Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 7-8, 2026

Comparative Analysis of Mitigation Effects of Improved DPG SAMG SACRG-01

Ji-Eun Oh [a*], Mi-Ro Seo[a], Jeong-Min Shin[a], Su Won Lee [b], Myeong Kwan Seo[b]
[a]*Korea Hydro & Nuclear Power Co., Ltd., Yuseong-Gu, Daejeon, Korea*
[b]*FNC Technology Co., Ltd.,10 Fl., 13 Heungdeok 1-ro, Giheung-gu, Yongin-si, Gyeonggi-do, Korea*
**Corresponding author: k12290641@khnp.co.kr*

***Keywords :** Severe Accident, SAMG, MCR SAG-01(SACRG-01), TLOFW, SG External Injection

1. Introduction

Domestic nuclear power plants (NPPs) currently in operation adopt the Severe Accident Management Guidelines (SAMG) developed by the Westinghouse Owners Group (WOG) in 1994. After the Fukushima accident, the Pressurized Water Reactor Owners Group (PWROG) developed the Diagnostic Procedure Guideline (DPG) based Severe Accident Management Guidelines (SAMG) to enhance severe accident management performance through a diagnosis-oriented approach [1].

The WOG SAMG determines entry into mitigation strategies through the Diagnostic Flow Chart (DFC)[2]. The DFC is performed sequentially according to the predefined priority. In addition, before implementing a mitigation strategies, the potential adverse effects associated with those strategies should be evaluated, and the decision to implement the strategies are made based on the evaluation results.

In contrast to the DFC used in the WOG SAMG, the SAMG developed by PWROG determines entry into mitigation strategies through the Diagnostic Procedure Guideline (DPG). The prioritization of mitigation strategies in the DPG SAMG is not predefined in a fixed sequence but is established based on plant symptoms and conditions.

To support the development of the DPG SAMG, Korea Hydro & Nuclear Power (KHNP) conducted comparative evaluations for mitigation effectiveness of the WOG SAMG and the DPG SAMG. Differences in mitigation level and timing were analyzed to assess the effectiveness of the DPG methodology. Furthermore, the validity of mitigation strategies and their associated potential adverse impacts were evaluated. Also, the effects of early mitigation actions described in the Severe Accident Control Room (SACRG) were evaluated quantitatively. SACRG-01 defines the emergent operator actions necessary to recover the plant in a controllable and safe conditions at the entrance of severe accident happened during full power operation.

In this study, the effects of early mitigation actions described in the SACRG-01 of WOG SAMG and the DPG SAMG were compared mainly focused on the external cooling water injection to Steam Generators.

2. Methods and Results

2.1 Accident Scenario Selection

The Westinghouse (WH) type NPP was selected as the reference plant for this analysis. To compare the outcomes of mitigation actions performed by the MCR under both the WOG SAMG and the DPG SAMG, prior to the activation of the Technical Support Center (TSC), the Total Loss of Feedwater (TLOFW) accident scenario was selected. In this study, we focused on analyzing the mitigation effects in the early stages of severe accidents progression due to changes in the sequence of external cooling water injection to steam generators based on the SACRG-01.

For the analysis, the EPRI severe accident analysis code MAAP 5.06 was used.

2.2 Assumptions for analysis

The basic assumptions for major equipments and system operations applied in the analysis are presented in Table 1.

Table 1. Main equipment and system operation assumptions

Equipment & System	Assumptions
Motor-driven Aux Feed System	N/A
Turbine-driven Aux Feed System	N/A
HPI and LPI	N/A
Accumulator	3 Available
Containment Spray System	N/A
Initiating Event	TLOFW

The emergency responses by the MCR, performed prior to the activation of the TSC, under the WOG SAMG and DPG SAMG regime exhibit the following differences in sequence as shown in Figure 1.

In the SACRG-01 of WOG SAMG, if the TSC has not yet been activated, SG level control is performed at Step 14 (Case 1). In contrast, in the SACRG-01 of DPG SAMG, the same action is performed at Step 8 (Case 2).

Once the TSC is activated, the WOG SAMG proceeds sequentially according to the DFC and does not return to a previously completed procedure after controlling a condition in which a severe challenge parameter exceeds its threshold value. In contrast, the DPG SAMG performs mitigation strategies based on the highest priority identified in the DPG Worksheet, which is updated every 15 minutes.

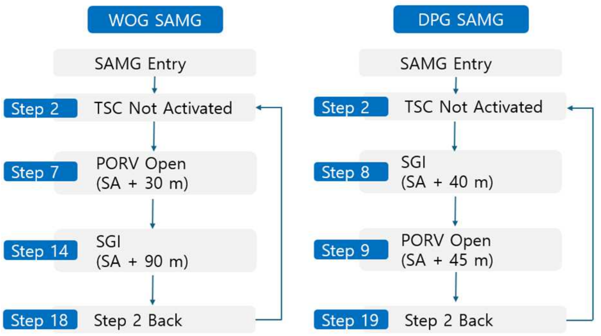

Fig. 1. Timing of Case 1 & Case 2

For comparison of plant responses resulting from the different SACRG-01 action sequences, the TSC was assumed to be not activated. This assumption allows the sequencing difference between the procedures to be clearly identified.

In the WOG SAMG, PORV opening is initiated at approximately SA + 30 minutes, followed by SG external injection at SA + 90 minutes. In contrast, in the DPG SAMG, SG external injection is performed at SA + 40 minutes, followed by PORV opening 5 minutes later.

The major differences of the process in Case 1&2 are summarized in Table 2.

Table 2. The major Condition of Case 1&Case 2

Event	Guideline	Portable Equipment Available	TSC Activated
Case 1	WOG SAMG	SA + 90 m	X
Case 2	DPG SAMG	SA + 40 m	X

2.3 Analysis Results

The major accident progression results are summarized in Table 3. After the availability of mobile equipment, the timing of SG external injection differs by approximately 50 minutes between Case 1 and Case 2. Although the time difference is relatively small in the overall accident progression, the results indicate that the DPG SAMG enables relatively faster core cooling compared to the WOG SAMG.

Figure 2 shows the reactor coolant inventory in the core. Compared to Case 1, Case 2 exhibits a relatively faster recovery of core inventory following the availability of mobile equipment.

Figure 3 presents the RCS pressure. In Case 2, the pressure reduction is initiated later compared to Case 1 due to the timing of PORV opening. However, a more effective depressurization is achieved thereafter, which contributes to improved heat removal.

Table 3. Event progression of Case 1 and Case 2

EVENT	Case 1	Case 2
	hr	hr
TLOFW	0	0
Reactor Scram	0	0
SAMG Entry	2.3	2.3
PORV Open	2.8	3.1
SG External Injection (using Mobile pumps) & SG Relief Valve Open	3.8.	2.97

Figure 4 illustrates the RCS temperature in the core. In Case 2, the decrease in RCS temperature is initiated later compared to Case 1. However, once mitigation actions are implemented, Case 2 achieves a more rapid temperature reduction, resulting in faster overall core cooling. This trend is attributed to the DPG SAMG strategy, in which RCS depressurization is effectively performed, enabling earlier SG external injection. As a result, enhanced heat removal leads to a faster decrease in RCS temperature.

Figure 5 shows the SG level. Based on the timing of SGI, a difference in the SG level recovery time is observed between two cases.

Figure 6 presents the SG pressure. Although the overall trends are similar in both cases, Case 2 exhibits a faster pressure reduction compared to Case 1 with earlier mitigation actions.

Overall, while the general accident progression trends are similar between the two cases, Case 2 achieves faster core cooling and earlier SG level recovery due to the more effective depressurization and earlier SG external injection enabled by the DPG based mitigation strategy.

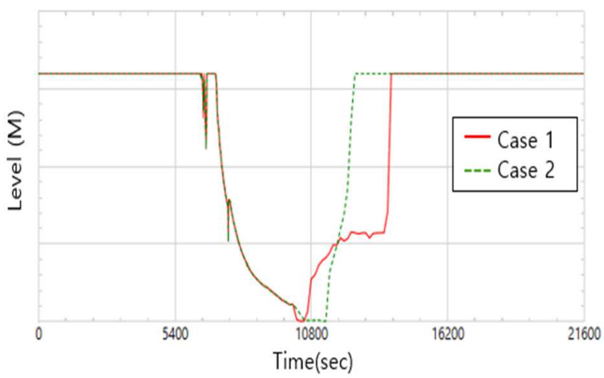

Fig. 2. Core Level of Case 1 & Case 2

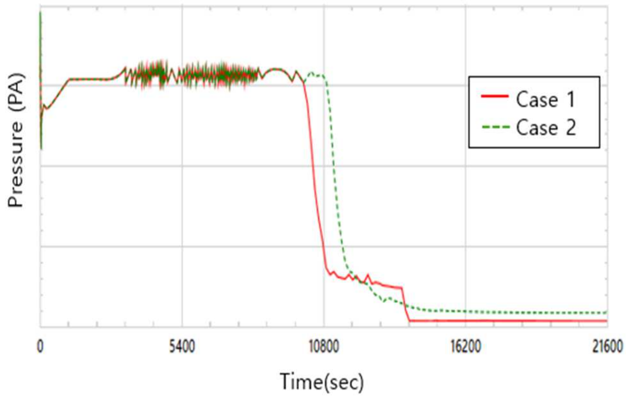

Fig.3. RCS pressure of Case 1 & Case 2

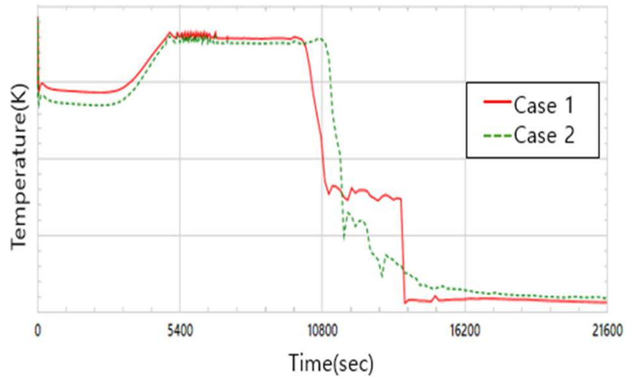

Fig. 4. RCS Temperature in Core of Case 1 & Case 2

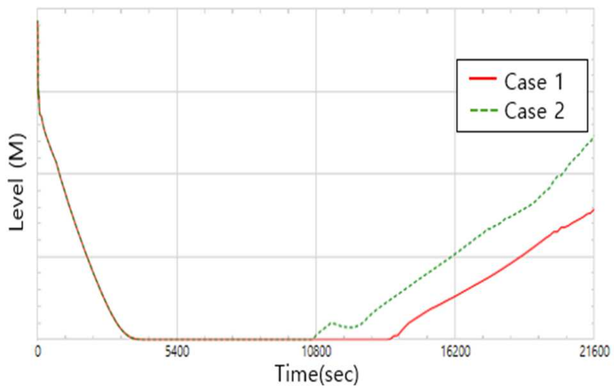

Fig. 5. SG Level of Case 1 & Case 2

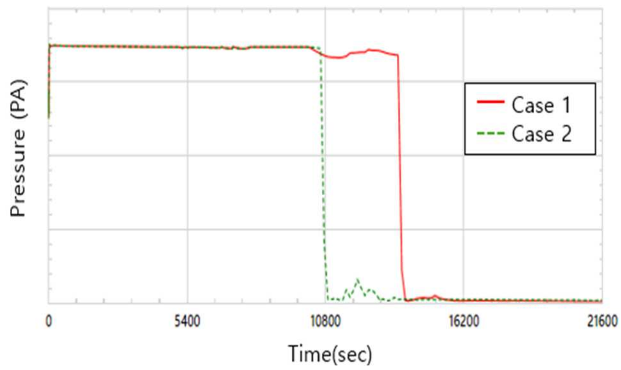

Fig. 6. SG Pressure of Case 1 & Case 2

3. Conclusions

This study comparatively analyzed the mitigation strategy focused on the external cooling water injection to Steam Generators described in SACRG-01 under the WOG SAMG and the DPG SAMG frameworks. To clearly identify the impact of procedure sequencing, the activation of the TSC was excluded, allowing a direct comparison of MCR based actions.

As a result of the sequencing difference, earlier SG external injection in the DPG SAMG leads to faster core cooling. However, Despite a significant time difference of 50 minutes in the external cooling water injection timing into the steam generators, it was analyzed that there were not much larger differences in overall reactor cooling performance than expected. Both procedures exhibited broadly similar accident progression behavior, with differences primarily limited to mitigation timing.

However, the conclusions of this study are limited to the specific accident sequence considered. The analytical assumptions—including delayed TSC activation, availability of portable equipment, and the necessity of SG level control—were configured for the TLOFW scenario. Similar comparative conditions may not be directly applicable to other deterministic accident sequences.

So, this analysis may be used as reference information for understanding early-phase mitigation behavior during severe accidents. In addition to this scenario-specific evaluation, further comparative analyses between the WOG SAMG and the DPG SAMG under diverse accident sequences may also be used as supporting reference material in the ongoing improvement of the plant specific DPG SAMG, and may contribute to enhancing severe accident mitigation capability for domestic nuclear power plants.

REFERENCES

[1] "PWROG Severe Accident Management Guidelines", PWROG-15015-P Revision 0, February 2016.

[2] "Westinghouse Owners Group Severe Accident Management Guidance", Westinghouse Electric Co, June 1994.