicator(s) under development:

No additional indicators in this area are considered for development at the moment.

The licensees are steadily developing their own indicator systems. Investigation of utility indicators being put in place that monitor maintenance and periodically screening the results (in the frame of thematic inspections on maintenance) might be an appropriate way to proceed in this area.

Finland/STUK

Indicator Area: E6 Maintenance

Performance Indicator(s) in use:

Failures of TS components and their repairs

1. Failures of components subject to the Technical Specifications

   Definition = As the indicator, the number of failures causing unavailability of components defined in the Technical Specifications (Tech Spec components) during power operation is followed. The failures are divided by plant unit into two groups: failures causing an immediate operation restriction and failures causing an operation restriction in connection with repair work.
   Maturity = 2

2. Maintenance of components subject to the Technical Specifications

   Definition = As the indicator, the numbers of failure repairs and preventive maintenance work orders for components defined in the Tech Specs are followed by plant unit.
   Maturity = 2

3. Repair time of components subject to the Technical Specifications

   Definition = As the indicator, the average repair time of failures causing unavailability of components defined in the Tech Specs is followed. With each repair, the time recorded is the time of unavailability. It is calculated from the detection of the failure to the end of repair work, if the failure causes an immediate operation restriction. If the component is operable until the beginning of repair, only the time of the repair work is taken into account.
   Maturity = 2

4. Production loss due to failures

   Definition = Loss of power production caused by failures in relation to rated power (gross).
   Maturity = 3

Assessment of indicator results:

Indicator results are assessed quarterly and yearly by trending. No thresholds for acceptable/unacceptable plant performance have been defined, but degradation in trending is enough for increased regulatory attention.

Purpose of indicator 1 = The indicator is used to assess the plant lifetime management and the development of the condition of components.

Purpose of indicator 2 = The indicator describes the volumes of failure repairs and preventive maintenance and illustrates the condition of the plant and its maintenance strategy. The indicator is used to assess the maintenance strategy executed at the plant.

Purpose of indicator 3 = The indicator shows how quickly failed Tech Spec components are repaired in relation to the repair time allowed in the Tech Specs.The indicator is used to assess the maintenance strategy, resources and effectiveness of the plants.

Purpose of indicator 4 = To follow the significance of failures from the point of view of production.

Discussion:

Experience and challenges in collecting the data:

Source of data, indicator 1= The data is obtained from the work order systems and operational documents of the power plants.

Source of data, indicator 2 = The data is obtained from the plant work order systems, from which all preventive maintenance operations and failure repairs are retrieved.

Source of data, indicator 3 = The data is obtained from the work order systems and maintenance and operational documents of the power plants.

Source of data, indicator 4 = Annual and quarterly reports submitted by utilities.

As a result of the intermediate assessment of the STUK indicator system conducted in 2003, it was decided to specify the definitions of certain specific indicators to improve their reliability and to find ways of enhancing the indicator process. The definitions of indicators in areas describing the maintenance of safety-significant components (failures in Tech Spec components, maintenance, and repair time) were changed as of the beginning of 2004, such that they would support, as well as possible, NRR's regulatory work and its sub-processes.

Previously the total number of failures of components defined in the Tech Specs during power operation was followed as the indicator for the whole plant (indicator 1). This averaged the plant specific data and was not useful for assessing condition of TS components, lifetime management, or maintenance strategy executed at the plant.

Previously, as indicator 2 only the ratio of preventive maintenance jobs to failure repair work orders was followed by plant. Because the numerical value as such indicated no definite variation or trend, and it was difficult to interpret the reasons for the variation, a change was made to follow the ratio of failure repairs to preventive maintenance jobs by plant unit as the indicator.

Previously, as indicator 3 the average of the percentage values of repair times in relation to repair time allowed in the Tech Specs was followed at the Olkiluoto plant. For the Loviisa plant, only those components whose allowed repair time is three days were included. There was a wish to unify the definition of the indicator so that it would be the same for both plants. Even now, the values given by the indicator are not comparable because the Loviisa nuclear power plant has a multiple number of Tech Spec components compared with the Olkiluoto plant, so in Loviisa repairs need to be prioritised within the framework of repair times allowed and resources available.

Experience and challenges in transforming the indicator data to meaningful information for decision making:

The indicators in accordance with the new definitions introduced of the beginning of 2004 and were calculated retrospectively over the previous few years (from 1999) to gain a base for comparison with the 2004 indicator values. There is not so much experience yet on the use and usability of these indicators. These indicators should be used quarterly more efficiently as a tool of inspectors; in inspections the printouts from plant work order systems should be reviewed to see which TS components are dealing with the failure data.

Leading or lagging indicators?: The indicators are understood to be lagging indicators, but quarterly updating and related inspections increase its effectiveness and usefulness making it more leading.

To what extent risk-informed?: They are not risk-informed even if the TS components and systems are safety related.

Supplemental Information:

These indicators are included in STUK indicator system into principal subgroup I "Quality and Safety Culture". These indicators describe the condition TS components and systems and its development. They can also used to assess the maintenance strategy executed at the plant, its effectiveness and recourses

These indicators are considered to be "low level" indicators.

Indicators are assessed together with several indicators of STUK's indicator system, as: WANO-indicators; number of events; and risk significance of events.
These indicator results with conclusions were first time collected for the year 2004 and presented with the data of few previous years to licensees before publishing them in annual report. This raised up lively discussions and initiated discussions and clarifications about trends also at power plants.

Performance Indicator(s) under development:
Not any at the moment.

Performance Indicator(s) in use:

Indicators based on plant specific fault data statistics

1. Common cause failures preventing operation

   Definition = As the indicator, the number of technical common cause failures (CCFs) causing unavailability of equipment or systems is followed for all plant systems.
   Maturity = 2

2. Potential common cause failures

   Definition = The indicator is the number of potential CCFs of technical origin that have no effect on the availability of the equipment or systems but do have a bearing on the reliability of their operation (ageing, wear and tear, corrosion, etc.).
   Maturity = 2

On the bases of STUK's experience useful indicators can also be extracted from failure data records, such as indicators for the common cause failures and the quality of maintenance. The analysis of common cause failures was based on a method jointly developed by STUK and VTT (STUK's main contractor for nuclear safety re-search). The idea was to examine the usability of fault data records in calculation and screening of different types of failures. These indicators have been developed and defined only for Olkiluoto nuclear power plant so far. The indicators are simply the numbers of different failure types.

The screening of the plant specific fault data covered years 1995-1996 (about 2800 cases). Failures at Loviisa NPP are currently have been analysed in a project contracted to VTT.

Assessment of indicator results:

Indicator results are assessed yearly by trending. No thresholds for acceptable/unacceptable plant performance have been defined, but degradation in trending is enough for increased regulatory attention.

Purpose of indicator = To follow the quality of maintenance.

Discussion:

Transforming indicator data to meaningful information for decision making:

Common cause failures were divided to two categories - to human or technical failures. These were further divided to critical or non-critical failure classes according to their influence on system or devices. In the screening of failures, also individual human errors and multiple technical failures were identified. The results of this part of the study showed clearly that hidden CCFs can be found from detailed examination of fault data history. The number of occurred human originated CCF's (2,3/y) corresponded well to earlier studies done at STUK and VTT.

It was concluded that there are many good ways to utilise the information in failure records as indicators. Based on the study carried out for Olkiluoto nuclear power plant, the indicators from failure statistics are already applicable for safety assessment. The monitoring of before mentioned indicators continues, and the aim is to focus on safety related systems.

Source of data = Data for the indicators is collected from the failure databases of the utilities. For the time being, the Olkiluoto indicator has been followed. The licensee has submitted the data in an Excel file, from which CCFs have been analysed. A corresponding procedure for the Loviisa plant will be established after the completion of a study into CCFs.

Purpose of indicator = The indicator represents the number of CCFs of a technical origin. A CCF preventing a function refers not only to the failure of a safety system but includes all systems. Thus conclusions on the safety-significance of CCFs are not to be made based on the indicator.

Source of data = Data for the indicators is collected from the failure databases of the utilities. So far, only the indicator for the Olkiluoto plant has been available. The licensee has submitted the data in Excel files from which CCFs have been analysed. A corresponding procedure will be established for the Loviisa plant after the completion of a study into CCFs.

Purpose of indicator = The indicator is an anticipatory sign for failures that could have developed into a failure preventing the operation of equipment or systems.

Leading or lagging indicators?: The indicators are understood to be lagging indicators.
To what extent risk-informed?: They are not risk-informed.

Slovenia/SNSA

Indicator Area: E6 Maintenance

Performance Indicator(s) in use:

1. Work orders opening

Definition: number of work orders that were opened in the last 3 months:

– with regard to priority (urgent / 1 / 2 / 3 level according to plant procedure)

– work orders that were not started within time limit as required by plant procedure and priority

Maturity: 1

2. Unsuccessful testing index

Definition: percentage of unsuccessful testing after:

– maintenance activities

– performed modification

Multiple successive unsuccessful testing are also included, regardless to cause of unsuccessfulness.

Maturity: 1

3. Safety system surveillance index

Definition: ratio of safety system failures discovered at walkdowns or testing to all safety system failures.

Maturity: 1

4. LCO index

Definition: frequency of LCO plant operation, presented as:

– number of planned LCO entries (surveillance testing, planned preventive maintenance, testing and modifications)

– number of unplanned LCO entries (external causes, components failure, corrective maintenance and testing)

– ratio of actual time in LCO to allowable LCO time

Maturity: 2 (data is part of inspection reports)

Assessment of indicator results:

1. Work orders opening

Threshold: 3 (only for work order delay)

Trend value: 5 (only for work order delay)

2. Unsuccessful testing index

Threshold: 90 %

Trend value: 120 %

3. Safety system surveillance index

Threshold: 95 %

Trend value: 70 %

4. LCO index

Threshold: 50 (LCO entries), 55 % (LCO index)

Trend value: 67 (LCO entries), 74 % (LCO index)

Discussion:

experience and challenges in collecting the data:

Data collecting is performed by plant. Additional information shall be reported regarding PI:

1. Work orders opening: identification of delayed work order, cause for delay

3. Safety system surveillance index: date and duration of safety system inoperability, safety system identification, description of inoperability, nature of inoperability discovery (walkdown/testing/other)

4. LCO index: date and duration of LCO

Spain/CSN

Indicator Area: E6 Maintenance.

Performance Indicator(s) in use:

Maintenance problems
Definition: The intent of the maintenance problems cause category is to capture the full range of problems which can be attributed in any way to programmatic deficiencies in the maintenance functional organization.

Activities included in this category are maintenance, testing, surveillance, calibration, and radiation protection. The deficiencies noted within this category generally lead to inadequate or improper upkeep and repair of plant equipment and systems or inadequate programs to monitor equipment and plant performance as necessary to prevent hardware failures.

Assessment of indicator results:

See generic information

Discussion:

Experience and challenges in transforming the indicator data to meaningful information for decision making:

CSN does not have a specific indicator in Maintenance area. We have one sub-indicator, “Maintenance Problems” included in a broad indicator category (Cause codes).which can give us information about events caused by maintenace activities.

Although data are collected from all LERS, in the majority of the cases data are obtained from a detailed analysis of the event, asking the plant and using information provided by resident inspectors. This aspect makes it difficult, in some cases, to obtain reliable information about events caused by maintenace problems

Supplemental Information:
"Maintenace problems" is the broadest of all "cause categories" and is intended to identify areas where improved plant performance is possible through a program which includes such things as increased attention to detail, more frequently performed surveillances, or the use of better trained personnel. The Maintenance Problems Cause category is used to track the performance of plant management's capability to properly repair failed equipment and to preclude equipment failures through improved preventative maintenance programs. Additionally, as an indication of potential maintenance problems, hardware failures which cannot be readily attributable to any preventable cause are also included in this category.

Maintenance related errors are often coupled with other cause categories such as Other Personnel Errors or Administrative Control Problems. The Maintenance Problems category is used in conjunction with other categories when an error occurs while a maintenance, surveillance, or test activity is in progress, whether the error was the result of a deficient procedure or a personnel error. It is used without other cause categories if the Maintenance Problem is not due to a deficient procedure or a personnel error.

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Sweden/SKI

Indicator Area: E6 Maintenance

Performance Indicator in use:

Events caused by maintenance deficiencies
The indicator is included in SKI MTO-indicators, indicator area E1(Human Performance).

All comments provided for the MTO-indicators apply for this indicator.

The indicator is in use (maturity level 3) but depending on the stakeholders different methods to present the result will be evaluated.

Performance Indicator in use:

RATIO OF PREVENTIVE VS TOTAL/ CORRECTIVE MAINTENANCE

The indicator relates to the ratio CM/(CM + PM) where CM stands for corrective maintenance and PM for preventive maintenance. This indicator is based on work orders and is monitored, for feasibility purpose, for three safety systems at one unit.

The systems monitored are:

- Containment spray and cooling system
- Low pressure emergency core cooling system
- Auxiliary feed water system.

The calculations of the ratio CM/(CM + PM) are made for two alternatives:

- The quarterly values of the ratio
- The yearly rolling values of the ratio presented quarterly.

The indicator has been selected to indicate how proactive the organisation is in maintaining the technical status of safety systems.

The indicator is in use (maturity level 3) but depending on the stakeholders different methods to present the result will be evaluated.

Assessment of indicator results:
The indicator is assessed quarterly by use of signal diagrams and colour coding (green, yellow and red) for the different ratio estimates. The chosen signal values are somewhat different, reflecting the averaged character of the yearly rolling values. The thresholds are only used for colour coding and without specific significance, yet, for eventual actions by SKI. The colour coding is primarily used for providing a fast overview/trending of the indicator.

Discussion:

Experience/challenge in collecting the data: The “work order” indicator is presently based on the number of orders established for the different maintenance activities on the chosen systems. The correctness of the indi presupposes a reliable maintenance management system at the plant. SKI is confident that the unit monitor a trial basis, has established such a system.

Experience/challenges in calculating indicator: The indicator CM/(CM + PM) is rather simplistic and non-controversial, and is based on transparent calculations of the number of work orders.

Experience/challenge in transforming the indicator data to meaningful information for decision making: The indicator is not mature yet for the establishment of fixed thresholds related to subsequent regulatory actions. Aggregated, the indicators provide however SKI with enough information which, together with other findings (for example from plant inspections) might result in regulatory action(s).

The presentation of signal diagrams needs to be adjusted for different stakeholders.

Leading or lagging indicators? The indicator coupled to work orders is a lagging indicator. It could be that the indicator is leading by representing the organisation ability to keep a good physical status of the plant/plant systems.

To what extent are these indicators risk-informed? This indicator is not risk-informed.

Limitations/benefits of current indicator: SKI judges that the monitoring of the ratio CM/(CM + PM) well fits into SKI’s safety indicator system. The ratio is a suitable indicator of how proactive the organisation is and how many resources the management devotes on preventive maintenance, in order to guarantee a good physical status of the plant/plant systems. Valid for the unit studied, so-called active rounds represent a major part of the preventive efforts the organisation puts on the surveillance of the plant system.

The monitoring covers the five latest years and is judged of significant value in a robust system of safety indicators. It could however be even more interesting to monitor the man-hours and/or money spent on corrective, respectively preventive maintenance. The latter has the disadvantage to be viewed by the licensees as proprietary information, thus not suited for public disclosure or publishing. SKI has started a discussion with the licensees as to which variable(s) of the work orders to monitor in the future.

Supplemental Information:
On the whole, the indicator provides SKI with a valuable overview of the repartition on the different systems of the maintenance efforts at the plant/unit. Considering that the maintenance efforts spent today at a unit will affect the availability of the unit systems in the near and longer terms, the signal diagram presenting yearly rolling values of the indicator is judged more convenient and well-founded that the diagram presenting the strict quarterly values of the same indicator.

Performance Indicator under development:

SKI IS ASSESSING THE POSSIBILITY TO EXTEND TO OTHER LICENSEES THE MONITORING OF THIS INDICATOR, AND TO INCREASE THE NUMBER OF SYSTEMS ACTUALLY FOLLOWED. THIS IN ORDER TO BE ABLE TO COMBINE ALL THE SYSTEMS NEEDED IN PERFORMING MAIN SAFETY FUNCTIONS, ALLOWING SKI TO MONITOR FOR EACH PLANT THE STATUS AND OPERATIONAL STRENGTH OF THESE FUNCTIONS. THIS ISSUE IS PRESENTLY MATTER FOR INTERNAL DISCUSSIONS WITHIN SKI, AND THE LICENSEES WILL BE INVOLVED LATER THIS YEAR.

Information related to indicator area E7 (Self-assessment)

Finland/STUK

Indicator Area: E7 Self-assessment

Performance Indicator(s) in use:

STUK has not yet included indicators of licensee self-assessment into its indicators system.

Performance Indicator(s) under development:

STUK is considering including indicator(s) of this area into its indicator system.

Hungary/HAEA NSD

Indicator Area: E7 Self-assessment

Performance Indicator(s) in use:

1. Number of independent internal audits

Definition = Recording the number of independent, internal inspections accomplished at certain organizational units and processes of the operator.

SIISI=NAIISI/NPIISI; SIISI – share of independent, internal safety inspections, NAIISI – number of achieved independent, internal safety inspections, NPIISI – number of planned independent, internal safety inspections.

Maturity = 2

2. Corrective measures of quality assurance audits

Definition = Annual share of violation of the implementation deadlines accepted or prescribed by the regulator for the corrective measures, determined based on the investigations of the reportable events, averaged for the plant.

Maturity = 2

Assessment of indicator results:

1. Green: > 95 %
Yellow: 70-95 %
Red: < 70%

2. Green: < 10 %
Yellow: 10-40 %
Red: > 40 %

Information related to indicator area E8(Operating experience feedback)

Belgium/AVN

Indicator Area: E8 Operating experience feedback

Performance Indicator(s) in use:

Recurring events
Definition = The number of reported events during the previous calendar year, for which a deficiency in the operating experience feedback process was identified as one of the contributing causes or root causes (at unit and site level).
Maturity = 2

Assessment of indicator results:

Indicator results are assessed yearly by trending. No thresholds for unacceptable plant performance or for increased regulatory attention have been defined.

The assessment of indicators in this area is supporting and complemented by thematic inspections of the licensee operating experience feedback process.

Discussion:

Experience and challenges in collecting the data:

All reportable events, which are registered in AVN's incident database, are screened for causes and root causes indicating recurrence of events. The robustness of indicator data collection depends on the reliability of the event reporting system (see area A1) and the quality of the incident analysis (including recognition of recurrence).
Experience and challenges in transforming indicator data to meaningful information for decision making:

The purpose of this indicator is to monitor the performance of the operating experience feedback process, through the recurrence of events. As the indicator is only built on reportable events, for which a certain threshold related to safety impact exists and usually (root) cause analysis has been performed, it might be that the indicator is not showing a correct picture of event recurrence and of efficiency of the plant operating experience feedback process. In fact low-level events or occurrences, which are not passing the threshold for reporting and are usually not analysed for causes, might have a much larger degree of recurrence.
Furthermore, it has been noticed that the indicator monitoring event recurrence at the station/site level might have more statistical significance for trending purposes (at both sites the operating experience feedback process is a common i.e. site-wide process).

Leading or lagging indicators?: This indicator is considered to be a leading indicator.

To what extent risk-informed?: The indicator is not risk-informed (risk significance might vary between events and not all events relate to core melt risk).

Limitations and benefits of current indicators: The main limitations reside in the fact that the indicator is only capturing "top events". Its real benefit needs still to be investigated.

Supplemental Information:

This indicator is considered to be a low-level type of indicator, which is preferably aggregated/combined with other indicator data for assessment of plant safety performance. Aggregation principles have still to be examined.

Performance Indicator(s) under development:

During the set-up of the PI pilot program in 2001, it was intended to develop also an indicator based on licensee event reporting delays. Due to uncertainties about the LER reporting criteria (including events for which a LER is requested and acceptable reporting delays) the further development of this indicator was put on hold but might be reactivated in the future.

Finland/STUK

Indicator Area: E8 Operating experience feedback

Performance Indicator(s) in use:

STUK has not yet included indicators of operational experience feedback into its indicators sytem.

Discussion:

Data would be easyli received from licnesees' annual reports on operational experibce feedback.

STUK shoul improve its effectiveness in the area.

Performance Indicator(s) under development:

STUK is considering including indicator(s) of this area into its indicator system.

Hungary/HAEA NSD

Indicator Area: E8 Operating experience feedback

Performance Indicator(s) in use:

1. Corrective measures of investigations

Definition = Annual share of violation of the implementation deadlines accepted or prescribed by the regulator for the corrective measures, determined based on the investigations of the reportable events, averaged for the plan.

SDCMI=NDCMI/WNCMI; SDCMI – share of delaying corrective measures of the investigations,

NDCMI – number of delaying corrective measures of the investigations, WNCMI – whole number of corrective measures of the investigations.

Maturity = 2

2.-3.-4. Delay of notification /report / investigation of events

Definition = Tracing the notification / reporting / investigation delay of the reportable events.

Maturity = 2

5. Recurring events

Definition = Number of those events that already occurred under the same conditions or in consequence of the same cause.

Maturity = 2

Assessment of indicator results:

1. Green: < 10 %
Yellow: 10-40 %
Red: > 40 %

2.-3.-4. Green: No delay of notification
Yellow: 0 % - 5 % notification/year
Red: > 5 % notification/year

5. Green: < 4 event/year
Yellow: 4-7 event/year
Red: > 7 event/year

Slovenia/SNSA

Indicator Area: E8 Operating experience feedback

Performance Indicator(s) in use:

1. Number of safety issues

Definition: number of safety issues that are applicable for plant. Safety issue can be opened regarding plant operation experience feedback or can be triggered by plant independent safety evaluation group who is in charge for tracking international praxis and legislation. Only the safety issues upon which intensive work/projects by plant itself or contractors are performed are counted.

Maturity: 1

2. Number of safety evaluations

Definition: number of:

- safety evaluations screening
- safety evaluations
- modifications (safety evaluations approved by SNSA) that have not been performed for more than 3 months (modifications that could be performed only during the nearest outage are not counted)

Maturity: 1

3. RCA event investigations performed by plant

Definition: number of RCA event investigations performed by plant.

Maturity: 1

4. Evaluation of external occurrences

Definition: number of events at other plants that undergo plant reviews/analysis

Maturity: 1

5. Recurring events

Definition: number of similar or recurring deviations, failures or events. Deviations, failures and events that can be prevented by appropriate corrective actions are counted.

Maturity: 1

Assessment of indicator results:

2. Number of safety evaluations

Threshold: 3

Trend value: 4

5. Recurring events

Threshold: 3

Trend value: 4

Discussion:

experience and challenges in collecting the data:

Data collecting is performed by plant. Additional information shall be reported regarding PI:

1. Number of safety issues: identification of safety issue, deadline for safety issue solution and appropriate action
2. Number of safety evaluations: identification of safety evaluation
3. RCA event investigations performed by plant: date of event, event categorisation with regard to plant procedure, short event description
4. Evaluation of external occurrences: short event description
5. Recurring events: short event description

Discussion (continued):

experience and challenges in transforming the indicator data to meaningful information for decision making:

3. RCA event investigations performed by plant

Indicator is also used for SNSA self-assessment. SNSA developed internal procedure for performing independent RCA analysis of plant events. Results of RCA are compared to plant RCA and if there is a need, additional corrective action are proposed or requested to be performed by plant. Since SNSA approach is rather new and decision making to start RCA is different to one of the plant, number of RCA performed by SNSA and plant can be also used to evaluate SNSA adequacy of procedure.

Information related to indicator area E9 (Backlog of safety issues)

Slovenia/SNSA

Indicator Area: E9 Backlog of safety issues

Performance Indicator(s) in use:

1. Number of safety issues

Definition: number of safety issues that are applicable for plant. Safety issue can be opened regarding plant operation experience feedback or can be triggered by plant independent safety evaluation group who is in charge for tracking international praxis and legislation. Only the safety issues upon which intensive work/projects by plant itself or contractors are performed are counted.

Maturity: 1

2. Number of safety evaluations

Definition: number of:

- safety evaluations screening
- safety evaluations
- modifications (safety evaluations approved by SNSA) that have not been performed for more than 3 months (modifications that could be performed only during the nearest outage are not counted)

Maturity: 1

Assessment of indicator results:

2. Number of safety evaluations
Threshold: 3

Trend value: 4

Discussion:

experience and challenges in collecting the data:

Data collecting is performed by plant. Additional information shall be reported regarding PI:
1. Number of safety issues: identification of safety issue, deadline for safety issue solution and appropriate action

2. Number of safety evaluations: identification of safety evaluation

Information related to indicator area G (Investments)

Finland/STUK

Indicator Area: G Investments

Performance Indicator(s) in use:

Annual investments to plant modifications and maintenance
Definition = Investments on plant maintenance and modification in current value of money improved by the building cost index.
Maturity = 2

Assessment of indicator results:

Data is received once a year about three months after the turn of the year. Indicator is assessed by trending in connection of annual overall assessment of the safety of nuclear power plants.

The indicator shows the relative fluctuation of investments. Sums in Euro are business information of the companies involved, not to be published within STUK' indicators.

Discussion:

Experience and challenges in collecting the data and calculating:

The data has been received directly from the management of plants.

The fluctuation in the indicator clearly shows the investments made in the plants' power upgrades and modernisation projects. The licensees are not so willing to discuss about numbers detailed.

Transforming indicator data to meaningful information for decision-making:
Licensee's annual investments is one of the newest indicators included into the STUK indicator system. The indicator was taken along some years ago to indicate and follow the potential influences and consequences of the deregulation of electric market and the possible increase of competition. The purpose of the indicator is to observe whether there is significant reduction in investments that would reveal a general change in the investment policy.

Use of the indicator should not be mixed with the general requirement that safety should take precedence over the production of electricity. Manifestation 'STUK does not take into account economical factor' means, that in its decision making STUK always sets the safety in the first place regardless of the costs.

Whether these indicators are seen as leading or lagging indicators: *This indicator is considered to be lagging*

To what extent these indicators are risk-informed: *This indicator is not risk-informed eventhough many of the improvements conducted are base on PSA calculations.*

Limitations and benefits of current indicators:

The scope of indicator "investments" is: Utilities' annual investments to plant modernisation and renovations in a contemporary value of money improved by the building cost index. The indicator includes all recent acquisitions at the plants and safety improvements are not sorted out.

Supplemental Information:

These indicators are considered to be "low level" indicators.

These indicators are included in STUK's indicator system into the principal subgroup I "Quality and Safety Culture".

Other indicators of STUK's indicator system belongin to the principal subgroup I illustrate the condition of the plant and performance of different functional groups at the plant; such as functioning of the maintenance unit (failures and their repairs, unavailability of saty systems), safety attitude of operation (non-compliance with the TS), performance of operation unit (events and their causes, risk significance of events), performance of radiation protection unit (doses and releases) and currency of plant documentation.

Performance Indicator(s) under development:
It has been assessed how the indicator could be changed more informative on safety improvements based on research and/or the latetstknowledge on modern technology.

Appendix 5 – Summary of activities and studies in and outwith the Task Group

This appendix is composed of three parts, covering

5.1 Summary of the meetings and the workshop of the CSNI/CNRA Task Group itself

5.2 Summary of other recent and relevant CSNI/CNRA work / meetings

5.3 Other relevant international work in the area of SPIs.

5.1: Summary of the Meetings and the Workshop of the CSNI/CNRA Task Group

First Paris Meeting, April 2002

The participants each provided a brief description of the SPI System at their organisation and its usage, and the group sought to identify a list of SPIs that could be used by all regulators. The group agreed that many regulatory bodies of the OECD countries have considerable experience in developing and using performance indicators. In several cases, performance indicator data have been collected for a significant period of time and the use of indicators has been gradually improved based on experience.

Seven indicators were identified that were used by the majority of regulators represented at the meeting and were assessed against the following basic criteria for selecting and using a PI system: the indicators should provide an objective indication of safety performance; the indicators should be easily understandable; and the data needed should be easily obtainable from existing data collection systems. The intent at that time was to produce a list of SPIs that would be applicable to international exchange amongst interested regulators. The indicators identified for consideration were: Power reductions, Scrams, Availability of safety systems, Fuel Integrity, Reactor coolant system integrity, Collective radiation exposure and *Significance of events.* "*Significance of events*" was eventually excluded, for the time being at least, because the definition of “significance” varies very much, even when PSA is used as the main “significance” measure.

Several difficulties were identified by this study: including differences in the definitions of the SPIs used by the various organisations. This lead the Task Group to advocate caution that the SPIs should preferably be used for comparison of trends within plants, rather than comparing plants, either in a country or between countries. But the overall conclusion was that the minimum set of PIs identified was commended to all CNRA/CSNI member countries and experience with the use of these indicators should be recorded. The Task Force identified other work being done in the field, particularly by IAEA and WANO and recommended co-operation with them.

Berlin Meeting, November 2002

In this meeting the change in mission statement from CNRA/CSNI was examined and discussed, and the work of WGIP, TGRE, IAEA and CNRA’s LSA group was examined in the context of the relationship between them. The group decided on relations with the TGRE and, since the LSA group was in recess, to factor their conclusions into its own work. It agreed to use the WGIP findings as a starting point for its work. It also agreed to use IAEA Tecdoc 1141 terminology and definitions to the extent possible.

SKI and STUK led a mini-workshop on the indicators they use, their definitions and collection, and how the information was used in regulatory decision-making. STUK reported that it was not using targets for most indicators and SKI reported that it was using colour coding and moving average tracking on mostly WANO indicators.

A decision was taken to construct a survey and consensus was reached on the items being covered by that survey. The survey template was refined in the months following the Berlin meeting.

Stockholm Meeting, June 2003

The Task Force discussed the regulatory effectiveness indicators and the CNRA report about licensee self-assessment (LSA), the final version of which was to be made available to the task force. It also discussed USNRC’s development of mitigating systems performance indicators, MSPIs, which offered a better, combined treatment of unreliability and unavailability.

Plans for the Granada workshop to be organised in 2004 and progress on the first questionnaire were discussed, as was the mechanism for collating and presenting findings. For the time being, no second round of questionnaire was planned, but the need for countries to revisit their replies in the light of discussions was agreed.

There was a report and discussion on the EC SPI Concerted Action Workshop held in Brussels, May 13, 2003.The Task Group also discussed the upcoming IAEA meeting on performance indicators for regulatory bodies in November 2003. The goal of that meeting was to be able to define a common subset of indicators presented in Tecdoc-1141 to be used by the regulatory agencies. A draft prepared by consultants to IAEA for such a system was to be presented during the meeting.

Second Paris meeting, February 2004

The majority of the second Paris meeting, in February 2004, was taken up by the organisation of the Granada workshop. Progress with the first questionnaire was also discussed and ways to continue the work identified.

Those that were present at the IAEA November 2003 Technical Meeting reported that its conclusions were that the regulatory authorities should use indicators as a part of the evidence they gather in judging a licensee's safety performance (including inspections, scrutinising documents, interviewing staff, etc.). Overall, there is still work to be done both nationally and internationally and no consensus had emerged on a common sub-set of the Tecdoc 1141 indicators for use by regulators.

Granada Workshop, May 2004

The Task Group organised, in cooperation with CSN a workshop on "Regulatory Uses of Safety Performance Indicators", held in Granada in May 2004 attended by 53 experts from the industry, regulators and technical support organizations in 18 countries.

The general observation was that all participating regulators used or intended to use SPIs in one way or another in their regulatory oversight as a tool to aid in decision making. It is generally accepted that there are other, complementary, sources of information on licensees' safety performance. Therefore, building indicator systems is not in itself an objective. Rather, the indicator system should be constructed so that indicators would provide decision makers with as much good quality information as possible for a variety of safety related decision-making situations. Thus it is clear that the needs of each regulatory body will determine the scheme of SPIs it will use. As licensees have different motivations than regulators for using SPIs, their suites or schemes of SPIs may differ from those of their regulators.

The experience, maturity and extent of dependence on SPIs and the openness of them to the general public vary strongly from country to country. Some countries were concerned that placing to much emphasis on SPIs could lead to "tunnel vision" in managing indicators, i.e. only attempting to minimise or maximise their values and forgetting other contributors to safety ("managing indicators and not safety"). However, it also seems that countries that have experience with indicators are learning to overcome this problem and are "Regulating safety with the aid of indicators".

Almost all countries seem to use the indicators to steer inspections, but only a minority use their systems in order to provide policy makers with information. This latter use means making at least part of the SPI system public. Different stakeholders with differing needs partly explain national differences in using indicators, and this is one reason impeding universal indicator systems. Experience from using indicators as a communication tool with e.g. Ministries and Parliament is still relatively sparse but in countries that have done so there is mostly very positive feedback.

The workshop discussed: misunderstandings with how indicators should be calculated or measured; trending; the use of thresholds; leading and lagging indicators; colour coding and its dangers of giving a wrong message to the public; PSA based indicators; and safety management and culture indicators. It noted that both regulatory and utility indicator systems tend to be hierarchical. This property is basically ideal: there are strategic parameters and decisions to be made and lower level parameters and decisions. Regulators and their stakeholders may require different information. However, a hierarchical system sometimes implies combining lower level SPI values by arithmetical means to form upper level aggregated indicators and caution has to be exercised in order not to loose functionality and transparency.

A theme, which was repeated by many participants, was that an indicator system needs a regular review. This is because the indicators may loose their information and safety management value over time.

Also, searching for a perfect SPI set was seen as not necessarily relevant – some saw it as more important to have a system which, even if imprecise, provides an aid for decision making in each country. Consequently, there was no agreement of a need for a “universal comparative SPI set”. Generally, experience shows that extreme caution is required when SPIs are compared – even in case of WANO indicators. This especially applies to comparisons between different designs and at an international level, where no access to basic data may be available. SPIs are better used for national assessments and decision-making rather than for international benchmarking.

An item raised in discussions was the need for indicators for safety management and safety culture. No clear agreement emerged about what the indicators of safety management and especially safety culture are or even whether such indicators could be developed. There was a view amongst some delegates, particularly from utilities, that indicators of safety management and culture may be seen as belonging to the domain of utility organisation, and consequently the regulatory bodies may not wish to go too far to that domain except by oversight and inspections. However, it is agreed generally that looking for indicators for human and organisational performance and safety management effectiveness is indispensable. It has a clear coupling to self-assessment and continuous development of both utility and regulatory organisations.

Prague Meeting, February 2005

The meeting's purpose was to discuss the completion and reporting of the work of the Task group. Progress on questionnaires was discussed: The first questionnaire gave useful but generic conclusions. The preliminary general conclusion from the second questionnaire was that the results provide an update or confirm results of the first. Seven countries had replied on a general level, but only four reported detailed experience with individual indicators. Consequently, little information was made available to the report-writing group on experience gained with use of PI-systems and on experience with specific indicators.

The task force discussed the output of the questionnaires and remaining actions: to complete the second survey with additional country inputs; a further analysis of the second survey results when input from member countries is more representative; validation of compilation of answers and summary table by member countries (update to situation of 2005 if necessary); reach agreement on common structure for representation of PI’s in use in member countries in task report.

An outline of the Task report was also discussed, in terms of: comprehensiveness; the layout; the chapter on experience with SPIs; other areas for brief review; conclusions and the timetable and programme for completion of the Task group's report.

A discussion was held on the structure of the SPIs – the structure used in the Questionnaires differed from that of Tecdoc 1141. It was decided that a mapping exercise be done to plot the coverage of regulators' SPIs into Tecdoc 1141 structure and a further structure based on barriers. The exercise allows to more easily compare PI systems in place in different countries including their scope/comprehensiveness.

Brussels meeting, August 2005

The meeting concentrated upon extracting messages from the two questionnaires and upon giving advice to the report authoring group. The outline of the report was discussed. The time line of the remaining activities was decided in Brussels.

The report authoring group

The authoring group for this report had three meetings outside the official meetings.

5.2: Summary of Other Recent and Relevant CSNI/CNRA Work / Meetings

WGIP Baltimore workshop

CNRA's Working Group on Inspection Practices (WGIP) holds workshops on inspection topics every two years. In the Baltimore workshop of 2000, (reported in ***Regulatory Inspection Activities Related To Radiation Protection, Long Shutdowns And Subsequent Restarts, And The Use Of Objective Indicators In Evaluating The Performance Of Plants, Workshop Proceedings, NEA/CNRA/R(2001)4 & 5***) one of the topics studied was "Use of objective indicators by the regulatory authority in evaluating the performance of plants". The workshop did not propose any universal PIs, but explored the questions:

- what are the objectives of using PIs?;
- what are the benefits and limitations?;
- what criteria can be used for designing PIs?; and
- how to combine PIs with other inspection and regulatory insights?

The workshop agreed that it was meaningless to use PIs for their own sake without having a clear reason for using them and reasonable assurance that they would deliver the objectives. There was a spectrum of usage; at one end a concentration on “outcomes”, at the other end was the concentration on "process". At one end a small number of measures, at the other, a large number of finely-focused measures with which to monitor trends, understand the effects of individual changes and monitor the licensees safety management system (contributing to self improvement). Various regulators worked at various parts of this spectrum.

The workshop established various uses of PIs:

- as a structured, formal process for communication between licensee and RB;
- to identify off-normal conditions, thus triggering regulatory actions;
- to improve the focus of regulatory activities (in combination with other insights and processes);
- to inform stakeholders (who, and to what degree varies radically!);
- to provide a measure of the effectiveness of other regulatory tools; and,
- to stimulate the ability of licensees to self-improve.

Further, the workshop listed the attributes of good PIs and the pitfalls and difficulties of their use.

Madrid Specialist Meeting in 2000

On the initiative of the NEA/CSNI Working Group on Operating Experience (WGOE), and with the cooperation of WANO and IAEA, the Spanish CSN hosted a workshop in Madrid in 2000 (Reported in ***NEA/CSNI/R(2002)2& 3 - Specialist Meeting on Safety Performance Indicators, Proceedings, Madrid,***

Spain, October 17-19 2000). A number of specialists from industry, regulators and international bodies in 19 countries met to make a broad presentation of the state of the art in the development and use of SPIs.

The first report of the CSNI Task Group

In its first report on performance indicators, ***NEA/CSNI/R(2001)11 - Summary Report on the Use of Plant Safety Performance Indicators***, the CSNI/CNRA Task Group referred to the conclusion that for regulatory bodies, a useful approach is to consider them under the two headings: direct and indirect indicators. The overriding criterion for any good PI is that it should be suitable for the purpose for which it is intended (fit for purpose) and measurable. Other criteria are discussed and the report importantly pointed out that indirect indicators are the most difficult to interpret in terms of the "safety value" added by the regulator.

Task Group on Licensee Self Assessment

A CNRA ad hoc task group, in 2003 produced a report: ***NEA Publication 04728, Nuclear Regulatory Review of Licensee Self-assessment (LSA), 2003***. This defined LSA as "all the activities that a licensee performs in order to identify opportunities for improvements". It suggests that LSA includes a systematic review at all levels in an organisation not only to identify weakness and deteriorating performance, but also to drive improvement by identifying potential improvements to plant, procedures or practices. It thus identified self-assessment as an integral part (but not the whole) of a management system. Thus a licensee's measurements of its own safety performance can be seen as an integral part of its system for managing safety and self improvement and should be part of a system which aims to improve safety, efficiency and economic performance. In addition to its contribution to improved safety performance, the Group concluded that the insights LSA produces and the potential improvements in safety performance offers regulators the opportunity for increased regulatory effectiveness through the opportunities for adjustments to their regulatory oversight.

Task Group on Regulator Effectiveness

In the NEA report ***NEA/CNRA/R(2001)3 - Improving Nuclear Regulatory Effectiveness***, the Task Group on Regulatory Effectiveness (TGRE) concluded that *given the necessary authority and resources as prerequisites, the regulatory body is effective when it*:

1 Ensures that an acceptable level of safety is being maintained by the regulated operating organisations;

2. Develops and maintains an adequate level of competence;

3. Takes appropriate actions to prevent degradation of safety and to promote safety improvements;

4. Performs its regulatory functions in a timely and cost-effective manner as well as in a manner that ensures the confidence of the operating organisations, the general public, and the government; and

5. Strives for continuous improvements in its performance.

The above attributes were developed from discussions in a previous IAEA Peer Discussion Group (***IAEA Peer Discussion Group (PDRP-4): Assessment of Regulatory Effectiveness***).

The TGRE report also concluded that the adoption of quality systems has the potential to contribute to the continuous improvement of a regulator's effectiveness and noted that relevant measures of performance are necessary prerequisites for quality systems. A performance-based management approach applied to decision-making processes which also permeate its organisational culture and performance history enables the regulatory body to be effective by establishing and promoting the above elements.

The report stated that performance indicators (PIs) can be categorised in several ways. Clearly, regulators must oversee licensee's safety performance and this is a primary usage of SPIs. But, in addition, when considering regulator's own effectiveness, CNRA/CSNI considers that the most useful approach is to consider them under two headings: direct and indirect indicators - Two simple definitions were adopted by CNRA – *Regulatory effectiveness* means *"to do the right work"*; *Regulatory efficiency* means *"to do the work right"*. Direct PIs attempt to measure the outputs of a regulator's own activities and tend to use data generated within the regulatory body itself, they tend to focus on measuring *efficiency* rather than *effectiveness*. Indirect PIs seek to deduce the effectiveness of the regulatory body in terms of the outcomes of its activities. It thus focuses on the stakeholders of the RB and principally on the safety performance of licensees. Thus, indicators of the safety performance of plants (SPIs) comprise the major part of a regulator's indirect effectiveness indicators.

The advantage of direct PIs is that they can provide a relatively unambiguous measure of relevant aspects of the regulator's performance, they can be considered generally to be measures of efficiency. The problem with most of them is that they measure activity and do not provide insights into the regulatory body's fundamental mission and desired outcomes in terms of risk reduction or safety achievement amongst its licensees. On the other hand, while indirect PIs can provide information useful for regulatory purposes, they must be treated with great caution in deducing a regulator's effectiveness, as it is difficult to isolate the contribution of the regulatory body from that of the licensee, to the achievement of the eventual outcome. The first and third of the above attributes are primarily outcomes and have the potential to be amenable to indirect measurement.

In parallel with the joint CNRA/CSNI Task group on SPIs, which identifies one **secondary** purpose of SPIs as being to provide indirect measures of a regulator's effectiveness, TGRE continues the development and evaluation of potential direct indicators of regulatory efficiency and effectiveness, based on the attributes defined above.

TGRE conducted a one-year pilot project with regulators from nine NEA member states which proved the usefulness of direct performance indicators in helping to assess and communicate regulatory efficiency and effectiveness. In the NEA report on this project, ***NEA Publication 03669, Direct Indicators of Nuclear Regulatory Efficiency and Effectiveness - Pilot Project Results. 2004***, TGRE shows the development of a set of direct PIs based on the attributes of regulatory effectiveness given in Appendix 2. TGRE confirmed the view that maximum benefit can be derived from the use of direct PIs if they are part of an established quality management model. PIs included in the pilot were being used to: communicate with stakeholders; monitor internal processes and budgeting; and, when necessary, to assist strategic development and to manage change. Their use should be part of a continuous improvement process involving all stakeholders, including regulatory staff.

At the conclusion of the pilot project, a joint NEA/WANO international forum of regulators, industry and other stakeholders (***Measuring, Assessing and Communicating Regulatory Effectiveness, MACRE 2003***) was held, which validated the work of the task group and provided helpful insights. It recommended that regulatory bodies utilise direct PIs to the extent possible and remain active in the area to continue development of an integrated framework for regulatory efficiency and effectiveness.

5.3: Other Relevant International Work in the Area of SPIs

IAEA Tecdoc 1141

IAEA has had a project in place for some time to establish a methodology for inferring, from measurements, the level of safety at a nuclear power plant. Tecdoc 1141 was issued in May 2000 (and is due for revision) and is primarily for the operators of plants to augment other methods of evaluating safety performance strengths and weaknesses and monitoring changes and trends. Three key attributes were identified, which, it is believed, are associated with plants that operate safely. These are that plants operate smoothly, operate with low risk and with a positive safety attitude. For each of these attributes, sub-attributes are identified and about 80 indicators relating to them proposed. The Tecdoc also gives consideration to (but does not reach conclusions on) consolidating the detailed indicators together to form overall indicators and using thresholds and colour coding. It reports on a number of pilot studies carried out by utilities across the world.

- *Plant operates smoothly* - The first means of preventing accidents is to strive for high quality plant operations with infrequent deviations from the normal operational state. The overall indicators chosen to represent smoothness of operation are: operating performance - state of structures systems and components - events.
- *Plant operates with low risk* - This safety attribute considers the overall risk of the plant and can be monitored using a deterministic approach and a probabilistic approach. The proposed framework presents both approaches for monitoring this safety attribute. It should be noted that the probabilistic and deterministic approaches are not mutually exclusive, but rather, complementary.
- *Plant operates with a positive safety attitude* - The overall indicators chosen to monitor the attitude of the plant staff towards safety. These indicators are ‘attitude towards safety’ and ‘striving for improvement’.

IAEA Technical Meeting on “NPP Safety Performance Indicators for Use by the Regulatory Organizations” November 2003

IAEA is seeking to build on its Tecdoc 1141 on Safety Performance Indicators for NPPs (which itself is due for revision shortly), by examining the needs of regulators and whether using the same indicators, or a subset of them can satisfy these needs. A Technical Consultants Meeting (CM) had been held in June 2003 which started with the assumption that the same framework could be used by regulators, as is proposed in the Tecdoc for utilities. It identified and graded a number of candidate indicators for use by regulators and the TM commented in detail on these.

The TM was of the view that the use of SPIs by licensees can be an important part of their delivery of safety, ideally as part of a safety management system and encouraged licensees to establish systems of SPIs. It endorsed the view that the SPIs used by licensees need to be comprehensive and systematic and recognised that the framework proposed in the Tecdoc and the detailed definition of specific indicators therein are not prescriptive, but guidance, and that each regulator needs to use its licensees’ SPIs in a way that is consistent with their own regulatory processes.

With respect to regulators’ needs, the TM accepted the view that regulators should use SPIs as a part of the evidence they gather in judging a licensee’s safety performance (other evidence is gathered from inspections, scrutinising documents, interviewing staff, etc.). The TM agreed that it is desirable that the regulators' indicators mirror (or if possible are the same as) some of the licensee’s SPIs. Amongst other things, this reduces the burden of data collection and increases the clarity of communication between RB and licensee: thus the definitions of the indicators for common use should arise from an agreement between regulator and licensee.

The TM commented on the problems of aggregation of SPIs and the setting of thresholds, and noted that the balance between the cost and resources needed to oversee SPIs against the benefit of improved oversight will condition the size of the sub-set of SPIs a RB might use.

WANO

The WANO Performance Indicator Programme supports the exchange of operating experience information by collecting, trending and disseminating nuclear plant performance data in 9 key areas, only some of which are directly linked to safety.

The data is gathered for a set of quantitative indicators of plant performance. These indicators are intended principally for use as a management tool by nuclear operating organisations to monitor their own performance and progress, to set their own challenging goals for improvement, and to gain additional perspective on performance relative to that of other plants. It is expected that their use will encourage emulation of the best industry performance. It should also further motivate the identification and exchange of good practices in nuclear plant operations.

It is now widely recognised that a good set of overall performance indicators can provide a partial, but important and useful, measure of how well a nuclear plant is managed overall. Currently, 99 percent of the operating nuclear power plants report at least seven indicators.

The following are the WANO performance indicators:-

- *Unit Capability Factor* - the percentage of maximum energy generation that a plant is capable of supplying to the electrical grid, limited only by factors within control of plant management.
- *Unplanned Capability Loss Factor* – the percentage of maximum energy generation that a plant is not capable of supplying to the electrical grid because of unplanned energy losses, such as unplanned shutdowns or outage extensions.
- *Forced Loss Rate* - the percentage of energy generation during non-outage periods that a plant is not capable of supplying to the grid because of unplanned energy losses, such as unplanned shutdown or load reductions.
- *Collective Radiation Exposure* – Person-Sieverts per unit
- *Industrial Safety Accident Rate* – the number of accidents that result in lost work time, restricted work, or fatalities per 200,000 workhours.
- *Unplanned Automatic Scrams per 7,000 Hours Critical*.

WANO monitors three additional performance indicators - defined in a manner that reflects differences in plant-specific designs, configurations, or operational practices - this data can not be summarised across reactor types:-

- *Safety System Performance* - the availability of three important standby safety systems at each plant.
- *Fuel Reliability* - monitors progress in preventing defects in fuel cladding.
- *Chemistry Performance* - provides an indication of progress in controlling chemical parameters to retard deterioration of key plant materials and components.

OECD Environment, Health and Safety Publications

In the non-nuclear field, **OECD** has produced an interim "Guidance on Safety Performance Indicators" as part of its work on guiding principles for chemical accident prevention, preparedness and response which provides some useful discussion (OECD Environment, Health and Safety Publications – Series on Chemical Accidents No.11).

European Union

The **EU** financed a concerted action group “Approaches and Recommendations for the Application of Safety Performance Indicators for Nuclear Power Plants” dealing with PSA-related indicators. A questionnaire with replies from 10 regulators and 13 utilities had been used, the main insights being that:

- there is uncertainty as to the adequacy of current SPIs in measuring safety performance;
- there is a view that current SPIs are incapable of measuring regulatory and inspection effectiveness and are inadequate as means for communication with the public;
- it would be useful and desirable to identify "lead indicators" and measure those;
- the approaches should be more directly related to risk through PSAs; and
- there is a problem with an inclusion of management, organisation and safety culture in PSA.

The main recommendations of a workshop organised as a part of the concerted action were to:

- continue development of risk-based SPIs using the PSA hierarchy including indicators representing initiating events, reliability and unavailability of safety systems, human reliability;
- evaluate operational & event data to identify potential "event forerunners" and MOSC influences and to develop related guidelines;
- identify most important PSA parameters that could be sensitive to managerial, organisational and safety culture influences;
- identify strong candidates for "lead indicators" that can correlate with safety performance and risk; and for regulators to support self-assessment by utilities, using indicators.