

## Emerging Framework of Safety Management after Fukushima Accident

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### 1. Introduction

Since the Fukushima accident onset, concerned organizations and experts have tried to identify the causes and effects of the incident. Many have formulated new national regulatory measures to strengthen nuclear safety in an effort to protect the general public to the extent of probabilistic cases of the most severe or extreme accidents. The Japanese government is set to install a regulatory authority, comparable to the US NRC, which is completely independent from the promotion of nuclear energy. An official report of the National Diet (or Senate) of Japan in June of 2012 laments a lack of safety culture and insists the accident could have been prevented if due consideration and attention had been provided. Both France and other European countries have performed stress tests to their operating units, and have identified many areas for improvement including that of their regulatory framework. The US NRC also conducted special inspections of all operating reactors. In addition, the NRC established both near- and long-term specific goals, and issued a policy statement for streamlining patch-worked regulatory framework. It is also applying the Risk-informed Defense-in-Depth Design which includes the extended design basis requirements. The IAEA General Conference adopted a Nuclear Safety Action Plan in September 2011 and organized an International Expert Meeting in March 2012 in order to analyze all relevant technical aspects from the Japanese incident in order to prevent a reoccurrence. Korea is not an exception to this trend. She was swift to conduct a special inspection of operating reactors and is now implementing many scheduled measures. Numerous facts and insights are now available, not only those gained from the Japanese incident, but also those gleaned from experts worldwide concerning a wide array of information. Therefore, this is an opportunistic time to summarize the insights that have been identified with respect to nuclear safety management and to overview what is occurring in numerous countries.



[Elements of Safety Management]

### 2. Methods and Results

Many facts and lessons have been collected from both the in-country Japanese data and overseas expert review highlighting specific insights which should be a strong basis for enhancing nuclear safety. The lessons learned teach us that nuclear safety can be greatly improved when three elements of safety management, i.e., accident prevention (AP), accident mitigation (AM) and emergency management (EM) are harmonized. The facts and data gleaned from the incident have been categorized and placed into three subsets accordingly. The measures, which are common among countries and organizations, are grouped with the appropriate learned insights, therefore highlighting current global trends.

Based on these insights and global trends, the Korean measures are then reviewed with recommendations made that could be reflected in future Korean policy.

#### 2.1 Insights from the accident

The Fukushima accident identified that any nuclear power plant is susceptible to a more severe or extensive external accident than previously accounted for. Such an accident results in not only extreme liability to a utility, but also creates an overwhelming socio-economic impact. This accident has proven again, as with past large scale nuclear incidents, that a heightened nuclear **safety culture** is the utmost prerequisite to nuclear utilization and that nuclear safety for the general public and the utility can be achieved only when the highest standards and expectations of safety are met through proper management. In this context, facts and lessons collected so far provide the following insights into various shortcomings in the nuclear culture:

##### A. Accident Prevention

- Underestimation of external event risk and a weakened focus on concurrent events
- Less emphasis on external event-induced common cause failures
- Focus on single reactor risk with little attention on multi-unit risk

##### B. Accident Mitigation

- Lack of diverse robust means for concurrent events
- Lack of mitigation capability for multi-unit events

##### C. Emergency Management

- Lack of back-shift human resources and emergency management capability for multi-unit events
- Lack of emergency management capability for concurrent events

## **2.2 Global Trends of Issues and Measures**

- A. Harmony between near- and long-term measures
  - Special inspection or stress test of operating reactors to mitigate rare but credible accidents
  - Transformation of patch-worked regulatory framework into an orderly one accommodating very rare but credible severe and extended damage accidents
  - Comprehensive application of probabilistic risk approach for safety analysis in parallel with a conventional deterministic approach
- B. Balance and harmony among three elements of safety management, i.e., AP, AM and EM
  - Very specific issue-by-issue review or revision of design/operation requirements
  - Emphasis in AM and EM for multi-unit events
  - Integration of improved emergency procedures such as emergency operating procedures (EOP), severe accident management Guides (SAMG) and extended damage management guides (EDMG)
- C. Special attention on external event-induced common failures
  - Expanded scope of external events to include fire, air plane crash, explosion and terrorist threat
  - Revisit of design data on external events (perhaps once in 10,000 years)
  - Stronger management in severe accident prevention
- D. Promotion of safety culture
  - Global and/or fleet-wide feedback mechanism of design/operating experiences
  - Enhancing human performance
  - Self-assessment and corrective action improvement
  - Amendment of international frameworks such as IAEA safety conventions to cover beyond-DBA which should achieve consistency among international norms and standards and to enlarge roles of international organizations such as IAEA, OECD/NEA, WANO, INPO and others

## **2.3 Issues and Measures in Korea**

The Korean government prompted a special inspection immediately after the Japanese accident and announced in May 2011 near-and mid-term measures. These measures are quite similar to those of other countries. However, the measures for AP seem very specific, while those for both AM and EM are notionally described. The measures only focus on activities of industry and research institutes while there is little focus on the regulatory framework which has been kept intact for many decades through editing and revisions without a holistic review. Although a severe accident, such as that of Fukushima, may never occur in Korea, multi-unit concurrent events should never be excluded from the Korean mindset. A new nuclear policy statement is highly recommended to incorporate the latest insights

and data. The following items should be included in the new policy statement to ensure optimum results:

- A. New and detailed consensus on safety culture
- B. Additional measures to reflect the latest insights from both the Japanese accident and other worldwide trends
- C. Principles of systematic allocation of resources to prioritize action items
- D. Risk-Informed Regulation and Application (RIR-RIA) in parallel with a deterministic approach
- E. New framework to replace the old multi-revised version. It should encompass all modalities concerned including utility, industry, academia, government authorities, and the general public
- F. Improvement in AM and EM against simultaneous multiple units failures on a site

## **2. Conclusions**

In hindsight, now freed from the confusion and chaos experienced immediately after the Japanese incident, numerous experts and organizations are publishing data which lends many insightful lessons. The issues and measures continue to become more specific and detailed which may result in a global, national, or regionally streamlined framework that could help meet the highest expectations for an improved culture of nuclear safety. This document has reviewed insights describing safety management failures and has overviewed the measured responses of various countries.

In this context, this paper reviews current Korean measures being implemented, and suggests what could be reflected later in an improved Korean policy statement. As Korea is a contributing member of the world community, a new and improved policy statement would be a very rare, but credible opportunity to both participate in, and lead global efforts for nuclear safety.

It is to be noted as more findings and lessons are forthcoming, today's insights and worldwide trends will naturally need to be updated.

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