Long-Term Behavior by Beam Tube Break (BTLOCA) Accident at HANARO

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Abstract

Beam Tube Break (BTLOCA) accident of HANARO is analyzed with MELCOR and the results showed

- **Thermal-Hydraulic behavior**
- **Fuel degradation**
- **Fission product release**

BTLOCA at HANARO

■ HANARO: 30 MW pool type research reactor with finned fuel.

- BTLOCA occurs by the simultaneous break of seal plate and diaphragm of beam tube, resulting in a loss of pool water
- The occurrence probability is very low, but causes long-term fuel damage by an excessive loss of coolant when there's no mitigation measure.
- The scenario was analyzed using MELCOR, an severe-accident analysis code.

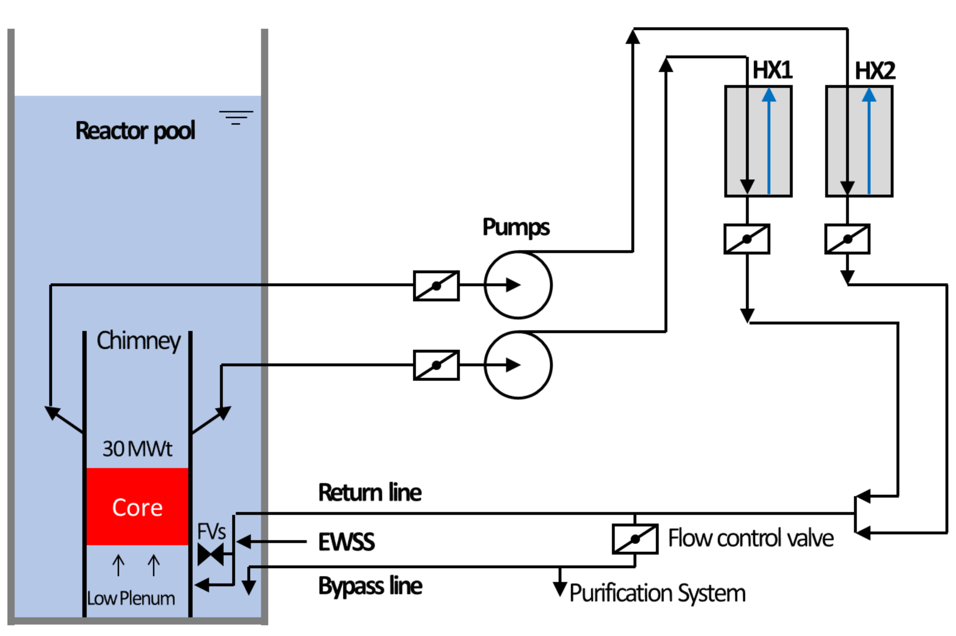

Fig. 1 Schematics of HANARO system

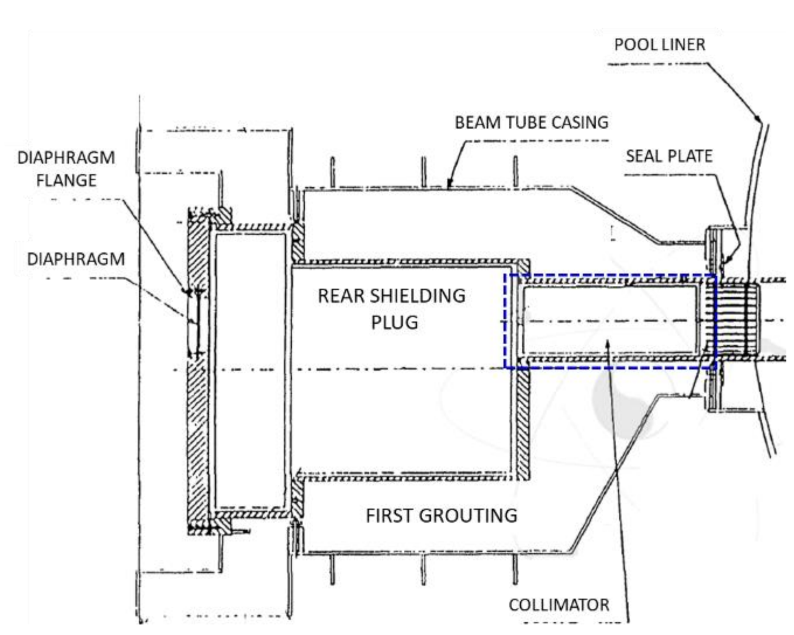

Fig. 2 Standard Beam Tube

Fuel Degradation

■ Fuel degradation and relocation

- After the pool water depleted, the fuel started heat up and melted finally.
- The molten fuel fall from the core region to the lower plenum.
- The molten fuel temperature did not increase higher than 1200K, due to the low melting temperature of the $U_3Si\text{-}Al_x$.

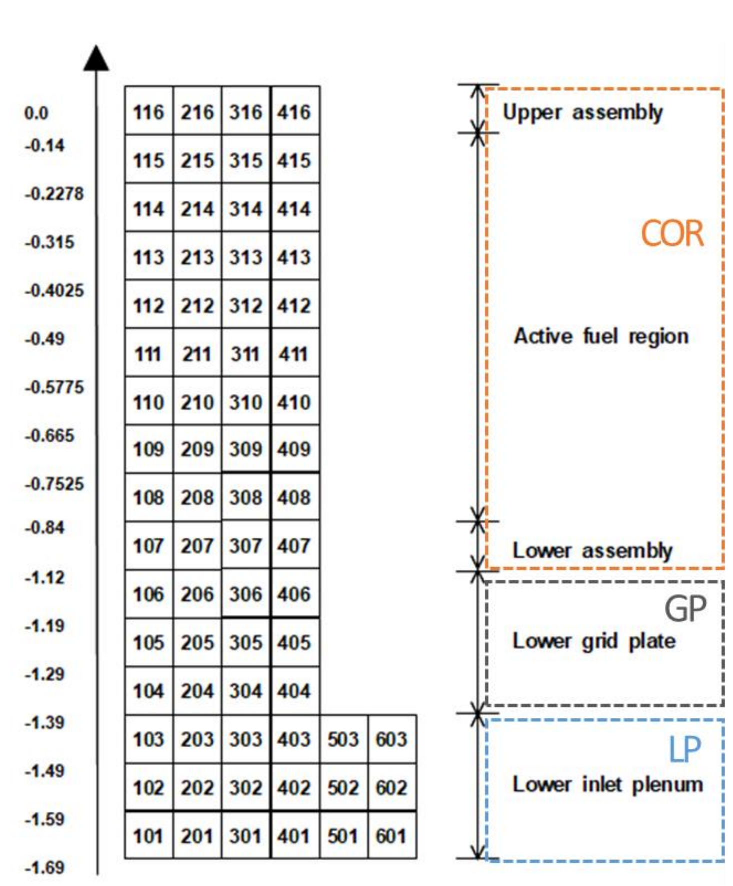

Fig. 4 Core model

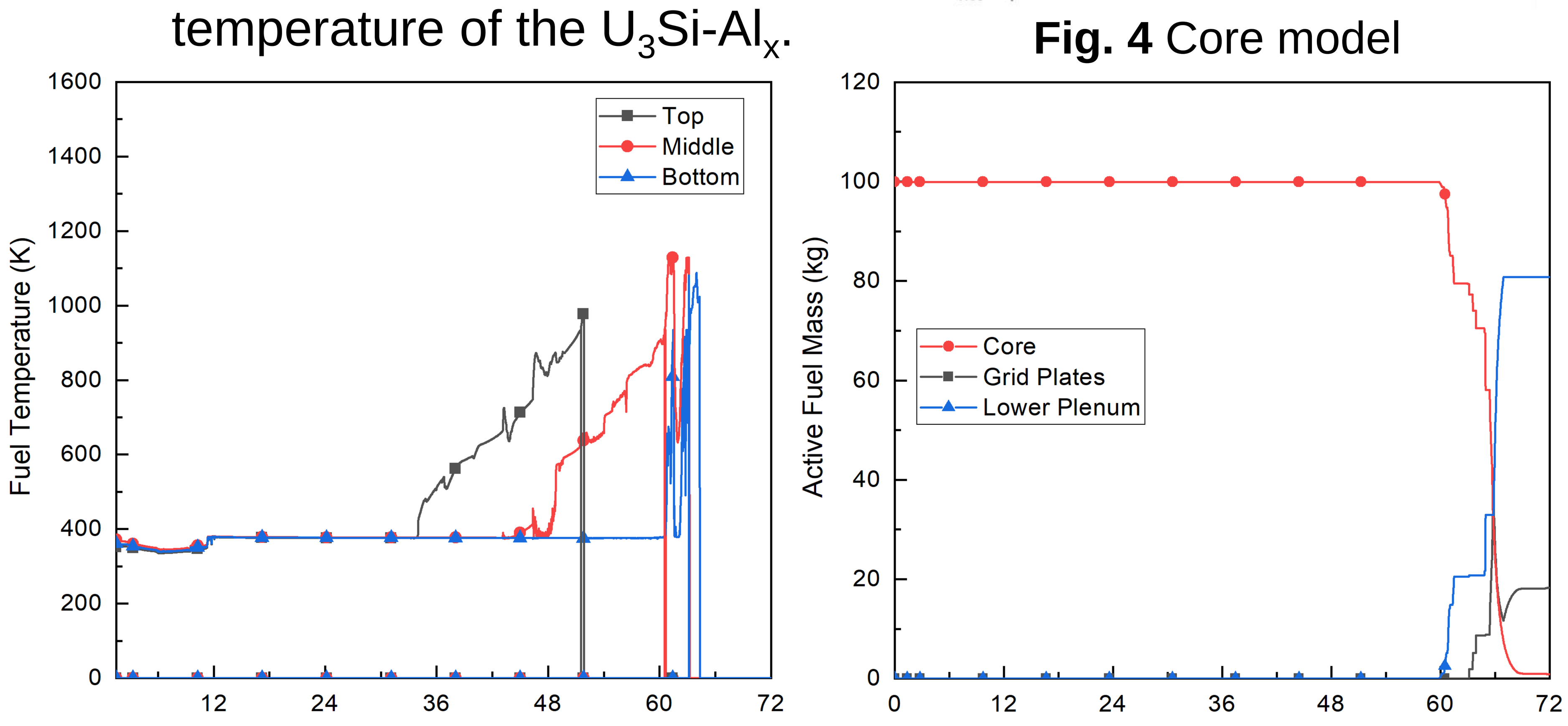

Fig. 5 Fuel temperature (left) and active fuel mass (right)

Conclusion

The fuel melted down after 60 hours from the accident initiation, however, negligible amount of fission product released to environment.

The low release fraction of fission product is due to the low temperature of fuel melts and the low pressure in the Rx building

Event Sequence & TH behavior

■ Event sequences of BTLOCA

- After the reactor trip by pool level decrease, fuels are cooled by natural convection via the flap valves.
- The coolant loss by the break flow stops before the fuels are exposed to air, and then the water slowly evaporates by the decay heat.

Tab. 1 Event sequences

Events	Time (s(hr))
Beam tube seals break (BTLOCA)	0
Reactor trip by low-low pool level. RCPs trip, HXs trip	3844(1.1)
Flap valve open passively	4169(1.2)
Level reaches chimney top	36800(10.2)
Fuel cooled by natural circulation	~

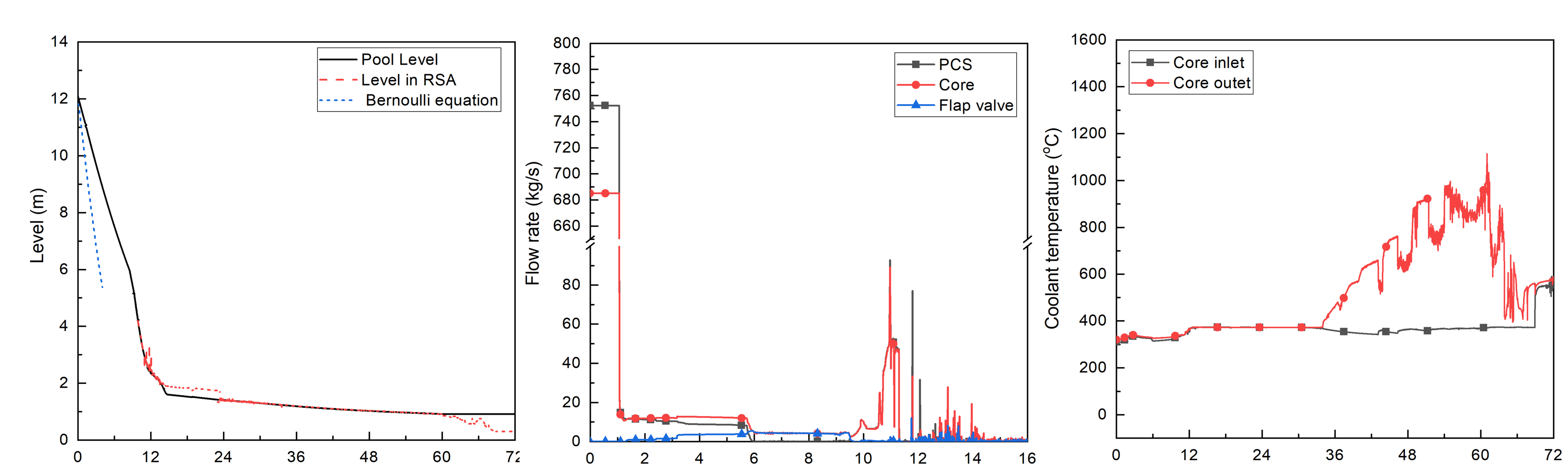

Fig. 3 Pool level, coolant flow and coolant temperature during BTLOCA

Fission Product Release

■ Fission product release

- The fission products released initially from the fuel to the pool by the fuel degradation, and then moved to Rx building.
- The total released fraction was only about 3% of total core inventory, because of the low temperature of fuel melts.
- The released fission products does not released to the environment, because of no pressure difference between the building and the environment.

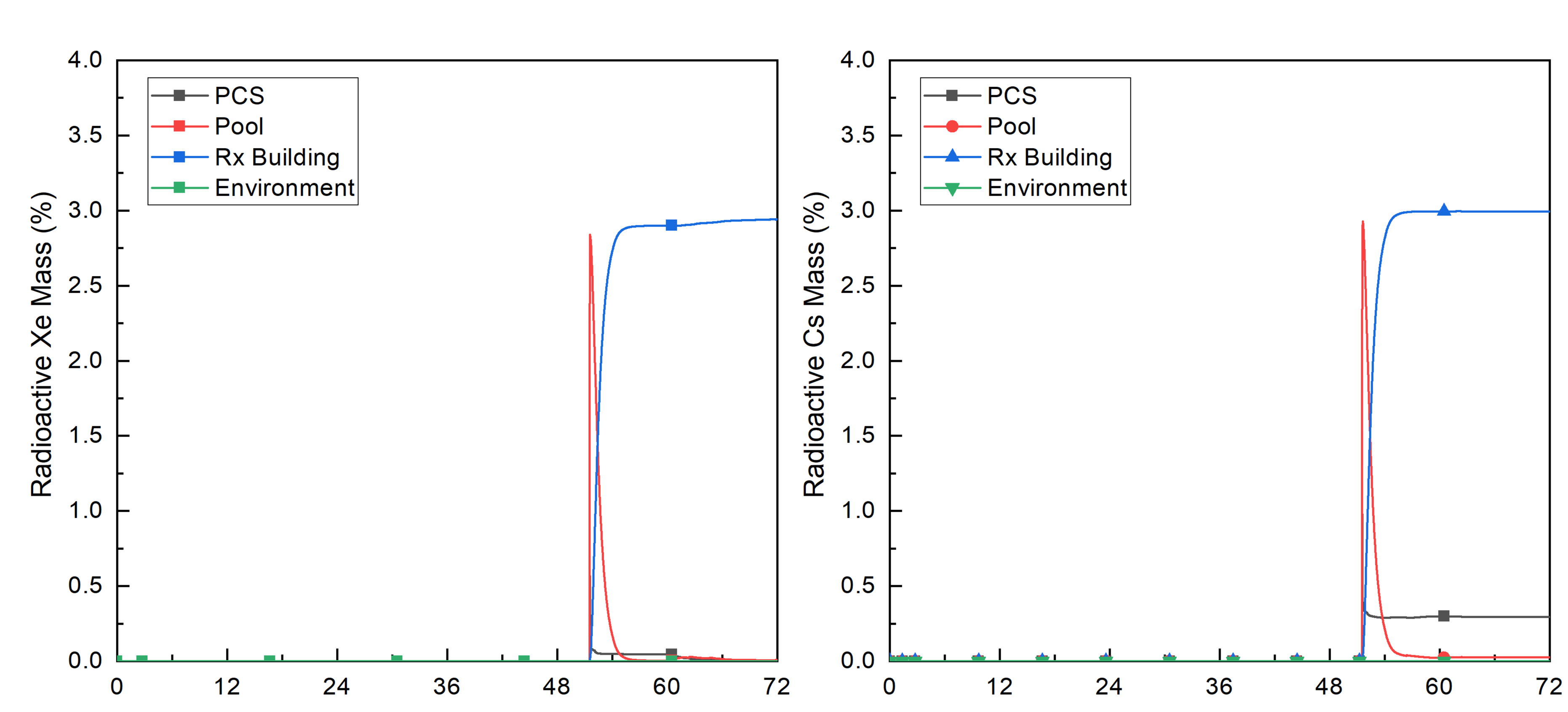

Fig.6 Radioactive Xe (left) and Cs (right) mass