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Preliminary analysis of iodine behavior in ISLOCA

Activation of iodine pool chemistry model in MELCOR(Ver. 2.2)

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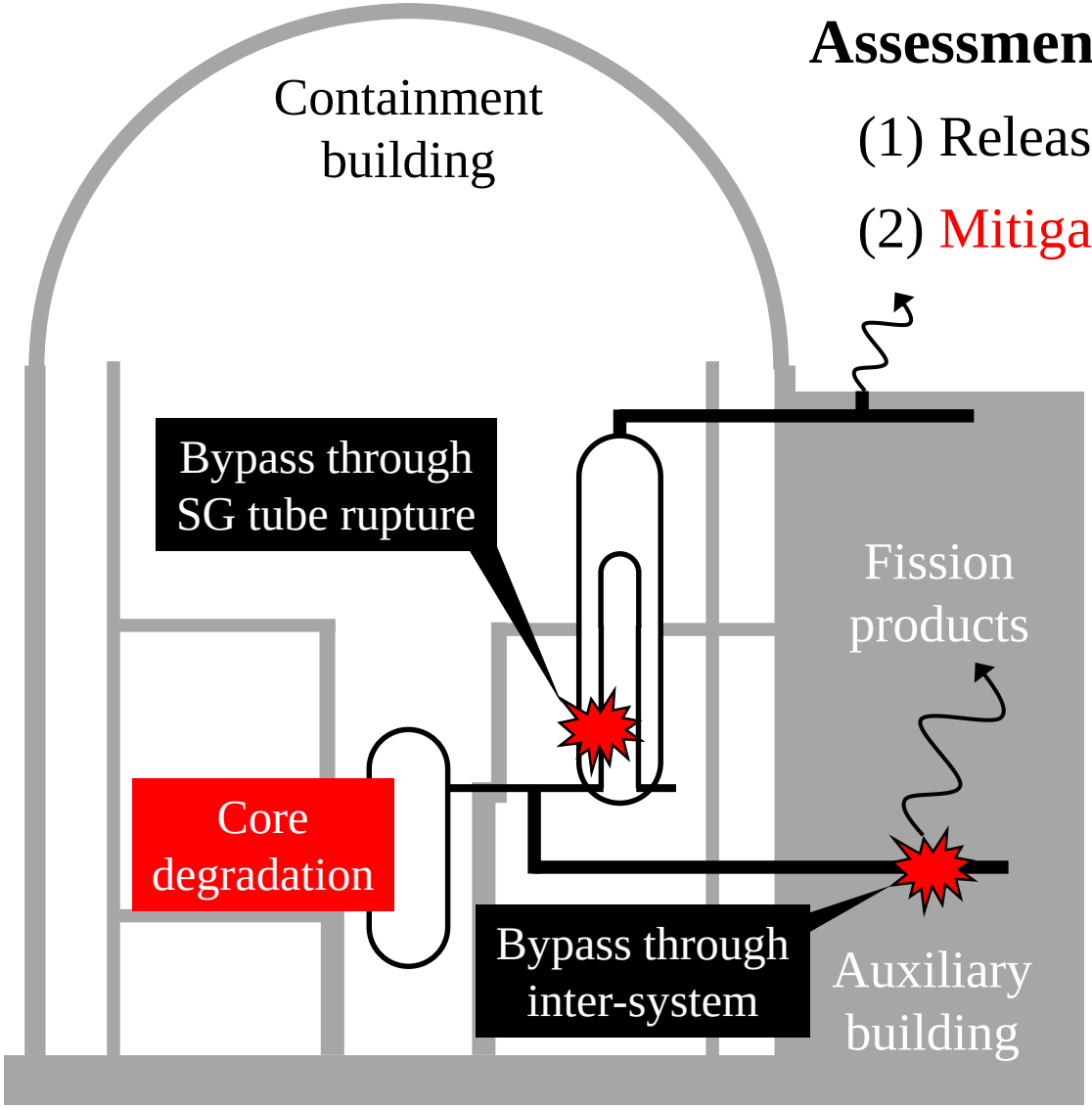
Bypass accident



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

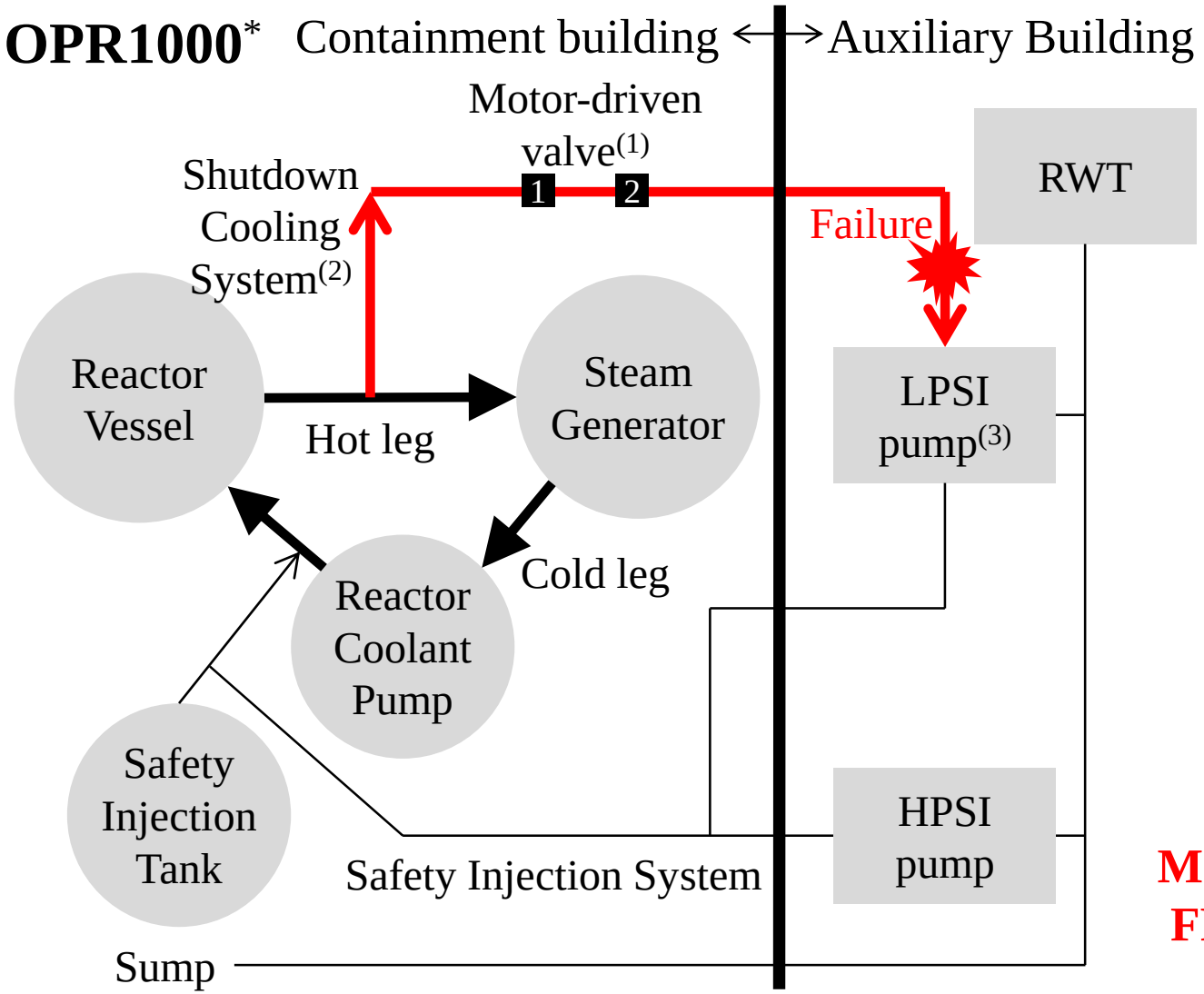
(Experiments + phenomena)

2012 SOARCA

Code with detailed models

Best-estimated source term of ISLOCA

ISLOCA scenario



Sequence

(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

Modeling of behavior of FP in MELCOR(v 2.2)

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

Iodine behavior in ISLOCA

1 CsI aerosol dynamics

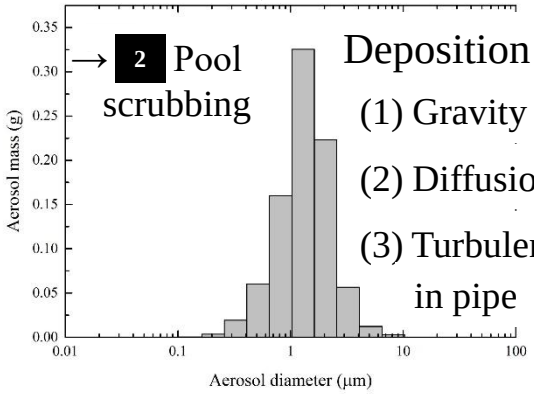
generation | gas↔particle

Size(mass) **distribution**(t) =

Source ± Condensation/Evaporation

± Agglomeration - Deposition

combination | MAEROS code | removal



→ 2 Pool scrubbing

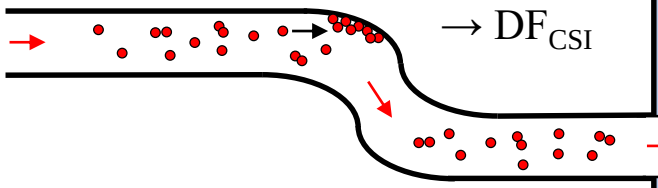
Deposition velocity

(1) Gravity = $f(d_p)$

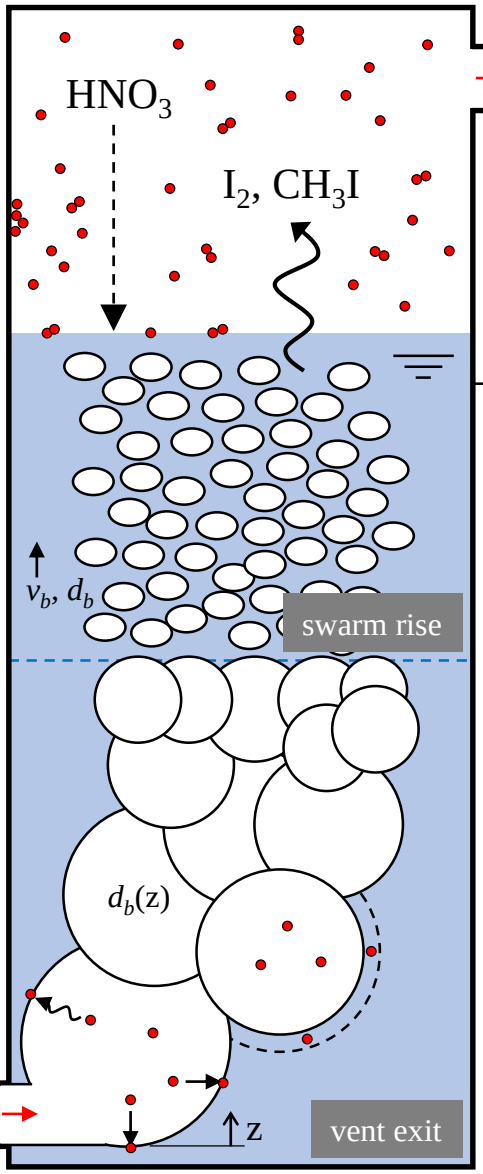
(2) Diffusion(∇C, T)

(3) Turbulence = $f(d_p)$ in pipe

Deposited aerosol on SCS pipelines



→ DF_{CSI}



3 Iodine pool chemistry

$[I_{2,atm}] = f([I_{2,aq}], PC_{I2}(T))$

Radiolysis, reaction = f (pH, dose rate)

Chemical eqs. ~#200

A + B ⇔ C + D

I^-, OH^-, H^+... in late pool

2 Pool scrubbing in AB

SPARC-90 code | vent exit | swarm rise

$DF = DF_1 \times DF_2 \times DF_3 \times DF_4$

DF_1	DF_2	DF_3	DF_4
condensation	inertial impaction(d_p)	gravity(d_p), diffusion, centrifugal	condensation, gravity, diffusion, centrifugal
			= $f(d_p)$

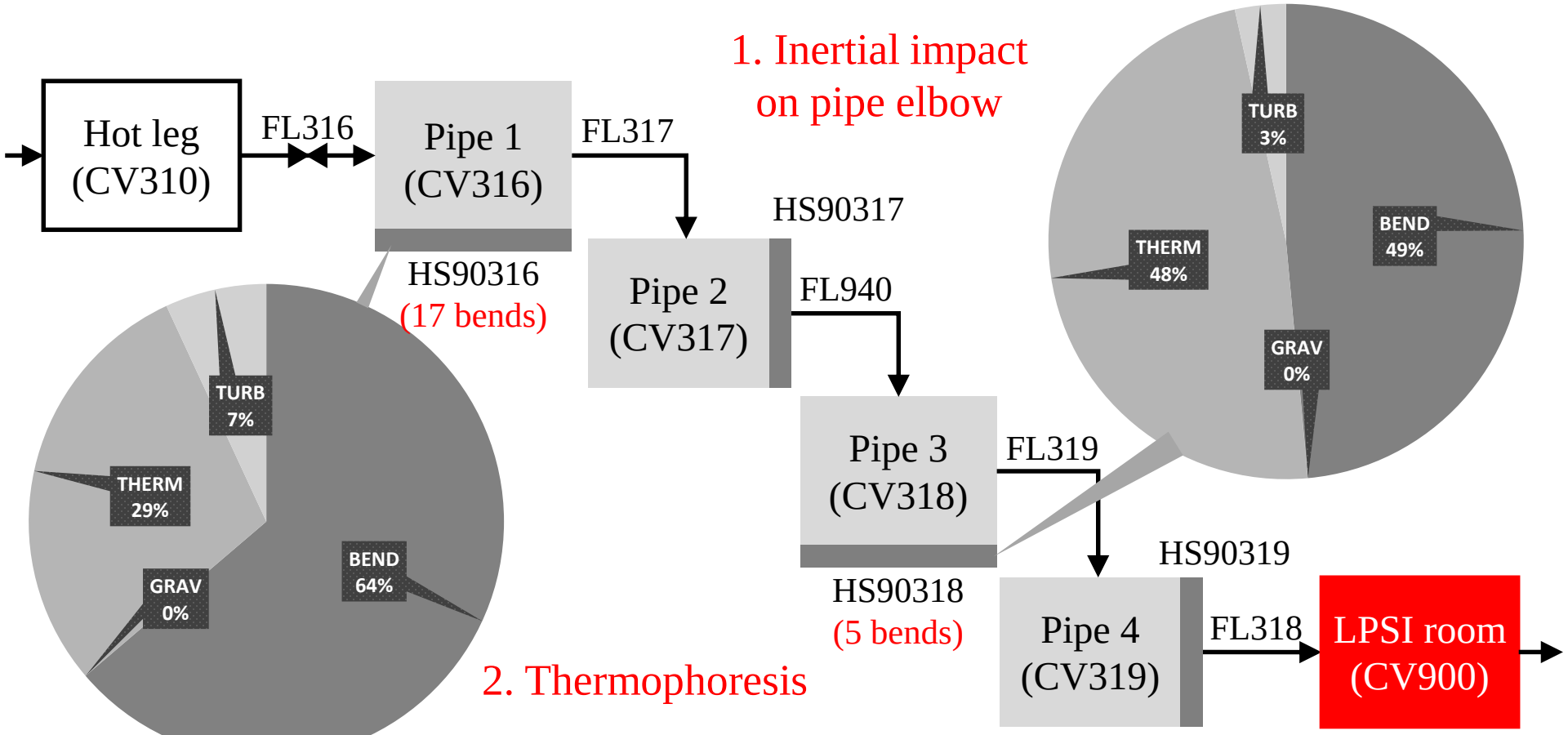
$DF_{CSI} = DF_1 \times DF_{2,d} \times DF_{3,d} \times DF_{4,d}$

$DF_{I2} = DF_1 \times DF_4$ in early accident

→ 3 Iodine chemistry(CsOH)

CsI deposited on SCS pipeline

Shutdown Cooling System(~89 m l, ~0.25 m d), pipe, elbow, tee, nozzle, valve, ...



$$v_{therm} = \frac{3\mu C_m\left(c_t Kn + k_{gas}/k_p\right)}{2\chi\rho_{gas}T\left(1+3F_{slip}Kn\right)\left(1+2c_t Kn + k_{gas}/k_p\right)}\nabla T$$

∇T > 100 K

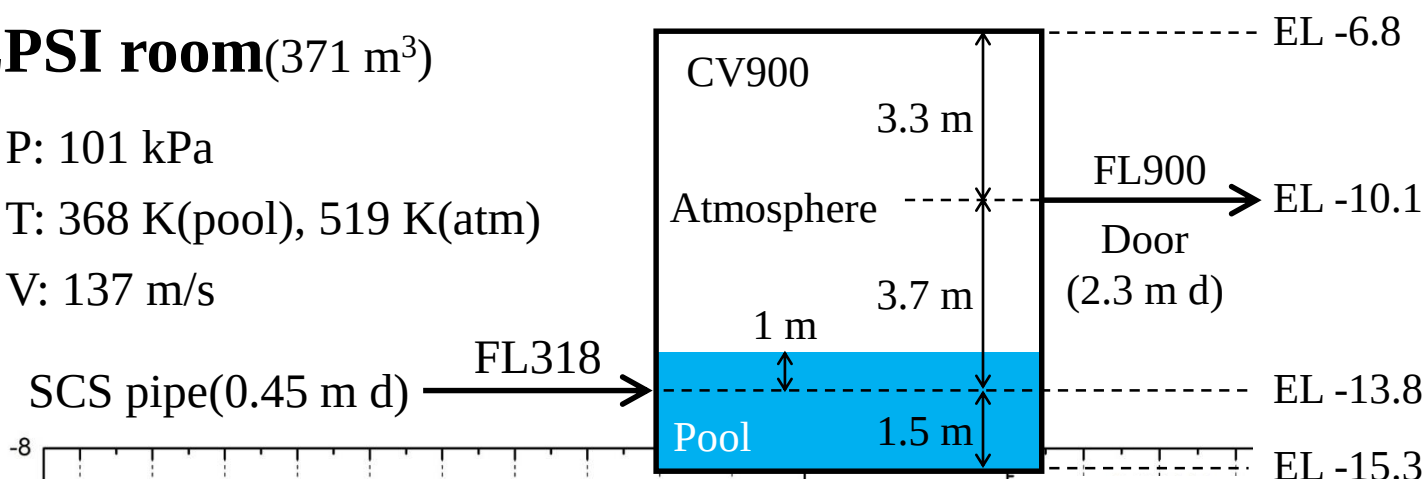
CsI released into pool formed in AB

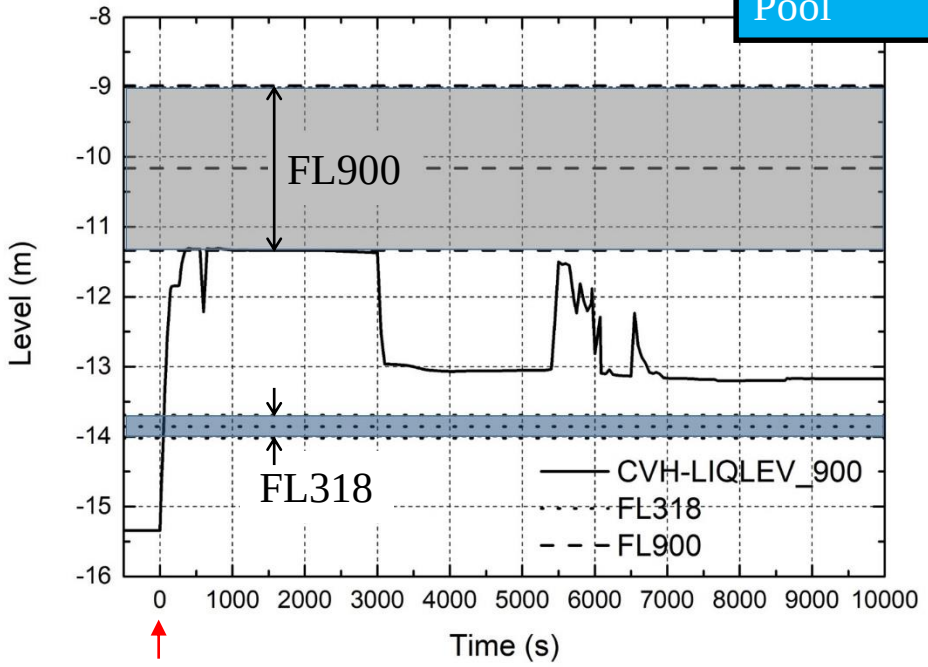
LPSI room(371 m^3)

P: 101 kPa

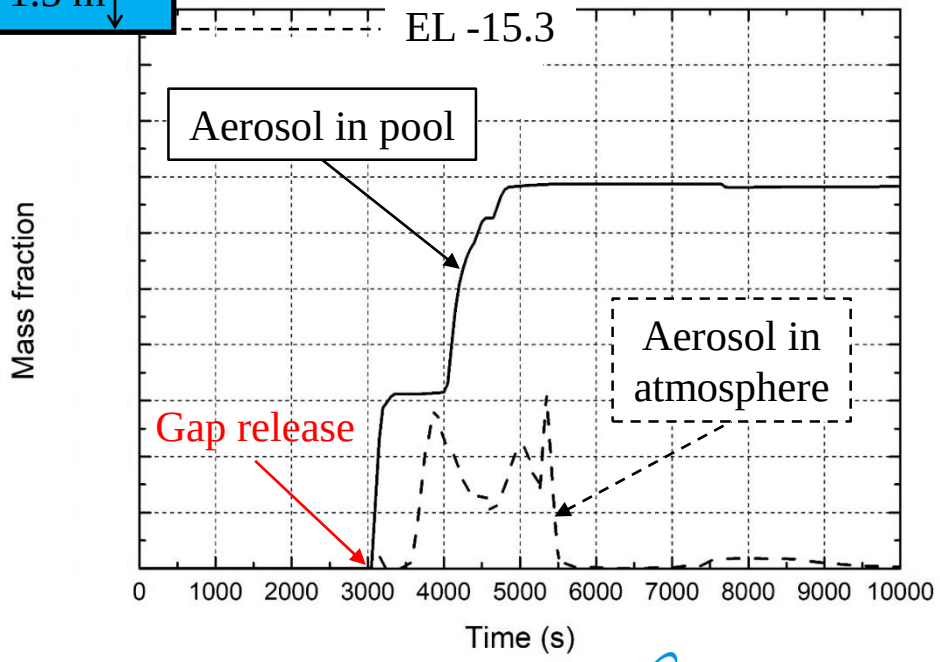
T: 368 K(pool), 519 K(atm)

V: 137 m/s





ISLOCA



Iodine pool chemistry in AB

Pool in LPSI room(264 m^3)

CV900

Atmosphere

Radiolysis → HNO_3, HCL

I_2 partitioning

Pool

I_2, CH_3I (high volatility)

f (pH, grays/s, T)

I_2 dissolves → I-, HOI, ...
(low volatility)

CSI in pool
(deactivate chemistry model)

CSI in pool
(activate chemistry model)

Gap release

Mass (kg)

0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

Time (s)

I2 released from LPSI room
(deactivate chemistry model)

I2 released from LPSI
(activate chemistry model)

(kg)

0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

Time (s)

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 SCS and AB
2021(4_{th} year)	Sensitivity analysis of mitigation action

- Cooling pipe, water level, spray, ...

2022(5_{th} year) Analysis for development of mitigation system

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

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