

Development of Draft Regulatory Guide on Accident Analysis for Nuclear Power Plants with New Safety Design Features

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1. Introduction

New safety design features (NSDF) have been introduced to the new constructing nuclear power plants (NPP) since the early 2000 and the issuance of construction permit of SKN Units 3&4. Typical examples of the new safety features includes Fluidic Device (FD) within Safety Injection Tanks (SIT), Passive Auxiliary Feedwater System (PAFS), ECCS Core Barrel Duct (ECBD) which were adopted in APR1400 design and/or APR+ design to improve the safety margin of the plants for the postulated accidents of interest [1,2]. Also several studies of new concept of the safety system such as Hybrid ECCS design have been reported.

Such a new safety design features should be considered in a reasonable manner for the affected accident analysis of the subjected NPP. Generally, guideline of the accident analysis for the licensee and designers was provided at the Safety Review Guide (SRG) [3], however, the new safety design features mentioned above were not considered in the currently available SRG for accident analysis. Thus, general and/or specific guideline of accident analysis considering the NSDF has been requested.

The present paper discusses the development process of the draft version of regulatory guide (DRG) on accident analysis of the NPP having the NSFD and its result.

2. Basic Consideration of DRG

During the licensing reviews of the APR+ and APR1400 plants, it was highlighted how to address the NSDF such as FD, ECBD, and PAFS in the accident analysis [4]. Lesson learned from those experiences was that impact of the NSDF should be identified in physical and realistic manner and incorporated into the accident analysis. It is true even for the accidents which conservative calculation has been applied to. Also, calculation uncertainty related to address the effect of NSDF should be considered. Taking into account this aspect, two separated analysis, impact analysis and actual accident analysis are required for the NSDF. It should be clearly implemented in the DRG.

3. Development Process

Fig. 1 shows a development process of the Regulatory Guide on Accident Analysis for NPP with NSDF. The process starts with what is defined as NSDF. Final output of this process is DRG applicable to the accident analysis for the NPP with NSDF and its technical background. Each part of the process is described as follows.

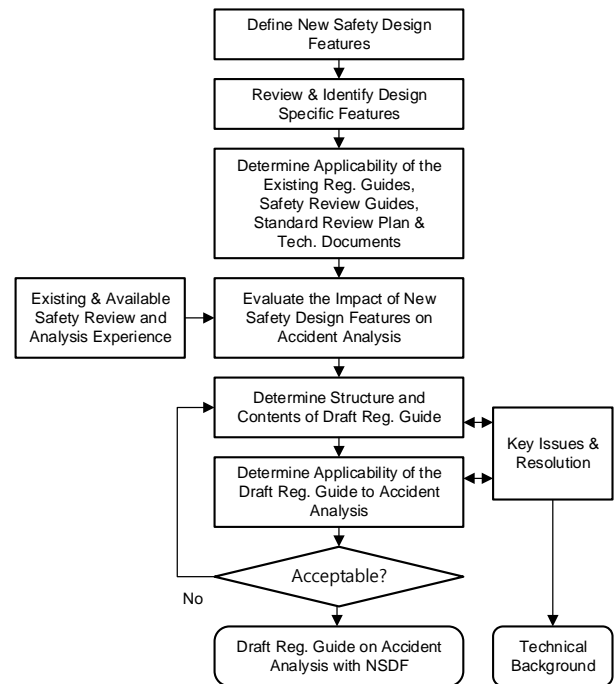


Fig. 1. Development process of regulatory guide on accident analysis for NPP with NSDF

3.1 Define NSDF

As mentioned above, PAFS, FD and ECBD have been considered as new design features, because they are not specifically discussed in the existing SRG. Proposal of the new feature by designer can be regarded as NSDF if it has impact of the accident analysis and not discussed in the existing SRG as of current time.

3.2 Review and Identify Design Specific Features

Identification of the important safety characteristics of the defined NSDF is a basis for further accident analysis. Mechanism, interaction of the existing design features and qualification of each NSDF should be identified.

3.3 Evaluate the Impact of NSDF on Accident Analysis

Especially, the impact of each NSDF on the analysis of each accident in Chapter 15 of Safety Analysis Report (SAR) should be identified. For this purpose, the existing safety review and regulatory position as well as the available analysis results can be used.

3.4 Determine Structure and Contents of DRG

A basic principle of development of the new regulatory guide in this study is to provide a guidance for the designer and licensee. Any change in the existing SRG induced by this regulatory guide is not desirable. Thus, the structure and contents of this new regulatory guide should be simple and general in order to be regarded as an addition to the existing SRG.

3.5 Determine Applicability of the DRG

The applicability of the DRG should be confirmed by the demonstration. If a certain portion of the draft regulatory guide has a problem on application to a specific accident analysis, that part should be improved. This process will be iterated by changing the subject contents.

3.6 Key Issues and Resolutions

During the preparation of the specific contents and the applicability demonstration of the DRG, several unclear points can be identified. They should be resolved by changing the subject contents.

3.7 Technical Background

All the considerations for the development, the demonstration, key issue resolutions of the DRG should be documented to provide a clear understanding for licensee and designers.

4. Structure and Contents of DRG

The structure and key words of the DRG developed through the above process are as follows:

1. Background
2. Regulatory Position
 - A. General
 - (1) Definition of NSDF
 - (2) Impact Analysis and Scope

- a. Implement of impact of NSDF to SAR
 - b. Impact on normal plant operation
 - c. Effect of undesired operation NSDF on accidents
 - d. Requirements of NSDF
 - (3) Compliance with the relevant SRG
 - B. Evaluation of impact of NSDF
 - (1) Scope
 - a. All AOO and Accidents in SAR
 - b. Case for exemption of impact evaluation
 - c. Exclusion of application to radiological consequence analysis
 - (2) Importance of NSDF impact
 - a. Identification of importance of each accident
 - b. Method to determine the importance
 - c. Sensitivity study required to importance
 - (3) Realistic evaluation
 - a. Realistic prediction of physical process induced by accident and NSDF
 - b. Justification of validity of computer codes, models and correlation, etc
 - c. Comparison with experimental data
 - d. Use of supporting calculation
 - e. Action for the unrealistic prediction
 - f. Exemption of evaluation for low-importance accident
 - (4) Consideration of Uncertainty
 - a. Uncertainty of NSDF performance
 - b. Uncertainty related to actuation, operation, boundary condition, etc
 - c. Reliable basis for individual uncertainty
 - (5) Conservative Evaluation
 - a. Allow use of conservative model for the case of justification
 - b. Consideration of uncertainty for the conservative evaluation
 - C. Accident analysis considering NSDF
 - (1) Direct incorporation of the impact into accident analysis for the accidents related to realistic calculation
 - (2) Indirect incorporation of the impact into accidents analysis for the accident related to conservative calculation
 - D. Implementation
3. References

5. Concluding Remarks and Further Works

Based on the consideration on the lesson learned from the previous licensing review, a draft regulatory guide (DRG) on accident analysis for NPP with new safety design features (NSDF) was developed. Realistic evaluation of the impact of NSDF on accident with uncertainty and separated accident analysis accounting the NSDF impact were specified in the DRG.

Per the developmental process, identification of key issues, demonstration of the DRG with specific accident with specific NSDF, and improvement of DGR for the key issues and their resolution will be conducted.

REFERENCES

- [1] APR+ SSAR Standard Design Approval Document, KHNP, 2013.
- [2] Shinkori Units 3&4 Final Safety Analysis Report, Rev.1, KHNP, 2015.
- [3] KINS, Safety Review Guide for Light Water Reactors, KINS/GE-N001, 2009.
- [4] KINS, Safety Evaluation Report on APR+ SSAR Standard Design Approval, 2012.