Analysis of the Radioactive Release Characteristics for Development of the Containment Bypass Mitigation System

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ABSTRACT: In recent years, a growing demand to strengthen safety regulations accompanied the increase in public distrust of the nuclear power plants. To reduce off-site radiological consequences from severe accidents, the nuclear industry and the regulatory agencies have begun to develop mitigation technologies and strategies that can limit the spread of radioactive material into the environment for the containment failure accidents. Although the containment bypass accidents are much less likely to occur compared with the containment failure accidents, consequences of the bypass accidents are more catastrophic. Therefore, new technologies similar to containment filtered venting systems should be developed to mitigate the consequences of the containment bypass accidents. The purpose of this study is analyze the radioactive release characteristics from the containment bypass accidents to develop such new technologies.

1. Introduction and Background

Since the Fukushima Daiichi accident in 2011,

- Public fear of nuclear energy has resurfaced
- Nuclear regulations have become more strict
- More technologies (such as containment filtered venting system, CFVS) are being developed to mitigate severe accident sequences

In the Republic of Korea,

- New design of CFVS is being developed through joint research
- Safety equipment has been installed or are being installed to help prevent containment failures

However,

- **There are relatively less focus in the industry on containment bypass accidents than containment failure accidents**
- Containment bypass accidents also poses significant health risk
- **No alternatives exist to prevent radioactive materials from spreading if they are discharged into the environment**

Therefore,

- New technologies are being investigated and developed at KAIST to effectively capture and treat radioactive releases from containment bypass accidents

2. Objective

The objective of this study is analyze the radioactive release characteristics from the representative containment bypass accident (unmitigated steam generator tube rupture, SGTR) to develop a mitigation technology

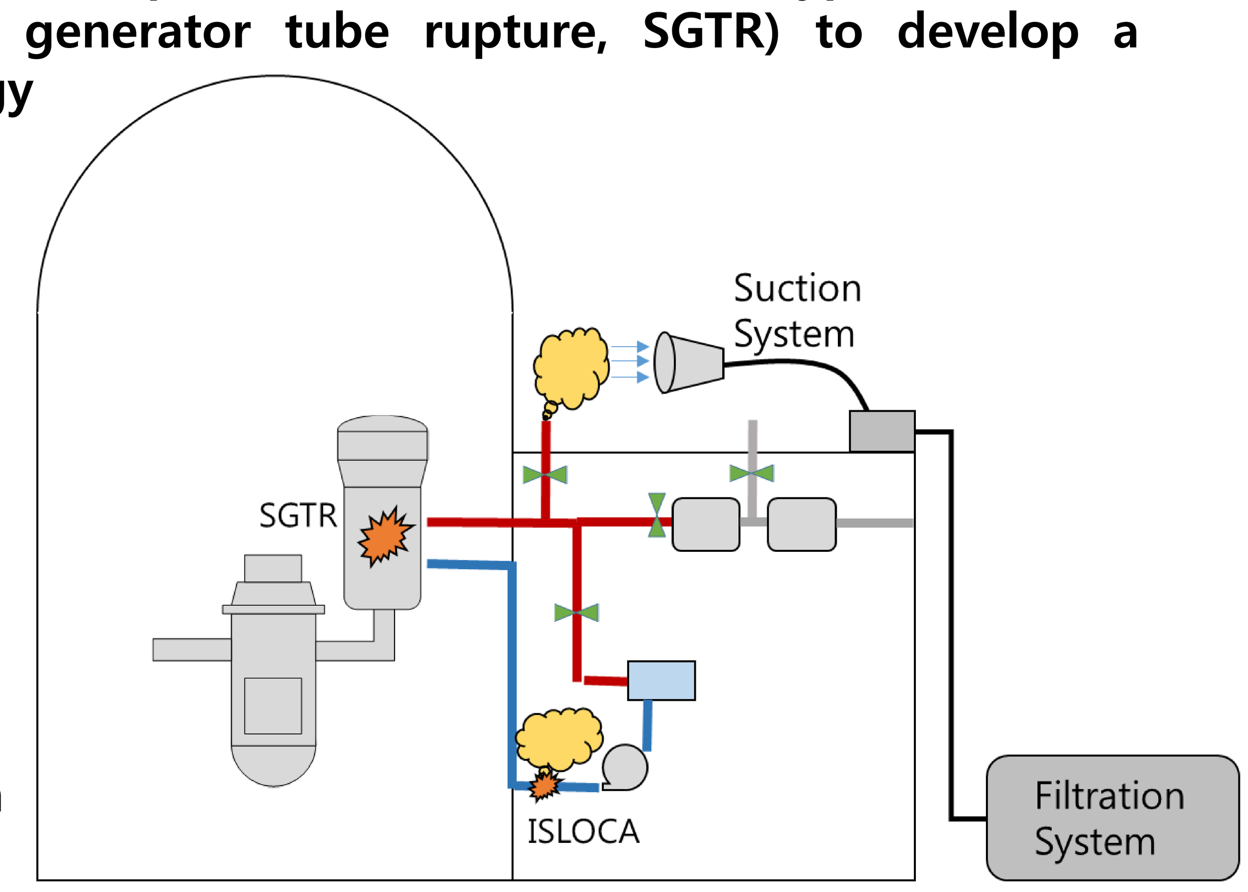


Figure 1. Concept of a Containment Bypass Accident Mitigation System

3. Methods

		MAAP		CFD Modeling
- Initiating Event - Accident Progression	Input ⇨	- CsI, CsOH release amount, timing - Release flow Rate - Pressure and temperature of the released materials	Input ⇨	- Dispersion characteristics after the environmental releases (steam flashing included)

Figure 2. Overview of steps to obtain required source term characteristics the development of the mitigation technology

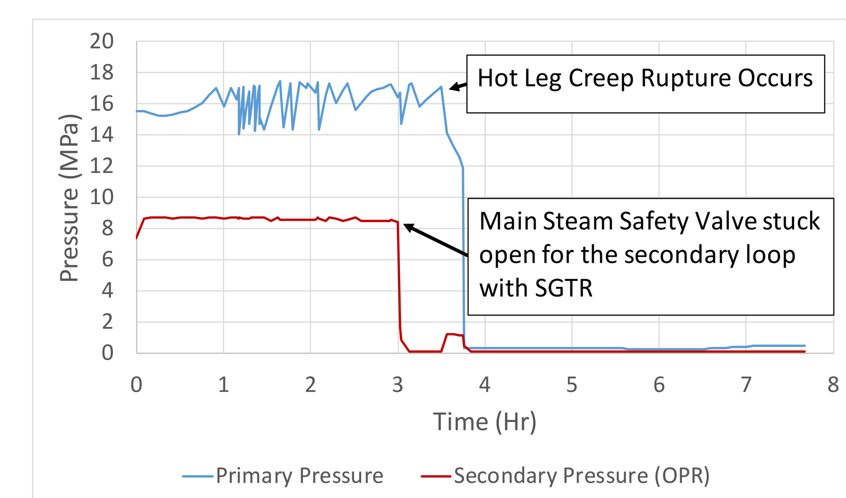
4. Results & Discussions

Representative accident for the analysis: unmitigated thermally-induced SGTR following station blackout accident

- From the U.S. NRC State-of-the-Art Reactor Consequence Analysis

Scenario:

- Loss of AC, DC power
- Successful reactor trip
- Complete loss of all feedwater system
- Secondary system safety valve stuck open after repeated openings and closures



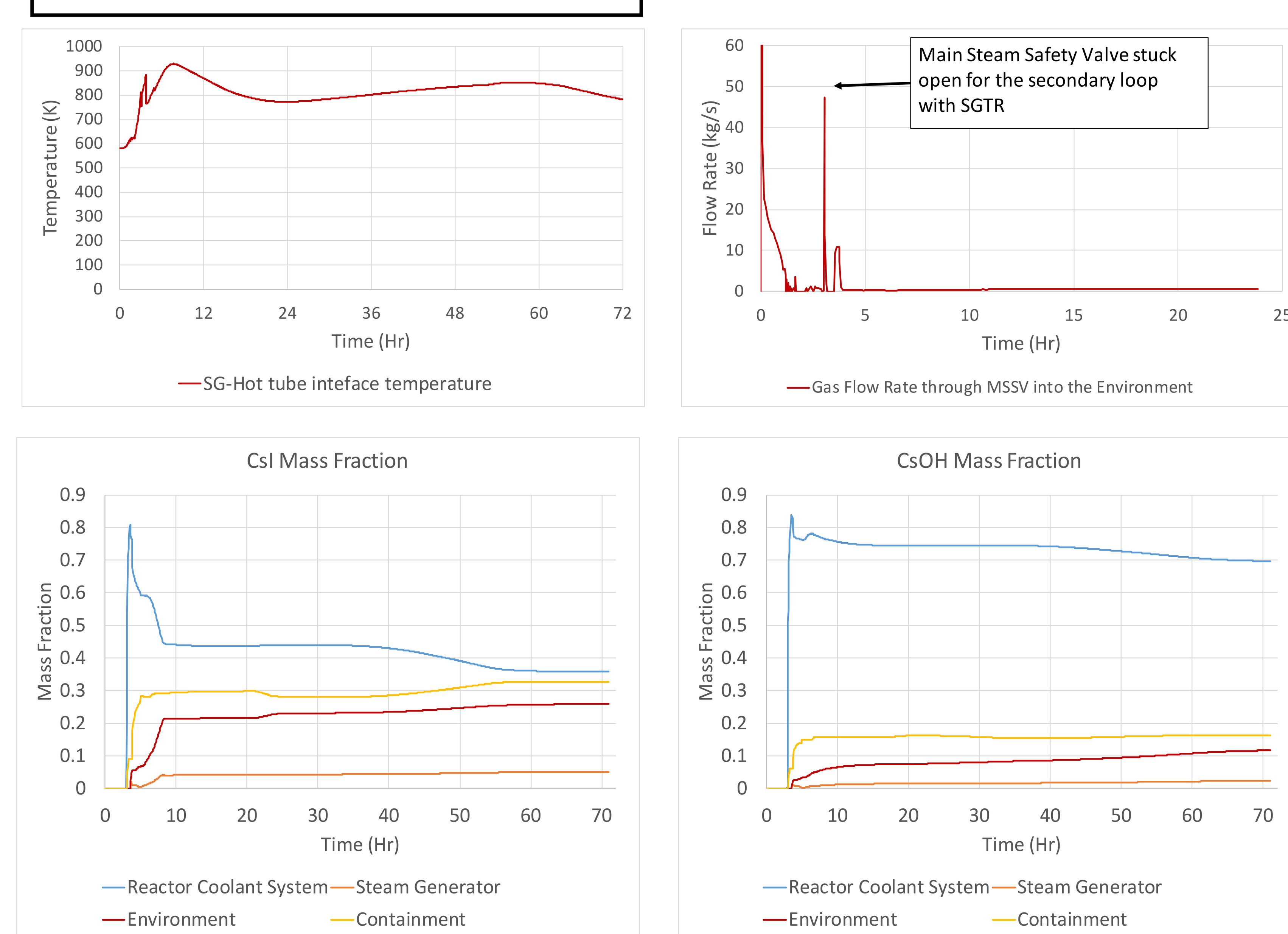


Figure 3. Results of the accident analysis using the integrated severe accident code (MAAP4)

To mitigate the health risks from the release through the MSSV with loss of AC and DC power, there is at least a 3-hour window to setup the bypass mitigation system before the fission products are being released into the environment

5. Future Work

The post-release characteristics of the environmentally released radioactive material will be simulated through CFD analysis between 1) the release point (MSSV) and 2) the suction system of the bypass mitigation technology

Results from the integrated severe accident code will be used as input for the CFD analysis

- CsI and CsOH environmental release amount through MSSV
- Flow rate of the released materials
- Temperature range of the released materials