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Thermal hydraulic behavior of feeding SG in severe SGTR accident

Preliminary analysis of aerosol behavior in secondary SG shell

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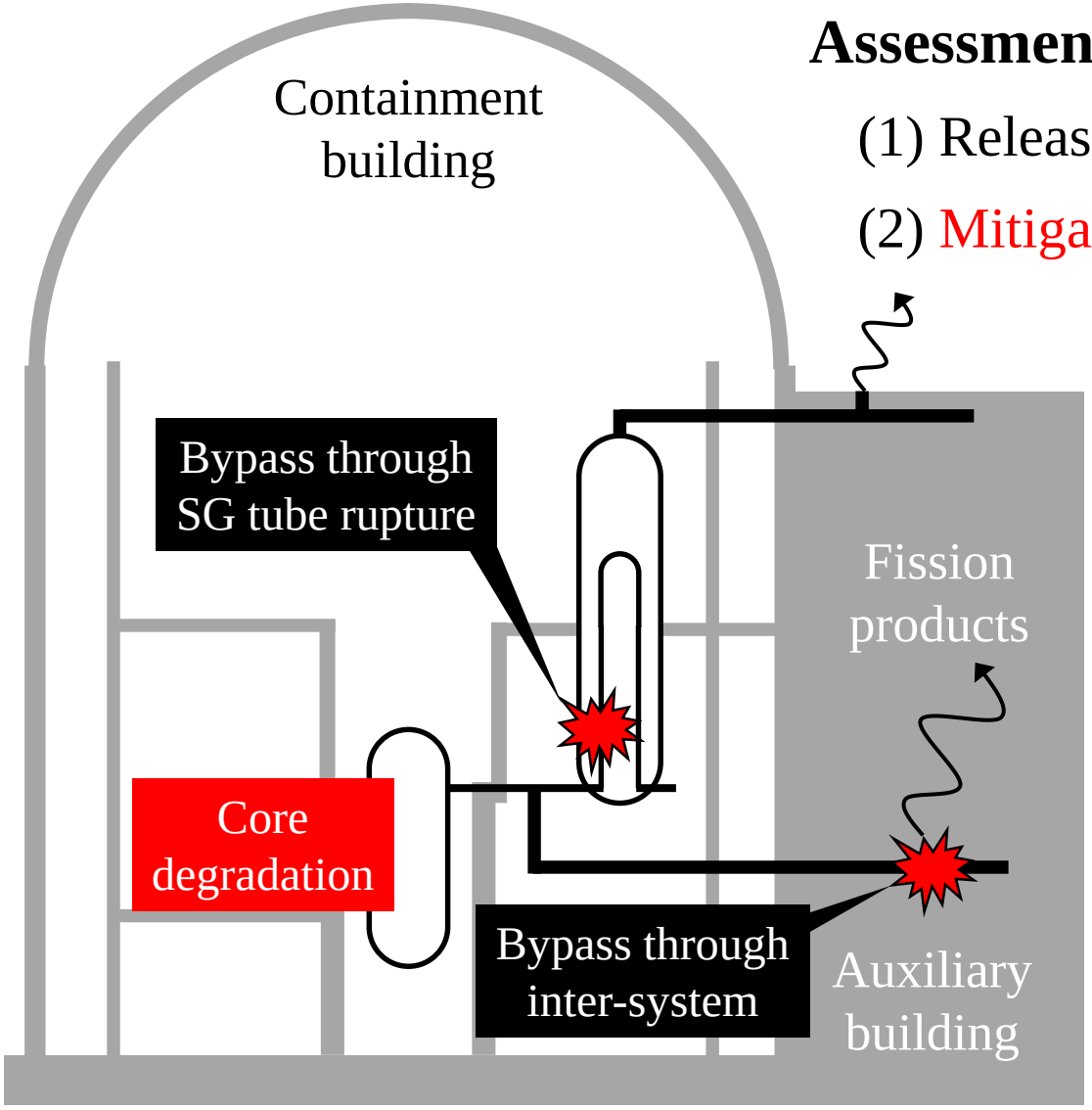
Bypass accident



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)

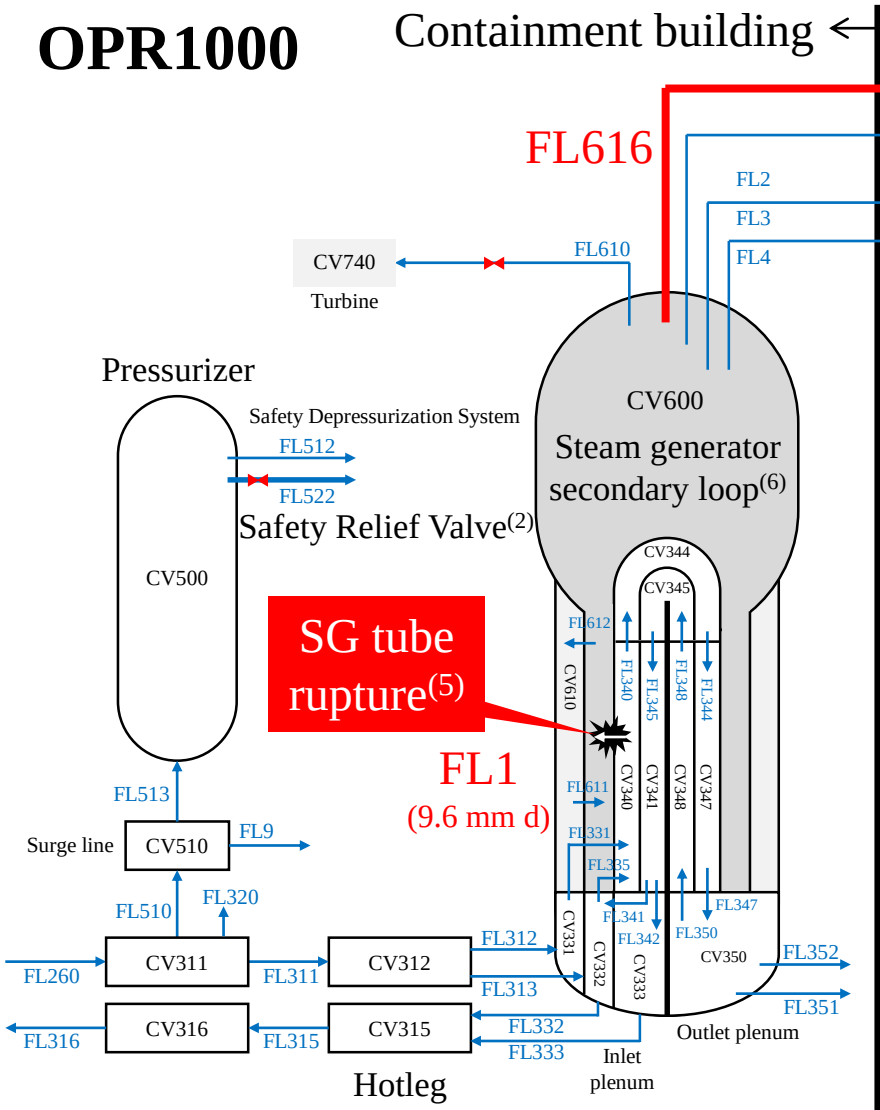
2012 SOARCA

Code with detailed models

Best-estimated source term of SGTR

SGTR accident scenario

OPR1000



Sequence(KAERI/TR-7852/2019)

(1) SBO → Reactor/RCP trip

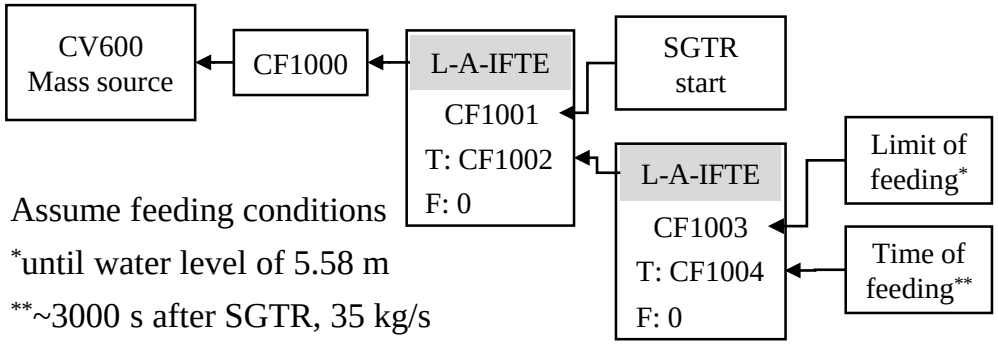
(2) SRV open/close → Fluctuating P

(3) CET > 923 K → SAMG

(4) ADV open → △P &T btw. SG & Env.

(5) SGTR → Discharging Fission products

(6) Feeding secondary SG shell

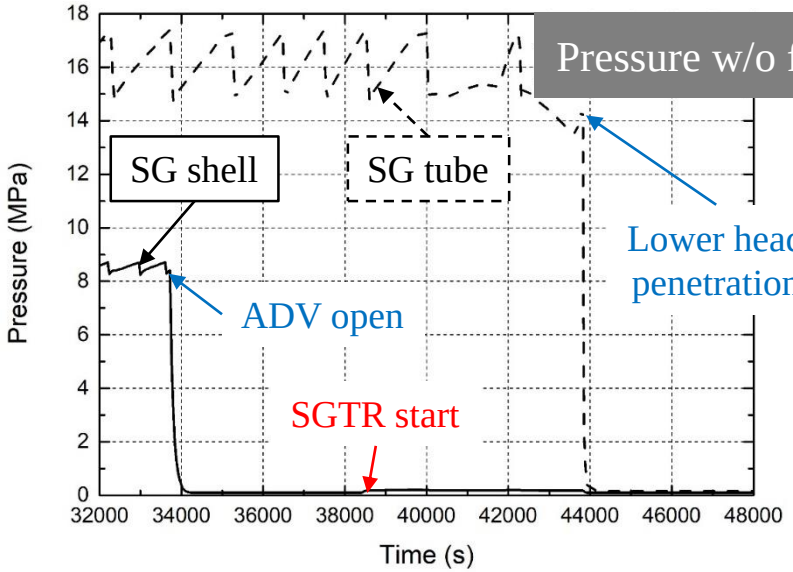


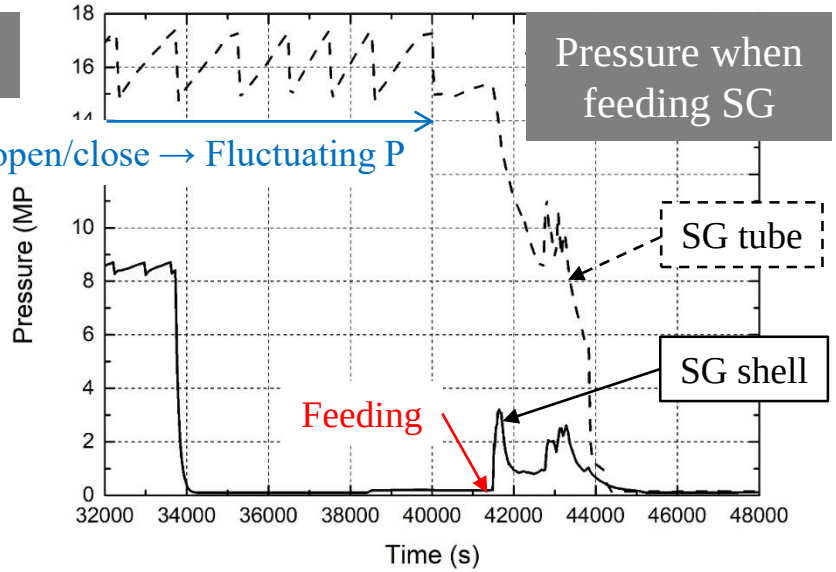
Assume feeding conditions

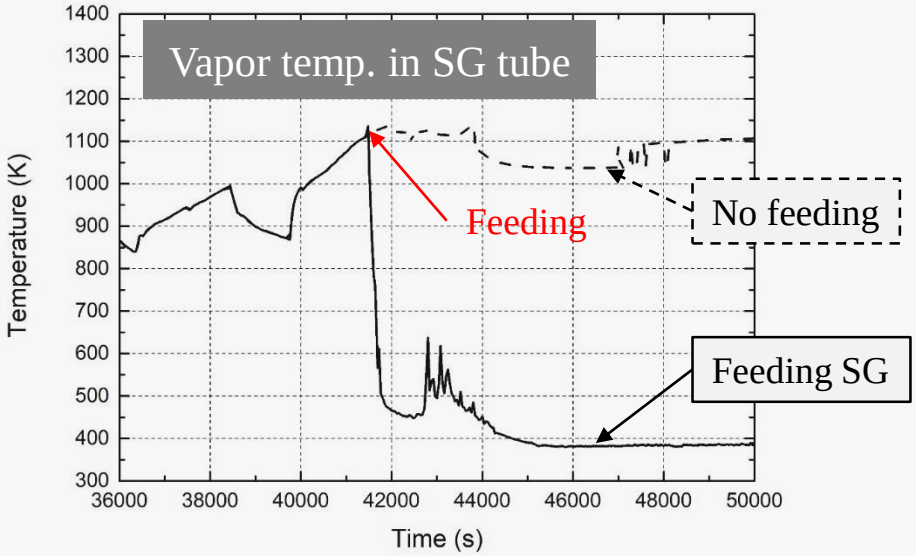
*until water level of 5.58 m

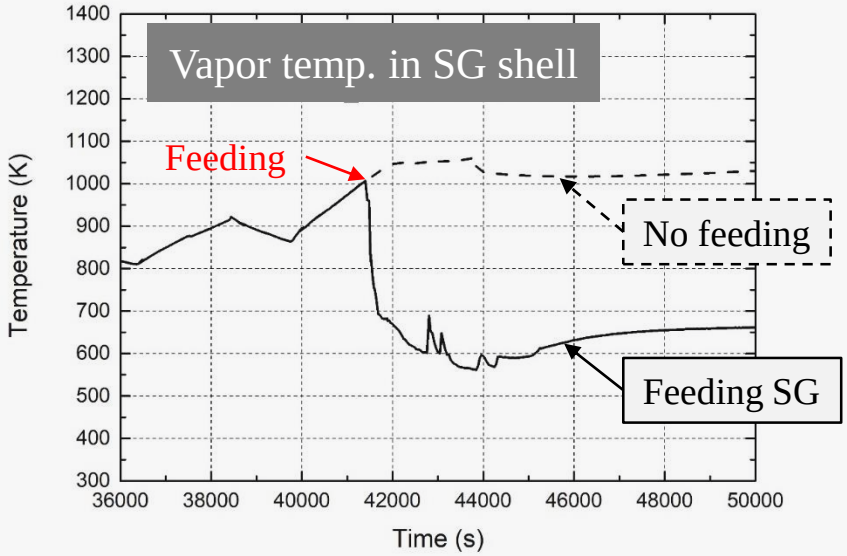
**~3000 s after SGTR, 35 kg/s

Pressure and Temperature

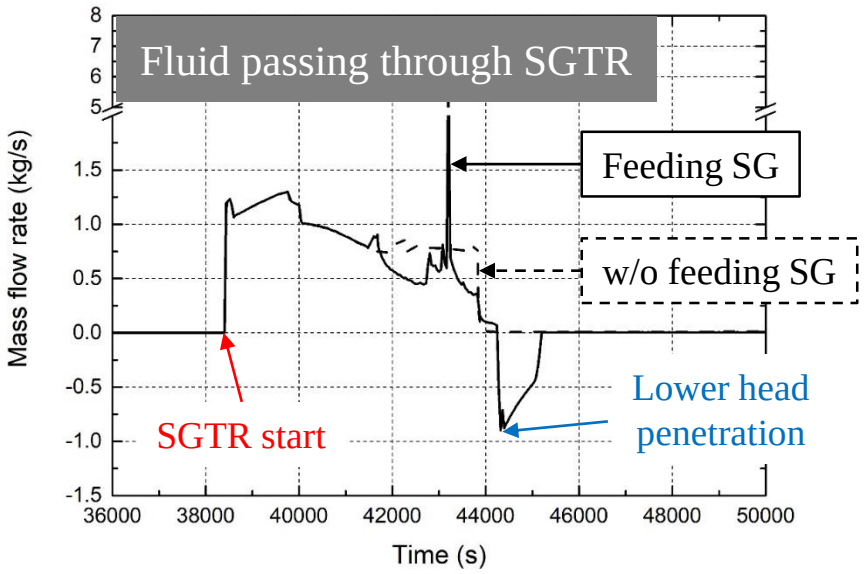


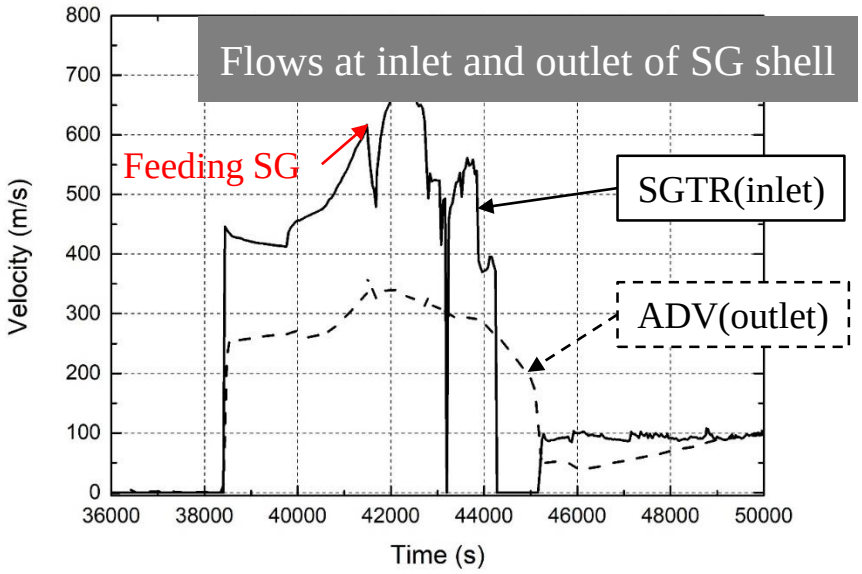


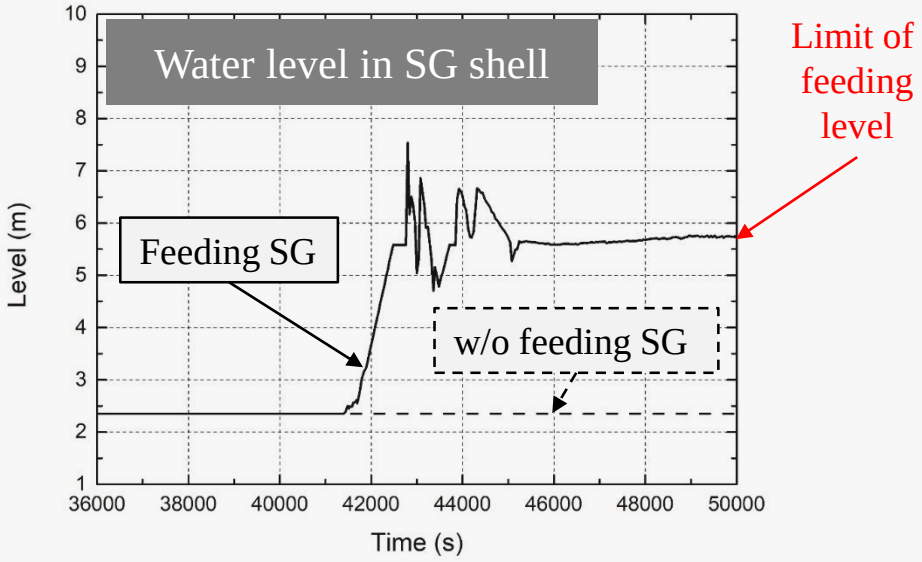


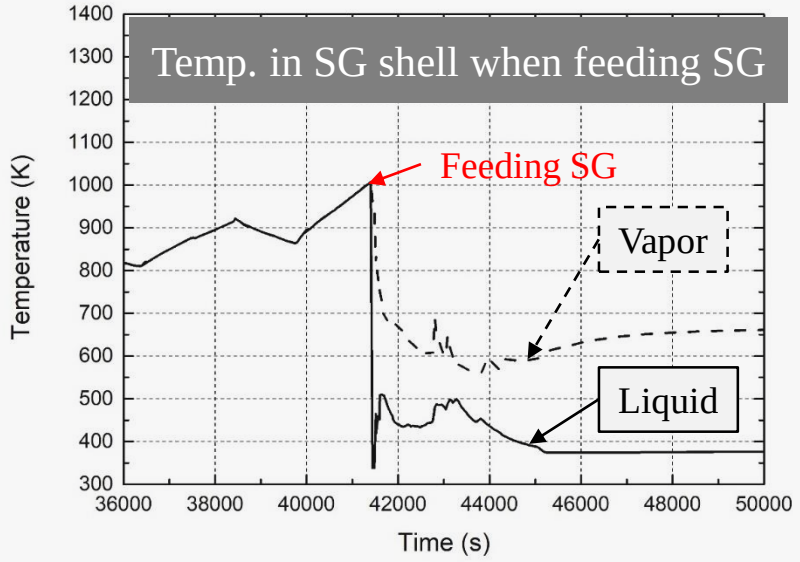


Flow rate and Water level









Behavior of fission products in SG shell

1 Aerosol dynamics

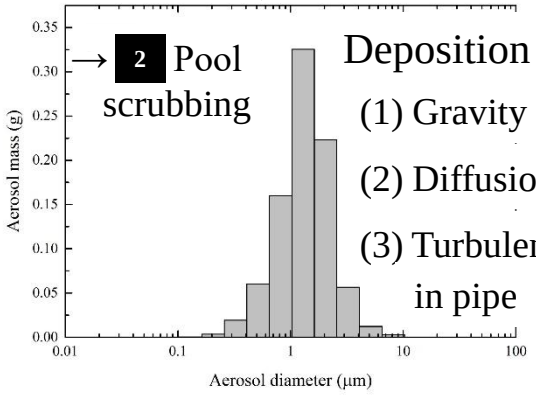
generation | gas↔particle

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

Source ± Condensation/Evaporation

± Agglomeration - Deposition

combination | MAEROS code | removal



→ 2 Pool scrubbing

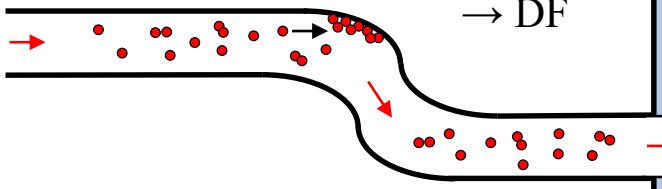
Deposition velocity

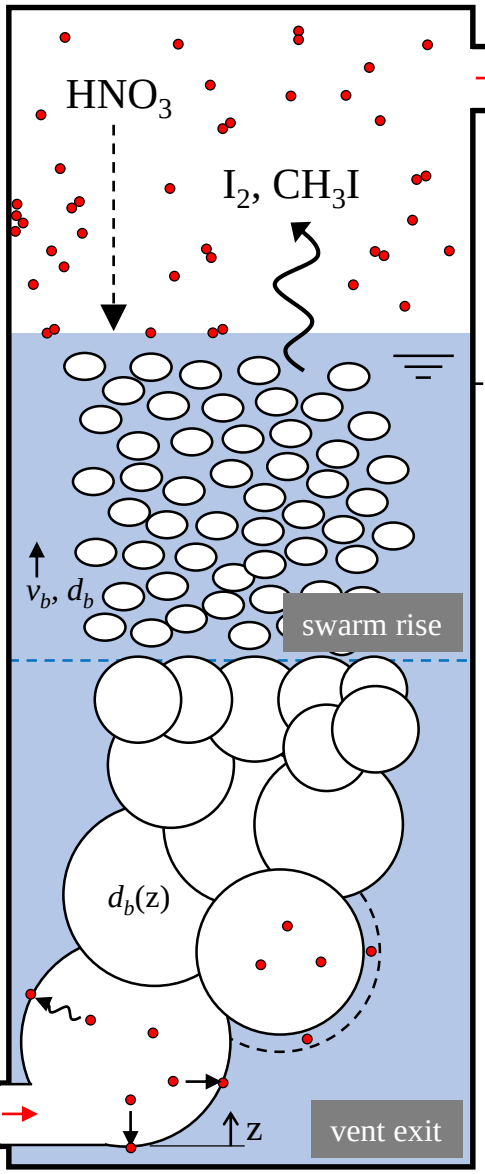
(1) Gravity = $f(d_p)$

(2) Diffusion(∇C, T)

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

Deposited aerosol on pipelines → DF





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 SG shell

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

$= f(d_p)$

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

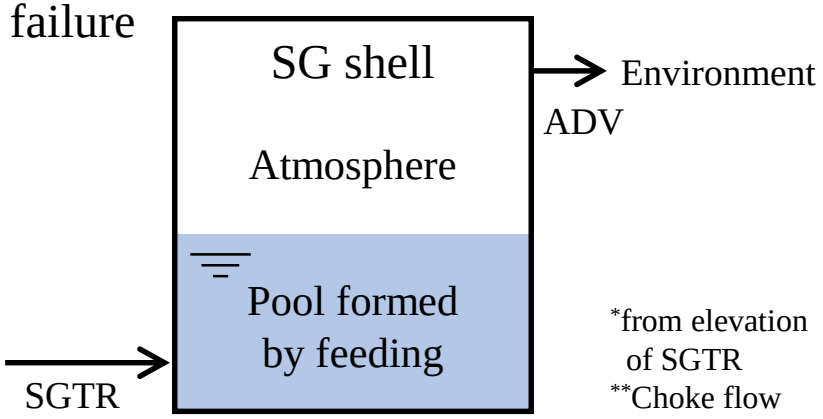
$\underline{DF_{I2}} = DF_1 \times DF_4$ in early accident

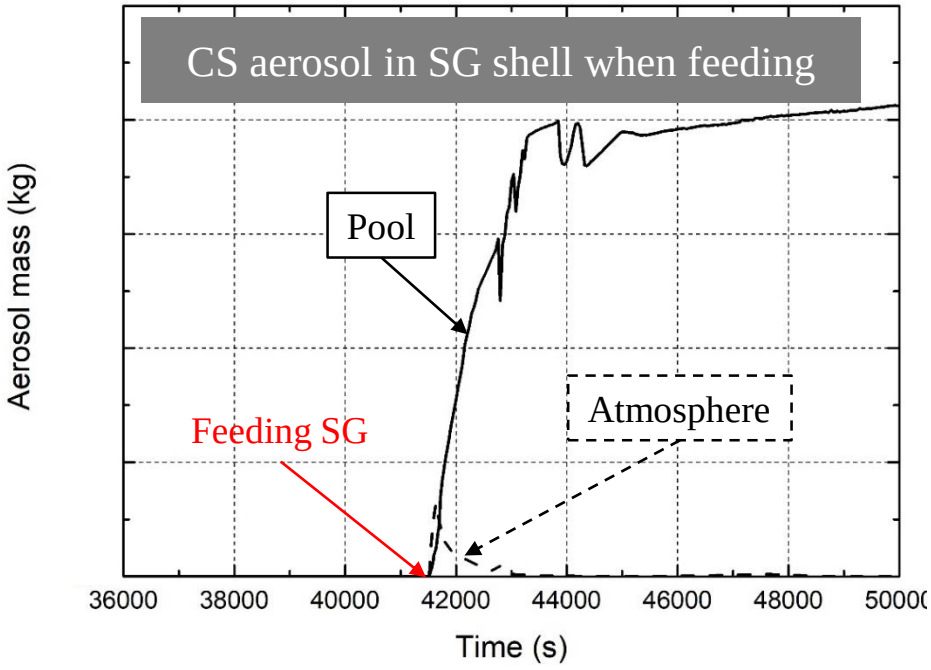
→ 3 Iodine chemistry(CsOH)

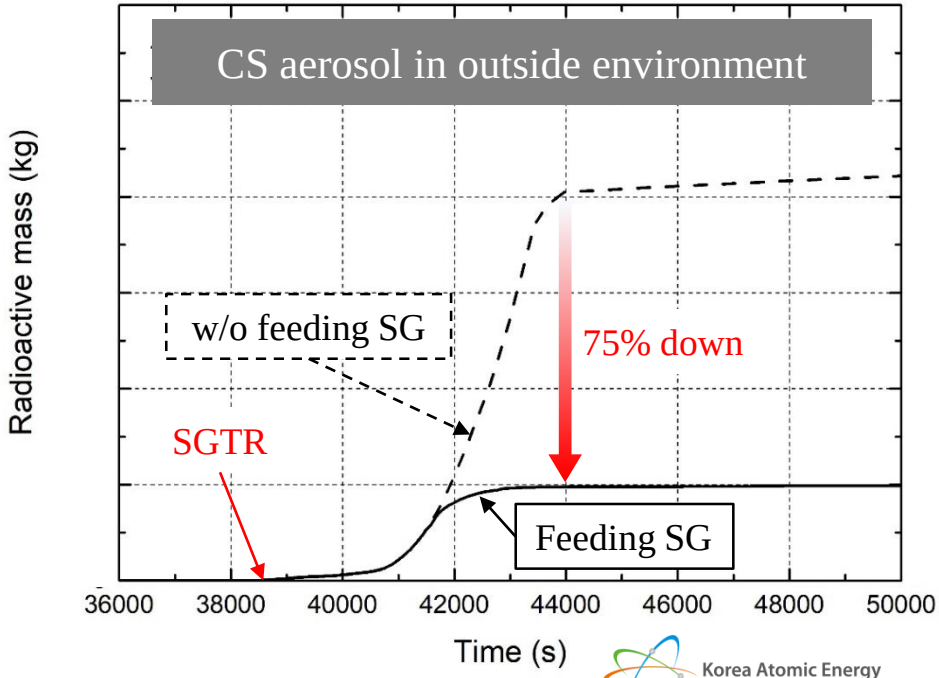
Aerosol behavior in SG shell

TH conditions in SG shell from gap release to vessel failure

	Before feeding	After feeding
Pressure(MPa)	0.15	1.54
Vapor temp.(K)	892	667
Pool temp.(K)	-	460
Water level(m)	-	4.1*
Flow rate(m/s)	487**	606**







Conclusion and Future work

"Development of evaluation technologies on radioactive material releases by steam generator tube rupture under severe accident"

2020(4_{th} year) Thermal hydraulic analysis → Pool in SG shell(1)

Behavior of fission products in SG shell

2021(5_{th} year) Sensitivity analysis of mitigation action → CS, I2, ...

- Feeding time/rate: 34,000~41,000 s/1~30 kg/s

Validation of calculation of pool scrubbing

- Jet regime experiments in THEMIS project

(1)KAERI/TR-8356/2020

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