TLOSHR Analysis of SMART-ITL using SPACE Code

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Introduction

❑ Improvement of SPACE for SMART Simulation

- Based on the phenomena identification and ranking tables (PIRT) for SMART100 design extension conditions (DEC), the thermal-hydraulic models of SPACE has been improved.
- Core makeup tank (CMT), helical SG model…

❑ Simulation of SMART-ITL DEC Scenario

- Total Loss of Secondary Heat Removal (TLOSHR) scenario has been selected for validation of improved SPACE.
- TLOSHR: Loss of entire feedwater system including passive residual heat removal system (PRHRS)

TLOSHR Experiment

❑ Sequence of Events in TLOSHR of SMART-ITL

- All feedwater pumps were stopped simultaneously.
- PRHRS was not activated (conservative assumption)
- Pressurizer safety valve (PSV) was not opened and following activations related with PSV opening such as ADS opening and RCP trip didn't occur during the test.

Event	Setpoint	Time (s)
Arrival of Steady State	-	0
TLOSHR start	FW stop PRHRAS generation all PRHRS failure	672
CMTAS	PRHRAS+1.45 s	674
CMT injection	CMTAS+1.45 s	675
MSIV / MFIV close	PRHRAS+5 s	677
Rx trip setpoint	PZR P=16.53 MPa	784
Rx trip signal (HPP)	HPP+1.1 s	785
Control rod insert	HPP+1.6 s	786
PSV open*	PZR P=17.27 MPa	-
PSV close	PZR P=13.87 MPa	-
ADS open*	38% level of CMT	-
RCP stop*	ADS open+10 min	-
SITAS	PZR P=L-LPP+1.45 s	97,562
SIT injection	SITAS+1.45 s	97,564

Steady-State Simulation

	EXP [3]	SPACE	Error (%)
Core Power (kW)	1,666	1,666	B.C.
Core inlet/outlet Temperature (K)	569.65	570.15	0.09
	594.75	595.14	0.07
SG primary inlet/outlet Temperature (K)	594.65	593.98	-0.11
	572.35	571.11	-0.22
RCS flowrate (kg/s)	10.177	11.48	Adjusted
PZR Pressure (MPa)	15.0	15.0	0.0
PZR water level (m)	3.064	3.061	-0.10
SG sec. inlet/outlet Temperature (K)	504.25	504.25	B.C.
	588.45	590.17	0.29
SG flow rate (kg/s)	0.761	0.768	Adjusted
FW Pressure (MPa)	5.71	5.71	B.C.
MS pressure (MPa)	5.62	5.64	0.36

Transient Simulation

❑ Key Parameters for TLOSHR

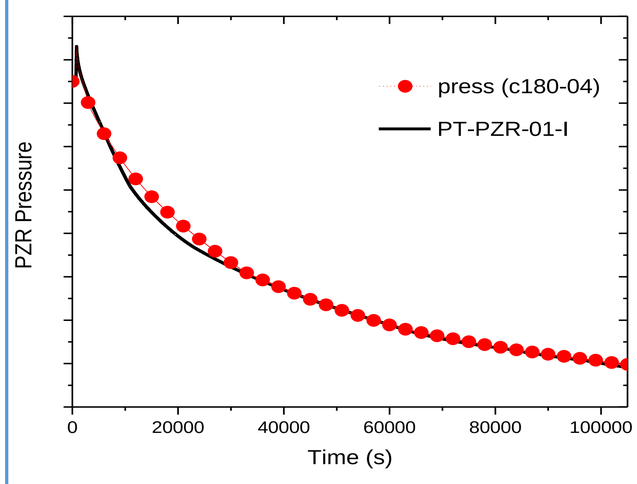
- Environmental Heat Loss
  - ✓TLOSHR is long term transient, so that environmental heat loss coefficient is the most important key parameter during transient.
  - ✓Environmental heat loss coefficient was adjusted for each component through the sensitivity study.

❑ Comparison of Sequence of Events

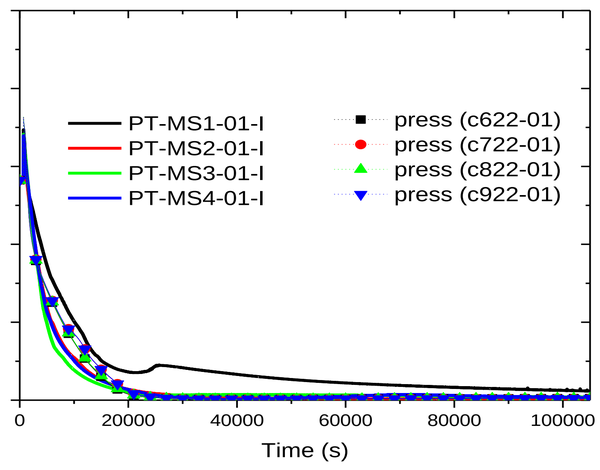
Event	Time (EXP [3])	Time (SPACE)
TLOSHR start	672	672
PRHRAS generation	672	672
CMTAS	674	673.5
CMT injection	675	674.9
MSIV / MFIV close	677	677.0
Rx trip setpoint	784	777.8
Rx trip signal by HPP	785	778.9
Control rod insert	786	779.4
SITAS	97,562	100,099
SIT injection	97,564	100,100

❑ Simulation Results

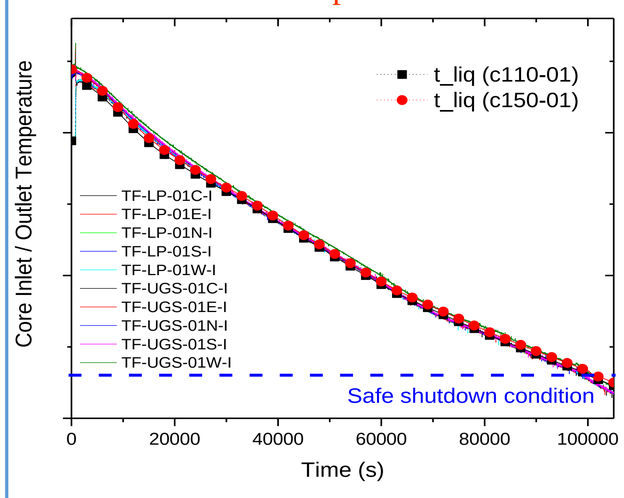
Pressurizer Pressure



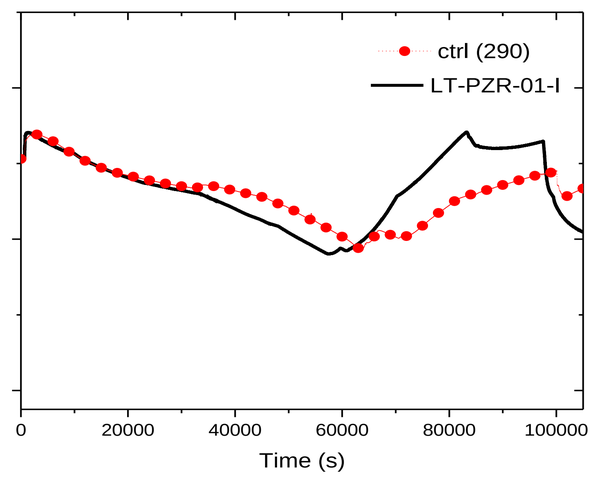
Fission Gas Release Fraction



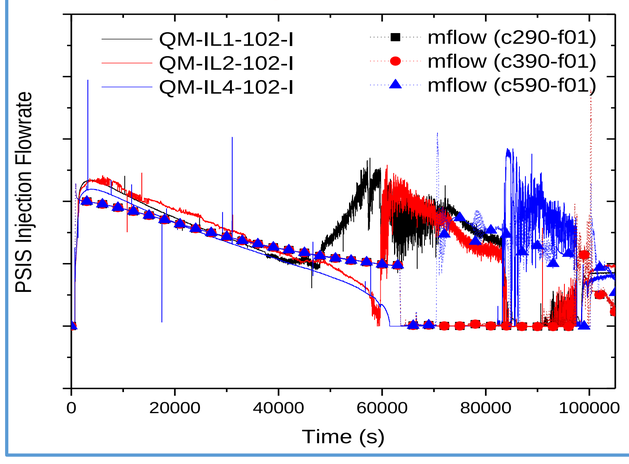
RCS Temperature



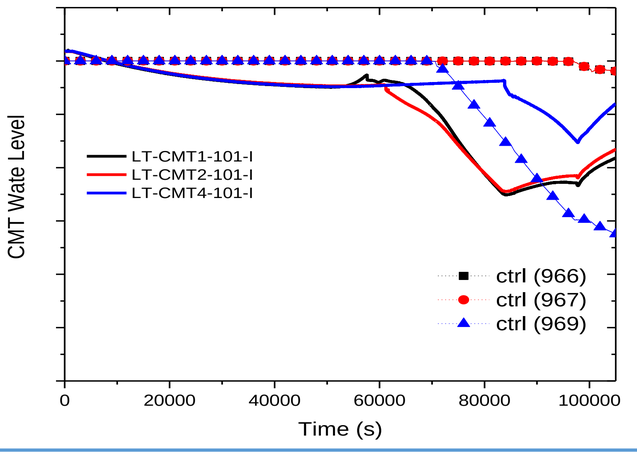
Pressurizer Water Level



CMT Injection Flowrate



CMT Water Level



Conclusions

- ❑ Improved SPACE for analysis of passive components such as CMT and SIT has been used to assess the TLOSHR scenario of the SMART-ITL.
- ❑ The effects of the heat loss and PSIS injection have been investigated.
- ❑ The predicted major parameters show reasonable agreements with the experiment and the sound capability of SPACE code.