Suggestion on Valuation of Implementation of Post-Fukushima Actions to Strengthen Nuclear Safety

Y.E.Lee*
Korea Institute of Nuclear Safety, 34 Gwahak-ro, Yuseong, Daejeon 305-338, Korea
Corresponding author: yelee@kins.re.kr

1. Introduction

Nuclear safety has been strengthened over the last 30 years by implementing the lessons learned from TMI and Chernobyl nuclear accidents, in other words, major nuclear accidents gave the regulatory bodies as well as utilities opportunities to move forward. After Fukushima accident occurred in 2011, many countries announced to install the safety features against extreme natural hazard beyond design basis and to strengthen the effectiveness of regulatory bodies. These efforts such as monetary investment and organizational improvement need to be evaluated and continually upgraded in terms of efficiency of outcomes.

The purpose of this paper is twofold: one is to identify and discuss technical issues arising from the accident and Korean efforts on how the lessons learned can be used to improve the safety of current and future plants.; the other one is to suggest roughly how to quantify non-market impact or efficiency of investment on post-Fukushima actions to strengthen nuclear safety, which is based on estimating the amounts of regulatory resource according to the various nuclear power development scenarios in the wake of accident.

The result, even though this study is still being in progress and will be presented at the KNS spring meeting, would be in use to prospect the direction of nuclear safety policy and incorporated into the innovative safety strategy.

2. Post-Fukushima Actions to Strengthen Nuclear Safety in Korea

2.1. Technical Approach [1]

The approach of inspection in Korea is using "Defense-In-Depth" concept to ensure that core melting is prevented and to minimize the undue risk to the public against events exceeding design basis including natural phenomena. The point of inspection is as follows: the first point is ensuring protection of NPPs from the natural hazard beyond design basis because the Fukushima accident is basically started from unpredictable natural phenomena. The second point is to secure electric power and reactor cooling capability. Assuming the beyond design tsunami, safety function should be provided to secure the heat removal from the reactor core through the protection of electric power systems. Also even in case of loss of power and cooling, the spent fuel pool cooling capability should be established. The third point is to strengthen the severe accident mitigation facilities and its response strategy. The Fukushima accident involved core damage and uncontrolled release of radioactive materials to the environment and the hydrogen explosion was occurred. In case of the condition of severe accident, robust measures should be provided to prevent the containment building failure due to pressure increase and hydrogen explosion. The final point is to strengthen training and strategy for severe accident management considering the multi-units accidents or combined disaster. Unpredicted severe accidents simultaneously occurred at multi-units in Fukushima and residents near a site were evacuated. It needs to protect the residents around site and the emergency response capability to the multi-units accidents and prolonged emergency situations needs to be requested.

Based on the inspection points mentioned above, Korean government conducted the Special Safety Inspection (SSI) from 23 March to 30 April, 2011. The purpose of SSI was to evaluate the safety of facilities against the earthquake and the Tsunami. Total 73 experts were participated in the inspection and they assessed the 21 units of NPPs in operation in terms of 6 areas and 27 items.

As a result of SSI, it was verified that "Korean NPPs are safe for expected maximum potential earthquake and coastal flooding based on investigation and research to date. However, 50 long- and short-term items should be improved for earthquake, coastal flooding, and severe accidents to secure safety event for natural hazards beyond the design basis such as the recent natural disaster at Japanese NPPs.

2.2. Operational Approach

The Korean regulatory body conducted IRRS mission in last July and its regulatory effectiveness was reviewed through the IAEA IRRS mission: Integrated Regulatory Review Service (IRRS) for peer review of regulatory effectiveness through a more comprehensive assessment of regulation. Mission team concluded that "Korea has a technically capable and effective nuclear safety regulatory program." The team also identified 15 items of good practices, 10 recommendation and 12 suggestions. Korean government is going to try implementation of mission results and officially request the follow-up mission.

According to suggestion from IRRS mission and IAEA Action Plan on Nuclear Safety, NSSC (Nuclear Safety and Security Commission), an independent and standalone government agency of minister level, was officially launched in last October.

2.3. Monetary Investment

After SSI in Korea, an investment program has been announced. One trillion won over the next five years to bolster nuclear safety measures was estimated.

France Nuclear Safety Authority (ASN) conducted the targeted inspections on the priority nuclear installations on topics related to the Fukushima accident. In the complementary safety assessments, ASN concluded "ASN considers that the facilities examined offer a sufficient safety level to require no immediate shutdown of any of them. At the same time, ASN considers that their continued operation requires an increase in their robustness to extreme situations beyond their existing safety margins, as soon as possible." ASN suggested the creation of a "hard-core" of material and organizational measures designed to ensure control of the basic safety functions in extreme situations.

In relation to strengthening safety of French NPPs, Chairman of ASN said "massive investment, many billions of Euros would have to be made to increase the fleet's resistance to extreme events." CEO of EDF told that he expected the costs of the post-Fukushima modifications to be less than Euro10 billion over 10 years, bringing the utility's total planned investment in its operating fleet over the next 30 years close to Euro 50 billion. French energy minister told that electricity prices would rise by 2% over 10 years because of the extra expenditures, adding that nuclear power would still be cheaper than any other electricity source.

Last year in Japan, a committee looking at nuclear-power costs and other matters, under Japan's ministerial level Energy and Environment Council presented the costs of various energy sources including nuclear power. According to the report, the per-kWh cost of nuclear power was estimated at JPY8.9. The figure of JPY8.9/kWh can be broken down as follows: (i) Cost of capital of JPY2.5, up 8.7% from the 2004 figure. (ii) Operation and maintenance costs of JPY3.1, up 48%. (iii) Nuclear fuel-cycle costs of JPY1.4, down 6.6%. In addition to those, the following three items were added: (i) Additional safety measures after the Fukushima accident of JPY0.2 per kWh. (ii) Policy expenses of JPY1.1 per kWh (iii) Costs of dealing with future nuclear risks of JPY0.5 or more per kWh [2].

3. Direction for Valuation of Implementation of Post-Fukushima Actions

The average age of the operating nuclear power plants in Korea is estimated according to the various nuclear power development scenarios. Reference will be the 5th Electric Power Demand and Supply Basic Plan. One obvious effect of the Fukushima disaster is that operating age will be quite different contrast to the expectation before accident. For example, the German government decided to suspend operation of all reactors over 30 years old immediately following the start of the crisis, which would be shut down before reaching to their lifetime limit.

Therefore the reference scenario in this paper assumes an average lifetime of 40 years for all operating and in construction reactors in order to estimate how many regulatory resources would be necessary year by year. This makes possible an evaluation of the optimum number of regulatory resources that would have to meet the public requirements to maintain the operating plants sufficiently safe. Also it would be even roughly quantified how much nuclear safety can be improved through the technical investment on post-Fukushima actions and efforts on strengthening regulatory effectiveness.

4. Conclusions and Further Study

Many countries announced nuclear energy is inevitable for a while until the innovative energy technologies are developed or renewable energy is more competitive in terms of generation capacity in the grid as well as economics in the market. Each country assessed the safety of its NPPs in operation and announced that massive investment would be undertaken to secure NPPs safe. To strengthen the nuclear safety, the regulatory body as well as utilities should make efforts on increasing regulatory resources and enhancing the technical excellence.

Regulatory body as well as utilities needs to establish means to evaluate and continually upgrade their capabilities. Safety activities should be consistent with the degree of risk reduction they achieve. Especially the use of regulatory resources should be optimized among several effective alternatives available and regulatory decisions should be made without undue delay. Therefore it needs to measure the performance, efficiency or effectiveness of outcome after regulatory body and utilities invest to strengthen nuclear safety.

Previous studies on measuring performance were about the wide range such as radiological environmental impact, loss of quality of life, or operational safety performance indicator. They were generally measured in the unit of monetary value or non-monetary term such as radiological risk reduction or qualitative term such as satisfaction rating. These different ways of measuring units make it difficult to understand the effectiveness of investment.

This study suggests how to quantify non-market impact or effectiveness of investment on post-Fukushima actions to strengthen nuclear safety. Typical approach of monetary valuation such as damage cost, control/prevention cost, contingent valuation, etc. would not be considered. The final results, which are still being analyzing, can be presented at the KNS Spring Meeting scheduled for 17, May.

REFERENCES

[1] OECD/NEA Expert Meeting, Korean Approach fir Enhancement of Nuclear Safety after Fukushima Accident, 2011.

[2] JAIF, Atoms In Japan: Nuclear Power Cost Estimation, 2011.