Transactions of the Korean Nuclear Society Autumn Meeting
Gyungju, Korea, October 26~27, 2017

Adopting the NFPA 805 to Korean NPPs: Necessities and Expected Problems

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1. Introduction

The NFPA (National Fire Protection Association) 805 Standard provides a risk-informed, performance-based (RI-PB) option to nuclear power plant licensees for demonstrating nuclear safety in the event of a fire.
In July 2004 the U.S. NRC (Nuclear Regulatory Commission) amended its fire protection requirements in 10 CFR 50.48(c) to allow existing nuclear power reactor licensees to voluntarily adopt the fire protection requirements contained in NFPA 805 which is an alternative to the deterministic, prescriptive fire protection requirements, such as 10 CFR 50 Appendix R, that was issued in 1980. One aspect of implementing NFPA 805 is that the licensee adopts the performance goals, objectives, and criteria for nuclear safety specified in the Standard. These goals, objectives, and criteria can be met through the implementation of deterministic approaches or performance-based approaches, including engineering analyses, probabilistic risk assessment, and fire modeling.

In recent years, there have been many new issues in the field of fire protection of Korean nuclear facilities due to changes in domestic and overseas environment. As the environment has been changed, fire protection design and fire safety analysis and regulation technology of domestic nuclear power plants are required to be at an international level. In addition, multiple spurious operations (MSOs) and operator manual actions (OMAs) for nuclear power plants have been added to regulatory tasks, licensees must perform fire safety shutdown analysis, including electrical circuit analysis, and should also develop the fire abnormal operating procedures. Thus, in the case that there are MSO issues not resolving with deterministic fire protection program, it is expected that the risk-informed, performance-based fire protection program is required as an alternative method. Therefore, in this paper, we studied the necessities of NFPA 805 introduction to Korean NPPs and the items should be considered.

2. Fire Protection Program for Nuclear Facilities

2.1 Korean Fire Protection Program for Nuclear Facilities

In Korea, there are many different types of nuclear power plants, and nuclear power plants are different from each other. Regulatory requirements and technical standards related to fire protection are different for each nuclear power plant, but works related fire protection are being implemented based on fire protection regulations of PWR (pressurized water reactor). On the other hand, fire PSA (probabilistic safety assessment) uses the same method and procedure regardless of reactor type or country of origin, but fire PSA is used in Korea to evaluate only the risk of fire from nuclear power plant. According to the recently revised Nuclear Safety and Security Commission Notice (No. 2015-11), licensees are required to obtain permission from the regulator to change to a performance-based fire protection system using fire PSA.

2.2 US NRC Fire Protection Program for Nuclear Facilities

On July 16, 2004, the U.S. NRC amended 10 CFR 50.48, Fire Protection, to add a new subsection, 10 CFR 50.48(c), which establishes new RI-PB fire protection requirements. 10 CFR 50.48(c) incorporates by reference, with exceptions, the NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants – 2001 Edition, as a voluntary alternative to 10 CFR 50.48 Section (b), Appendix R, and Section (f), Decommissioning. As stated in 10 CFR 50.48(c)(3)(i), any licensee's adoption of a RI-PB program that complies with the rule is voluntary. This rule may be adopted as an acceptable alternative method for complying with either 10 CFR 50.48(b), for plants licensed to operate before January 1, 1979. NEI developed NEI 04-02 to assist licensees in adopting NFPA 805 and making the transition from their current fire protection licensing basis to one based on NFPA 805. The NRC issued RG 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light Water Nuclear Power Plants," which endorses NEI 04-02, with exceptions, in December 2009.
Licensees voluntarily adopting the fire protection requirements in NFPA 805 must submit a license amendment request (LAR) to the NRC. The LAR provides

the new proposed fire protection licensing basis, including the methodology and results of required evaluations and analyses that show how the NFPA 805 performance criteria are met. As of August 2014, licensees have submitted LARs for 26 nuclear power plants, representing 42 nuclear reactor units. Of these, 7 nuclear power plants, representing 10 nuclear reactor units, have been issued a safety evaluation (SE) by the NRC approving transition of their fire protection licensing basis to one that complies with NFPA 805. Fig. 1 shows the relation between the regulatory and guidance on the process of the RI-PB fire protection program implementation.

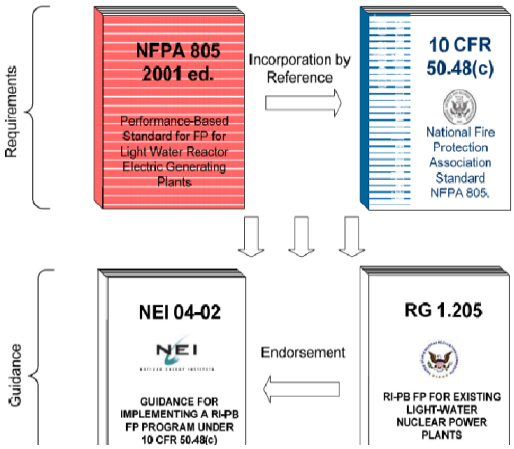

Fig.1 10CFR50.48(c)/NFPA 805 Transition Regulatory/Guidance Implementation Process

3. Risk-Informed, Performance-Based Fire Protection Program

The US NRC's fire protection regulatory requirements can be divided into deterministic fire protection and performance-based fire protection regulatory requirements. The performance-based fire protection regulatory requirement is to resolve fire risk analysis issues by performing fire modeling or fire PSA at the option of the nuclear operator. As of 2014, 46 of the operational nuclear reactors in the United States adopted the performance-based fire protection regulatory requirements and performed fire PSA to perform multiple spurious operation (MSO) analyzes and operator manual action (OMA). Fire PSA implementation uses a new fire PSA method based on NUREG/CR-6850. Fire PSA should be peer reviewed using ASME / ANS PRA Standard to secure PSA quality and submit the result to regulatory agency. In general, when evaluating only the risk due to fire, the performance category II or higher should be satisfied for the performance category II or higher if the performance based fire protection regulation is adopted.

Fig. 2 depicts the implementing guidance steps but does not include all the steps required to establish a new NFPA 805 licensing basis.

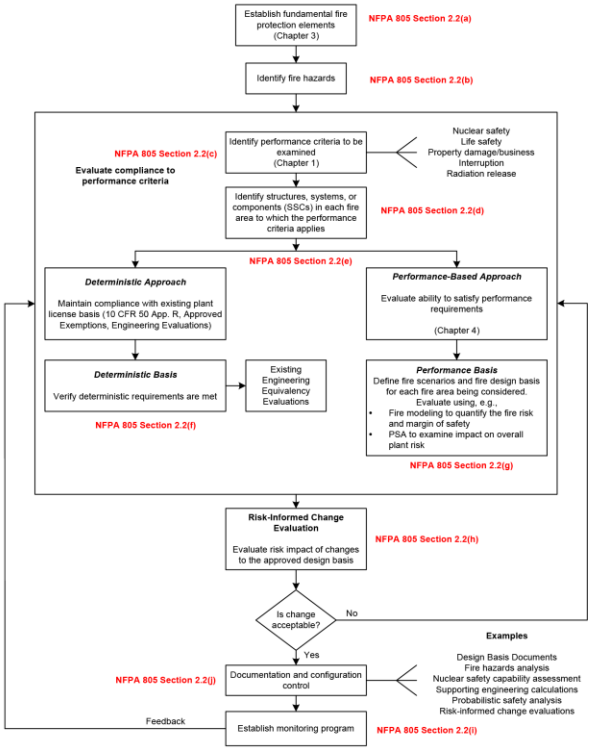

Fig.2 NFPA 805 Process (Figure 2.2 of NFPA 085)

3.1 Necessities of adoption to Korean NPPs

In US, since most NPPs constructed before App. R adoption, there are many issues related to MSO and OMA that cannot be resolved through a simple change under the deterministic fire protection program. In this case, licensees voluntarily show that the performance criteria is satisfied by implementing the NFPA 805.

The electric circuit analysis considering MSO has been carried out on a limited range, but there is no case in which the entire range is performed in Korea. Therefore, it is uncertain how many MSO issues which are not met regulatory requirement with deterministic fire protection program exist. However, there is no alternative method to solve the MSO issues so far. Since, the Korean regulatory environment is very different from the US, it is impossible to implement the US performance-based fire protection program without any change. Thus, it is necessary to establish the performance-based fire protection program considering the domestic condition.

3.2 Expected Problems

In the case of the United States, the PSA model revision was the area where the greatest effort was needed when transferring to NFPA 805. However, in the case of Korean NPPs, efforts to develop the Fire PSA model may not be necessary. In Korea, the fire PSA was carries out for all NPPs under operation in accordance with Severe Accident Policies (2001.8), and then, 'Enforced Decree of the Nuclear Safety Act' was revised, the PSA was included in the PSR (periodic safety review) and the fire PSA should be performed by PSR. NUREG-6850 method is gradually applied. Therefore, it is expected that the efforts to revise the PSA model will be reduced.
The MSO and OMA issues may be small for Nuclear Power Plant built with App. R, but it is expected that the transition to NFPA 805 will be relatively easy. Also, there is an advantage that the fire program can be easily implemented in the future.

4. Conclusions

The necessities of adoption of performance-based fire protection program to Korean NPPs are very dependents on the results of MSO analysis. However, there are some MSO issues expected at Korean NPPs. Thus, it is necessary to establish the performance-based fire protection program considering the domestic condition since the Korean regulatory environment is very different from the US.

Acknowledgements

This work was supported by Nuclear Research & Development Program of the National Research Foundation of Korea grant, funded by the Korean government, Ministry of Science and ICT (Grant number 2017M2A8A4016659).

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