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Spraying Water on Auxiliary Building to Mitigate Bypassing Aerosol in ISLOCA

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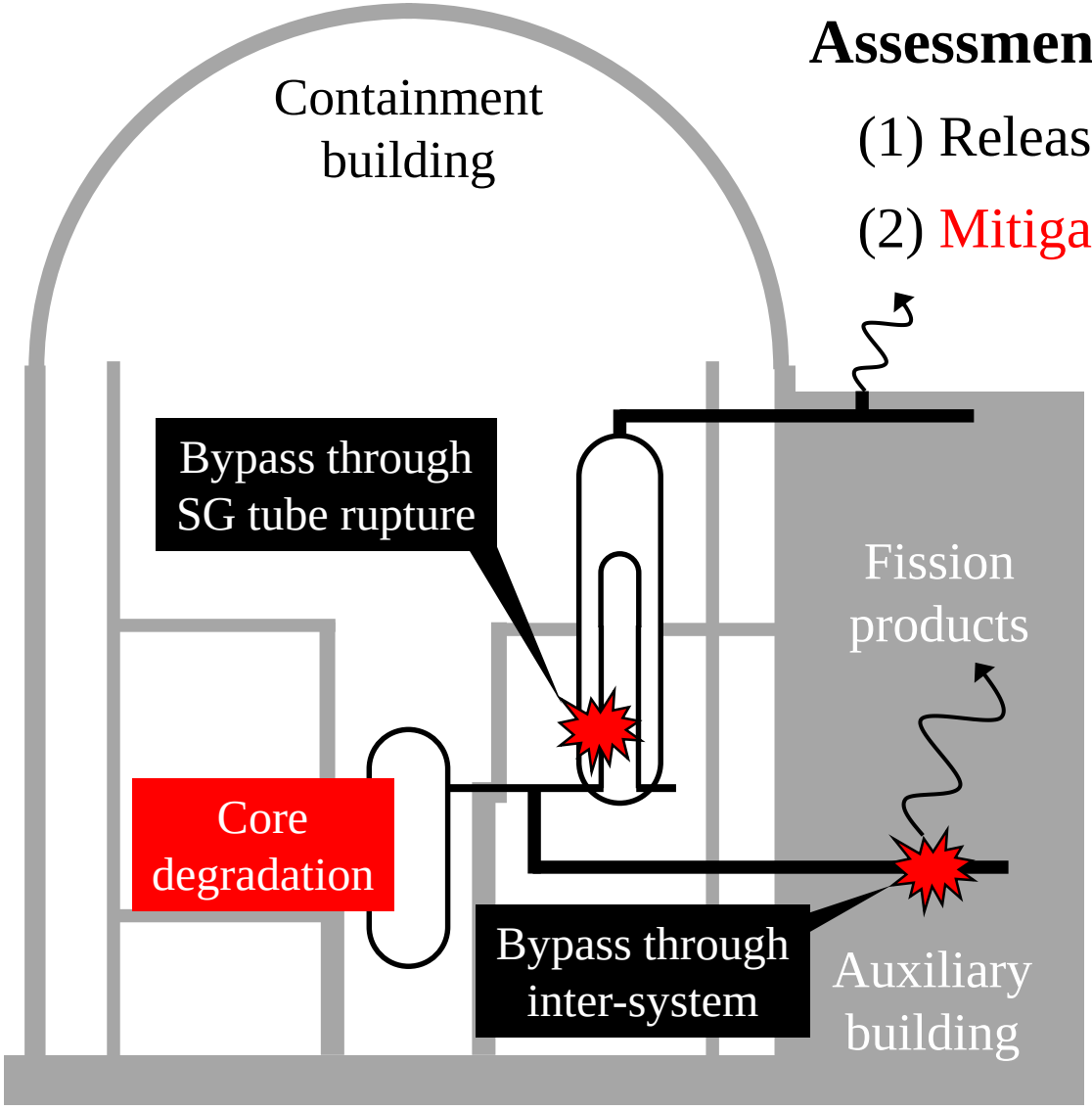
Bypass accident



Assessment of accident source term

(1) Release rate of radioactive nuclide

(2) Mitigation effect during release

1962 TID-14844

Experts' opinions

(Conservative approximation)

1995 NUREG-1465

Code for severe accident

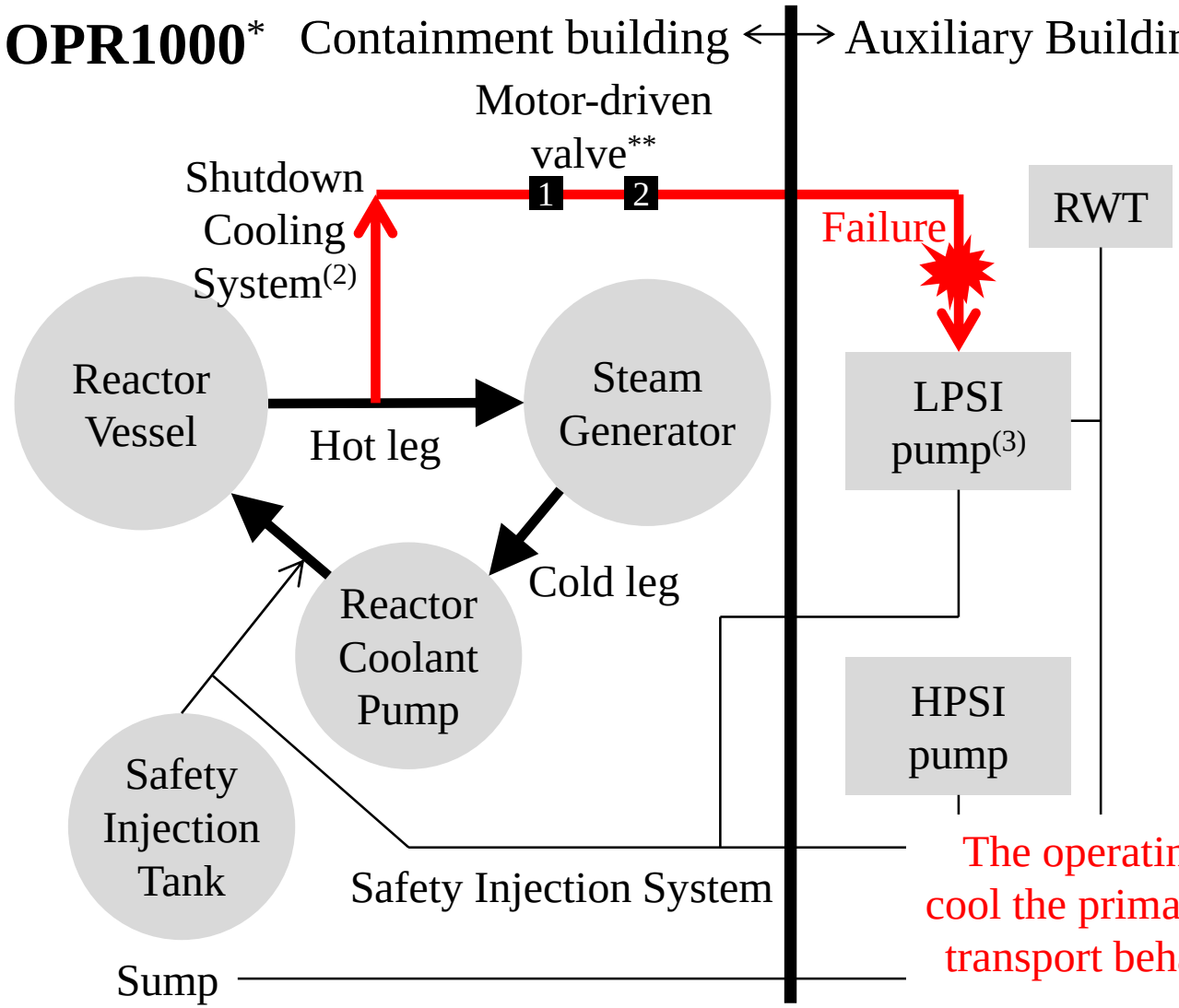
(Experiments + phenomena)

2012 SOARCA

Code with detailed models

In ISLOCA, radionuclides bypassing the containment could be released into the environment through an AB.

ISLOCA scenario



Sequence of base case

(1) MOV failure**

(2) Coolant flows through SCS pipe

(3) LPSI pump front is ruptured

(4) Core dry → SA

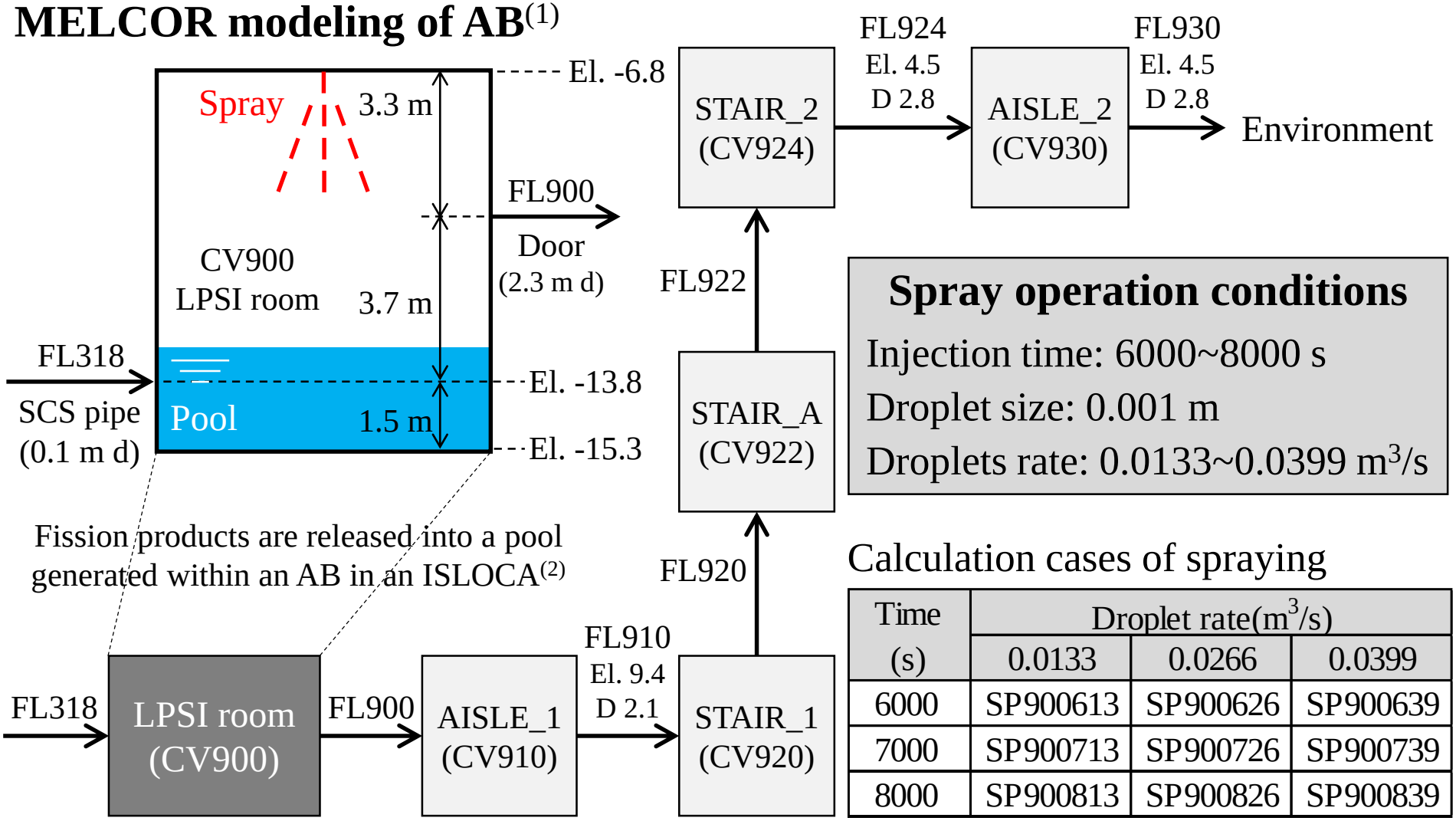
(5) Fission products discharge into AB

The operating of spray in an AB did not cool the primary circuit, but it can affect the transport behavior of the fission products.

*MELCOR input from KINS/HR-464/2002, **KAERI/TR-6020/2015

Operate spray in AB

MELCOR modeling of AB[1]



Spray operation conditions

Injection time: 6000~8000 s

Droplet size: 0.001 m

Droplets rate: 0.0133~0.0399 m^3/s

Calculation cases of spraying

Time (s)	Droplet rate(m^3/s)		
	0.0133	0.0266	0.0399
6000	SP900613	SP900626	SP900639
7000	SP900713	SP900726	SP900739
8000	SP900813	SP900826	SP900839

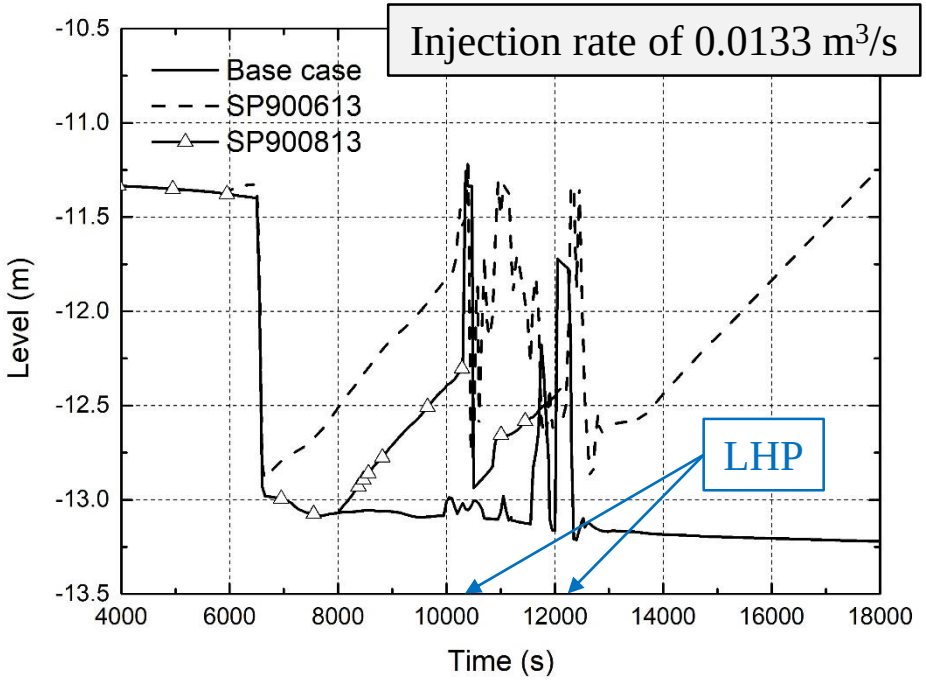
(1) The shortest path from LPSI to environment(KAERI/TR-6020/2015), (2) KAERI/TR-8437/2020

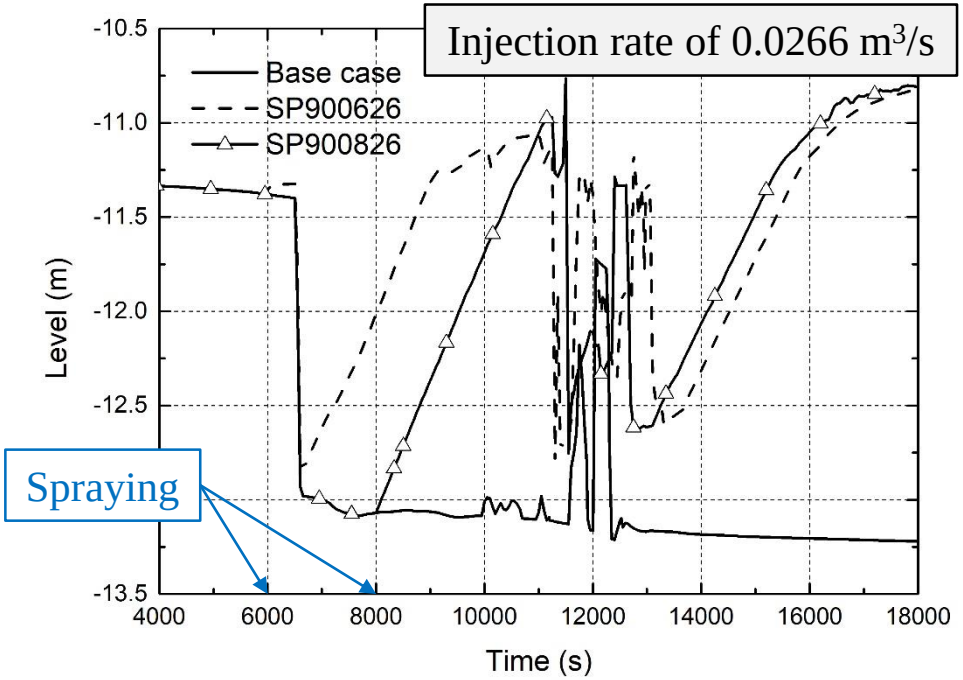
Pool formed in LPSI room

Base case without spraying

(1) ISLOCA occurred at 0 s → (2) Gap release of the FPs was started at 6593 s →
(3) Lower Head of a reactor vessel was Penetrated(LHP) at 12292 s

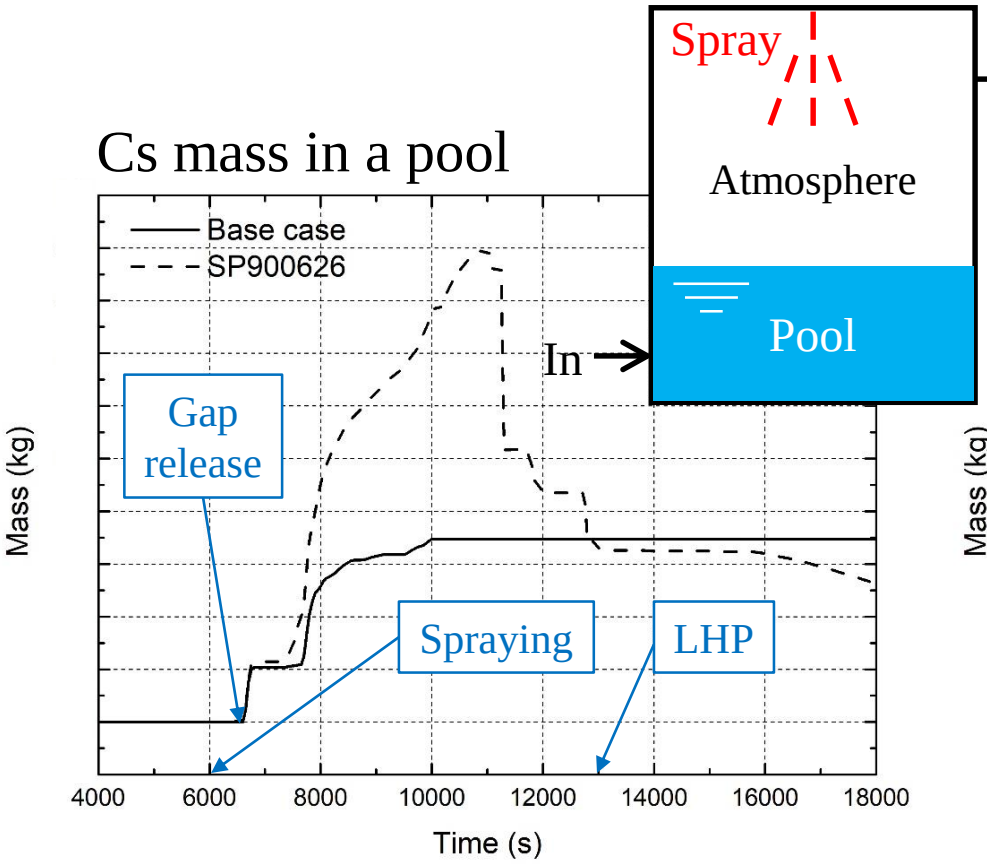
Water level in LPSI room

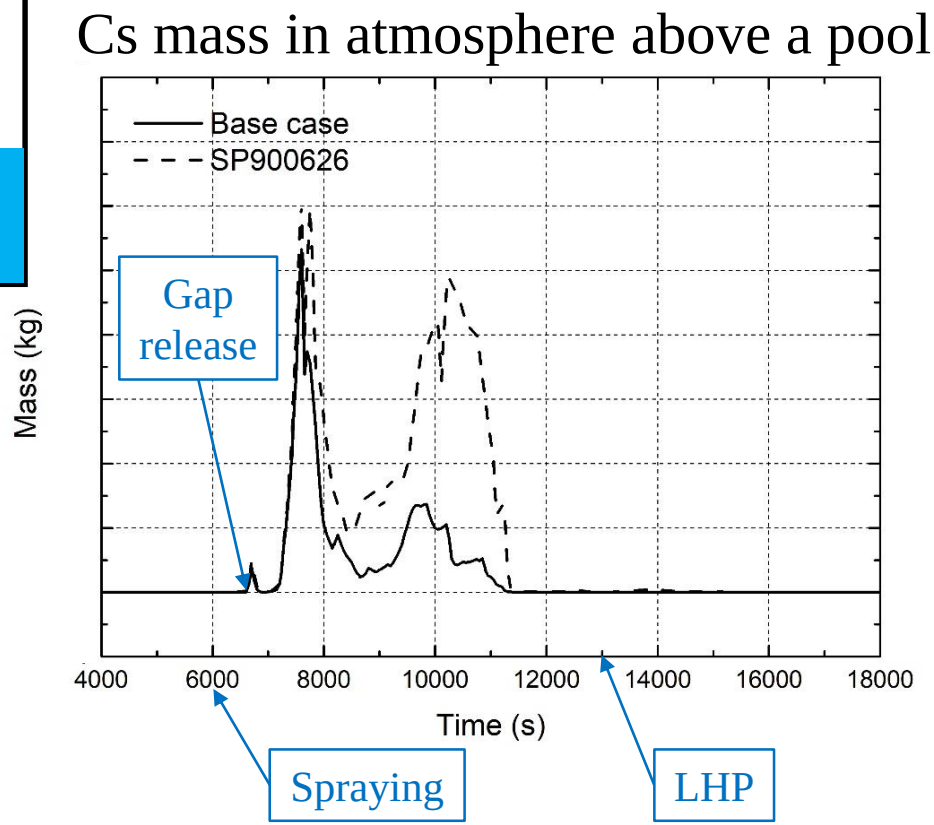




Water level in a LPSI pump room was linearly increased by spraying.

Cs aerosol in LPSI room



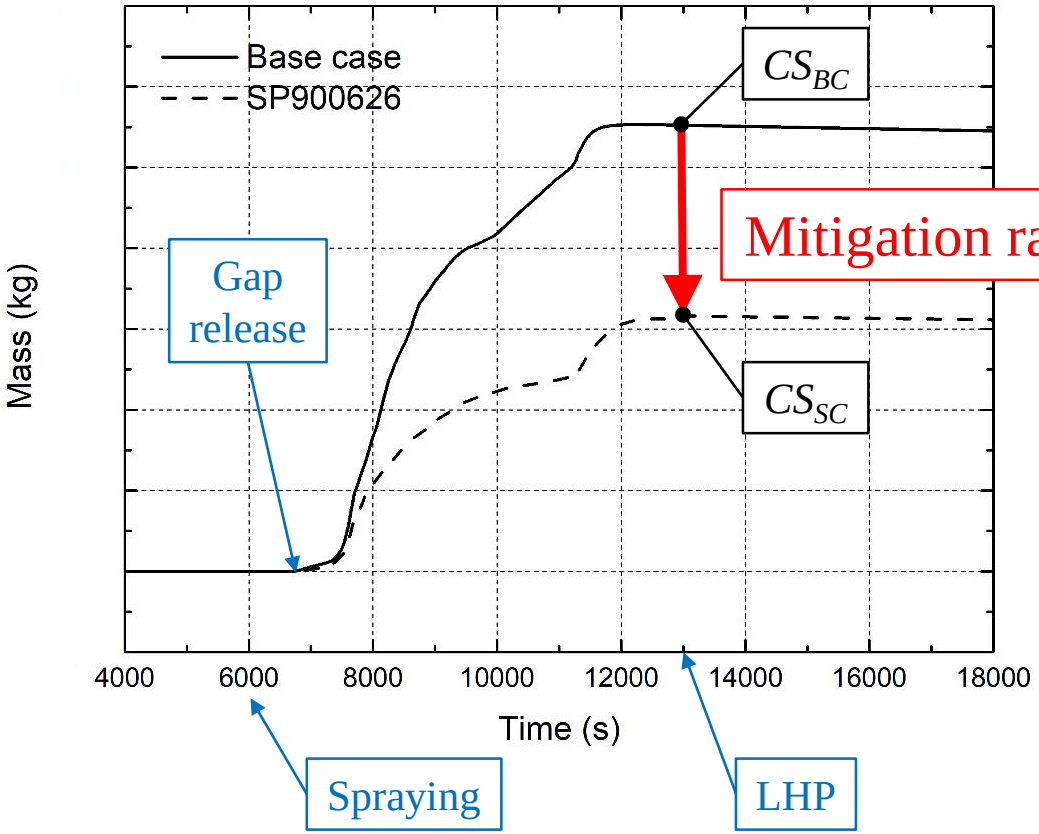


In a LPSI room, Cs mass of a spraying case was greater than that of a base case.
→ Aerosol mass releasing into the outside environment could be reduced by spray scrubbing as well as pool scrubbing.

Reduction of bypassing Cs aerosol

Cs releasing into the environment of the spray cases was reduced than that of the base case. The mitigation rate based on the mass difference of Cs at the spray case and base case increased with the increment of an injection rate and at the faster injection time.

Cs mass in environment



$$R_{CS} = \frac{(CS_{SC} - CS_{BC})}{CS_{BC}} \times 100$$

Mitigation rate(R_{CS}) = -43%

Mitigation rate of spray cases

Time (s)	Droplet rate(m^3/s)		
	0.0133	0.0266	0.0399
6000	-12%	-43%	-46%
7000	-9%	-35%	-47%
8000	-12%	-26%	-39%

Conclusion and Future work

"Development of Mitigation System for Containment Bypass Accident in Nuclear Power Plant"

2018(1_{st} year)	MELCOR input to simulate ISLOCA in OPR1000[(1)]
2019(2_{nd} year)	Thermal hydraulic analysis(P, T, V) → Pool in AB[(2)]
2020(3_{rd} year)	Behavior of fission products in a pipe and a pool[(3)]
2021(4_{th} year)	Effect of mitigation action in ISLOCA ▪ Spray scrubbing in AB = *f* (injection rate, time)
2022(5_{th} year)	Analysis for development of mitigation system

(1) KAERI/TR-7290/2018, (2) SAMRC 2019, (3) KAERI/TR-8437/2020

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