A Study on Reinforcement of the Accident Management System in Korea

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1. Introduction

The Fukushima accident revealed that EOPs and SAMGs were not effectively coping with and mitigating the severe accident caused by extreme natural hazards such as earthquake and tsunami. The accident indicated needs for strengthening the existing accident management procedures such as emergency operating procedures (EOPs) and severe accident management guidelines (SAMGs). In particular, these procedures should address the possibility of extreme natural hazards causing a prolonged SBO condition, which affects multiple-units and Spent Fuel Pools (SFPs) (NTTF Recommendation 9) [1].

In addition, in order to prevent and mitigate the potential damage in an extensive scale at a multi-unit site due to external events, fire, various kinds of countermeasures are required by the Regulatory Body. These are the follow-up actions to the special safety inspection carried out just after the Fukushima accident and the stress tests for old plants [2]. Especially, the Extensive Damage Mitigation Guidelines (EDMGs) are being provided by the utility in conjunction with adoption of the FLEX strategy (diverse and flexible mitigation capability) proposed by the utility in the U.S.

The aim of this study is to present the status of post-Fukushima actions with respect to accident management and also provides the current status of developing EDMGs and applicability of a FLEX strategy in Korea.

2. Post-Fukushima actions with respect to accident management

The regulatory body of Korea has taken the follow-up actions to ensure the implementation of actions plans that incorporate the lessons learned from the Fukushima accident. The review of SAMGs revealed the need for improvements for further effective implementation. Therefore, the actions are being conducted to strengthen the severe accident training and education, and revise SAMGs to improve the effectiveness of accident management strategies and develop ones for low-power and shut-down operations. Also, especially in recognition of the need for addressing the mitigation of beyond-design-basis accidents due to extreme natural hazards, the utility plans to develop EDMGs for every nuclear power plant as a way to enhance emergency response capabilities.

In addition, the severe accident research is being conducted domestically and in the foreign countries so that the research results will contribute to strengthening the SAMGs incessantly. Research activities are now going on in the areas relevant to the severe accident phenomena and important accident management strategies such as steam explosion, in-vessel retention (IVR), containment venting and cavity flooding.

Following the Fukushima accident, in the case of the U.S, the Nuclear Regulatory Commission (NRC) plans to develop a step to integrate EOPs, SAMGs and EDMGs. In response to the NRC requirements, the U.S. industry will update the technical bases of SAMGs. Based on the updated technical bases, the EOPs, EDMGs, and SAMGs will be integrated by 2016 [3]. Also, a FLEX strategy is being implemented in order to establish an indefinite coping capability and maintain the containment integrity.

Contrary to the U.S, the European Nuclear Safety Regulatory Group (ENSREG) and the Commission developed the 'EU Stress Tests Specifications' and all owners of NPPs in EU have performed the stress tests based on these specifications. Therefore, the EU and neighboring countries (Switzerland and Ukraine) performed stress tests and published national reports. There is no explicit recommendation on EDMG development and implementation, but development of SAMGs for all operating states including low power and shut-down operations, similar to the domestic actions, was recommended [4].

3. Applicability of EDMG and FLEX

3.1 Extensive Damage Mitigation Guideline (EDMG)

The EDMGs are the generic term used by the industry in the U.S. at first. They are intended to be used when the normal command and control structure is disabled and use of EOPs is not feasible [5]. EDMGs were designed to address the mitigation of extensive damage in the plant due to a large explosion or fire. It covers SFP makeup and spray strategies and enhanced initial command and control, and response strategies for reactor challenges in accordance with the B.5.b requirement of the U.S.NRC order EA-02-026 issued after 9.11 accidents.

In Korea, development of the EDMGs by the utility is being made to respond to simultaneous accidents at multiple-units due to a natural hazard. In the first phase, the Generic EDMG will be developed by 2013. And then the specific EDMG will be developed for six different types of nuclear power [2].

However, there are some concerns to develop the EDMGs. First of all, in connection with EDMGs in a

multiunit site, it might have to be clarified whether an EDMG should be developed individually for each unit or could be shared between two or more similar units. Also, in the case of an extreme natural disaster, several units in a multiunit site might suffer considerable damage. Hence, a hierarchical command and control process will have to be established in advance for effective implementation of EDMGs in coping with severe accidents.

3.2 Diverse and flexible mitigation capability (FLEX)

The U.S. industry has developed the FLEX strategy to provide a diverse and flexible means to prevent fuel damage in the reactor and spent fuel pools, and to maintain the containment integrity by using installed equipment, on-site portable equipment and off-site resources. Portable equipment provides means of obtaining power and water to maintain or restore key safety functions for all reactors and spent fuel pool cooling at a site. This capability will address both an extended loss of ac power (ELAP) and a loss of ultimate heat sink (LUHS) which could arise following external events [6]. Fig. 1 shows the outline of FLEX strategies.

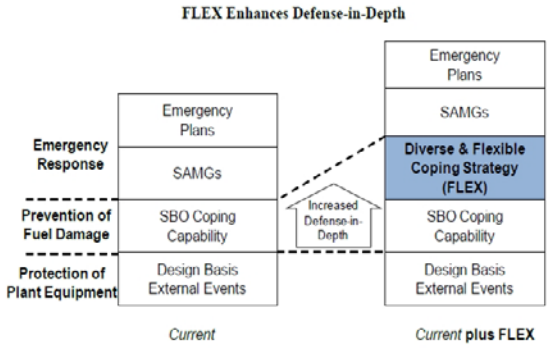

Fig. 1. FLEX Enhances Defense-in-Depth

FLEX equipment such as portable pumps, mobile generator vehicle and chargers located in diverse locations throughout the plant site should be protected from seismic and extreme high temperatures. The equipment will be able to connect to a variety of locations for injecting coolant and providing a continuous supply of electricity [7]. In addition, the regional response center (RRC) will be capable of delivering FLEX equipment to any site by air, ground or sea early after an extreme event. Also, the technicians will accompany the equipment to the site to assist with their setting up and deployment [8].

In order to reinforce the domestic accident management program against ELAP and LUHS accidents, it is recommended to adopt the FLEX strategies by the utility [9]. FLEX will provide reliable backup electrical power and cooling capability under the situation of a prolonged station blackout (SBO) for which the current EOPs and SAMGs do not provide effective means to cope with. Therefore, periodic training and exercises for the utility staff should be conducted for multi-unit and prolonged SBO scenarios as well as FLEX strategy interfaced with EOPs and SAMGs. The protection of the portable equipment from the external event also must be considered when establishing storage locations and requirements. Also, clearance of pathways should be considered for equipment deployment. Since dispersing additional pumps, generators, battery banks, chargers, compressors and hoses among various locations provides redundancy, consideration for RRC may be required.

4. Conclusions

As part of the post-Fukushima actions in Korea, SAMGs will be revised to improve the effectiveness of accident management. For this purpose, it is recommended to revise the EOPs and SAMGs and establish the EDMGs with consideration of prolonged SBO, spent fuel pool cooling, using mobile equipment for accident control, feedback of the implementation of the action items of the special safety inspection, multiple severe accidents for all reactors at a site. It is considered that the FLEX strategy may be useful to mitigate the accidents like Fukushima. Therefore, it is recommended to adopt this strategy including provision of the equipment with protection from external events.

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