Basic Approach of Korean EDMG and FLEX Development

Moon-Hak Jee *, Hyeong-Taek Kim
KNHP Central Research Institute (CRI) 70-1312-gil, Yuseong-daero Yuseong-gu Daejeon 305-343, Korea
**Corresponding author: jmhak@khnp.co.kr*

1. Introduction

Following the terrorist attacks to New York City and the Washington D.C. areas in September 11, 2001, Nuclear Regulatory Commission (NRC) in US issued a series of Advisories and Orders [1] to enhance the security of the nuclear power plants. Power reactor licensees took a number of measures to fortify securities by physical protections, reinforcement of security forces and communications, restrictive control of site access, law enforcement, and other several responses.

In addition, regulatory requirement for Loss of Large Area (LOLA) due to explosions or fires came into effect by 10CFR50.54(hh)(2) [2]. It requests that each licensee shall develop and implement guidance and strategies intended to maintain and restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with LOLA. In 2006, NEI has issued the NEI 06-12 [3], so called B.5.b, to fulfill the regulatory requirements by implementation of the spent fuel pool makeup strategy, enhanced initial command and control for reactor challenges, and enhanced response strategies for reactor challenges.

2. Subsequent Approaches in US and Korea

In this section, US and Korean approaches to B.5.b and post-responses to Fukushima accident are described. In Korea, the follow-up actions to 911 terrorist attacks and Fukushima accident are different in the aspect of social responses to the man-made hazard and the site operating conditions with a number of operating units.

2.1 US Approaches

According to NRC document, B.5.b event is defined that a beyond design basis loss of a large area of a reactor plant due to fires or explosions initiated by a terrorist threat. Based on the B.5.b strategies, NRC nominated the B.5.b guidelines as EDMG that means the Extensive Damage Mitigation Guidelines whose major purpose is to mitigate the damage of LOLA by the terrorist attack while SAMG (Severe Accident Mitigation Guidelines) applies for the mitigation of damage beyond DBA (Design Basis Accident).

After Fukushima accident, NEI developed NEI 12-06, Diverse and Flexible Coping Strategies (FLEX) implementation guide [4] as post-Fukushima strategies and NRC accepted the suggested strategies at the report in August, 2012.

The worst case for the postulated beyond design basis external events (BDBEEs) is the loss of power and loss of ultimate heat sink. FLEX will increase defense-in-depth for BDBEEs by adoption of following elements that are addressed in NEI 12-06, and Fig.1 and Fig.2.

- Portable equipment that provides means of obtaining power and water to maintain or restore key safety functions for all reactors at site.
- Reasonable staging and protection of portable equipment from BDBEEs applicable to a site.
- Procedures and guidance to implement FLEX strategies.
- Programmatic controls that assure the continued viability and reliability of the FLEX strategies.

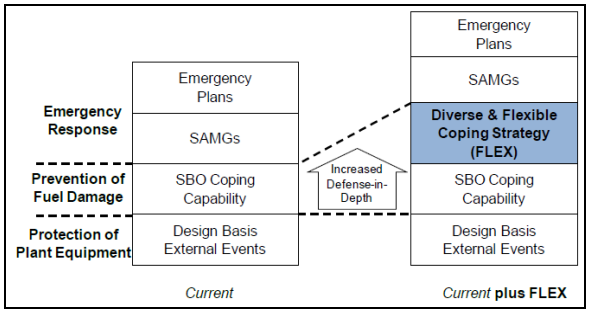

Fig. 1. Introduction of FLEX to enhance DID

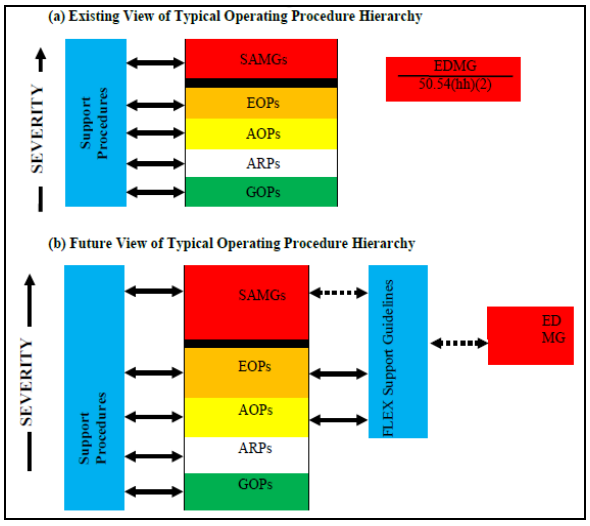

Fig. 2. Application of FLEX Support Guidelines

2.2 Major Differences in US and Korean NPPs

At most sites in US except three sites such as Palo Verde or Browns Ferry, the number of units is one or two at a site. While at each site in Korea, there are at least six operating units and other construction units. The number of units is important factors to deal with BDBEE. If the number of units is one or two, it is easy to implement command & control of the BDBA and deploy the portable equipment and procedures. Nuclear power plants in US are planning to apply the FLEX support guidelines (FSG) that are suggested in Figure 2. When referring to objectives of FLEX at NEI 12-06, FSG will support Emergency Operating Procedure (EOP), SAMG, and EDMG. FSG also complement the existing procedures that need command and control for DBA and BDBA. Nonetheless, the strategies for FSG are focusing to the EOP and not to extend to the boundary of SAMG.

On the contrary in Korean sites, it is not easy to incorporate the FLEX strategies due to the following reasons.

- A number of operating units at a site
- Possibilities of simultaneous failures of MCR and Technical Support Center (TSC) by terror
- Unavailability of N+1 strategies for portable equipment and deployment
- No regulatory declaration of beyond licensing conditions, such as 10CFR50.54(x)
- No technical or supporting responses (EDMG in US) after 911 terrors

In consideration of site conditions and present follow-up responses for Fukushima accident, it is better to develop the specific Korean EDMG and FLEX strategies rather than US approaches.

2.3 Korean Approaches

Each plant in Korea has its own Abnormal Operating Procedure (AOP), EOP, and SAMG individually. They are plant specific and no interactions with other units. As shown in Figure 3, each unit has an independent AOP, EOP, SAMG and the command & control center is MCR, MCR, TSC respectively.

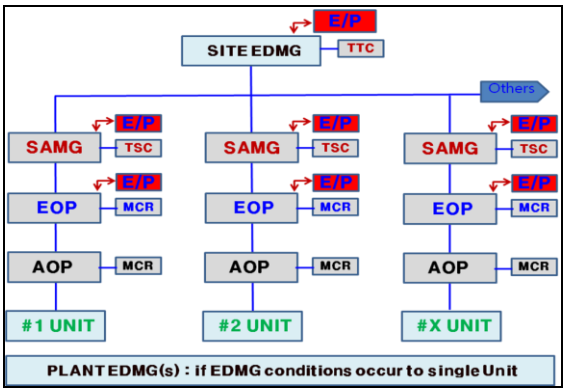

Fig. 3. BDBEE Management Structure in Korea

In case of extensive hazards to multiple units due to natural or artificial disaster, each unit will implement its own EOP or SAMG. If the hazard conditions exceed the SAMG boundary and extend to a number of units, EDMG will be executed which covers the natural and artificial disasters in Korea.

In this regard, our research institute is planning to develop the integrated EDMG and FLEX for Korean NPPs with the following elements in mind.

- Development of Site EDMG to manage the multi- unit natural hazard and artificial threat
- Development of Plant-Specific EDMG to control individual unit disasters under the command and control of Site EDMG
- Entry condition of Site EDMG to activate the top-tier command and control center
- Entry condition of Plant-Specific EDMG to manage plant individual disasters
- Management of Site EDMG ; emergency staffing, key safety factors, emergency power, cooling sources, communication, offsite supporting, etc
- Information and data interaction with relevant entities; Headquarters, government, regulation, emergency facilities, and so on

3. Conclusions

After the 911 terrorist attacks and Fukushima accident, the US and Korean responses [5][6] are quite different in the aspect of government policy and utilities post-accident measures. Particularly in Korea, the number of units in a single site is at least six units and will be twelve units at maximum. Additionally, a couple of outstanding elements are the main reason to develop the Korean specific strategies.

In conclusion, the Site and Plant-specific EDMGs in Korea should deal with the newly identified elements such as new construction of top command and control center, appropriate number of portable equipment, regulatory requirement to declare BDBA condition, and the configuration of many post-Fukushima actions already developed in Korea.

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