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# Assessment of Feeding in Steam Generator in SGTR Accident

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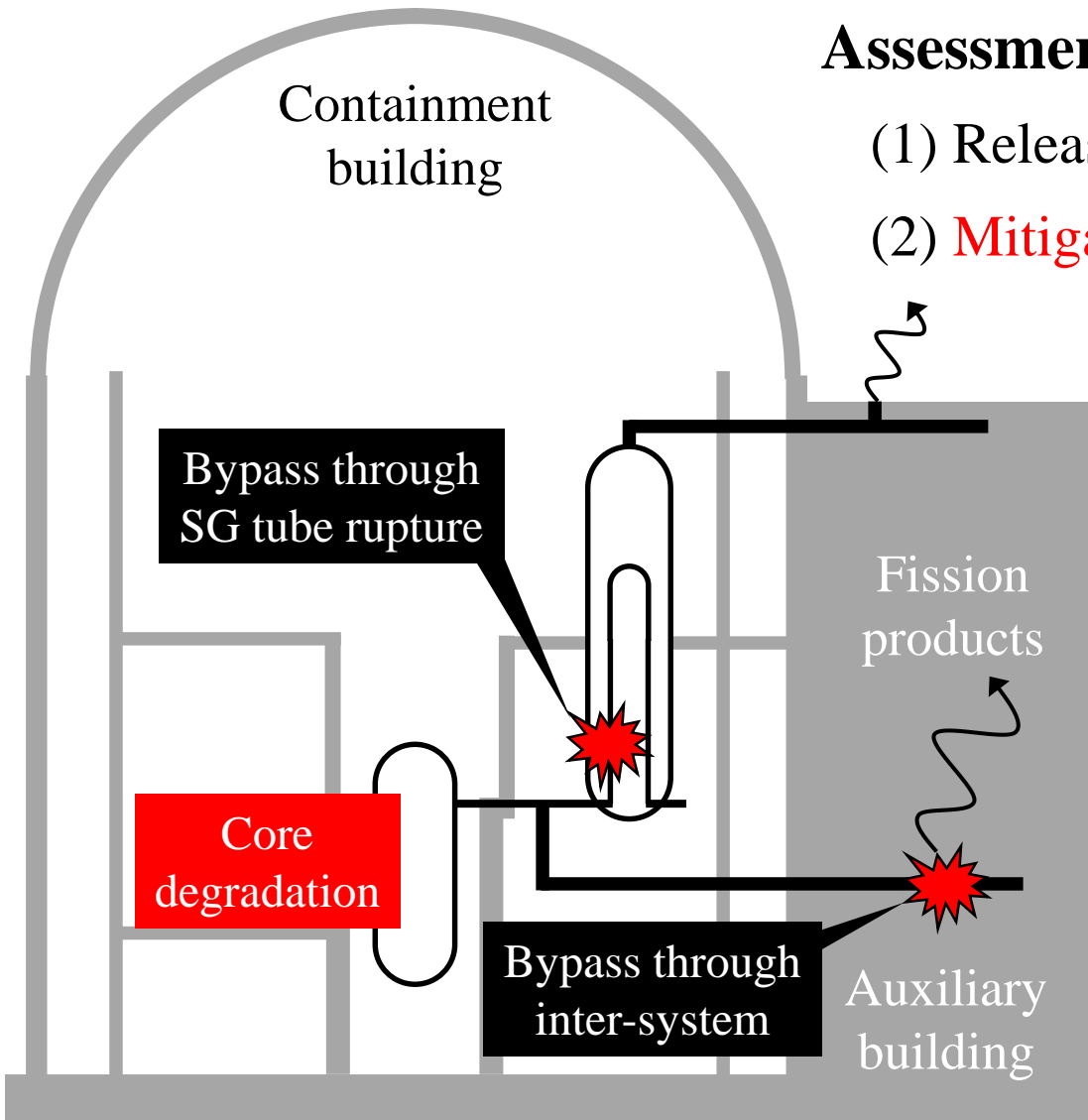
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# Bypass accident

## 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

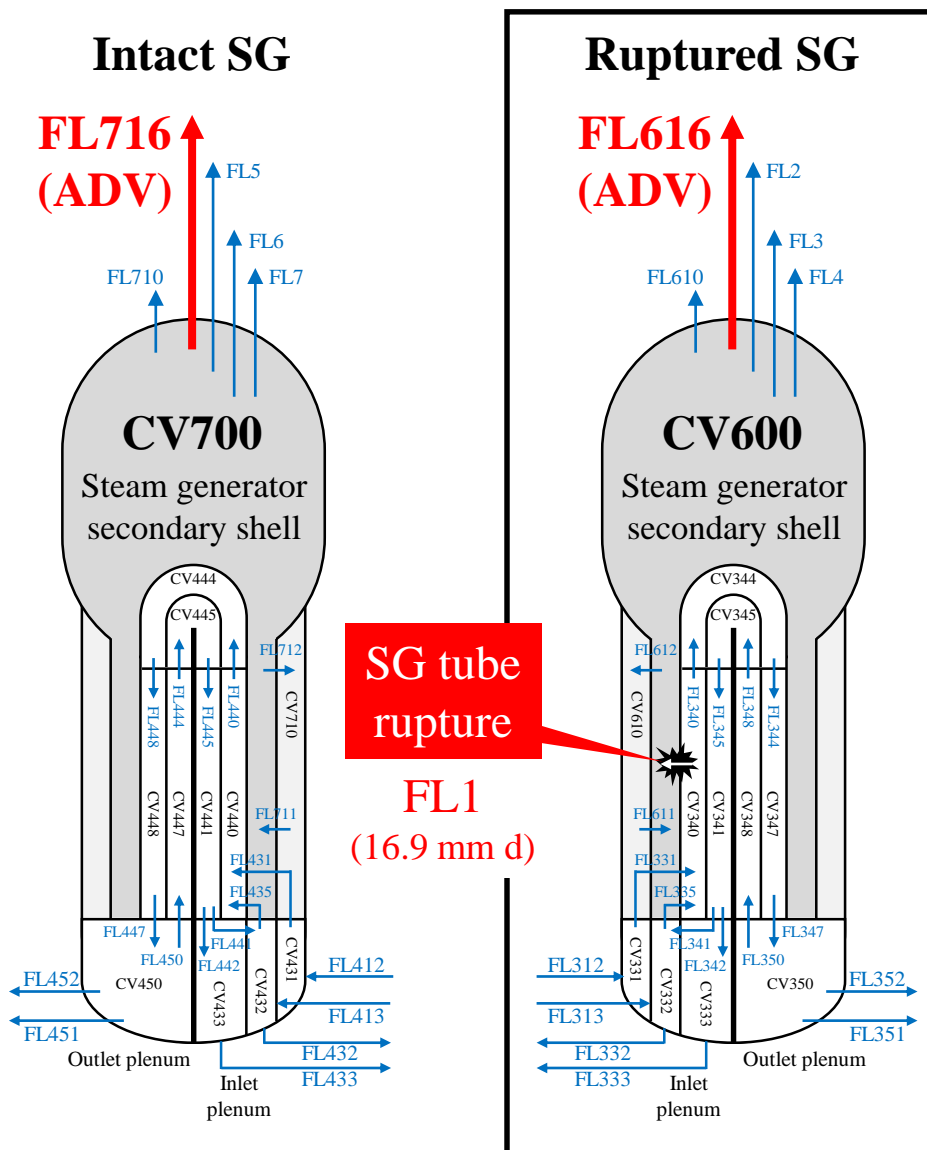
Code for severe accident  
(Experiments + phenomena)

2012 SOARCA

Code with detailed models

**Feeding strategies in SGTR**

# SGTR accident scenario



## Base case(w/o feeding in SG)

- (1) SBO in OPR1000 at 0 s
- (2) ADV open at 33724 s
- (3) Gap release from 34781 s
- (4) Occurrence of SGTR at 37867 s
- (5) Lower Head Penetration(LHP) at 42590 s

## Feeding cases

- (1) Feeding time\*: 34000~44000 s
- (2) Injection rates: 5, 10\*\*, 15 kg/s
- (3) Feeding locations: Ruptured SG(CV600),

Intact SG(CV700), Both SGs

\*Interval of 1000 s, \*\*Max. ext. feeding of 13.6 kg/s

## Comparison of the cases

- (1) Occurrence of SGTR and LHP
- (2) Mitigation rate of bypassing Cs aerosol

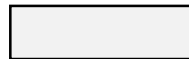
# The occurrence of SGTR and LHP

**Base case(w/o feeding):** ADV open(33724 s) → SGTR(37867 s) → LHP(42590 s)

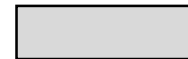
Feeding time(s)		Feeding a Ruptured SG shell			Feeding an Intacted SG shell			Feeding Both SG shells		
		5 kg/s	10 kg/s	15 kg/s	5 kg/s	10 kg/s	15 kg/s	5 kg/s	10 kg/s	15 kg/s
Early feeding	34000	FRS3405	FRS3410	FRS3415	FIS3405	FIS3410	FIS3415	FBS3405	FBS3410	FBS3415
	35000	FRS3505	FRS3510	FRS3515	FIS3505	FIS3510	FIS3515	FBS3505	FBS3510	FBS3515
	36000	FRS3605	FRS3610	FRS3615	FIS3605	FIS3610	FIS3615	FBS3605	FBS3610	FBS3615
	37000	FRS3705	FRS3710	FRS3715	FIS3705	FIS3710	FIS3715	FBS3705	FBS3710	FBS3715
Late feeding	38000	FRS3805	FRS3810	FRS3815	FIS3805	FIS3810	FIS3815	FBS3805	FBS3810	FBS3815
	39000	FRS3905	FRS3910	FRS3915	FIS3905	FIS3910	FIS3915	FBS3905	FBS3910	FBS3915
	40000	FRS4005	FRS4010	FRS4015	FIS4005	FIS4010	FIS4015	FBS4005	FBS4010	FBS4015
	42000	FRS4205	FRS4210	FRS4215	FIS4205	FIS4210	FIS4215	FBS4205	FBS4210	FBS4215
	44000	FRS4405	FRS4410	FRS4415	FIS4405	FIS4410	FIS4415	FBS4405	FBS4410	FBS4415



SGTR(X), LHP(X)



SGTR(O), LHP<sup>(1)</sup>(X)



SGTR(O), LHP(O)

## Classification of the feeding time

## Events

Early feeding(34000~37000 s)<sup>(2)</sup>

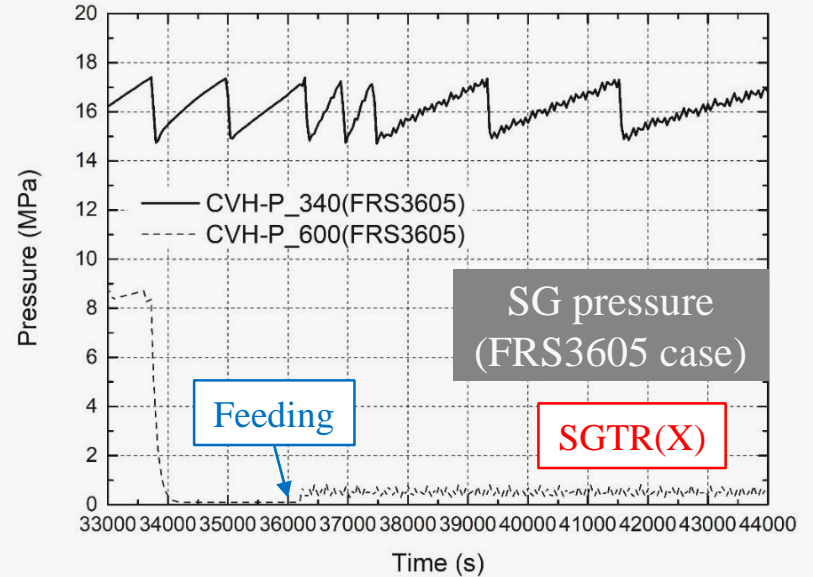
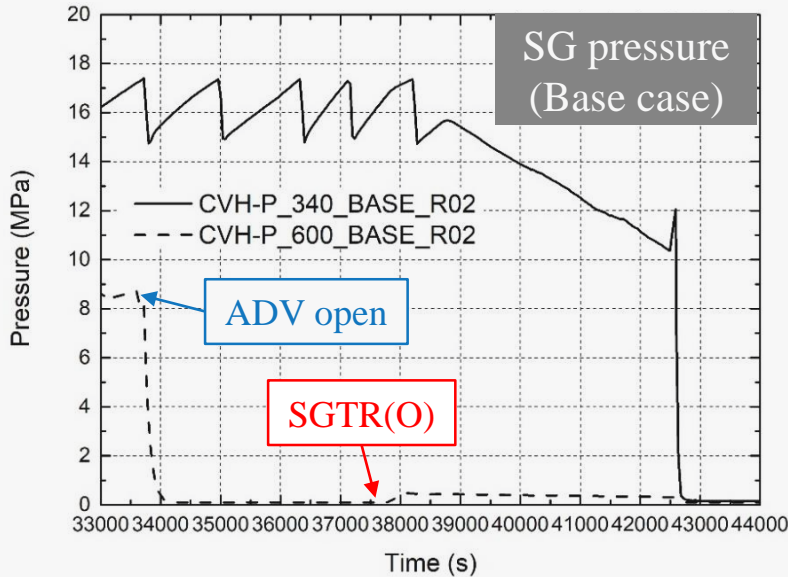
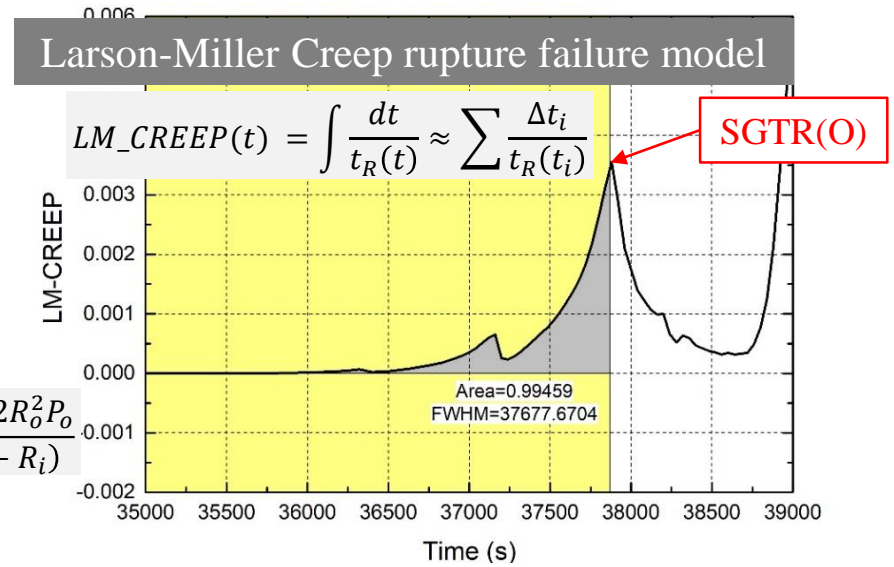
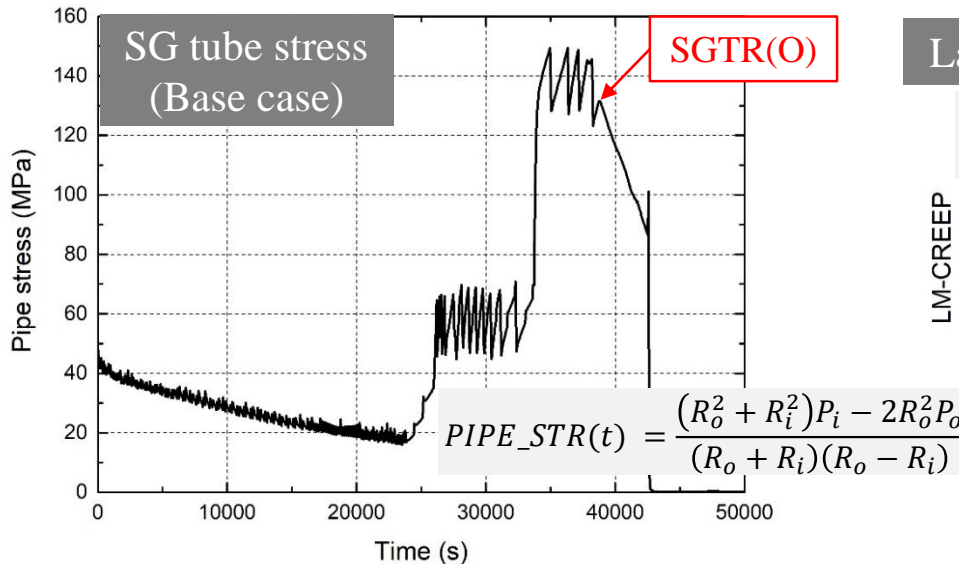
SGTR(X<sup>(3)</sup>) → Cooled by feeding SG  
→ No bypassing FPs

Late feeding(38000~44000 s)

SGTR(O) → Bypassing FPs  
→  $f$  (feeding time, injection rate, feeding locations)

(1) End of calculation: 100,000 s, (2) Feeding before SGTR, (3) Except FIS3605 and FIS3705

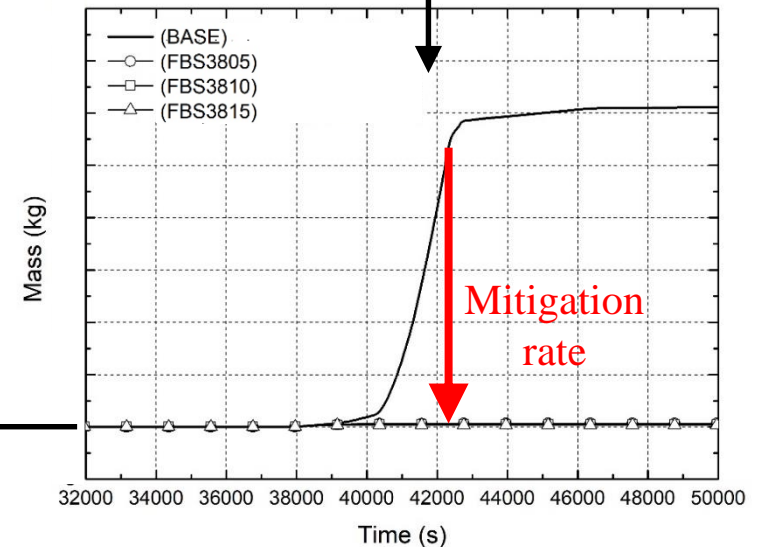
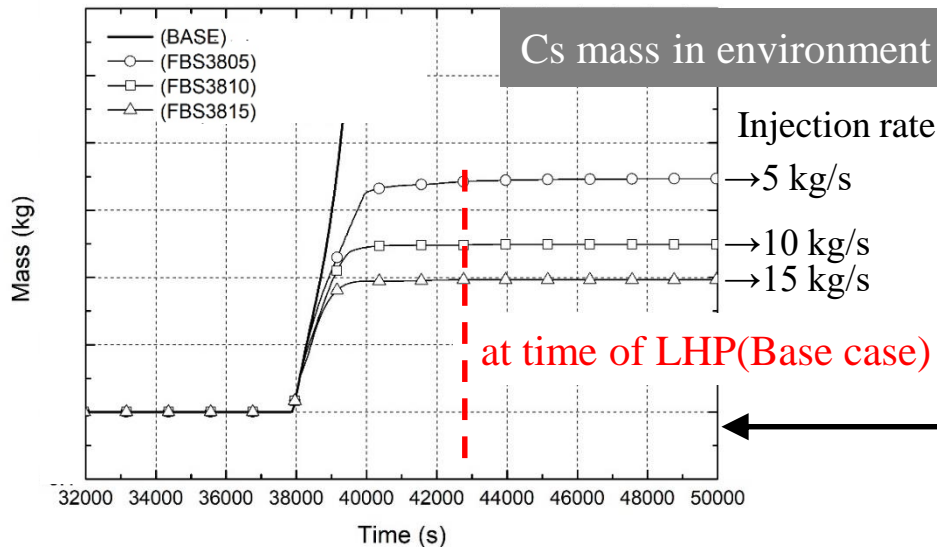
# Occurrence of SGTR



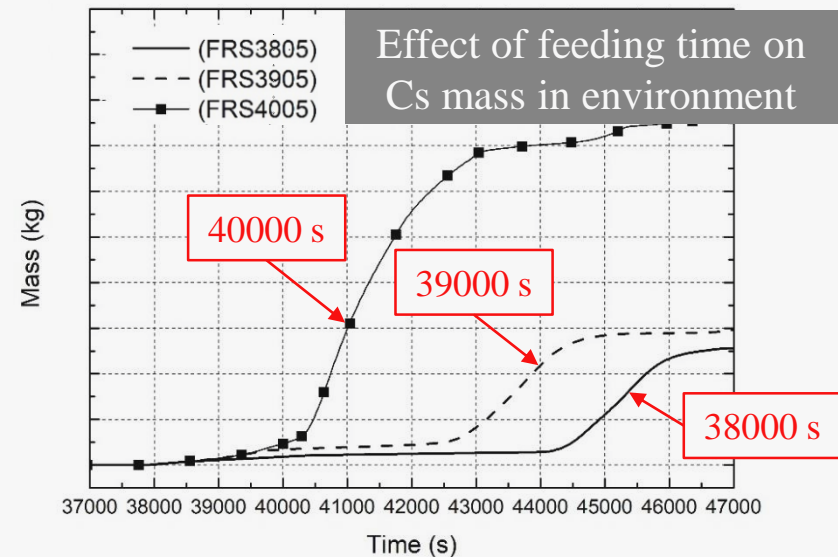
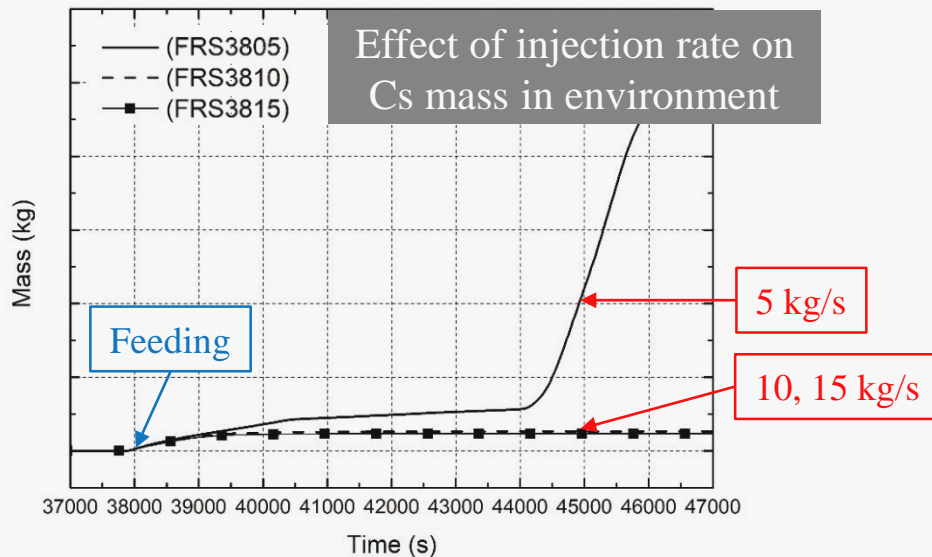
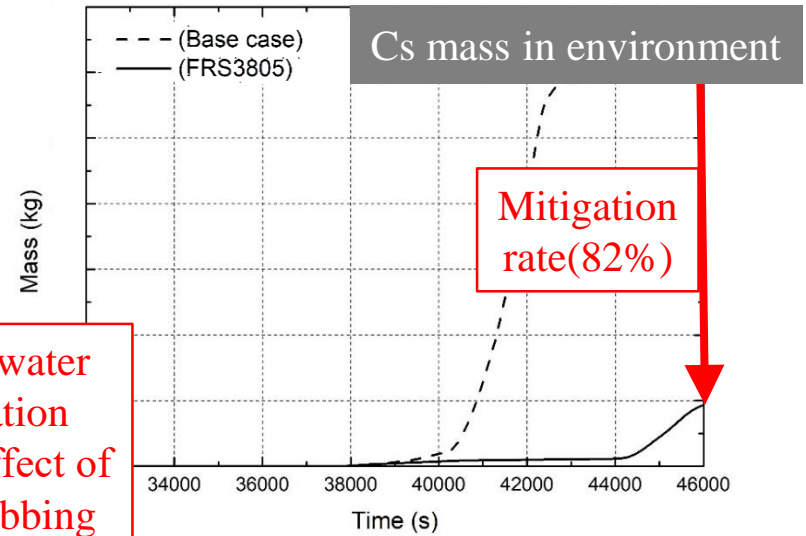
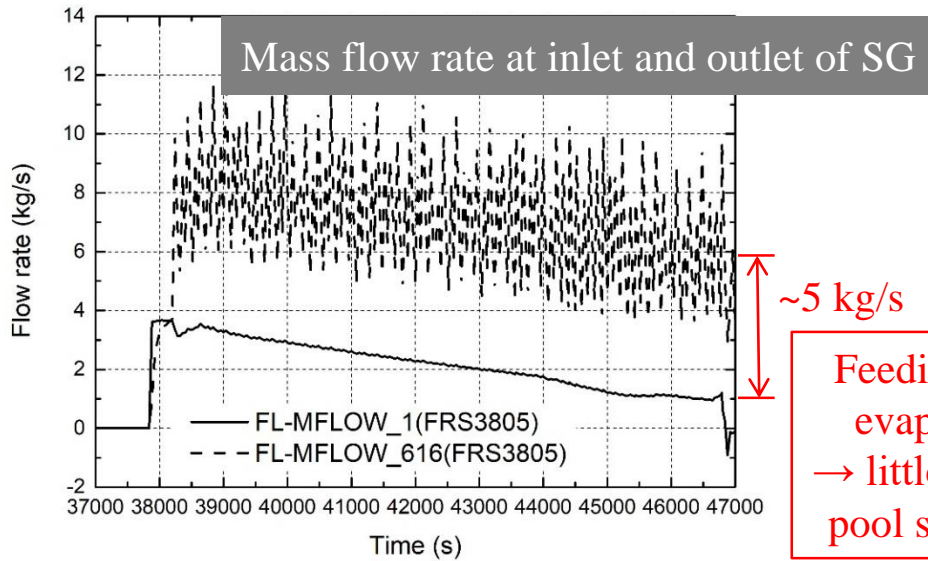
# Mitigation rate of bypassing Cs aerosol

Base case(w/o feeding): ADV open(33724 s) → SGTR(37867 s) → LHP(42590 s)

Feeding time(s)		Feeding a Ruptured SG shell			Feeding an Intacted SG shell			Feeding Both SG shells		
		5 kg/s	10 kg/s	15 kg/s	5 kg/s	10 kg/s	15 kg/s	5 kg/s	10 kg/s	15 kg/s
Early feeding	34000	FRS3405	FRS3410	FRS3415	FIS3405	FIS3410	FIS3415	FBS3405	FBS3410	FBS3415
	35000	FRS3505	FRS3510	FRS3515	FIS3505	FIS3510	FIS3515	FBS3505	FBS3510	FBS3515
	36000	FRS3605	FRS3610	FRS3615	-100%	FIS3610	FIS3615	FBS3605	FBS3610	FBS3615
	37000	FRS3705	FRS3710	FRS3715	-81%	FIS3710	FIS3715	FBS3705	FBS3710	FBS3715
Late feeding	38000	-82%	-99%	-99%	-72%	-98%	-99%	-99%	-99%	-99%
	39000	-80%	-98%	-98%	-57%	-97%	-97%	-97%	-98%	-98%
	40000	-53%	-81%	-89%	-49%	-71%	-53%	-75%	-89%	-93%
	42000	0%	-3%	-6%	0%	-1%	-2%	0%	-3%	-7%
	44000	0%	0%	0%	0%	0%	0%	0%	0%	0%



# Bypassing behavior of Cs aerosol



# Conclusion and Future work

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

2020(4<sup>th</sup> year) Thermal hydraulic analysis → Pool in SG shell<sup>(1)</sup>  
Behavior of fission products in SG shell

2021(5<sup>th</sup> year) Feeding strategies in Steam Generator

- Feeding time, injection rate: 34000~44000 s, 5~15 kg/s
- Feeding location: Ruptured SG(FRS), Intact SG(FIS), Both SGs(FBS)

Occurrence of SGTR

- Early feeding(34000~37000 s): SGTR(X except FIS3605 and FIS3705)

Mitigation rate of bypassing Cs aerosol

- Late feeding(38000~44000 s) =  $f$  (feeding time, rate, location)

(1) KAERI/TR-8356/2020

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