Thermalhydraulic Analysis of Spent Fuel Pool using RELAP5 taking Insight from Fukushima Accident

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Introduction

- The objective of the study is to perform thermal-hydraulics analysis of SFP to observe coolant flow through the spent fuel storage racks under all anticipated events/conditions taking insight from Fukushima Accident.
- The attributes of study include thermal response of pool, boiling initiation time during loss of cooling and maximum fuel cladding temperature.
- The analysis is carried out by using RELAP5/SCDAP/Mod3.4 computer code.
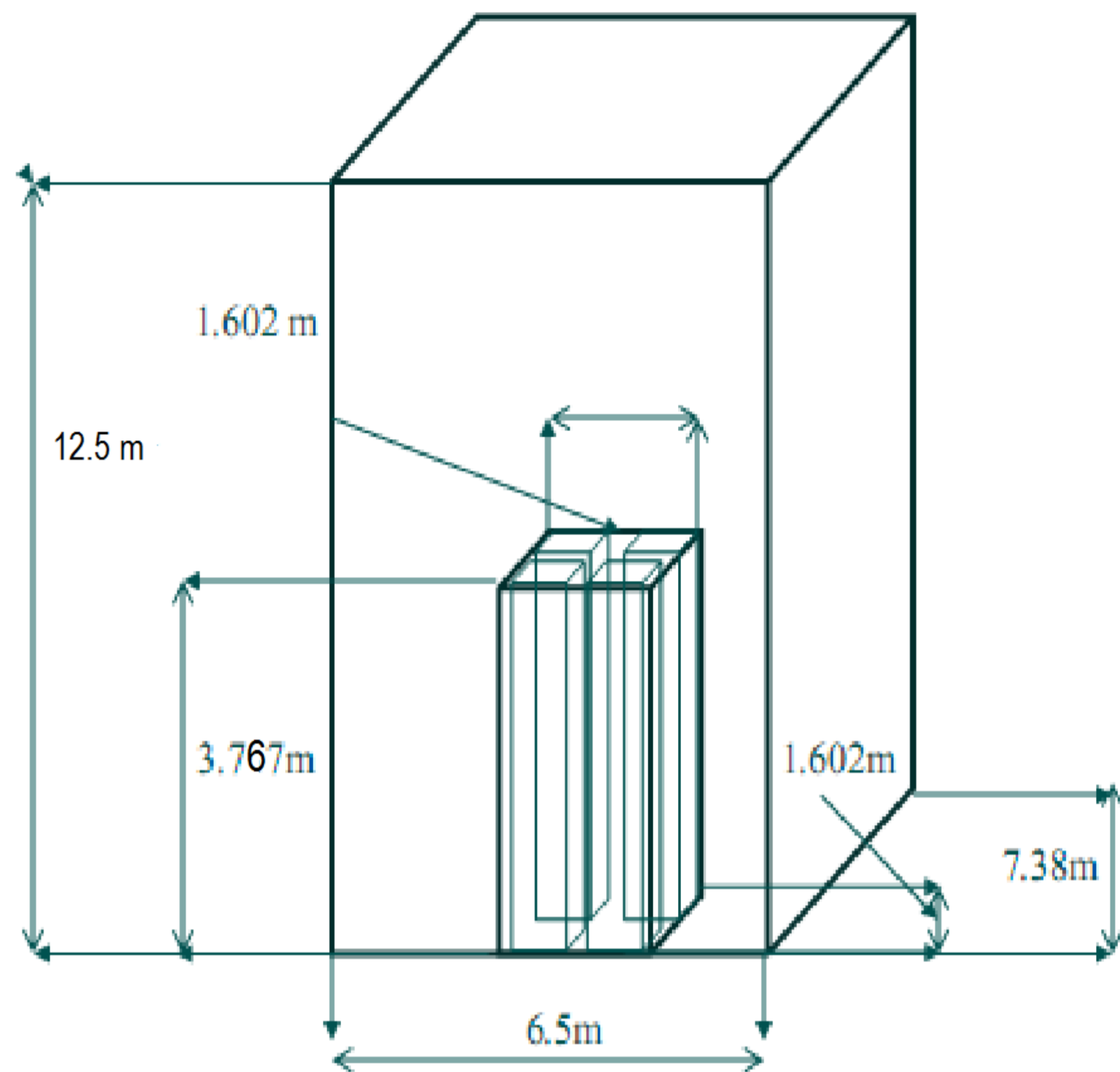
Spent Fuel Pool Description

Dimensions of SPF :

Length = L= 6.5m

Width = W = 7.38m

Height = H= 12.5m

Volume = V = 600m³

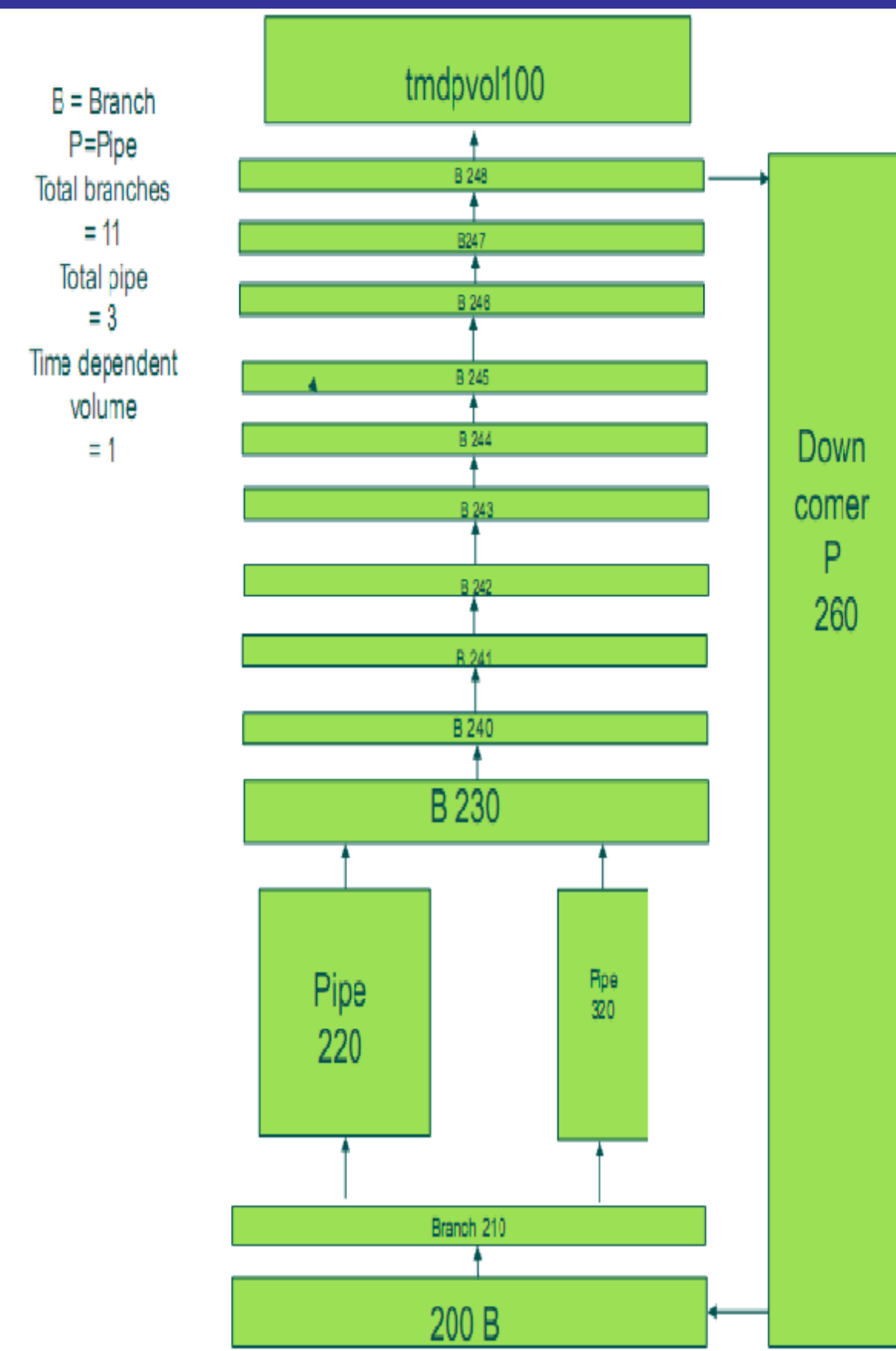**Dimensions of SFP Rack**
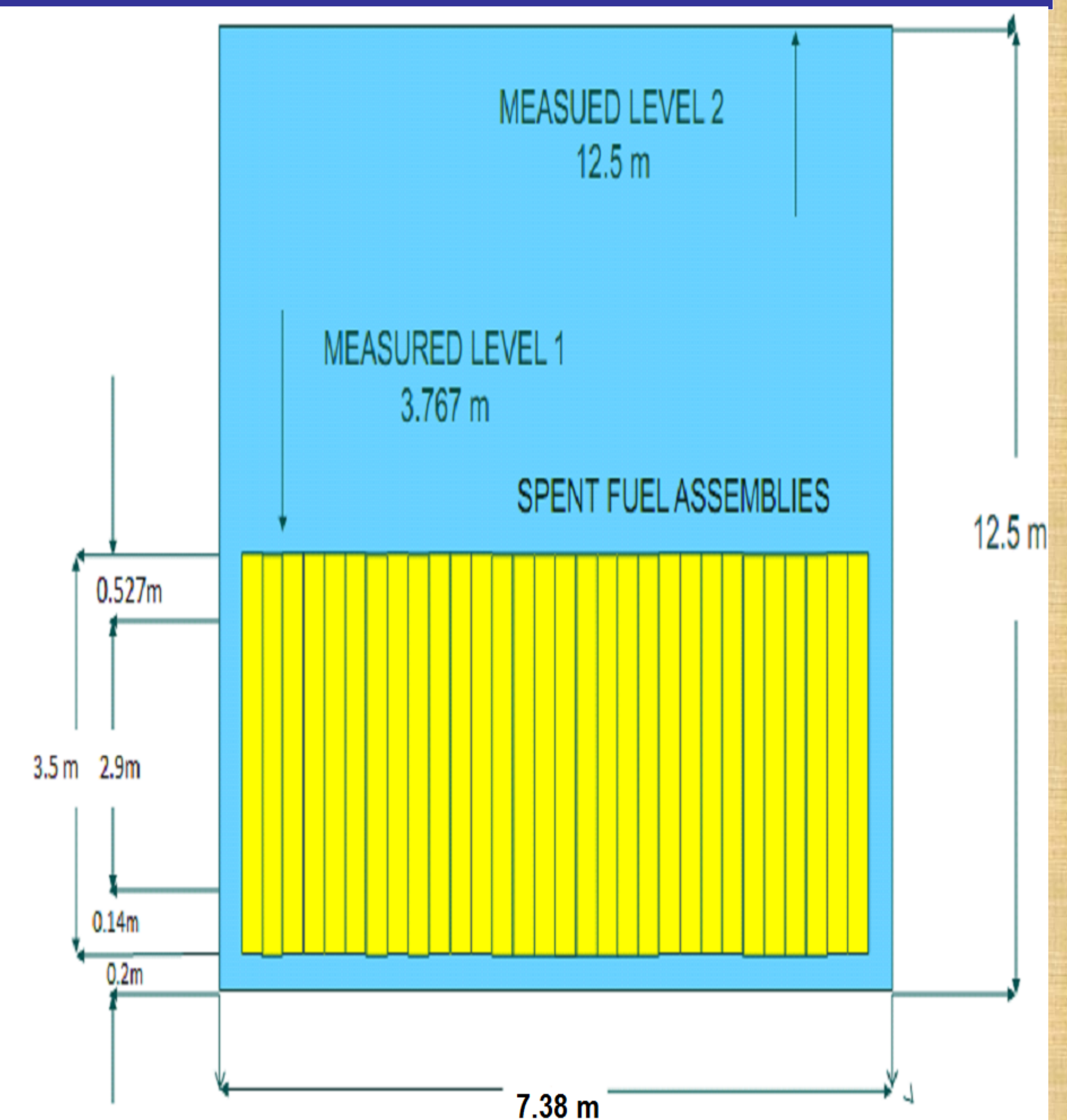
Length = 1.602m

Width = 1.602m

Height = 3.767m

Water above top of the fuel assemblies is 8.783 meters

## Description of Input Model of RELAP5

RELAP5 Model Nodalization

Decay Heat Profile of SFAs

BATCH NO	SUM OF ASSEMBLIES IN POOL	ASSEMBLY QUANTITY IN POOL CORRESPONDING COOLING TIME	COOLDOWN TIME AFTER SHUTDOWN (HOURS)	P/P₀ DECAY HEAT FRACTION OF INITIAL POWER	Q HEAT RATE (KJ / H) / (KW)
16	721	121	150	6.34×10^{-2}	7.37×106/2048.1
15	600	40	330+150	1.86×10^{-2}	2.14×106/595.1
14	560	40	1yr. & 480	3.22×10^{-4}	3.70×105/102.9
13	520	40	2yr. & 480	1.57×10^{-4}	1.80×105/50.0
12	480	40	3yr. & 480	9.19×10^{-5}	1.06×105/29.17
11	440	40	4yr. & 480	7.25×10^{-5}	0.83×105/23.17
10	400	40	5yr. & 480	5.6×10^{-5}	0.64×105/17.89
9	360	40	6yr. & 480	4.78×10^{-5}	0.54×105/15.26
8	320	40	7yr. & 480	3.08×10^{-5}	0.35×105/9.837
7	280	40	8yr. & 480	2.89×10^{-5}	0.33×105/9.228
6	240	40	9yr. & 480	2.74×10^{-5}	0.31×105/8.748
5	200	40	10yr.& 480	2.66×10^{-5}	0.305×105/8.494
4	160	40	11yr. & 480	2.57×10^{-5}	0.296×105/8.228
3	120	40	12yr. & 480	2.50×10^{-5}	0.288×105/7.991
2	80	40	13yr. & 480	2.43×10^{-5}	0.280×105/7.774
1	40	40	14yr. & 480	2.37×10^{-5}	0.273×105/7.570
					TOTAL=10.6×106/2957

Results of Computation of RELAP5/SCDAP/Mod 3.4
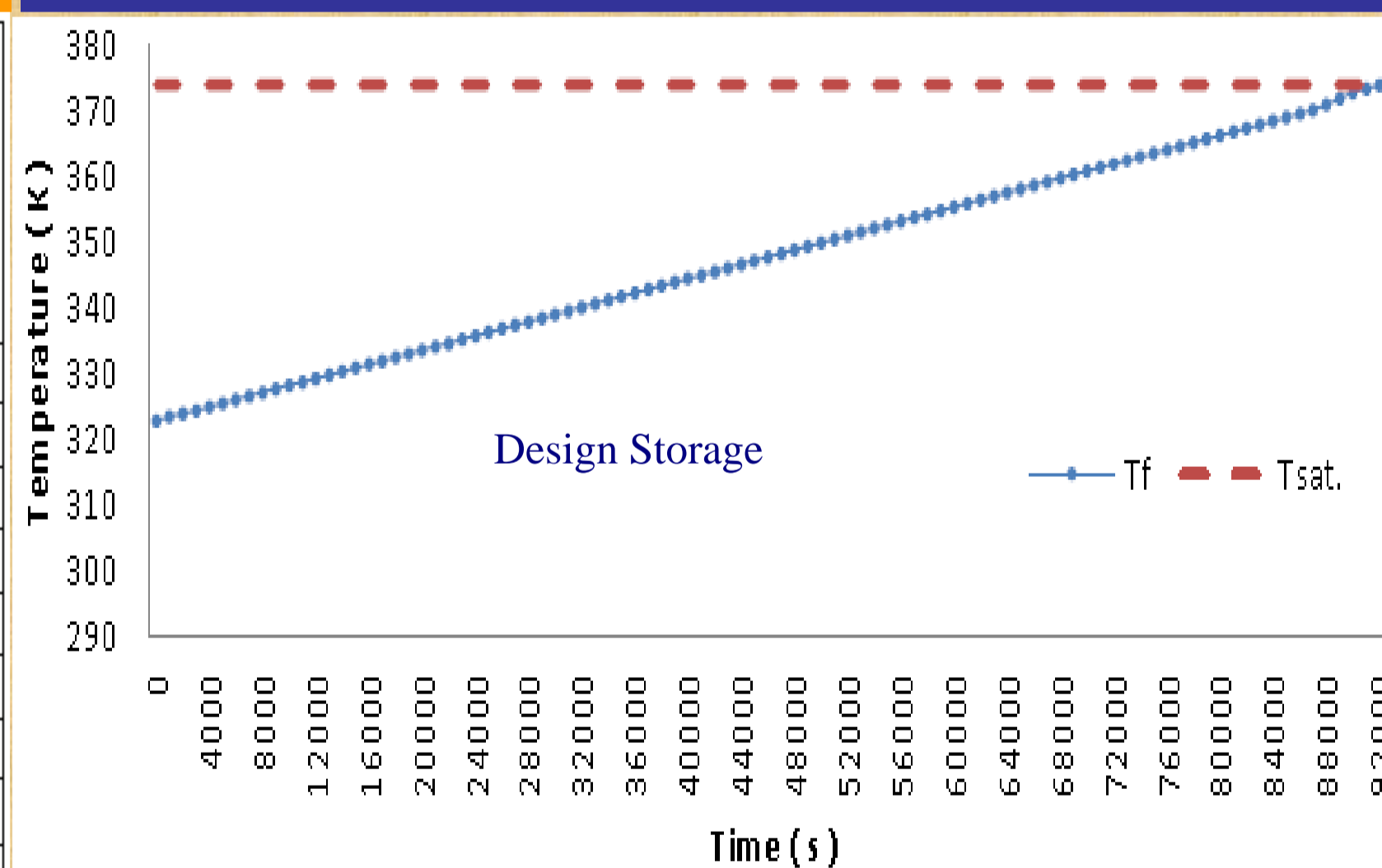
Initiation of Boiling in SFP in Case of Loss of Heat Removal
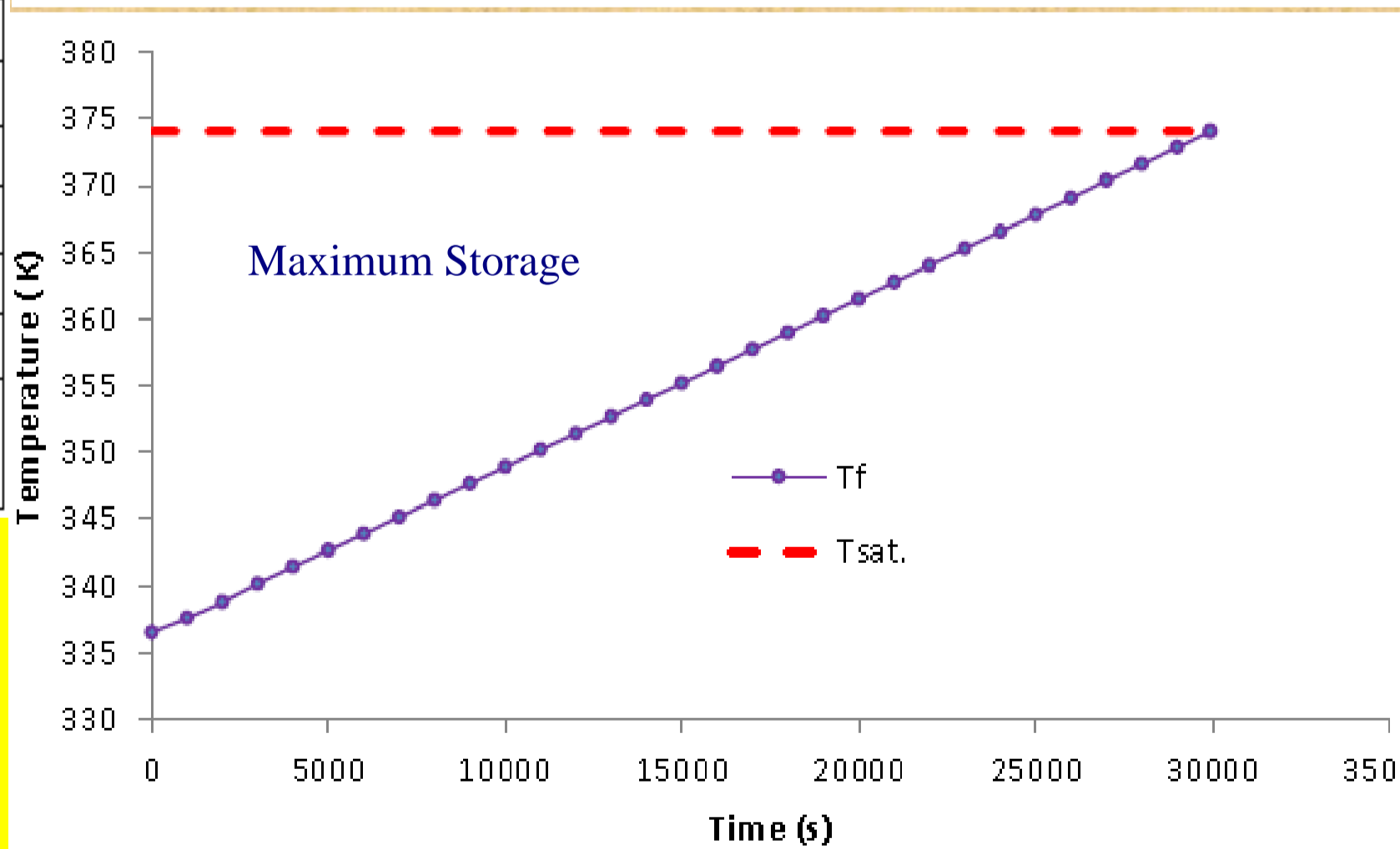
Design storage case (600 FAs) with loss of heat removal	
Boiling initiation time calculated by RELAP5	25.56 hrs
Reference value of boiling initiation time	25 hrs
Boiling initiation time calculated theoretically	25.29 hrs
Max. storage case (721 FAs) with loss of heat removal	
Boiling initiation time calculated by RELAP5	8.32 hrs
Reference value of boiling initiation time	7.8 hrs
Boiling initiation time calculated theoretically	7.987 hrs

Maximum storage case: Cladding Temperature at the time of boiling

Design Storage case: Cladding Temperature at the time of boiling
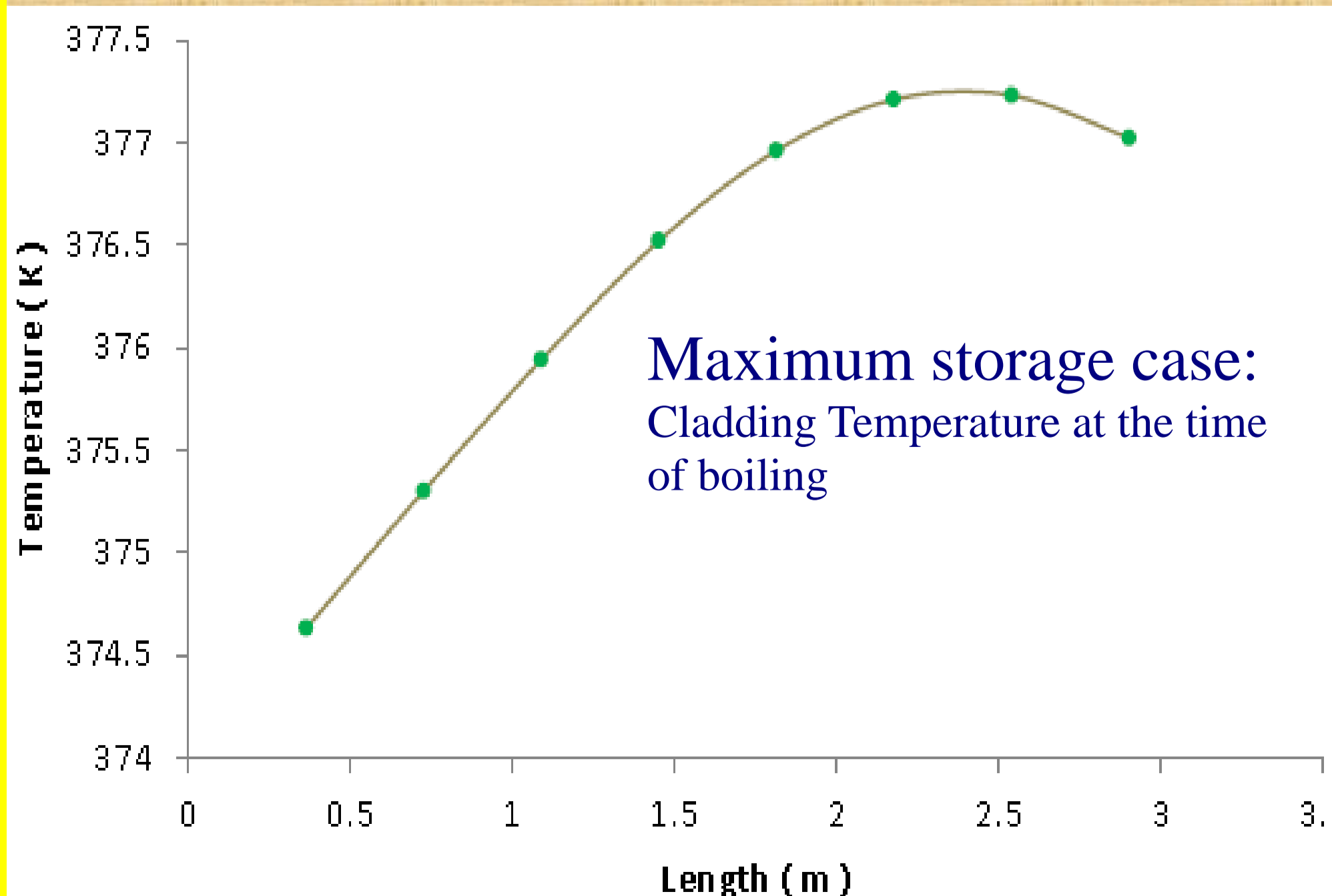
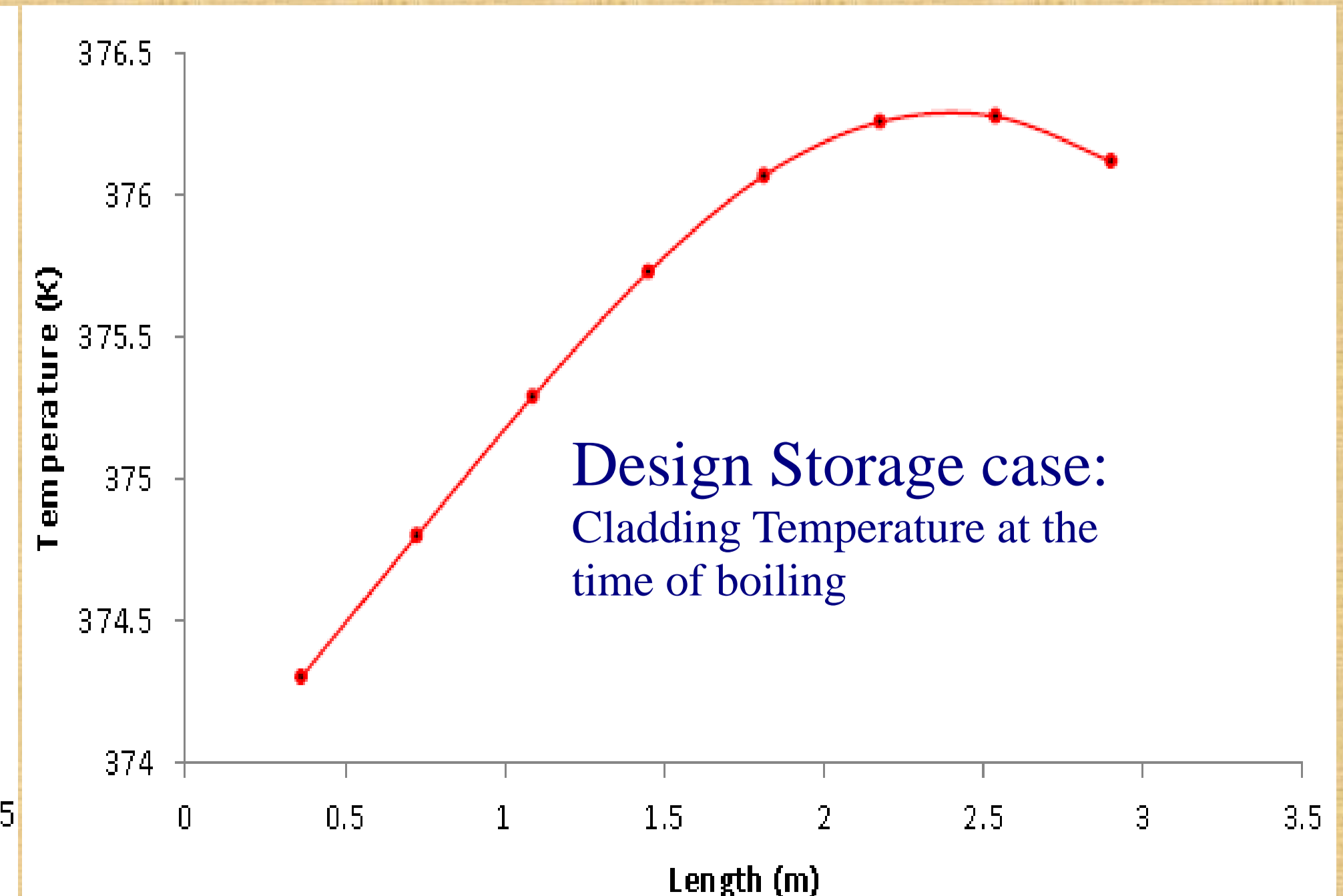## Conclusion to current analysis (RELAP5 Model):-

Boiling initiation time is in agreement with theoretical calculations and reference value.

Conclusion to improve the calculation:-

The use of realistic model of turbulences with actual flow conditions in spent fuel pool (i.e. CFD calculations) may improve the results

Acknowledgement

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