# Current R&D Status and Considerations of Fire Protection SDP

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## 1. Introduction

Since early 1999, the U.S. Nuclear Regulatory Commission (NRC) has suggested the Reactor Oversight Process (ROP) that is a risk-informed approach to improve the operational safety of nuclear power plants (NPPs) [1]. Seven cornerstones in the ROP contain inspection program and performance indicator (PI) to assure that the performance criteria are met. The Significance Determination Process (SDP) is a tool to help that the regulatory staff determine the potential safety significance of inspection findings. Currently, various fields of SDP have been suggested. Among them, fire protection SDP (FPSDP) was developed and implemented to evaluate the safety significance of fire protection inspection findings.

The KINS has also proposed a comprehensive implementation R&D plan for achieving risk-informed and performance-based regulation since 2006, which has an objective to optimize current regulatory activities by integrating risk and safety performance information with existing deterministic approaches [2]. As a part of this R&D regulation program, SDP methodology is essential to evaluate the risk significance of inspection findings resulted from risk-informed periodic inspection.

In this paper, a FPSDP methodology being used by NRC staff is presented and the feasibility of FPSDP implementation to operating NPPs in Korea is checked.

## 2. Fire Protection SDP

The FPSDP is a tool to estimate the risk significance of inspection findings affecting the fire protection defense-in depth (DID) elements [3]:

- Prevention of fires
- Rapid detection and suppression of fires, and
- Protection of structures, systems, and components (SSCs) important to the safe shutdown (SSD) of the plant.

The FPSDP is based on the simplified classical fire-PSA methodology. This SDP methodology consists of three phases including two screening phases. Each phase is presented and summarized as follows;

### *2.1 FPSDP Phase 1*

The phase 1 is a preliminary screening check to identify fire protection inspection findings with potential risk significance. The phase 1 consists of four analysis steps including three screening processes as shown in Fig. 1. At first, the finding category is assigned based on the plant fire protection program element and then the degradation rating to reflect the severity of the observed deficiency is assigned. Then the first qualitative screening check including the supplemental questions for "Fire Confinement" is performed. Finally, initial quantitative screening check considering duration factor and fire area total fire frequency for finding is performed. If the finding is screened out (i.e. the screening criteria are met), the finding is assigned "Green" significance. But the finding is not screened out, the analysis continues to Phase 2.

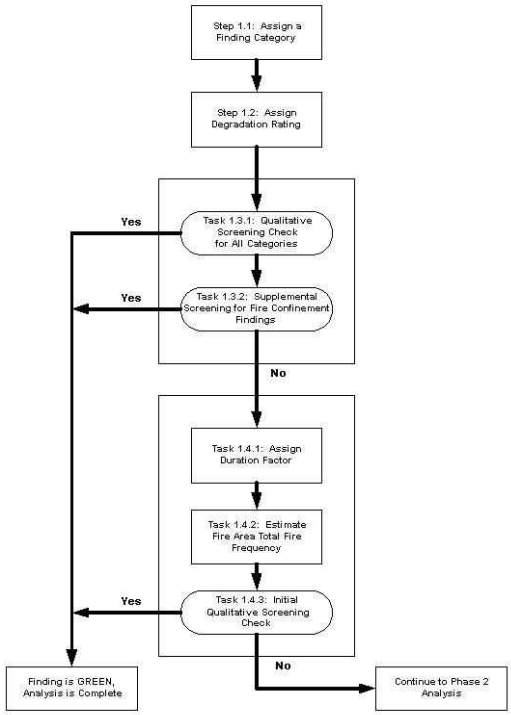


Fig. 1. Phase 1 Flow Charts

### *2.2 FPSDP Phase 2*

The phase 2 is a quantitative assessment of the increase in core damage frequency (CDF) that can be caused by the inspection finding. Phase 2 consists of nine analysis steps including five screening processes as shown in Fig. 2. The safety significance of inspection finding is determined considering independence check of SSD path, fire scenario and ignition source screening based on the individual fire frequency, non-suppression probability reflecting the fire growth and damage time, and conditional core damage probability (CCDP) resulted from SSD response analysis.

If each quantitative screening criterion is met, the finding screens to "Green" and subsequent steps need not be performed. Otherwise, the finding is potentially risk significant.

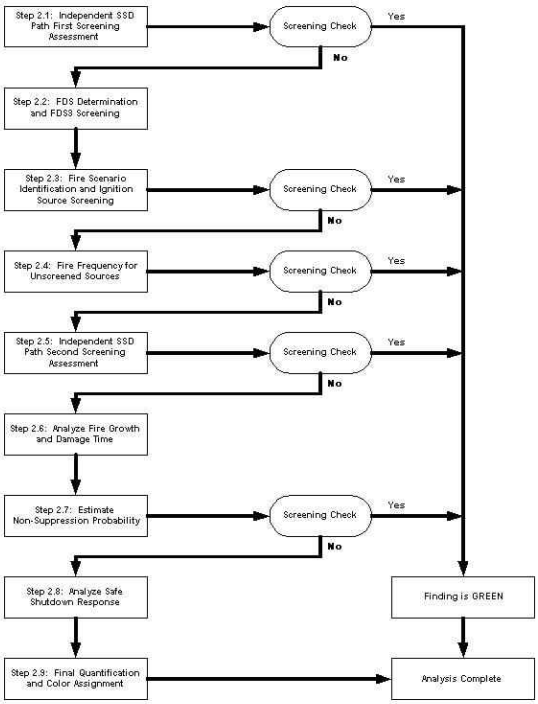


Fig. 2. Phase 2 Flow Charts

*2.3 FPSDP Phase 3*

The objective of phase 3 is to evaluate the increase in CDF as in the phase 2. Phase 3 is a process to confirm or refine the result of phase 2 analysis. Phase 3 utilizes the current fire-PSA methodology and expertise about the fire-PSA is required. Phase 3 is not mandatory. In case the finding is over "Green" resulted from phase 2 analysis, this phase will be considered.

## 3. Considerations for Domestic Application

*3.1 Risk-Informed Inspection Notebook*

The plant specific risk-informed inspection notebook contains categories of initiating events table, initiators and system dependency table, SDP worksheets, and SDP event trees. In FPSDP, SDP worksheets are used to analyze the plant SSD response and assess the fire scenario CCDP. Initiators and system dependency table, and SDP event trees provide additional information for SDP worksheets.

If other approaches are not provided, then the development of plant specific risk-informed inspection notebook may be required.

*3.2 Inspector's Convenience*

Even though this methodology has been developed for use by non-fire PSA analysts in mind and avoids much of the complexity associated with full scope fire PSA, it is still difficult for technical staffs to obtain a risk significance assessment of the inspection findings due to the remaining complexity.

Also this methodology is more elaborate than any of the other screening tools in U.S. NRC Inspection Manual Chapter 0609, and it takes more time in evaluating a performance deficiency.

Therefore the current methodology by U.S. NRC should be further simplified for application to operating NPPs in Korea as a screening tool.

*3.3 Current Technical Status*

There has been a considerable movement in the regulatory framework of U.S NRC towards the use of risk information. In the area of fire protection, NFPA 805 and new fire PSA implementation guide has been developed for this movement [4-5].

Since the quantification approach and analysis methods used in existing FPSDP are based on old fire PSA methodology, the current FPSDP would be needed to upgrade the new fire-PSA methodology.

## 4. Conclusions

The FPSDP is a useful tool to evaluate the risk significance of inspection findings and support the ROP program. However, the current FPSDP methodology still remains as a complex process and is not easy to apply. Therefore, a lot of resources are always needed for evaluating the risk significance of inspection findings on fire protection area.

For domestic applications of FPSDP to operating NPPs, development of a risk-informed inspection notebook may be required, and an update of current fire-PSA methodology should be done.

## REFERENCES

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