# Integrated Safety Assessment for Assuring Acceptable Level of Nuclear Safety

Kwang Sik Choi*, Young Sung Choi
Korea Institute of Nuclear Safety, PO Box 114, Yuseong, Daejon 305-600, Korea
*Corresponding author: choi@ kins.re.kr

## 1. Introduction

The discussions on regulatory goal of assuring an acceptable level of nuclear safety at nuclear facilities have been made among regulators worldwide so far. Several meetings were held and documents have been also prepared on safety goal, safety objectives, regulatory safety goals and so on. In 2008, the Greenbook "The Regulatory Goal of Assuring Nuclear Safety" was published by OECD/NEA CNRA (Committee on Nuclear Regulatory Activities) task group consisting of experts from OECD/NEA member countries. In Korea, similar efforts have been made and some practices have been already implemented in regulatory activities although they are not explicitly shown up.

This paper reviews discussions made so far on the safety objectives or goals of regulation, and presents some examples adopted for integrated safety assessment in Korea. Some suggestions for future directions on this discourse are made.

## 2. Safety Objectives and Regulatory Goal

### *2.1 Safety Objective & Regulatory Safety Goal*

In the "Basic safety principles for nuclear power plants(INSAG-12, 1999), three safety objectives are defined. They are general nuclear safety objective, radiation protection objective and technical safety objective. The first one is general and the other two are complementary objectives that interpret the general objective. The general nuclear safety objective is "to protect individuals, society and the environment by establishing and maintaining in nuclear power plants an effective defense against radiological hazard." The safety objective defined in this INSAG-12 is literally general safety objective that is pursued by utilities and regulators.

In the technical document "Policy for setting and assessing regulatory safety goal"(IAEA-TECDOC-831, 1995), it has been described that safety goals express the desired level of safety being aimed for. They are the high level expressions in philosophical and practical terms of aspirational level of safety being striven for, though ultimate achievable, in the design, construction, commissioning, operation and regulation of nuclear facilities.

The identification of safety goals should provide strong incentives for achieving high standards of operation and for achieving a realistic minimization of risk. The safety goal should be acceptable to the public. Lower safety objectives or criteria can be derived from safety goals for effective monitoring and enforcement. As indicated in the title of this document, it delineates the safety goal pursued by utilities and also by regulators.

In the IAEA 2006 document "Fundamental Safety Principles", it has been described that the fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation.

### *2.2 Regulatory Goal of Assuring Nuclear Safety*

Regulatory goal has been addressed in several NEA documents on nuclear regulation, so-called "Green Booklets". The first clue is shown in "Improving Nuclear Regulatory Effectiveness (2001)" such that regulatory body is effective when it ensures that an acceptable level of safety is being maintained by the regulated.

Acceptable level is spelled out in more detail as shown in "Improving versus Maintaining Nuclear Safety (2002)": What is acceptable is a matter for society to decide by weighting the risks and benefits of any particular activity and judging where the balance lies. It is also stated that the fundamental objective of all nuclear safety regulatory body is to ensure that nuclear utilities operate their plants at all times in an acceptably safe way.

Another document "Nuclear Regulatory Decision Making (2005)", states that in meeting this objective, the regulator should be guided by an integrated framework for making regulatory decision and indicates 9 basic elements of the framework. However, it leaves a basic question, "what criteria should be used for the level of assurance that the required safety criteria are met?"

In 2007, Forum on Assuring Nuclear Safety (FANS 2007) was held in Paris. The main theme of the forum was on "how can regulators be assured that a nuclear installation is operating safely?" Discussions made in the forum were feedback to develop a new Green Booklet with the title of "The Regulatory Goal of Assuring Nuclear Safety".

## 3. Integrated Safety Assessment

### *3.1 Concept*

The green booklet adopts the definition of nuclear safety in a broader way as "freedom from physical harm, unreasonable risk and environmental damage due to the operation of nuclear facilities" and presents elements of safety in three broad categories: Technical; Human and Organizational; and Programmatic and Cross-cutting, as shown in the Figure 1. It also addresses the necessary attributes of any systematic methods for organizing and evaluating the safety information to arrive at the integrated safety judgments. It concludes that a

systematic approach to make integrated safety assessment is desirable for the regulator to make judgments about the acceptability of safety.

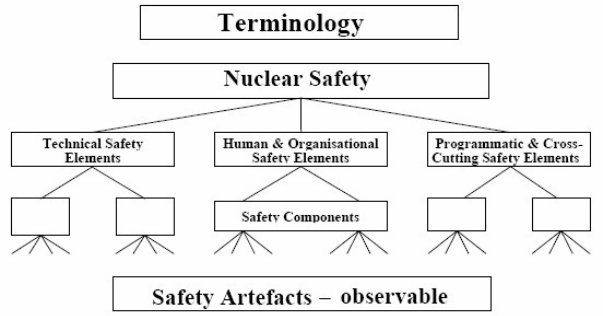


Figure 1 Relationship between safety elements, safety components and safety artifacts

### *3.2 Korea's Approach to Integrated Safety Assessment*

The approach of representing nuclear safety into several elements and then integrating them suggested in the report of 'Regulatory Goal of Assuring Nuclear Safety' is usually adopted in regulatory activities of Korea, although the terms and relevant activities are different. The technical safety aspects such as system or component performances are confirmed through periodic inspection, daily inspections and safety performance indicators (SPIs). Organizational aspects such as education and qualification of operators are examined from the viewpoint of technical competences of licensee when conducting periodic and QA inspections. The human factors aspects are reviewed using Human Performance Inspection program (HUPI). The programmatic aspects such as QA program of nuclear facility and Operating Experience Feedback are also regularly audited. Lastly, cross-cutting safety activities including emergency preparedness exercise evaluation, environmental radiation monitoring and chemical analysis performed by regulator itself are being implemented.

Followings are three examples of Korean practices in collecting and analyzing safety information and making integrated safety assessment.

First, the permit of reactor restart after planned outage is based on the results of periodic inspection, which particularly focuses on technical, organizational and human factors elements. Before the final decision to permit criticality, inspectors convene to discuss the overall status of the plant in consideration of both weak points of the plant from their field inspection results and performance trends in previous operating periods. Restart permit will not be given if the plant does not conform to the conditions of the Operating License. Thus integrated assessment is directly related to regulatory enforcement of permitting restart or not.

Second, all the events including reactor scram are under regulatory scrutiny by specialized investigation team dispatched to the site. Since even a reactor scram is considered as abnormal condition to affect safety, restart is allowed only after the completion of regulatory investigation. This mainly focuses on technical, human factors and programmatic elements. At that time, information on new aspects of plant behaviors not shown in normal condition is collected and analyzed to find latent safety weaknesses in the plant.

Third, Korea has maintained a practice which requires both safety review and inspection on each specialized part to be conducted and managed by the same expert group. This scheme enables regulatory staff to enhance their expertise and it also gives overall insights in their specialized areas. This linkage between review and inspection results leads to continuous feedbacks between them and contributes to effective analysis of safety information.

### *3.3 Important Points to be considered in Integrated Safety Assessment*

When integration of safety is addressed, it should be recognized that safety level is determined by the weakest point of the plant. The regulator should strive for finding the weak points, which can be collected and analyzed through field-oriented activity. And these weak points must be rectified through regulatory enforcement. Thus, three important points in integrated safety assessment have been emphasized in Korea's regulatory activities. First, field-oriented information should be collected by the regulator itself independently of licensee. Second, regulatory staff with competences and experiences in both safety review and inspection should be maintained to enable effective analysis of safety information and thorough management of weak safety points. Third, safety assessment should be connected to regulatory enforcement for corrective actions.

## 4. Conclusion

The concept of integrated safety assessment has been adopted in many regulatory bodies such as Swiss Federal Nuclear Safety Inspectorate (HSK), the United Sates Nuclear Regulatory Commission, the Swedish Nuclear Power Inspectorate (SKI) and Canadian Nuclear Safety Commission (CNSC). The systems that they are using are broadly consistent in terms of principles and attributes. Each regulatory body has to develop its own system based on its national laws, regulations, regulatory practices and cultures. Korea has endeavored to develop comprehensive risk-informed oversight system for NPPs. Suggestions from FANS 2007 and examples from its resultant booklet could be considered in improving our system.

## REFERENCES

[1] OECD/CEA, Improving Versus Maintaining Nuclear Safety (2002)
[2] OECD/CEA, Nuclear regulatory decision making (2005)
[3] OECD/CEA, The Regulatory Goal of Assuring Nuclear Safety (2008)