GOTHIC Simulation of APR1400 Auxiliary Charging Pump room heat up

Hui-Un Ha*, Sun Heo
Advanced Reactors Development Laboratory, Central Research Institute, KHNP, Ltd.,
70, 1312-gil, Yuseong-daero, Yuseong-gu, Daejeon 305-343, Republic of Korea
**Corresponding author: huiun98.ha@khnp.co.kr*

1. Introduction

As a part of the Advanced Power Reactor 1400 (APR1400) U. S. Nuclear Regulatory Commission Design Certification (NRC DC) project, we have been investigating Auxiliary Charging Pump (ACP) room heat up. With reference to the design specification of the ACP room, we determined input information and developed a GOTHIC model of the APR1400 ACP room. This calculation model is described herein, and representative results from the calculation are presented as well. The results of the present paper are used to determine the integrity of ACP operating in the accident.

2. Calculation Methodology

In this section some of the input parameters used for the model of APR1400 ACP room are described. The model includes control volumes, flow paths, and passive heat sinks.

2.1 Calculation Case

For calculation, some conditions were assumed as follows: Station Black Out (SBO) event happened and HVAC was disabled. Room was initially filled with air. After the accident, ACP was activated immediately. Model was calculated until 72 hours after the accident.

2.2 Calculation Model

2.2.1 Computer Code

Thermal-hydraulic phenomena of ACP room were calculated by using the GOTHIC Version 8.0 computer code. GOTHIC code calculates the thermal-hydraulic behavior of a containment response from design basis accidents and severe accident sequences. GOTHIC code provides detailed thermal-hydraulic information in various containment areas.

2.2.2 Calculation Scope

A calculation area includes ACP room and General Access Areas (GAAs). They are located in the underground of APR1400 reactor building and connected through the door.

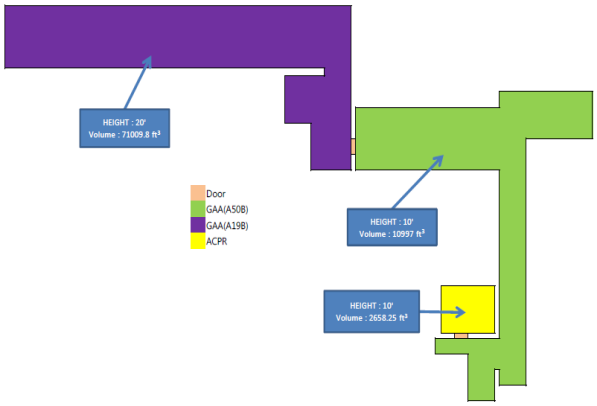

Fig. 1. Schematic Diagram of Calculation Area.

2.2.3 Initial Condition and Input Parameter.

Initial conditions and input parameters are summarized below:

Initial condition

- Temperature: 104℉
- Pressure: 14.7 psia
- Relative humidity: 60%

Concrete property

- Density: 140 lbm/ft^3
- Conductivity: 1.0 Btu/hr-ft-F
- Specific heat: 0.2 Btu/lbm-F

After ACP operates, total amount of ACP room heat output is 30,990.3 Btu/hr. This value is input parameter of heat source. In GOTHIC model, heat source is located in ACP room control volume. Initial temperature of passive heat sinks is average value of inside and outside surface. Calculation was performed on the two cases: case (I) the door of ACP room is closed, and (II) door is opened 30 minutes later.

2.2.4 GOTHIC Model

A calculation model was composed of 3 control volumes, 4 doors, 42 heat conductors, and 4 flow paths. The door size and area volume are presented in table. 1. Detailed geometry is presented in Fig. 1.

Table. 1. Model Input Parameters

	Volume (ft^3)	Surface area (ft^2)
ACP room(Yellow)	2658.25	-
GAA1(Green)	10997	-
GAA2(Purple)	71009.8	-
Door(ACPR-GAA1)	-	19.5
Door(GAA1-GAA2)	-	42.25

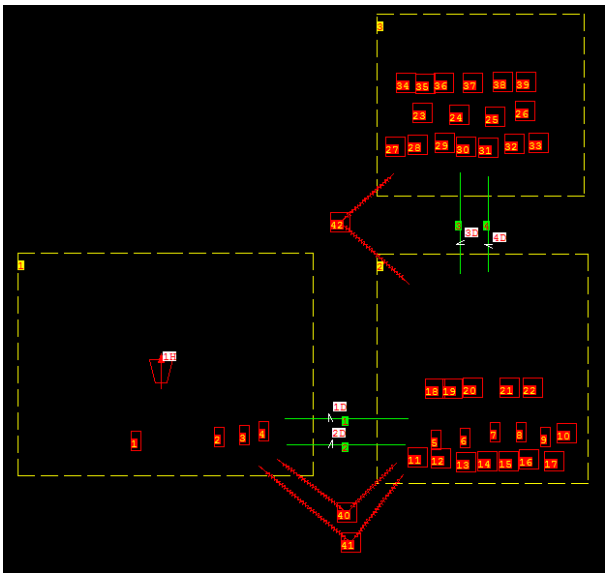

Fig. 2. GOTHIC Model.

3. Calculation Results

The response of the ACP room temperature of case (I) is presented in Fig. 2. As seen from the figure, it can be confirmed that room is not cooled properly. At 72-hour, room temperature reached 165℉. The difference due to the surface option of heat conductor is slight

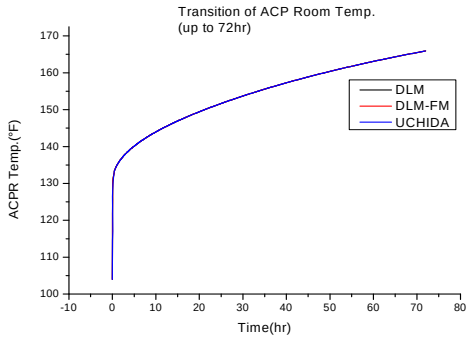

Fig. 2. ACP Room Temperature Response of Case (I).

Fig. 3 shows the response of the ACP room temperature of case (II). After door opening, temperature decreases sharply in contrast to the previous case. Final temperature is approximately 128℉.

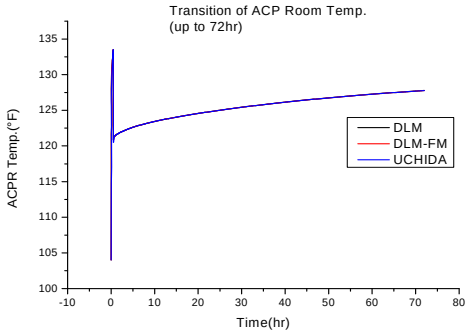

Fig. 3. ACP Room Temperature Response of Case (II).

4. Conclusions and Further Studies

APR 1400 GOTHIC model was developed for ACP room heat up calculation. Calculation results confirm that door opening is cooling the room properly. It is found that the difference due to the surface option of heat conductors is insignificant. Based on this result, further studies should be performed to confirm integrity of ACP.

REFERENCES

[1] NAI 8907-06, GOTHIC Version 8.0 Code Manual, 2012.
[2] Idelchik, I.E., Handbook of Hydraulic Resistance, Second Edition, Hemisphere Publishing Corporation, 1986.
[3] KHNP, Shin-kori 3,4 Final Safety Analysis Report, 2012.