

# KNS 2016 Autumn Meeting

## Improvement of Diagnostic Flow Chart in Severe Accident Management Guidance for Nuclear Power Plants in Korea

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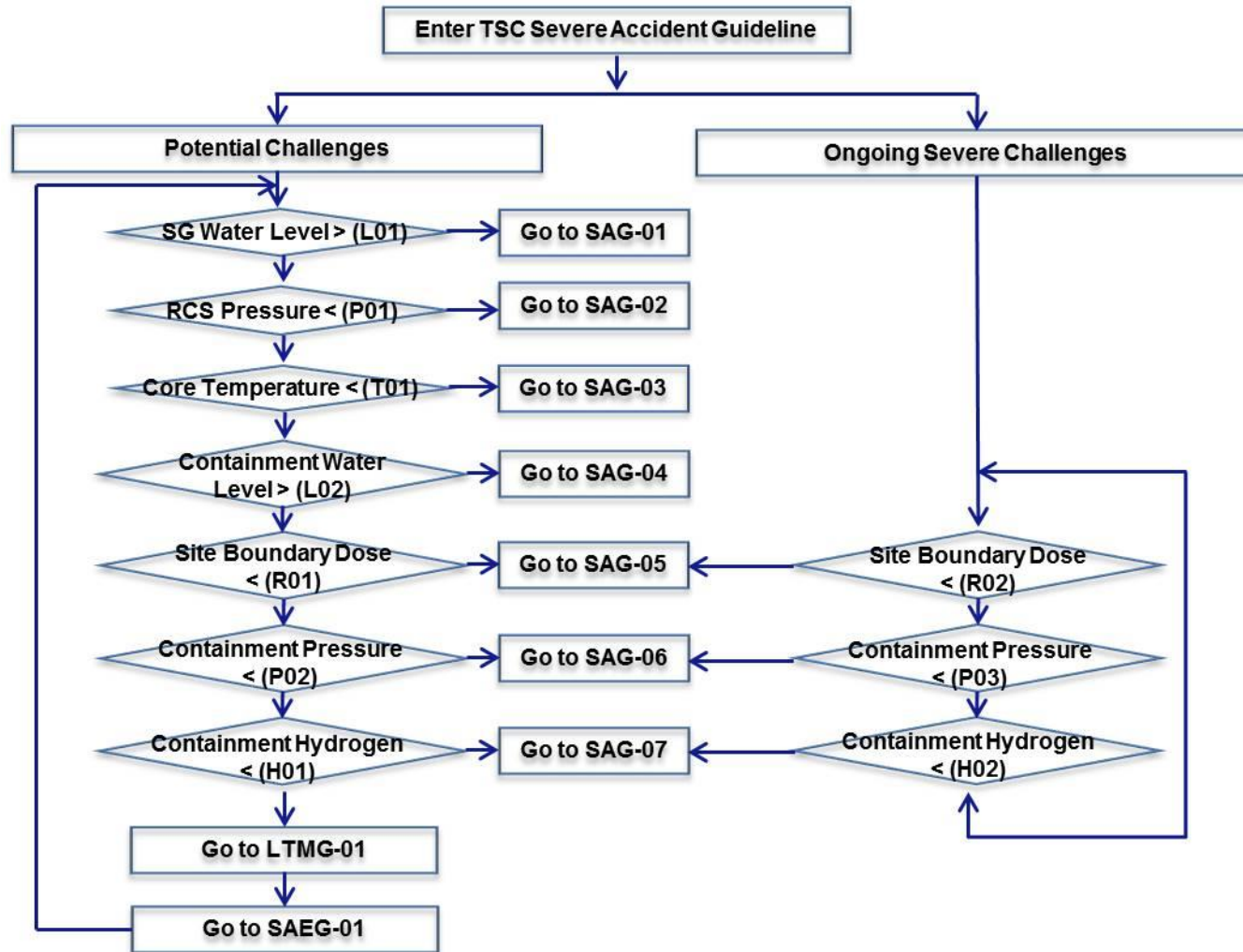
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# 1. Introduction

- Preliminary study for developing accident management guidance for Nuclear Power Plants (NPPs) in Korea was conducted in July 1997.
- Generic Severe Accident Management Guidance (SAMG) for NPPs in Korean has developed in November 1999.
  - ▶ Structure of Korean SAMG was adopted from Westinghouse Owner's Group(WOG) SAMG.
- SAMG of Pressurized Water Reactor Owner's Group (PWROG) was developed in February 2016 by incorporating the best features from the previous PWR generic SAMG.
  - ▶ PWROG SAMG is also based on WOG SAMG.
- The purpose of this study is to provide improvements of Korean SAMG by comparing between Korean SAMG and PWROG SAMG to reflect the state of the art and trends.

## 2. Comparison between Korean SAMG and PWROG SAMG

### ■ DFC in Korean SAMG



## 2. Comparison between Korean SAMG and PWROG SAMG

### ■ Similarities between Korean SAMG and PWROG SAMG

WOG SAMG	KOREAN SAMG	PWROG SAMG
SACRG-1	SACRG-1	SAG-1
SACRG-2		SAG-2
DFC (Diagnostic Flow Chart)	DFC (Diagnostic Flow Chart)	DPG (Diagnostic Process Guideline)
SCST (Severe Challenge Status Tree)		
SAG-1~8 (Severe Accident Guideline)	SAG-01~07 (Severe Accident Guideline)	SAG-3~9 (Severe Accident Guideline)
SCG-1~5 (Severe Challenge Guideline)		

## 2. Comparison between Korean SAMG and PWROG SAMG

### ■ Differences between Korean SAMG and PWROG SAMG

#### ▶ Level to Identify Severity of the Plant

- DFC in Korean SAMG consists of **Potential Challenges** and **Ongoing Severe Challenges**.
  - Ongoing Severe Challenges have higher priority than Potential Challenges.
- DPG in PWROG SAMG consists of four levels of parameter.
  - **Red, Orange, Yellow, and Green**
  - Color of conditions signifies the first order of priority.  
e.g. The Red have higher priority than the Orange.
- Concept of DFC and DPG is similar, but **DPG has more detail levels to identify severity of the conditions** for implementing the strategies in accordance with the SAGs.

## 2. Comparison between Korean SAMG and PWROG SAMG

### ■ Differences between Korean SAMG and PWROG SAMG

#### ▶ Order of Priority of Strategies

- Hydrogen reduction has a higher priority than containment pressure control.

Korean SAMG		PWROG SAMG	
SAG-01	Injection into the Steam Generators	SAG-3	Injection into the Steam Generators
SAG-02	Depressurize the RCS	SAG-4	Depressurize the RCS
SAG-03	Injection into the RCS	SAG-5	Injection into the RCS
SAG-04	Injection into the Reactor Cavity	SAG-6	Injection into the Containment
SAG-05	Control Fission Product Releases	SAG-7	Reduce Containment Hydrogen
SAG-06	Control Containment Conditions	SAG-8	Control Containment Conditions
SAG-07	Control Containment Hydrogen	SAG-9	Mitigate Fission Product Releases

## 2. Comparison between Korean SAMG and PWROG SAMG

### ■ Differences between Korean SAMG and PWROG SAMG

#### ▶ Entry Parameter into the Strategy

- Entry parameter to enter SAG-03, "Inject into the RCS" is **core temperature** in Korean SAMG.
- Entry parameter to enter SAG-03 is **RCS injection rate** in PWROG SAMG, since the core temperature indication may be not reliable as an accurate indication of core cooling in a severe accident.



## 2. Comparison between Korean SAMG and PWROG SAMG

### ■ Differences between Korean SAMG and PWROG SAMG

#### ▶ Integration of Guidelines

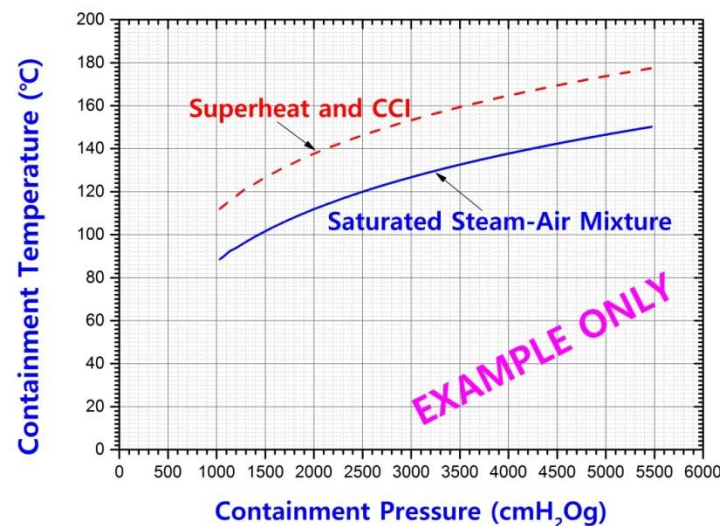
- **LTMG-01**(TSC Long Term Monitoring) : provide information for TSC to monitoring the long term concerns associated with strategy implementation.
- **SAEG-01**(SAMG Termination) : provide information for the TSC that is important to supplement recovery actions after the use of SAMG is discontinued.
- DFC, LTMG-01, and SAEG-01 are **separated** as another guideline in Korean SAMG.
- DFC, LTMG-01, and SAEG-01 are **integrated** as DPG in PWROG SAMG.

## 2. Comparison between Korean SAMG and PWROG SAMG

### ■ Differences between Korean SAMG and PWROG SAMG

#### ▶ Occurrence of Core Concrete Interaction

- TSC checks correlation between the **containment pressure and temperature** to identify whether CCI has occurred or not, using DFC of Korean SAMG
- If current plant states correspond to **superheat and CCI curve**, then CCI assumed to have occurred.
- However, TSC has no explicit direction when containment pressure and temperature are **out of range** described in curve.



## 2. Comparison between Korean SAMG and PWROG SAMG

### ■ Differences between Korean SAMG and PWROG SAMG

#### ▶ Occurrence of Core Concrete Interaction(Cont.)

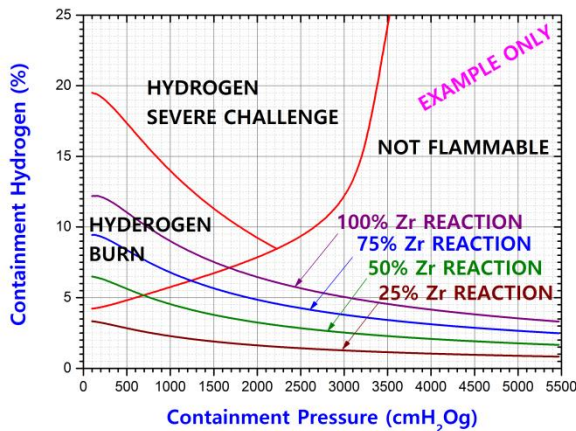
- TSC checks the **pressure difference between RCS and containment**, and **the containment water level** to identify whether CCI has occurred or not for the first step in DPG of PWROG SAMG
- If CCI has occurred, TSC identify the **time after reactor vessel failure** for the next step.
- TSC can make a decision when TSC conducts hydrogen control strategies by using the **elapsed time of CCI** in CA-3(Hydrogen Flammability in Containment) of PWROG SAMG, given the **predicted generated amount of CO following the CCI**.
- To minimize uncertainties of production of the flammable gases according to duration time of CCI, **Figures for 2, 8, and 16 hours corresponding to the elapsed time of CCI** are presented in CA-3 of PWROG SAMG.

## 2. Comparison between Korean SAMG and PWROG SAMG

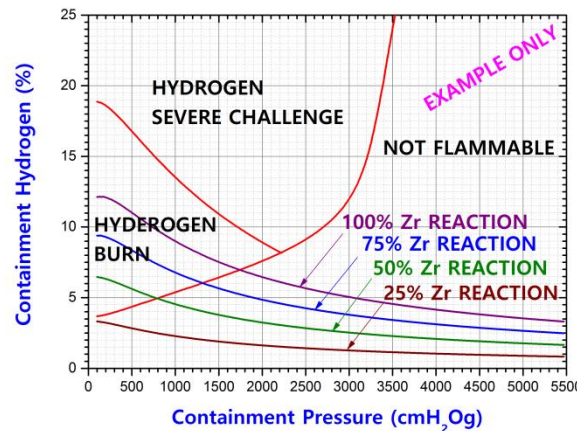
### ■ Differences between Korean SAMG and PWROG SAMG

#### ▶ Occurrence of Core Concrete Interaction(Cont.)

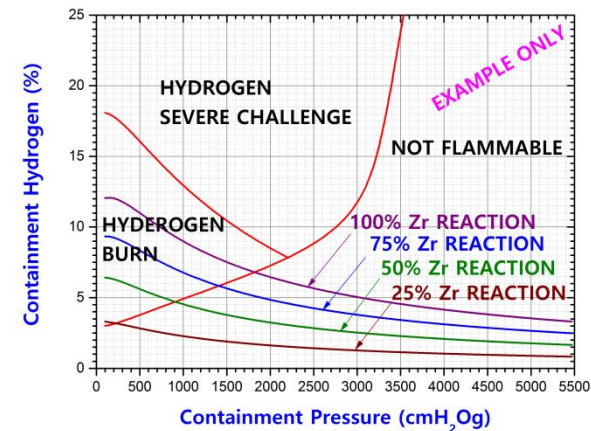
- Potential for Hydrogen Combustion Based on Wet Hydrogen Measurement



[2Hours of CCI]



[8Hours of CCI]



[16Hours of CCI]



### 3. Improvement of Korean SAMG

- Flow chart for of DFC in Korean SAMG is maintained, but the level to identify the severity of the plant condition.
- Order of priority of the strategies
- Entry condition into the RCS injection strategy
- LTMG-01 and SAEG-01 cone under DFC as parts of the step
- Step whether CCI occurred or not is added in DFC

## 4. Conclusion

- Comparing between Korean SAMG and PWROG SAMG
- There are similarity and differences between Korean SAMG and PWROG SAMG.
- Improved DFC for Korean SAMG is proposed.
- In order to increase the effectiveness of Korean SAMG and to reflect the state of the art and trends, it is appropriate to apply the suggestions contained in this paper to Korean SAMG.

**THANK YOU**

