Utilization of Risk Insights for Safety Management of Nuclear Facilities in Japan[1]

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Thank you, Mr. Chairman. Good morning, ladies and gentlemen, it is indeed a great pleasure and honor for me to be here this morning and present you an overview of the history of use of risk insights in the safety management of nuclear facilities in Japan.

1. Before Chernobyl Accident

It was in 1960's when Tasaboro Yamada proposed at the occasion of an IAEA symposium held in Vienna that the safety of nuclear reactors should be judged by the occurrence probability of loss of life due to them of the general public around the site and that it could be calculated through the reliability analysis of safety systems. However, his presentation did not cause any impact upon the execution of regulatory activities in Japan since then as he could not present the result of such analyses thereafter, mainly because of the difficulty in gathering relevant data of the failure rate of safety systems and structures.

The publication of the Rasmussen Study in 1976 did not change the behavior of regulators and operators in Japan as the report was accepted in Japanese nuclear reactor safety circle as another evidence of the assertion that the probability of a large scale radioactivity release from nuclear power plants was extremely small, though a group of experts including several former students of the late Professor Rasmussen started to advocate the benefit of preparing failure rate data and methodologies for this kind of risk analyses.

When the TMI accident occurred, the regulatory authority requested operators of nuclear power plants to establish an emergency planning, of which realistic base could only be found in the Rasmussen study, and take measures to reduce human errors in control rooms including the introduction of safety parameter display system (SPDS). These actions of the regulator indicated their admittance of the existence of rooms for the risk management based on risk insights outside of the deterministic world of safety, of which insights could only be obtained through the PSA of the plants.

2. Severe Accident Management

[1] Edited form of the presentation at the Symposium on PRA and Decision Making held at Residence Inn, Marriot Cambridge Center, Cambridge, Massachusetts in USA to honor the late Professor Norman C. Rasmussen on Thursday, April 29, 2004.

The Chernobyl accident forced the regulatory body to accept the PSA as a tool to obtain insights on the effective management of severe accidents far outside of the design basis accidents and since then, the regulator has strongly recommended nuclear power plant operators to identify and implement the most effective and efficient severe accident management measures based on risk insights obtained from the PSA of their plants.

Plant operators have implemented severe accident management measures in every plants, at the occasion of the periodic safety review executed in every 10 years, of which purpose is to ascertain that the safety level of their plant was equivalent with that of the most recently licensed plant. It should be noted that most of the measures taken were those contributed to the reduction of the core damage frequency (CDF) as it was difficult to find practical measures to improve the ratio between the CDF and the large early release frequency (LERF) of the plants when the CDF is very small. It has been often questioned whether it is really necessary to have a factor of ten difference between the CDF and the LERF as recommended in INSAG 3 when the CDF is less than a target LERF. It is expected that this issue will be revisited in the process of developing performance goals such as CDF and LERF as parts of safety goals.

3. Safety Goals

The Nuclear Safety Commission recently issued the interim safety goals for accident risks to a member of the public around the site of nuclear facilities. This consists of Qualitative Health Objectives and Quantitative Health Objectives. The former requests that the risk to the life of a member of the public from the radiation and / or radiological materials accidentally released from a nuclear facility should be sufficiently small as compared with the average fatal risk of individuals in society. The latter, Quantitative Health Objectives, requests that a) the prompt fatality risk of an average individual in the vicinity of a nuclear facility that might result from the accidents of the facility should not exceed the level of 1E-6 per year; and b) the average cancer fatality risk of individuals within a specified distance from the facility that might result from the accidents should not exceed the level of 1E-6 per year.

Remaining tasks in this activity of setting safety goals are;

a) To develop performance criteria for each type of nuclear facility, reference CDF and LERF in the case of nuclear power plants.
b) To determine the way to apply the goals: whether the goals should be bright-lines or fuzzy-lines for the acceptability of a facility.
c) To determine the way how the cost of improvement necessary be considered in the request for back-fitting.
d) To determine the way the uncertainties accompanied with the results of a PSA be considered in the acceptability decision.
e) To establish PSAs or equivalent methodologies for assessing the risk of

non-reactor facilities.

f) To determine whether or not societal goals are necessary in addition to individual risk goals?

g) To decide how we should treat multiple-unit sites: whether the goals should be applied on the basis of risk from a site or risk from a unit?

It is hoped that these will be settled in a year or so.

4. Risk-Informing the Seismic Design Evaluation Guideline

The Nuclear Safety Commission started to revise the Seismic Design Evaluation Guideline three years ago, in order to reflect on it the vast amount of knowledge obtained since its publication in 1981. It is quite logical for those experts involved in the development and application of quantitative risk analysis technologies and seismic risk analyses in particular to try to make the guideline risk-informing at this occasion.

One of the key proposals made was to clarify the target frequency of design-basis seismic motion and the other was to assure the satisfaction of safety goals. Currently 1E-04/y was proposed as a tentative target frequency of design basis seismic motion under which important safety functions should be maintained. At the same time it is proposed to ascertain by a PSA that the risk to the public by the accident caused by earthquakes should be small enough before the first fuel loading.

The discussion has not been concluded yet. An issue in the discussion about the introduction of these proposals is whether the seismic PSA methodology is mature enough and the hazard curve evaluated for a specific site is defensible in the court, in particular. This issue is largely caused by the uncertainties in both the probability of detection of faults, especially around the site and the attenuation of seismic motion traveling from the epicenter to the site. An appropriate method to take the effects of unidentified faults around the site into the consideration of design basis seismic motions is also under discussion.

Finally it is claimed that when the uncertainty of the seismic motion of the specified exceedance probability at the site with existing plants is found too large, decision makers had better being prepared to answer the question why they are sure that they made a proper decision.

5. Rationalization of Inspection and Testing and Regulatory Oversight Process

In recent years, the regulator has accepted the optimization of the inspection schedule and its items as well as allowable outage time (AOT) of the systems, structures and components (SSCs) based on risk insights obtained from the PSA at the occasion of revision of technical specifications. Operators review the risk significance of SSCs and propose the optimized

inspection intervals, taking into account the risk insights and setting the allowable ICCDP at 5x10-7.

Quite recently the Nuclear and Industrial Safety Agency (NISA) started the discussion about the rationalization of regulatory oversight processes. A key question in this discussion is how we can wisely utilize risk insights in the design and execution of regulatory oversights of plant management. An often raised question in this connection is what the indication of the degradation of safety culture is, under the assumption that the safety culture should be an item for review. Personally I do not believe it practical to review the status of the safety culture in an operating organization. I have proposed that regulators should be satisfied with the review of the risk significant activities specified in the quality management guideline.

6. Countering Terrorism Threat at Nuclear Facilities

Since September 11, 2001, concerns on the risk due to terrorist attacks on the plants have been heightened. Though it is not easy to openly discuss the countermeasures to this threat, I believe it a responsibility of regulators to assure the public by explaining that proper actions are taken based on a sound logic.

In his book titled Terrorism and America, P. Heymann specified the task of terrorist as follows: a) locate the target, b) get to it, c) with the needed associates, d) with the necessary information, equipment and facilities, e) with an expectation of enough safety. Therefore their intention should be thwarted by employing defense-in-depth strategy composed of prevention measures to assess the threat based on information about criminal or clandestine move and establish security check at important nodes of personal and material move, protection measures to establish physical security measures on the spot to protect a facility from terrorist actions, and mitigation measures to prepare measures to manage the consequences of an attack. It is the nuclear regulator's position that although general prevention measures should be taken in the society at large as a prerequisite, specific protection measures for the safety of nuclear facilities against terrorism should be implemented in effective and efficient manners, and need for additional efforts at nuclear facilities should be decided based on the evaluation of the risk of nuclear facilities to such threat, though the results of this kind of risk analyses should not be made public as the information contained in these analyses might be used by would-be terrorists.

7. Environment Shaping

The recognition of the usability of risk insights obtained from PSAs by the regulator facilitated the preparation of standard procedure guides for on-power PSA, shutdown PSA and seismic PSA, and the reliability database for PRAs as consensus standards. The publication of interim safety goals by the Nuclear Safety Commission was an

epoch-making event as a step to utilize risk-insight in legally binding regulatory decisions.

In recent years, media attention to risk has been increasing, mainly because of the considerable increase of the public interest in the risk management for food safety, SARS disease and terrorism. Needs for risk communication are also often mentioned in the articles in mass media as a part of needs for the accountability of regulators as well as operators. The reason why the discussion of risk informed regulation in the Nuclear Safety Commission white paper was accepted favorably by mass media is presumably due to coincidental shaping of this environment.

In summary, risk insights have been utilized slowly but steadily, in the decision as to the need and the method for severe accident management in the first phase and progressively in the areas of optimization of safety management activities including inspection and testing. The pace is slow as compared with that in the United States and might be more appropriately described as slow but slowly. The ongoing discussion about the safety goals hopefully will open a new world of rational decision making in the regulation of safety design and operation of nuclear facilities.