Goals of NPP Operators' Risk Assessment and Management Activities in Japan

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The NAIIC's Verdict

The National Diet of Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) concluded that

1. The root causes of the accident were in the organizational and regulatory systems that supported faulty rationales for decisions and actions. The accident was "manmade" :
2. There were organizational problems that limited an effective emergency response in the utility such as insufficient level of knowledge, training, equipment inspection and emergency procedures related to severe accidents:
3. The nuclear power plant operator did not fulfill its ultimate responsibility for the safety of his facility, relying on the regulators taking final responsibility. This relationship weakened the pursuance of minimizing risk in line with the principle of as low as reasonably practicable (ALARP):
4. Laws and regulations related to nuclear safety have only been revised as stopgap measures when an accident happened: the latest technological findings from international sources have not been reflected in existing nuclear energy laws and regulations. What must be admitted is that this disaster was 'Made in Japan': and

Recommended fundamental reforms of both the structure of the electric power industry and the structure of the related government and regulatory agencies as well as their operation processes, the elimination of insular attitude, in particular.

Response to NAIIC's Verdict

- The Diet amended Atomic Energy Basic Act to add;
  - Clause 2 to Article 2 that specifies that the assurance of safety should aim at protecting people's life, health, property and environment and making for national security, with a full recognition of internationally established standards of safety; and
  - Article 3.2 to Article 3 that specifies the establishment of Nuclear Regulatory Authority as an extra-ministerial bureau of MOE.
- The newly established NRA is now responsible to promote effective and efficient safety regulation, with a full recognition of international safety standards, maintaining an able team with right skill, experience, knowledge and behavior, and following the five principles of good regulation; independence, proportionality, accountability, consistency and transparency, and thereby enhancing confidence and trust of the public.

The Gist of New Regulation Rules Set By the NRA

A. Ensure that design base external events (seismic, seismic-tsunami and other events) are properly evaluated and reflected in the design: in this connection, all the nuclear operators have been asked to accelerate the survey and characterization of **active faults around the site, including their interlock condition**, based on the most up-to-date knowledge in seismology, including that obtained by detailed geological survey.

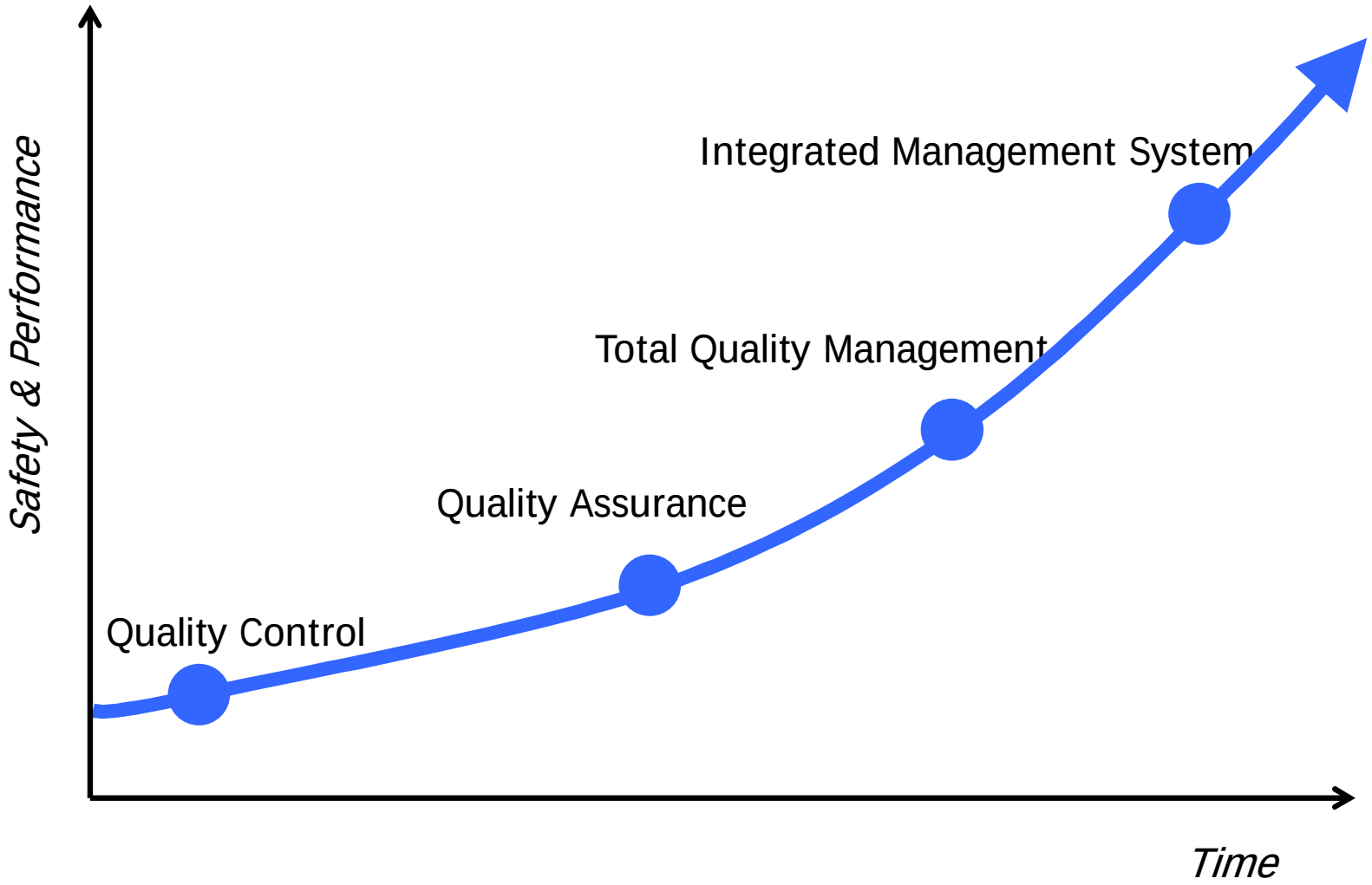
B. Satisfy the requirement 20, **design extension condition** of the IAEA safety design standard, covering extended losses of power and ultimate heat sink by providing a diverse and flexible alternative capability to supply power and cooling.

C. Ensure that **severe accident management procedures including reliable hardened vents** for specific reactor containments, which take into consideration of the fact that external events might affect the entire site, are in place so as to protect against broader societal and environmental harms.

What actions should nuclear operators take in response to the verdict of the NAIIC?

- Towards the end of the previous century, nuclear operating organizations were faced with increasing needs for introducing new requirements and goals, which included **safety, health, environmental, security, quality and economic elements and other considerations such as social responsibility**.
- As a result, a new management system was evolved to accommodate these needs and to ensure that the employees understand what has to be done to meet all requirements, based on the recognition that **the daily practices and the results achieved by the organization, the organizational culture and the management processes were deeply interrelated**.

Simplified Evolution to Management Systems



K.D. Persson: IAEA Safety Standards on Management Systems and Safety Culture
Atom Indonesia **33**, 1 (2007)

Integrated Management System

- The **management system integration** was the development where the organizations became increasingly aware that other stakeholders, apart form just their customers and employees, had to be addressed while conducting their business.
- Organizations put increasing attention on issues such as the safety, health, quality, environment, finance, security, human resources, cultural aspects, etc., and aimed to **manage the totality of them** by integrating management system so that **top management can deliver his/her vision and the goals and objectives of the organization in a coherent, harmonious and optimal way**.
- Recognizing the importance of this evolution, the IAEA replaced the IAEA 50-C-Q **Code on Quality Assurance** for Safety in Nuclear Power Plants and other Nuclear Installations (1996) with the Safety Requirements GS-R-3 and Safety Guide No. GS-G-3.1 that specify **the Management System requirements for all nuclear installations and activities**.

IAEA Safety Guide No. GS-G-3.1

- The management system shall be used to promote and support a **strong safety culture** by reinforcing a questioning attitude at all levels of the organization
- Organization's plans and objectives for safety should represent an ambitious picture of the future of the organization, in addition to a strong willingness to undertake continual improvement in other areas of performance, such as availability of products, costs, industrial safety and communication with interested parties, establishing a learning culture in the organization.
- **Measurement, assessment and improvement** are essential activities for avoiding any decline in safety performance. Senior management should remain vigilant and objectively self-critical, promoting objective measurement and assessment activities as a key to this discipline.

Performance Indicators

- After TMI accident, nuclear operators in Japan had used performance indicators such as **the unplanned automatic trip rate, number of defect fuel, plant availability and the unavailability of EDGs and had been proud of their high performance based on them.**
- Since the late 1980s, the IAEA has been actively sponsoring work in the area of indicators to monitor nuclear power plant operational safety performance. In the IAEA work*, three key attributes were chosen that are associated with plants that operate safely:
  - **plants operate smoothly**
  - **plants operate with low risk**
  - **plants operate with a positive safety attitu**de.
- Dominant performance indicators to monitor the attribute “plant operate with low risk” are **probabilistic indicators such as CDF obtained by level 1 PRA, LRF obtained by level 2 PRA and consequences-frequency relation obtained by level 3 PRA**.

*IAEA TECDOC-1141:Operational safety performance indicators for nuclear power plants (2000). It recognizes that focusing on any single aspect of safety performance is ineffective and can be misleading.

Risk Management in the Safety Management for Nuclear Facilities Before Fukushima Daiichi in Japan

- Before severe accident at Fukushima Daiichi, the activities to review the entire safety case including risk assessment of plant considering internal and external hazards have not been ranked properly in the safety management systems of Japanese utilities.
- A review process that is refereed to PSR has been carried out at the interval of 10 years under the guidance of regulatory authorities since 1994. However, the PRA submitted to the procedure covered only internal hazards, even though there appeared significant progress in the seismology after Kobe earthquake, not to mention the pioneering seismic PRA activities in the IPEEE* in the USA.
- Why was the activity so superficial? Looking back the positions Japan had taken on regulating and managing risks, the emphasis had been on simply **"addressing risk in some way"**. **It mattered not what to do for safety or how to improve safety!**

*Individual plant examination for severe accidents initiated by external events (IPEEE)

Through and Deep Risk Analysis: an Essential Tool for Survival

- It is a **condition for the survival for Japanese nuclear operators in post Fukushima society** to conduct thorough and deep risk analysis and use the process as an essential tool to ensure the fundamental requirement for nuclear power plant risks to be maintained as low as reasonably practicable (ALARP). Though, to do so is now their obligation in light of the revised Atomic Energy Basic Act and the revised Act on the Regulation of Nuclear Reactors.
- In the risk analysis, PRA should be used in the largest possible variety of situations to assess risks arising from any nuclear accident due to its facilities or to natural events.
- The risks should be periodically reviewed, taking into account changes over time such as new knowledge about the risk or the availability of new techniques for reducing or eliminating risks.

Where We Are

- The levels of risk to people that are acceptable is a combination of both individual risk and societal concerns: **the levels of societal concern are very high after the severe accident at Fukushima.**
- This requires nuclear operators to apply a very stringent risk control regime, both to reduce the level of individual risk and to assuage the societal concerns, such that the risk of long-term restrictions on the use of extensive areas of land and water, should a major accidental release of radioactivity occur due to rare yet credible events, is brought down to a very low level.
- Traditional paternalistic approach that government, corporations and associations have taken in the past in determining how involuntary risks should be addressed is no longer acceptable to society.
- People want to be involved or at least to have opportunity to be involved in decisions about how the risks to which they are involuntarily exposed are addressed in the context of ALARP principle.

Risk Communication and Trust

- As society wants that only institutions that are trusted should take such decisions, nuclear operators have to work hard to earn and maintain the trust of society.
- Recognizing that effective communication is the key to creating trust in risk management, the senior management of nuclear operating organization should make an utmost effort to establish and sustain civic trust in its managers' and expert's competencies, communicating the rationale for the risk management decision so as to allow people to make informed decisions about the risk and the disaster management.

Risk Management Strategy

- The results and insights from the risk analysis should be communicated to a wide range of the operating organization itself in the first place as they help people there expand the number of undesired events they envision so that they can expand the number of precautions they will take in their practices. *To avoid failure, you have first got to embrace it.*
- Based on the result and insight of PRA, operators should take all measures to reduce risk where doing so is reasonable. A straightforward approach to do so is to apply existing relevant good practice and international standards, as their development includes ALARP considerations in many cases.
- In other cases where it is less evident that they are standard and relevant good practice, the operator should implement measures to the point where the costs of measures would be **grossly disproportionate** to the further risk reduction that would be achieved by them.

Uncertainties: Don't Make Their Large Size as an Excuse for Indecision

- It is often proposed that when you want to introduce **protection systems against highly uncertain hazards,** you should pursue to **make your system resilient** so that it can withstand or even tolerate surprises.
- Specific approach to be proposed are increase in safety margins, diversification of the means for attaining identical or similar ends, pursuance of means to reduce the overall catastrophic potential, providing protection systems with flexible response options and improving the conditions for emergency management.
- Though there is something to be proposed in that way, it is prudent, before jumping to such proposals, to consult with USNRC guidance in NUREG-1855, Rev. 1 that provides guidance on how to treat uncertainties associated with PRA in risk-informed decision-making. You might be reminded in your underestimation of uncertainties or find helpful hints for the selection among the proposals for resilience.

*USNRC, " Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking", NUREG-1855, Rev. 1 DFC Washington, D.C., March 2013.

How to Do With Complexity

- The major challenge in the safety assessment for multiple-units site or nuclear facilities attacked by external events is to define the factual base for making risk management, overcoming the apparent complexity of the messy situation to be expected in such events. The interconnections and interdependencies among support systems and troubled systems must be taken into account in risk assessment, since these relationships can dramatically affect event consequences.
- Though it may sound like inconsistent with the description that the event is messy and complex, it is highly recommendable to pursue the improvement in the reliability and validity of the results that are produced in the appraisal of risk of such complex situation.
- In order to manage such category of risks, the emphasis should be placed on **the improvement of the robustness** in responding to whatever the troubled system is going to be exposed to.
  - Inserting conservatisms or safety factors as an assurance against unreliability of prediction of situation
  - Introducing diverse safety devices to improve protection against multiple stress situations
  - Reducing the susceptibility of the system to be protected
  - Improving the organizational capability to initiate, enforce, monitor and revise emergency management actions quickly.

Guidance from Professional Associations and Science and Technology Organizations

- Operating organizations as a group should encourage the effort each other and reinforce it by using all possible synergies within the group in the framework of its common nuclear safety policy, establishing the Nuclear Power Plant Operators' Principles of Conduct that specifies norms of corporate self-management based on risk analysis for the safe operation of nuclear power plants.
- As some of the really big issues in risk management cannot be solved by individual organizations, you should also seek guidance from standards organizations and professional organizations at home and abroad.
- As risk analysis is to quantify its effects by modeling, it is essential to adopt the language and the philosophy of modeling uncertain systems, which is scientific activity. The process of analysis and its application should be scientific process. Therefore nuclear operators as a group should strengthen Science and Technology Organizations (STO) that support good risk analysis, by promoting activities to assure human resources and knowledge basis by developing models, standards, data-basis and the state of the art PRAs steadily.

Thank you for attention