POSITION PAPER

Principles for Developing and Implementing Safety Improvements to Existing NPPs

October 2019

Summary

This document provides an overview of the ENISS common licensee understanding of what constitutes good practice when developing and implementing safety improvements during the lifetime of a Nuclear Power Plant (NPP).

To develop this position paper, the experiences of ENISS members have been collated and reviewed in order to identify good practices to adopt and pitfalls to avoid. To communicate the common position, six principles have been developed which cover:

– The need for a positive licensee to regulator relationship

  Principle 1: *The development of Reasonably Practicable risk informed safety improvements under a framework of periodic safety review and continuous improvement is best achieved where a mature, outcome focussed regulator and licensee environment exists*

– The need to be able to optimise the priorities of different safety improvements

  Principle 2: *The licensee's portfolio of safety improvements should be adaptable to changing circumstances throughout the lifecycle of the plant*

– The need for a robust yet flexible safety improvement lifecycle

  Principle 3: *Each safety improvement initiative follows a proportionate development process through which options are proposed and evaluated as the design is progressed from identification of an issue, through options definition, concept design, detailed design and implementation*

– The need to respect and remain suitably aligned with the original Design Intent

  Principle 4: *Safety improvements must be evaluated against a thorough understanding of the original balanced Design Intent and current safety philosophy in order to avoid unintended consequences and safety disbenefit*

– The need to be able to factor in the residual lifetime of the plant

  Principle 5: *The remaining life of the station must be factored into the optimal solution for a particular safety issue*

– The need for timely implementation of safety improvements.

  Principle 6: *Safety improvements should be implemented on Reasonably Practicable timescales; prioritised according to relative safety benefit and taking into account reasonable constraints*

These principles complement those contained in the ENISS companion position paper covering the concepts of Cost Benefit Analysis, Reasonably Practicable and Risk Informed.

1. Identification of Safety Improvements - General Introduction

The IAEAs Fundamental Safety Principles SF-1 [1] states “The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation”. To reach this general objective, ten fundamental principles have been formulated. The fifth principle states that “Protection must be optimised to provide the highest level of safety that can reasonably be achieved”. Human activities and natural phenomena present risks and are possible sources of harm. The term ‘risk’ implies that harm to people and the environment needs to be considered both in terms of the magnitude of the possible harm and its likelihood. Safety is achieved by ensuring that risks are maintained As Low As Reasonably Practicable (ALARP) throughout the lifetime of the plant. To achieve this, all such risks, whether arising from normal operations or from abnormal or accident conditions, must be assessed (using a graded approach) a priori and periodically reassessed throughout the lifetime of facilities and activities. This principle gives rise to the requirement for continuous improvement which leads to the consideration of safety improvements throughout the lifetime of the plant.

There is a relatively wide range of ways in which national legislation describe, licensees apply and regulators accept approaches to periodic safety review, continuous improvement and resultant safety improvements. Whilst in some countries a more permissive and outcome focussed licensee to regulator framework exists, in others a more prescriptive and rule based approach is adopted. Despite these national differences, the nuclear safety objectives remain well aligned globally, and furthermore, on a European wide basis, legislation such as Nuclear Safety Directive 2014 [2] ensures that risks are maintained ALARP.

This document gives a short overview about the ENISS common licensee understanding of what constitutes good practice when developing and implementing safety improvements during the lifetime of a NPP.

The following section 2 outlines the range of common approaches to periodic review and identification of safety improvements. Sections 3 and 4 summarise common licensee experiences highlighting areas of good practice and potential pitfalls. Section 5 then draws out a set of key principles for a successful approach. Note that these are intended to complement the principles laid out in the ENISS companion paper covering the concepts of Cost Benefit Analysis (CBA), Reasonably Practicable (RP) and Risk Informed (RI).

2. Definitions, Existing Framework and Documents

There are several concepts and associated programmes that lead to the development of safety improvements during the lifetime of a NPP. The key ones are defined as follows:

Continuous Improvement: Continuous Improvement is a term generally used to describe the concept that a licensee's organisation and the NPPs that it is responsible for are continually implementing changes to improve nuclear safety over time. This is in response to changing circumstances, OPerating EXperience (OPEX) and new knowledge, with the objective of optimising the plant, processes and people in support of maintaining nuclear safety risks ALARP. The concept directly supports the IAEA's fifth fundamental safety principle; "The safety measures that are applied to facilities and activities that give rise to radiation risks are considered optimised if they provide the highest level of safety that can reasonably be achieved throughout the lifetime of the facility or activity, without unduly limiting its utilisation". There may be several programmes and processes within a licensee's organisation that would be considered continuous improvement activities and may be managed in an overall programme labelled as such. The term may also be used within the nuclear safety culture initiatives to promote an understanding and acceptance of the need for continual review of nuclear safety leading to change and improvement where required. Care needs to be taken not to create a culture of change for its own sake. Rather that change arises from identification of improvements that can be made to nuclear safety.

Potential improvements can range significantly from large engineering modifications to small scale process improvements and can arise from a range of improvement processes both formal (e.g. a systematic investigation following key OPEX) and informal (e.g. application of Human Performance tools on a particular job).

Given this range, different improvement proposals are treated differently according to the risks involved. For example, a small change to a process with little potential for unintended consequences may be implemented on short timescales via a document update and associated briefing. A large scale engineering modification which has the potential to unintentionally undermine the Design Intent may take several years of development via a structured design and safety case process, as well as design configuration management and consequential update of operational documentation. Licensees use a controlled process for such modifications [3] which usually employ a graded approach to quality according to worst case nuclear safety consequences in the event of inadequate conception or execution.

Implementation strategies can also be tailored to minimise risk. For example, an optimum plant state arising during a particular operational mode within an outage may carry the least risk for implementation. Alternatively, installation of replacement spares to deal with an obsolete component can be staggered in order to allow the replacement to be evaluated on the plant before replacing all such components.

Indeed, as reminded in ENISS position paper [4], even simple changes may introduce new risks. Safety impacts of the changes have to be evaluated (spurious events, human and organisational factors etc.).

Periodic Safety Review: Notwithstanding all the continuous improvement activities that a licensee undertakes, there is also the need for a formal Periodic Safety Review which ensures that a licensee completes a systematic stand-back review of nuclear safety, usually on a 10 yearly basis, considering all aspects such as:

- Benchmarking the design against changes to standards, guidance and Relevant Good Practice.
- Inspecting the plant to ensure that the actual configuration and design details match that contained in the associated safety documentation and analysis.
- Checking that all relevant OPEX has been adequately captured and that associated plant fault frequencies used within the Probabilistic Risk Analysis (PRA) are representative.

Periodic Safety Reviews are a national regulatory requirement for a licensee to be allowed to start or restart the operation of a NPP. As such they undergo formal regulatory review and approval.

The benefit of PSR in addition to continuous improvement activities is the overall re-evaluation of nuclear safety with reference to an updated understanding of plant status and consideration of the most recent OPEX and developments in knowledge [5]. There can be indirect benefits from PSR with respect to developing and maintaining knowledge within an organisation.

Operating Experience Feedback & Organisational Learning: OPEX [6] is a key continuous improvement process whereby a licensee continuously assesses operational events and associated learning and considers what changes to Plant, Processes or Training may be required to enhance nuclear safety. OPEX may be generated internally within an organisation or received from external sources such as IAEA, WANO, Original Equipment Manufacturers, national regulators or other licensees. The term organisational learning encompasses all feed-back and learning processes that a licensee may use, including those that may be more business efficiency focussed and which may only have an indirect benefit to nuclear safety.

Other Safety Improvement Initiatives: There are many other initiatives that may result in safety improvements being identified for NPPs. Examples are:

- Benchmarking Programmes
- Discipline Working Groups and Peer Review activities
- ‘Excellence’ Programmes
- Ageing Management Programmes
- Equipment Reliability Programmes
- Margin Management Programmes
- Research and Development leading to new and improved knowledge

Reasonably Practicable: The definition of 'Reasonably Practicable' is fundamental to the overall safety objective of maintaining risks ALARP via continuous improvement/safety improvement programmes. This is considered in detail in the ENISS companion position paper covering the concepts of Cost Benefit Analysis, Reasonably Practicable and Risk Informed. From the ENISS point of view, Reasonably Practicable is interpreted in a way that necessary measures (to fulfil a certain requirement) should be taken unless the utility is able to demonstrate that the measures are unreasonable from a practicability point of view and provide only small safety benefits. In some cases it is supported by providing quantitative data in terms of PRA results, but most often a qualitative argument is presented involving engineering judgment and sound reasoning. The following diagram on figure 1 helps to communicate how Risk Informed, Reasonably Practicable solutions are determined from the suite of safety analysis information available.

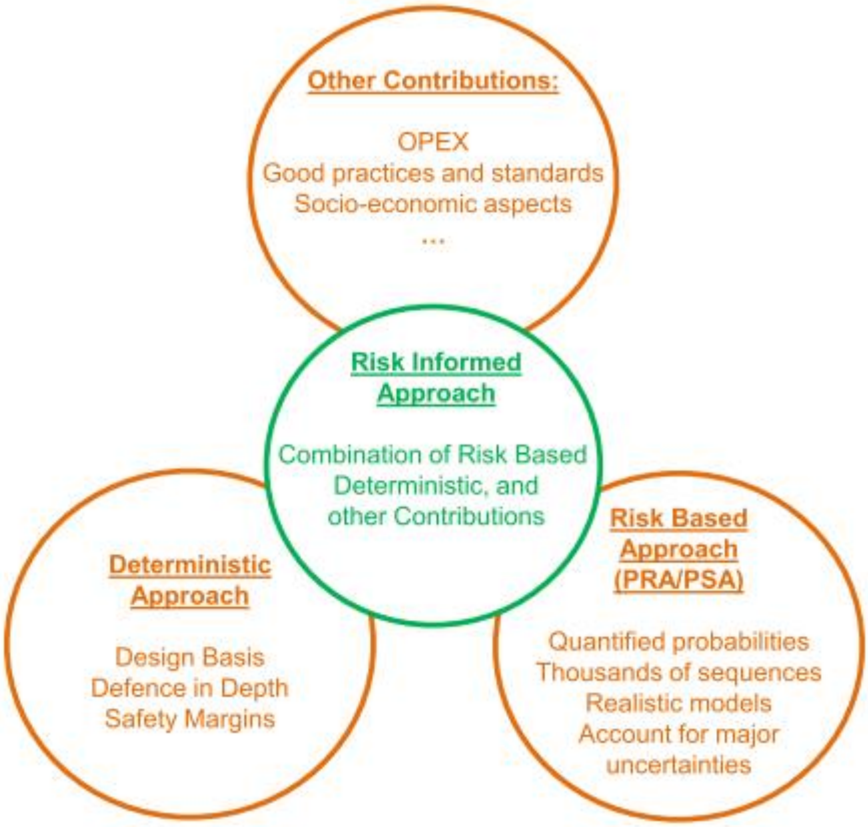

Figure 1: Risk Informed Approach

Relevant Good Practice (RGP): The term 'Relevant Good Practice' (or equivalent according to the particular country) is often used within guidance and benchmarking exercises to establish where accepted practice lies for a particular issue in order to consider whether it should be adopted as a safety improvement for a particular NPP. The term needs to be used with care to ensure that it is not used in an inappropriate way. The ENISS perspective is that a Relevant Good Practice should be:

- Applicable to the NPP design being assessed taking into account the full safety philosophy for the NPP including all layers of defence in depth (***Relevant***). For example, relevant Severe Accident measures are design type dependent.
- Have been critically evaluated as being worthwhile such that the time, trouble and costs of the RGP are significantly outweighed by the risk benefits (***Good***). Care should be taken not to embellish a RGP to the point that it becomes cost prohibitive.
- Be adopted at a sufficient number of NPPs to be considered an accepted industry standard (***Practice***).

Change in Regulatory Requirements: Changes to regulatory requirements can be a driver for safety improvement. The majority of changes are generally incremental and relatively small and are developed as a result of new knowledge development, new NPP design development or as a result of OPEX. Generally, these changes should not lead to significant programmes of work as the requirement to back-fit to existing designs will only arise if there is significant risk benefit and the sudden discovery of significant safety gaps should not arise for an existing NPP with a mature safety analysis which undergoes regular review.

One notable exception where changes in regulatory requirements led to more extensive programmes of work was the worldwide response to Fukushima which led to a step change in the perception of risk and uncertainties and fundamental changes for how low probability, high consequence risks should be treated via provision of additional defence in depth resilience measures. As a result ‘stress tests’ have been performed worldwide in order to identify any vulnerabilities at nuclear installations which need to be addressed on short timescales. Longer term, the IAEA has also co-ordinated an industry wide response as captured within the Vienna Declaration on Nuclear Safety [7] which requires periodic review of the nuclear safety of existing NPPs against an updated suite of IAEA standards and guidance which are to be translated into national regulatory frameworks. The responsibilities of licensees, regulators and national governments to prioritise and continuously improve nuclear safety in accordance with this IAEA initiative and the activities of organisations such as WENRA and ENSREG has been reinforced in legislation such as EU Nuclear Safety Directive 2014 [2].

3. Observations and Examples of Application

The following observations and examples concerning the application of safety improvement processes have been collated from a set of questionnaires prepared by ENISS members and from a review of relevant literature. Of necessity, national experiences are summarised and generalised in order to draw out the themes and it is acknowledged that the full range of experience within each country will be much broader and more complex. Only key points have been repeated here where it assists the narrative in terms of developing the safety improvement principles presented in this document. No attempt has been made to systematically cover the same issues for each country.

Common Experience: For all licensees the requirement to assess and improve their NPPs (via PSR and on a continuous basis) is embedded within the licensee's arrangements via policies, procedures and guidance. These requirements are in turn largely derived from national and international requirements. Figure 2 shows a simplified diagram of the safety improvement process for a licensee and the influencing requirements and associated organisations.

The general experience is that potential safety improvements can be identified at any time from the range of assessment activities that are commonly undertaken (see Section 2 & Figure 2). Either a design vulnerability or weakness is identified from analysis work being undertaken for which improvement options need to be considered, or a standard safety improvement is identified, the suitability of which needs to be considered for a particular plant. Either way, detailed options need to be developed and evaluated to decide what, if anything, needs to be developed and implemented. At any one time several such potential safety improvements will be under consideration and each may be at different stages of development. This portfolio of work needs to be managed and optimised against available budgets, resources and timescales in order to maximise long term benefits for the plant.

A key finding from the ENISS assessment of safety improvement practices is that the national legislation and regulator approach that exists in a particular country can have a significant bearing on the approach to safety improvement adopted by a licensee. Across Europe, there is a spectrum of legislative approaches which range from prescriptive to non-prescriptive. Here, prescriptive is taken to mean that a more deterministic, rule based approach is employed as a starting point for consideration of safety benefits. Non-prescriptive regimes tend to be more outcome focussed and goal setting as a starting point.

Regardless of the starting point for consideration of safety improvements, the effectiveness of the national legislation, in the view of ENISS, is highly dependent upon the regulatory approach and the maturity of the relationship between regulator and licensee. If the regulatory practices are outcome focussed and flexible and permit the use of a risk informed approach when developing safety improvements, it tends to lead to a strong regulator/licensee relationship which can enhance nuclear safety overall.

Notable National Differences/Characteristics:

Spain: The legislative framework and regulatory regime within Spain is essentially prescriptive, which limit the use of a risk informed approach. This could lead to relatively rigid interpretations of international and national requirements which in turn leads to less opportunity to consider a range of options for treating each nuclear safety issue and to use risk informed tools such as cost-benefit analysis and PRA for determining optimal solutions.

France: The legislative and regulatory regime within France tends to be prescriptive in nature which can limit the use of a risk informed approach.

The existence of a large fleet of NPPs has a significant effect on how safety improvements are identified, evaluated and implemented. In practice, deployment on the fleet is subject to a first-of-a-kind implementation, followed by an evaluation, prior to overall fleet implementation. In order to be able to manage such a large fleet, PSR is used as the main focus for periodically identifying a set of safety improvements which need to be implemented across the fleet in the subsequent period (via controlled changes to the 'Reference Design' for each reactor type). The regulator has a significant influence on the scope of PSR safety improvements either by influencing those proposed by the licensee or specifying some of the safety improvements directly. The presence of such a large fleet means that industrial stakes induced by even relatively minor safety improvements can be significant (these improvements being identically replicated several times). As a consequence it is deemed that risk informed approaches should be developed and used to ensure that the most beneficial safety improvements are implemented in order to achieve the safety objectives in an optimal way.

For instance, there is a concern that there has been excessive focus put on post-Fukushima severe accident and hazards resilience safety improvements that were prescribed by French regulations: by focusing the discussions on the means (a Hardened Safety Core) rather than the objectives, it attracted more opportunities to question and request enhancements than would necessarily be warranted on a risk informed basis. This concern is shared by other ENISS members.

Czech Republic: The legislative and regulatory approach within the Czech Republic has been recently (2016-17) revised and harmonised with the EU Nuclear Safety Directive, WENRA Reference Levels and IAEA standards. It has started to change as a result of the inclusion of the concept of ALARP and a Practical Elimination approach within the legislation. The methods for how this is applied in practice are still developing, with examples where a more risk informed approach can be adopted by the licensee backed by CBA and PRA. PSR, OPEX, Asset Management Planning, Equipment Reliability Management, Margin Management, Design Basis Reconstitution program and other programs are used as a key sources of safety improvements.

The Czech Republic has performed a particularly large amount of assessment work as part of the post Fukushima stress tests. A significant amount of work has been completed to increase levels of defense in depth and increase severe accident prevention measures.

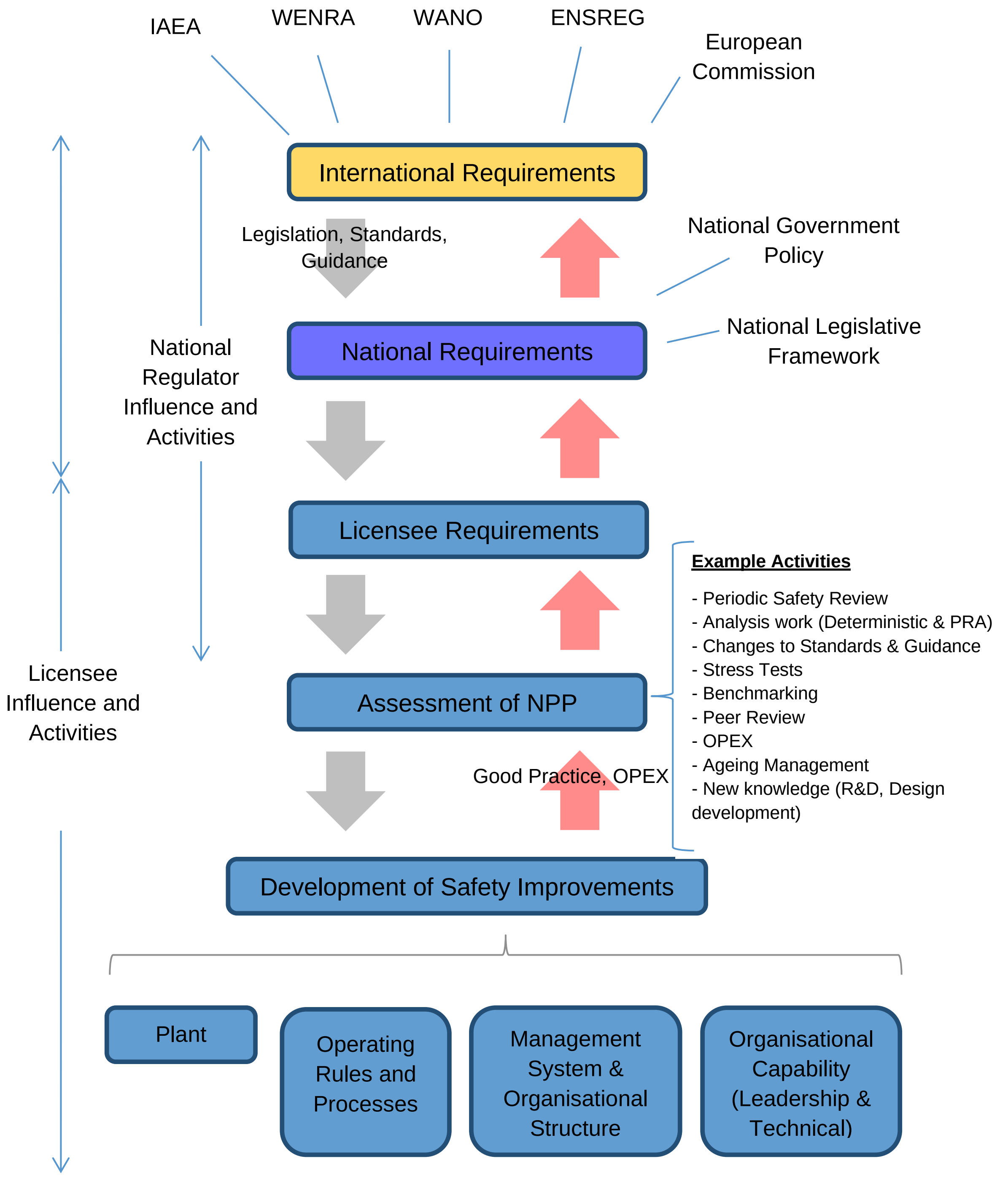

Figure 2: Simple Overview of Safety Improvement Processes

Switzerland**:** The legal and regulatory framework allows under certain circumstances for a risk informed approach for evaluating potential safety improvements where CBA and PRA may be used. These approaches have been extended for the purposes of evaluating potential safety improvements as a station approaches end of life by the development of the concept of an 'integral safety assessment' approach which takes into account the period of time that the safety improvement will provide benefit for. The ability to adopt a flexible approach to safety improvements relies on a mature suite of safety documentation and a mature relationship with the regulator.

Belgium**:** The legislative and regulatory approach within Belgium tends to lead to more requirements mandated directly through law. However, some flexibility is retained to be able to optimise safety improvements by the licensee. For example PRA can be used to some extent to evaluate and prioritise safety improvements. International standards and guidance tend to be used more directly by the regulator and licensee when assessing NPPs for potential safety improvements.

Finland**:** The legislative and regulatory approach within Finland is less prescriptive and more outcome focused. This leads to a more balanced approach across deterministic and probabilistic considerations when evaluating safety improvements. Good flexibility is permitted with respect to evaluating options as long as there is a sufficiently robust demonstration that the optimal solution has been selected based on risk informed considerations including the option to use PRA based arguments. Safety improvements tend to be identified and developed on a more continuous basis with PSR tending to report on progress and demonstrating sufficient progress has been made with respect to identifying and addressing safety issues and keeping up with changes to standards, guidance and relevant good practice. The relationship with the regulator is mature and open.

United Kingdom The UK is seeking to undertake a significant new build programme led by the development of Hinkley Point C EPR and with other designs being considered. The regulatory environment is possibly the least prescriptive in strict legal terms and is very much goal setting and outcome focused, however, there is a very strong requirement to demonstrate that all options have been considered for any given nuclear safety issue and that the most optimal solution in terms of maintaining risks ALARP has been selected. This regulatory approach tends to lead to a greater degree of modification throughout the NPP lifecycle from assessment of the initial design through to end of life.

4. Key elements drawn from Implementation Experience

The following key elements were drawn from the discussions of ENISS members' experiences with respect to the development of safety improvements for existing NPPs:

Risk informed analysis and the use of PRA provide significant benefit when evaluating options for safety improvements against the overall objective of maintaining risks ALARP. Risk informed processes ensure that the principle of proportionality is applied in practice.

Development of an optimal scope of Reasonably Practicable safety improvements works in practice where the licensee to regulator relationship is strong with respect to nuclear safety culture and options can be openly discussed without fear of inappropriate ratcheting of safety improvements i.e. where further risk reductions are sought even if not Reasonably Practicable.

Flexibility is required across portfolios of safety improvements in order to allow the most safety significant modifications to be prioritised in terms of risk benefit. Care needs to be taken with respect to any safety improvements that are labelled as 'compliance' as these can tend to be prioritised even if the risk benefit does not warrant it compared to other safety improvements. Note that what is required for compliance can be subjective and judgemental. If appropriate, it should be permissible to agree a permanent non-compliance if there are no compliant options which are Reasonably Practicable.

There is a need to consider the interface with security related safety improvements as these can give rise to conflicting requirements with respect to nuclear safety.

There is potentially a need to rebalance effort away from post Fukushima safety analysis and improvements in order to focus on more frequent faults.

The best strategy for implementing safety improvements can be influenced by a number of factors. For example, for licensees operating small fleets, focussing on continuous improvement year on year with consistent resource levels applied may be advantageous. In contrast, managing safety improvements via 10 yearly PSRs as a focal point may be advantageous for licensees operating large fleets. Other factors which might influence safety improvements are:

- National / International OPEX
- The scale of the safety improvement and the impact on the operational documentation
- The time required to develop it
- The potential for unintended safety consequences
- The need to optimise the sequencing and grouping of interrelated safety improvements
- The need to pilot and evaluate a particular safety improvement before fleet roll out
- The need to identify the optimal plant state for implementation in terms of minimising risk
- The need to optimise resource availability

5. Principles for a successful approach

The following principles have been developed to complement those contained in the ENISS companion paper covering the concepts of Cost Benefit Analysis, Reasonably Practicable and Risk Informed.

1. ***The development of Reasonably Practicable risk informed safety improvements under a framework of periodic safety review and continuous improvement is best achieved where a mature, outcome focussed regulator and licensee environment exists.***
    a. Regulator and licensee should be aligned on:
        i. Nuclear safety objectives,
        ii. The legal and regulatory framework which supports these,
        iii. Application of the key concepts of Periodic Safety Review and Continuous Improvement
        iv. Application of the key methodologies which support the identification and evaluation of safety improvements; e.g. Defence-in-Depth, etc. (Also see ENISS paper on CBA/RP/RI)
        v. Acceptable levels of residual risk.
    b. A trusting relationship, between regulator and licensee, should exist such that nuclear safety issues and the development of safety improvements to address them can be openly and objectively discussed in the best interests of nuclear safety. Discussions may be required at any stage during the safety improvement development lifecycle in support of decision making which ensures risks are maintained ALARP.

2. ***The licensee's portfolio of safety improvements should be adaptable to changing circumstances throughout the lifecycle of the plant.***
    a. Flexibility should be allowed with respect to the particular management arrangements for offsetting the safety improvements to be implemented. For some licensees, the major modifications may be captured in PSR agreements and minor modifications captured in local 'live' station plans. For other licensees, combined plans may be maintained on different timescales.
    b. The overall portfolio should cover a balanced suite of safety improvements from large safety improvements to smaller enhancements covering all disciplines and areas of operation.

   i. Particular areas of interest should not be prioritised to the detriment of others when one considers a risk informed approach; e.g. over emphasis on extreme hazards following Fukushima

c. The portfolio must be flexible in terms of scope and implementation timing such that it can be re-evaluated and optimised at any stage to adjust the priorities in response to changing circumstances to ensure risks are maintained ALARP.

   i. A major nuclear safety event

   ii. Annual review and budget setting

   iii. In-year adjustments

3. ***Each safety improvement initiative follows a proportionate development process through which options are proposed and evaluated as the design is progressed from identification of an issue, through options definition, concept design, detailed design and implementation.***

   a. Open discussion between licensee and regulator should be promoted from the outset with agreement of key decisions and milestones.

   b. Premature decisions between regulator and licensee concerning the preferred option should be avoided. Equally, late communication of licensee decisions and/or regulator requirements should also be avoided.

   c. The flexibility to reassess an option during the development process should be supported, as in some cases, refined risk analysis or revised cost estimates might lead to different conclusions in a later phase of the development process.

   d. Incremental ratcheting of requirements and cost escalation as the design is developed should be avoided where it may lead to an overall final solution where the risks are no longer ALARP.

   e. The flexibility to adopt an optimum installation strategy should be supported which may be influenced by a number of risk factors.

4. ***Safety improvements must be evaluated against a thorough understanding of the original balanced Design Intent and current safety philosophy in order to avoid unintended consequences and safety disbenefit.***

   a. An optimised plant which is streamlined and relatively simple to understand is preferable to an excessively modified plant where maintenance of all potential safety related systems is a burden and required responses to faults are excessively complicated and likely to be difficult to implement in practice.

   b. Excessive modification based only on benchmarking should be avoided. For example, optimum severe accident measures will differ between larger reactors and smaller reactors due to inherently different threats and potential plant damage states. Solutions should not be automatically copied across.

5. ***The remaining life of the station must be factored into the optimal solution for a particular safety issue.***
    a. Essential compliance requirements must be met and/or maintained, however, it is reasonable to reduce investment in enhancement/excellence safety improvements towards end of life as the remaining lifetime benefit value for potential improvements reduces.
    b. Greater flexibility should be supported for addressing safety issues toward end of life:
        i. More emphasis on process / procedural changes and enhanced human factors claims in preference to costly hardware modifications.
        ii. Flexible resilience measures (which could be moved to protect other stations following shut down) may be preferable to significant permanent hardware modifications.
        iii. Avoidance of excessively demanding standards for new equipment preventing upgrades to obsolete plant; e.g. Control and Instrumentation standards.

6. ***Safety improvements should be implemented on Reasonably Practicable timescales; prioritised according to relative safety benefit and taking into account reasonable constraints.***
    a. The licensee and regulator should seek a common understanding of the risks and priorities for each safety improvement to justify the associated commitments for implementation, including reasonable timescales. In practice it should be understood that timely implementation cannot be determined according to set rigid rules, however, classification and grouping of different improvements according to safety benefit with associated target timescales may assist with managing a large portfolio of safety improvements.
    b. The setting of specific timescales for each safety improvement should be realistic and accommodate all reasonable constraints and requirements associated with each safety improvement. Table 1 lists a number of these which may apply.
    c. The licensee should target implementation of the most safety significant improvements for a particular design of station within maximum timescales of 10 years which is linked to PSR periodicity.
    d. For safety improvements which involve staged implementation (e.g. taking multiple outages), opportunities should be sought to accrue the maximum safety benefit as early into the project as Reasonably Practicable.

Table 1: Factors Affecting Timely Implementation of Safety Improvements

Safety significance of the improvement, in absolute and relative terms – noting that new OPEX and knowledge may impact the assessment
Design phase duration, including the consideration of several options and the associated decision making process
Complexity and interfaces with other SSCs (in design, manufacturing, installation and/or testing)
The need for optimising the design and installation to reduce the dose uptake and other risks to the workers when implementing the change
The need for applying a thorough process to avoid errors or undermine the overall plant safety, accounting for the safety improvement portfolio
The necessary R&D activities and testing, especially when the improvement includes novelties
The implications of changes in codes & standards
The optimal order of the implementation of a set of modifications, with possible interfaces to be dealt with
Existence of alternatives, e.g. interim or partial improvements
Remaining lifetime of the NPP operation
The need for new safety analysis methodologies, DBA or DEC for example, which then have to be assessed by the regulator
Supply chain issues (capacities, competencies, availabilities, interfaces …)
Schedule and durations of plant outages
Minimisation of needs for documentation updates and training (i.e. minimise the number of design and operation configurations)
Other operational constraints within the licensee organisation, e.g. human resources

6. Conclusion

The experiences of ENISS members have been collated and reviewed in order to identify good practices to adopt and pitfalls to avoid when developing and implementing safety improvements during the lifetime of a NPP. This has resulted in six principles being derived to communicate the common position and which cover:

- The need for a positive licensee to regulator relationship.
- The need to be able to optimise the priorities of different safety improvements.
- The need for a robust yet flexible safety improvement lifecycle.
- The need to respect and remain suitably aligned with the original Design Intent.
- The need to be able to factor in the residual lifetime of the plant.
- The need for timely implementation of safety improvements.

References

[1] IAEA, Safety Fundamentals, SF-1, 2006

[2] Council Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations

[3] IAEA, Modifications to Nuclear Power Plants, NS-G-2.3, 2001

[4] ENISS position paper – Cost Benefits Analysis – Reasonably Practicable – Risk informed, 2018

[5] IAEA, Periodic Safety Review for Nuclear Power Plants, SSG-25, 2013

[6] IAEA, Operating Experience Feedback for Nuclear Installations, SSG-50, 2018

[7] Vienna Declaration on Nuclear Safety, IAEA, 2015

Acronyms & Abbreviations used in this report

ALARP	As Low As Reasonably Practicable
CBA	Cost Benefit Analysis
DBA	Design-Basis Accident
DEC	Design Extension Conditions
ENISS	European Nuclear Installation Safety Standards
ENSREG	European Nuclear Safety Regulators Group
EPR	European Pressurised Water Reactor
IAEA	International Atomic Energy Agency
NPP	Nuclear Power Plant
OPEX	OPerating Experience
PRA	Probabilistic Risk Analysis
PSR	Periodic Safety Review
R&D	Research and Development
RGP	Relevant Good Practice
RI	Risk Informed
RP	Reasonably Practicable
SSCs	Safety Classification of Structures, Systems and Components
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators' Association