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Status and Future Prospects of Extensive Damage Mitigation Guidelines in Korea

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1. Introduction

Previous severe accidents such as TMI-2 and Chernobyl accidents occurred due to combinations of equipment failures and human errors. However, the Fukushima accident is the first severe accident caused by extreme natural hazards. The Fukushima accident indicated need for integration of accident management such as emergency operating procedures (EOPs), severe accident management guidelines (SAMGs), and extensive damage mitigation guidelines (EDMGs) [1]. Therefore, in order to mitigate the effect of simultaneous accidents at multiple-units of a site due to extreme natural hazards such as earthquake, tsunami, flooding, the EDMGs in Korea are being evaluated in terms of its effectiveness in prevention and mitigation of a severe accident after the Fukushima accident.

In the first step, the Generic EDMG will be developed by KHNP for Wolsong, Kori, Yonggwang, Ulchin, Shin-Kori, Shin-Wolsong sites by 2013 and then the Specific EDMG will be developed for six nuclear power plants that represent each type of reactors by 2015 [2].

The aim of this paper is to describe the EDMGs and also introduce the activities to improve effectiveness of EDMGs through efforts for reflecting lessons-learned from the Fukushima accident. Also, this paper provides the status of developing EDMGs in Korea.

2. Extensive Damage Mitigation Guideline (EDMG)

The EDMGs are the generic term used by the industry in U.S. at first. EDMGs do not follow the type of EOPs or SAMGs. Rather, they are intended to be a replacement for EOPs to provide a bridge between normal operational commands and control that is provided by the emergency response organization when the normal command and control structure is disabled. With regard to command and control, MCR, TSC, or emergency operations facility (EOF) personnel could make EDMG decisions. However, the EDMGs do not play an important role in the formal training and licensing of plant operators.

There were two types of EDMGs considered by NEI [3]; Initial Response EDMGs and Technical Support Center (TSC) Response EDMGS. The initial response EDMGs are intended to provide a bridge between normal operational command and control and the command and control that is provided by the emergency response organization (ERO). The purpose of the initial response EDMGs is to define the actions to be taken in the event normal procedures and/or command and control structures are not available. The entry conditions for this EDMG might include loss of plant control and monitoring capability due to a large explosion or fire. This may led to damage to the control room and loss of all AC and DC power. On the other hand, the technical support response EDMGs is to provide initial actions and alternative methods of plant operation for responding to an event that results in a total loss of unit power (AC and DC), or prevents operation from the control room or the remote shutdown panel. But, the entry conditions for TSC EDMGs are not clearly defined yet.

The EDMGs were designed to address the mitigation of beyond-design-basis accidents due to extreme natural hazards such as earthquake or tsunami that would involve SBO. In addition, the EDMGs and associated equipment could be useful and available immediately to the operators to mitigate the accidents like Fukushima. However, the equipment to implement the EDMGs would need to be reasonably protected from external events because the equipment is not expected to be protected from design-basis or beyond-design-basis external events, such as floods, earthquakes, or hurricane. In addition to responding to prolonged SBO conditions, the EDMGs also address contingencies for cases when the spent fuel pools fail to retain water above the top of the fuel. This situation could also occur with significant beyond-design-basis seismic events. One effective strategy for mitigation is to blanket the spent fuel with a water spray.

Following the terrorist attack on September 11, 2001, the NRC issued security advisories, orders, license conditions, and ultimately a new regulation (10 CFR 50.54(hh)) to develop and implement guidance and strategies to maintain or restore capabilities for core cooling and containment integrity and spent fuel pool cooling under the circumstances due to a fire or explosion. These requirements have led to the development of EDMGs at all U.S. nuclear power plants. The guidelines and strategies included in the EDMGs are NRC requirements; and the NRC examined EDMG implementation in detail following the accidents at Fukushima [4].

As mentioned above, the Fukushima accident indicated the need for integration of EOPs, SAMGs, and EDMGs as a way to enhance emergency response capabilities. In particular, these improved 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) [5].

The NRC NEAR TERM Task Force concludes that modified technical specifications would consolidate EOPs, SAMGs, EDMGs, and other key elements of emergency procedures, guidance, and equipment in a manner that would clearly define command and control and decision-making during accidents.

Through surveying and analyzing the NRC's plan with regard to developing a rulemaking to integrate EOPs, SAMGs, and EDMG, an integrated procedure connects SAMG and EOPs that will be developed by 2015 to prevent and mitigate severe accidents as much as possible by using equipment installed, such as securing reactor injection flow for emergency cooling water from off-site resources as part of post-Fukushima actions. The EOP-SAMG integrated procedure will be reviewed in association with EDMG; and an optimized accident response procedure will be developed to prevent and mitigate severe accidents based on the review results. Then, the regulatory body will analyze information and discuss the scope and methods for each action item with the operator and set performance and design standards.

In addition, the NRC issued an ANPR that integrate onsite and off-site emergency response processes, procedures, training and exercises. And The U.S. industry is developing FLEX strategy used equipment stored at the on-site or off-site to address these events by providing various means of power and water supplies to support key safety functions [6]. Therefore, an ANPR and FLEX strategy will be analyzed and examined whether the applicability is taken into account in domestic NPPs.

3. Activities on Development of EDMGs in Korea

In response to the follow-up actions required by the government after Fukushima accident, KHNP (Korea Hydro & Nuclear Power) plans to strengthen education and training on severe accidents and strengthen effectiveness of accident management strategy such as EDMGs through revising severe accident management manual. In addition, the NSSC (Nuclear Safety & Security Commission) plans to bring together EOPs, SAMGs and EDMGs by system in compliance with international standards.

Accordingly, efforts to develop the EDMGs are being made to respond to simultaneous accidents at multiple-units due to a natural hazard such as earthquake, tsunami, flooding or fire as well as human errors with a target of December 2015. In the first phase, the Generic EDMG will be developed for Wolsong, Kori, Yonggwang, Ulchin, Shin-Kori, Shin-Wolsong sites by 2013 and in the second phase, the specific EDMG will be developed for six nuclear power plants that represent each type of reactors by 2015. To this end, initiating events, their impact to be considered during the development of EDMG and the association between existing EOPs SAMG and EDMG will be determined based on discussion with the regulatory body [2].

However, there are some concerns to develop the EDMGs. At first, 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 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 such events.

4. Conclusion

The aim of this paper is to describe EDMGs and also introduce the activities to improve effectiveness of accident management system through development of EDMGs. Also, this paper presents the status of developing EDMGs in Korea.

In order to mitigate the effect of simultaneous accidents at multiple-units of a site due to extreme natural hazards such as earthquake, tsunami, flooding, EDMGs will be developed by KHNP. In the first step, the Generic EDMG will be developed for Wolsong, Kori, Yonggwang, Ulchin, Shin-Kori, Shin-Wolsong sites by 2013 and then the Specific EDMG will be developed for six nuclear power plants that represent each type of reactors by 2015.

Finally, further work for the EOP-SAMG integrated procedure is needed in association with EDMG and then an optimized accident response procedure will be developed to mitigate and cope with severe accidents based on the review results. In addition, the regulatory body continues to review the causes and the sequence of the nuclear accident at Fukushima to establish an essential coping capability to prevent and mitigate damage to the fuel in the reactor and SFP, and maintain the containment integrity in Korean NPPs.

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