MSIV Room EQ Analysis of APR1400 Using RELAP5-ME and GOTHIC

2015. 11.4

KEPCO E&C NSSS Division

Safety Analysis Department
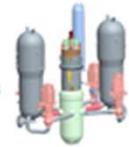
Park, Seok Jeong
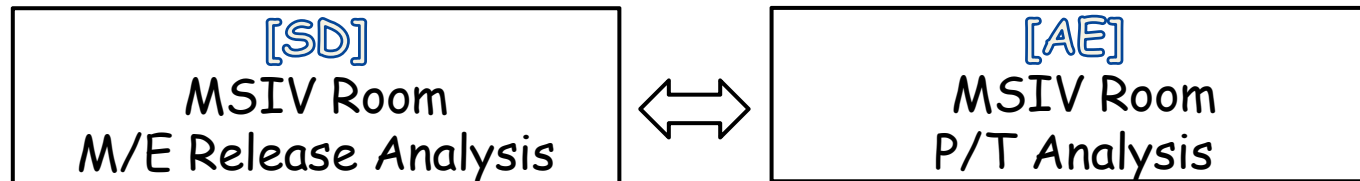
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1. Introduction

■ **Procedures of MSIV Room EQ Analysis**

[SD] MSIV Room M/E Release Analysis	⟺	[AE] MSIV Room P/T Analysis

■ **Conventional EQ Analysis Methodology (w. Codes)**

M/E Analysis	EQ Temp Analysis	Remark
SGNIII	COMPARE	conventional

■ **Application of SGNIII and COMPARE Codes to APR1400**

  ➢ This methodology for APR1400 led to unrealistically conservative results and the EQ requirement was excessively conservative than necessary.

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1. Introduction (cont.)
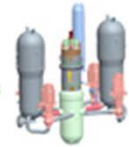
- ➢ SGNIII code basically assumes the discharged steam of MSLB to be always saturated steam, so it was forced to assume that the break flow has a enthalpy of the hot leg temperature during the steam generator tube uncovery to make up for a superheating effect (most conservative model) required by NRC IN 84-90

- ➢ COMPARE code has momentum equations only considering differential pressure and not considering of the gravitational forces based on buoyancy driving force.

- ➢ These characteristics of the computer codes make the result overly conservative, resulting in excessively high EQ temperature.

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2. New EQ Analysis Methodology
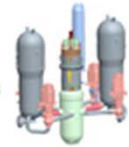
■ **New EQ Analysis Methodology**

M/E Analysis	EQ Temp Analysis	Remark
RELAP5-ME	GOTHIC	new

➤ A new methodology has been developed to evaluate the MSIV room EQ temperature with appropriate conservatism by using mechanistic models for the steam behavior inside steam generators.

➤ The methodology utilizes the RELAP5-ME and GOTHIC codes

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2. New EQ Analysis Methodology (cont.)
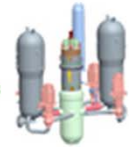
■ **RELAP5-ME Code**

➢ Approved by Korean Regulatory Authority

➢ **Purpose**

  ▪ **To develop** M/E release analysis method

  ▪ **To improve** the conventional M/E analysis methodology

  ▪ **To increase** design and/or operational **margin** to the containment design

➢ RELAP5-ME is a best estimate code and includes the models for the special design features of APR1400 such as SIT with fluidic device.

➢ M/E release analysis for the containment design for LBLOCA, SBLOCA and MSLB accident can be performed by RELAP5-ME code.

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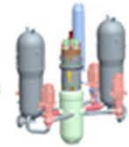
■ **Comparison of Computer Code Systems**

SCOPE	CURRENT CODE SYSTEM	NEW CODE SYSTEM	REMARK
LBLOCA M/E	**CEFLASH-4A** (Blowdown Analysis) **FLOOD3** (Reflood & Post-Reflood Analysis) Hand Calculation* (Long Term Analysis)	**RELAP5-ME**	Single Step Calculation of RELAP5K and CONTEMPT4/MOD5
SBLOCA M/E	**CEFLASH-4AS** * (Blowdown Analysis) **CELDA, CEPAC** * (Recovery Analysis)		
MSLB M/E	**SGN-III** (Blowdown Analysis)		

Note) * Used for Equipment Environmental Qualification

2. New EQ Analysis Methodology (cont.)
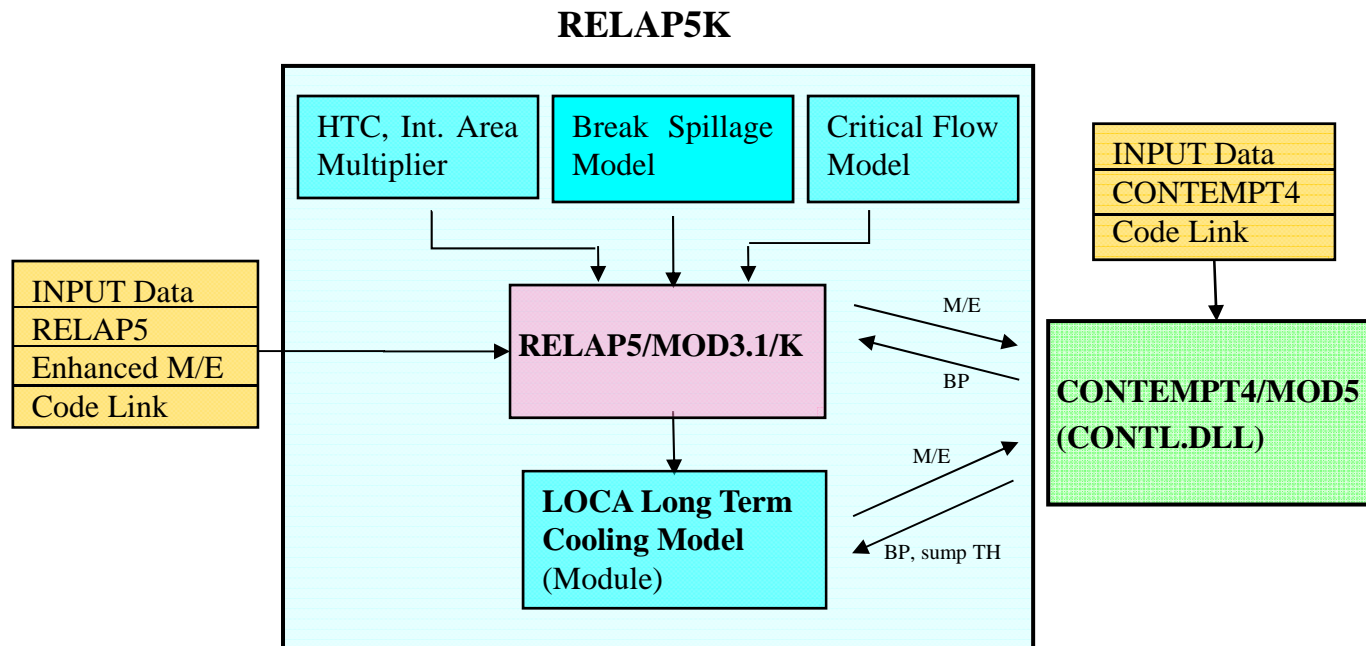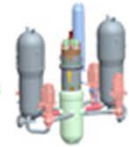
- **RELAP5-ME**

  (Code Link: RELAP5K and CONTEMPT4)

RELAP5K

HTC, Int. Area Multiplier	Break Spillage Model	Critical Flow Model

INPUT Data
CONTEMPT4
Code Link

INPUT Data
RELAP5
Enhanced M/E
Code Link

RELAP5/MOD3.1/K

M/E

BP

CONTEMPT4/MOD5 (CONTL.DLL)

LOCA Long Term Cooling Model (Module)

M/E

BP, sump TH

Figure 1. Code System of RELAP5-ME

2. New EQ Analysis Methodology (cont.)

- **Application of the New Methodology to APR1400**

  - RELAP5-ME and GOTHIC are highly generic thermal-hydraulic transient behavior analyses codes, and more realistic analysis codes in NSSS and containment, respectively

  - RELAP5 solves 6 eq's of mass, energy and momentum for 2-phase (vapor, liquid)

  - GOTHIC solves 9 eq's with multi-phase/component of 3-phase (vapor, drop, liquid)

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3. Analysis Models and Results
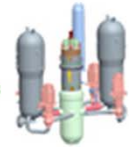
- **Thermal-Hydraulic Modeling of MSLB using RELAP5-ME**

  - M/E release data using RELAP5-ME

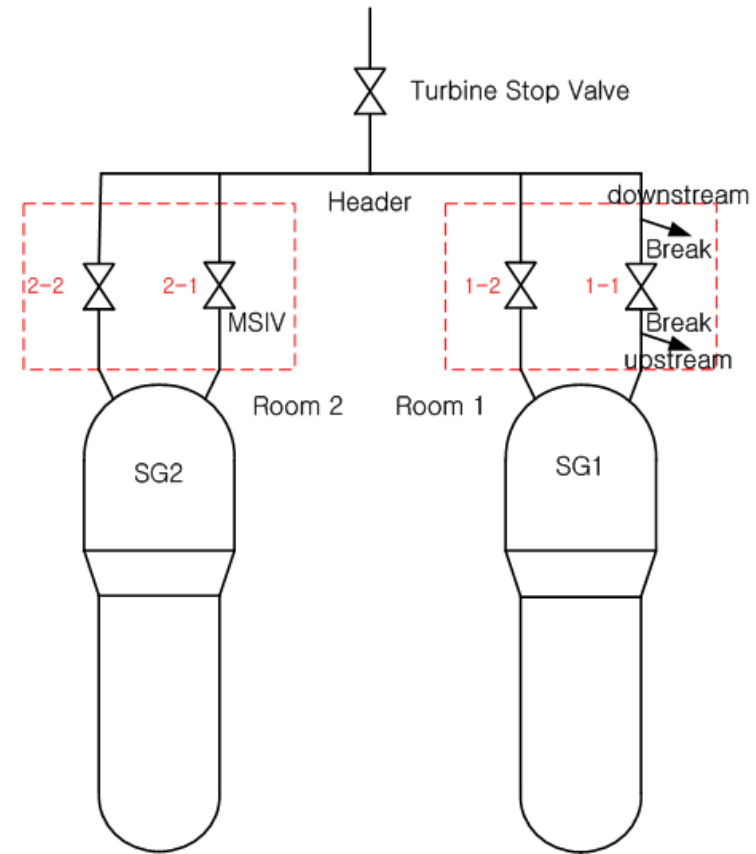   - Conservative values of I.C. and B.C.

Figure 2. MS Line and MSIV Room Model

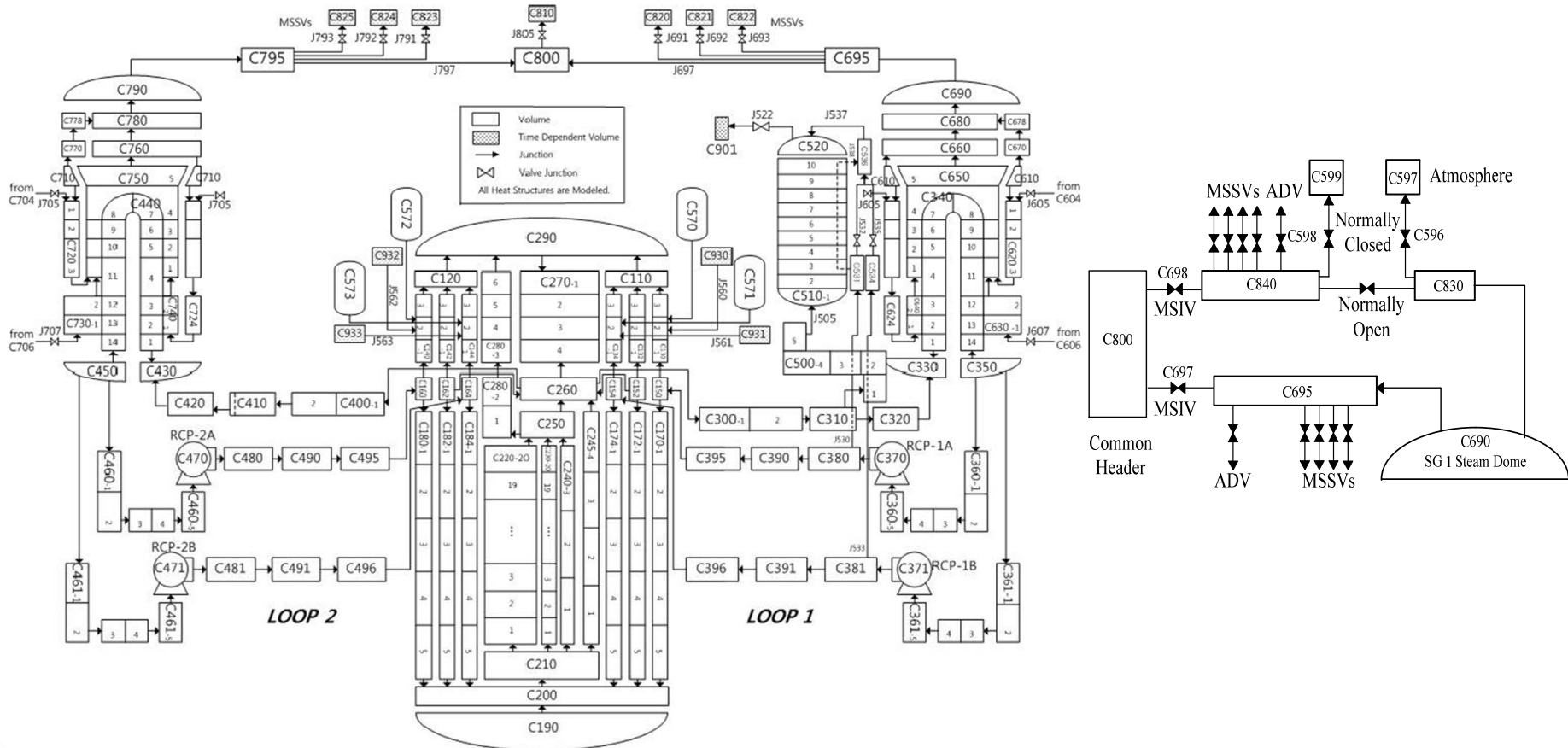KEPCO NSSS Division

■ **REALP5-ME Nodal Scheme for APR1400**

Figure 3. RELAP5-ME Nodalization

3. Analysis Models and Results (cont.)

■ **Thermal-Hydraulic Modeling of MSIV Room using GOTHIC**

  ➢ Beneficial models

   ✓ Buoyancy driven flow

   ✓ Chimney effect

  ➢ Selected licensable GOTHIC user options at surfaces for condensation heat transfer model and radiation to steam model
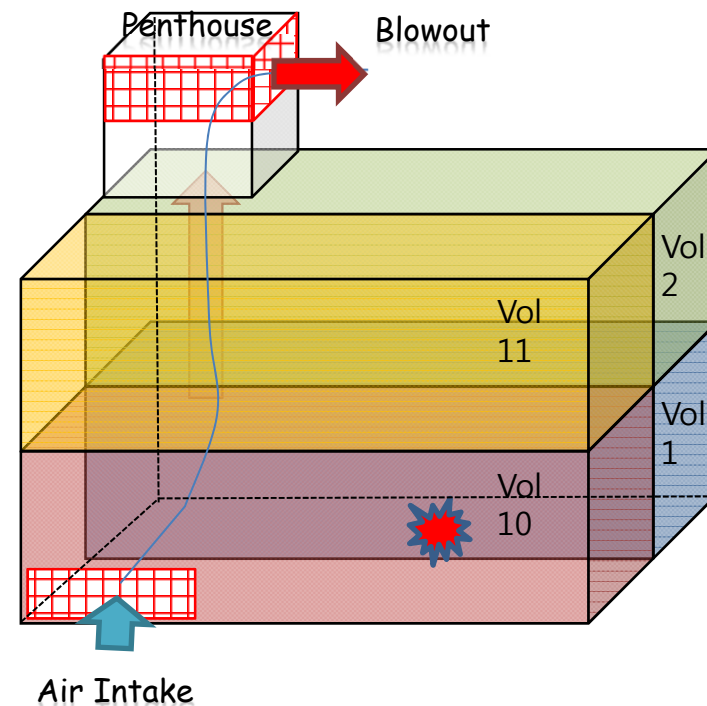

Figure 4. MSIV Room Model

■ Compared to conventional methodology, MSIV room EQ temperature of APR1400 was lowered by more than 40 ^{o}F

4. Conclusions

- A new methodology using RELAP5-ME and GOTHIC codes has been developed to evaluate the MSIV room EQ temperature with conservatism.

- By applying the new methodology to ARP1400, MSIV room EQ temperature of APR1400 was lowered by more than 40 ^{o}F.

Thank You!

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