INAC 2019 — INTERNATIONAL NUCLEAR ATLANTIC CONFERENCE
XXI ENFIR · XIV ENAN · VI ENIN

RELAP5 MODELING OF A SIPHON BREAK EFFECT ON THE BRAZILIAN MULTIPURPOSE REACTOR

RMB Reator Multipropósito Brasileiro
Tecnologia Nuclear a Serviço da Vida

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AMAZUL · SÃO PAULO GOVERNO DO ESTADO · ipen · CNEN Comissão Nacional de Energia Nuclear · MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES · PÁTRIA AMADA BRASIL GOVERNO FEDERAL

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SUMMARY

- OBJECTIVE
- BRAZILIAN MULTIPURPOSE REACTOR
- THERMAL HYDRAULIC MODEL
- LOSS OF COOLANT ACCIDENT CALCULATION ON THE RMB
- RESULTS
- CONCLUSIONS
- ACKNOWLEDGMENTS

OBJECTIVE

Simulate the Siphon Breaker phenomenon on the Core Cooling System (CCS) of the Brazilian Multipurpose Reactor (RMB) using the RELAP5/Mod3 code after of the Loss of Coolant Accident (LOCA).

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BRAZILIAN MULTIPURPOSE REACTOR

RESPONSIBLE FOR THE PROJECT

CNEN
Comissão Nacional
de Energia Nuclear

CURRENT STATUS

DETAIL ENGINEERING DESIGN PHASE

INVAP

AMAZUL

RMB MAIN PURPOSES

SOCIAL APPLICATIONS

National autonomy in the production of radioisotopes for health applications, industry, agriculture and environment.

Emphasis on the Mo-99 production to ensure the technetium-99m radiopharmaceutical supply.

STRATEGIC AND INDUSTRIAL

National capacity development for testing and qualifying:

- Nuclear power reactor and naval propulsion fuels;
- New research reactor fuels and materials;

SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

Expansion of national capacity in research and applications of nuclear techniques.

Activation Analysis Laboratory (national scientific community).

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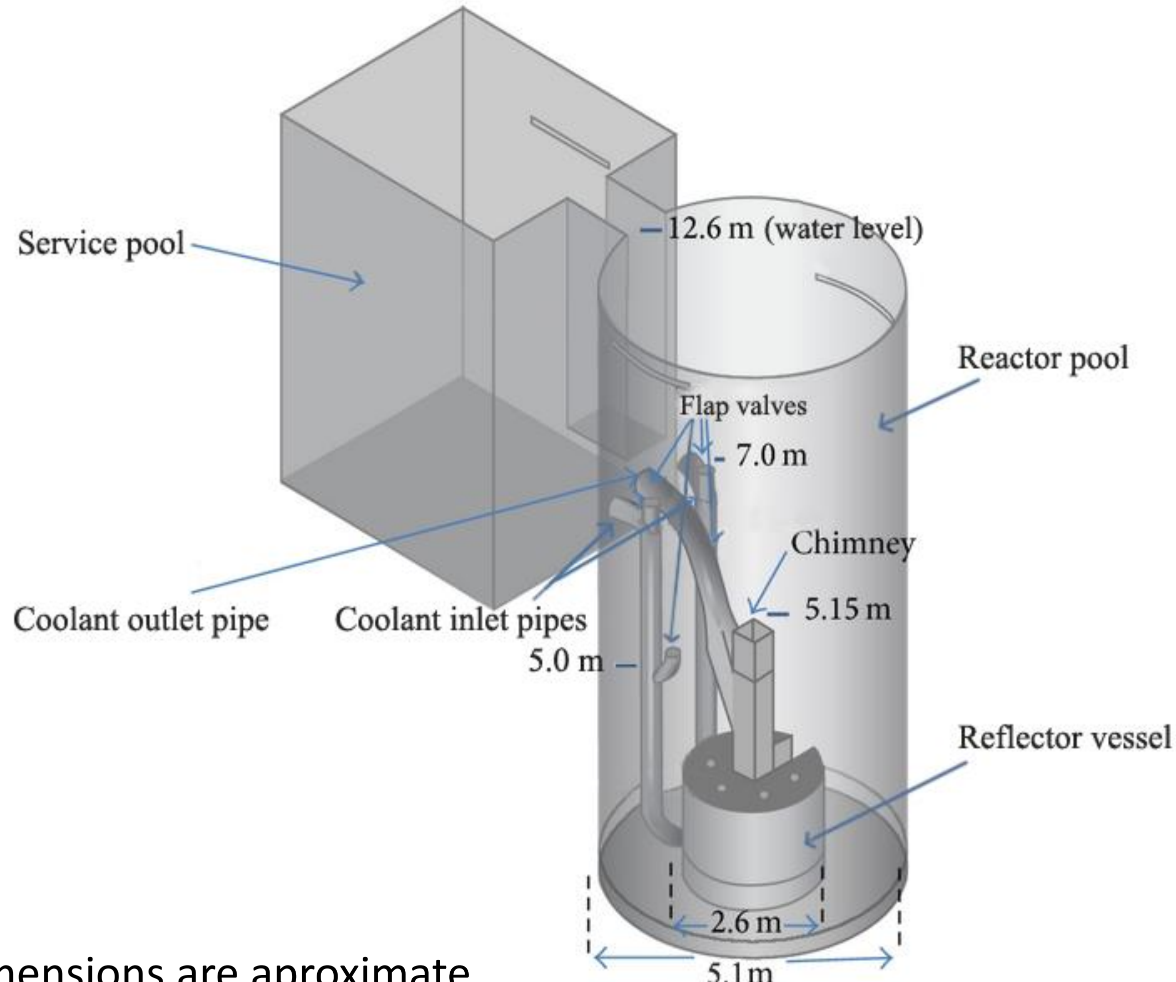
GENERAL CHARACTERISTICS OF RMB

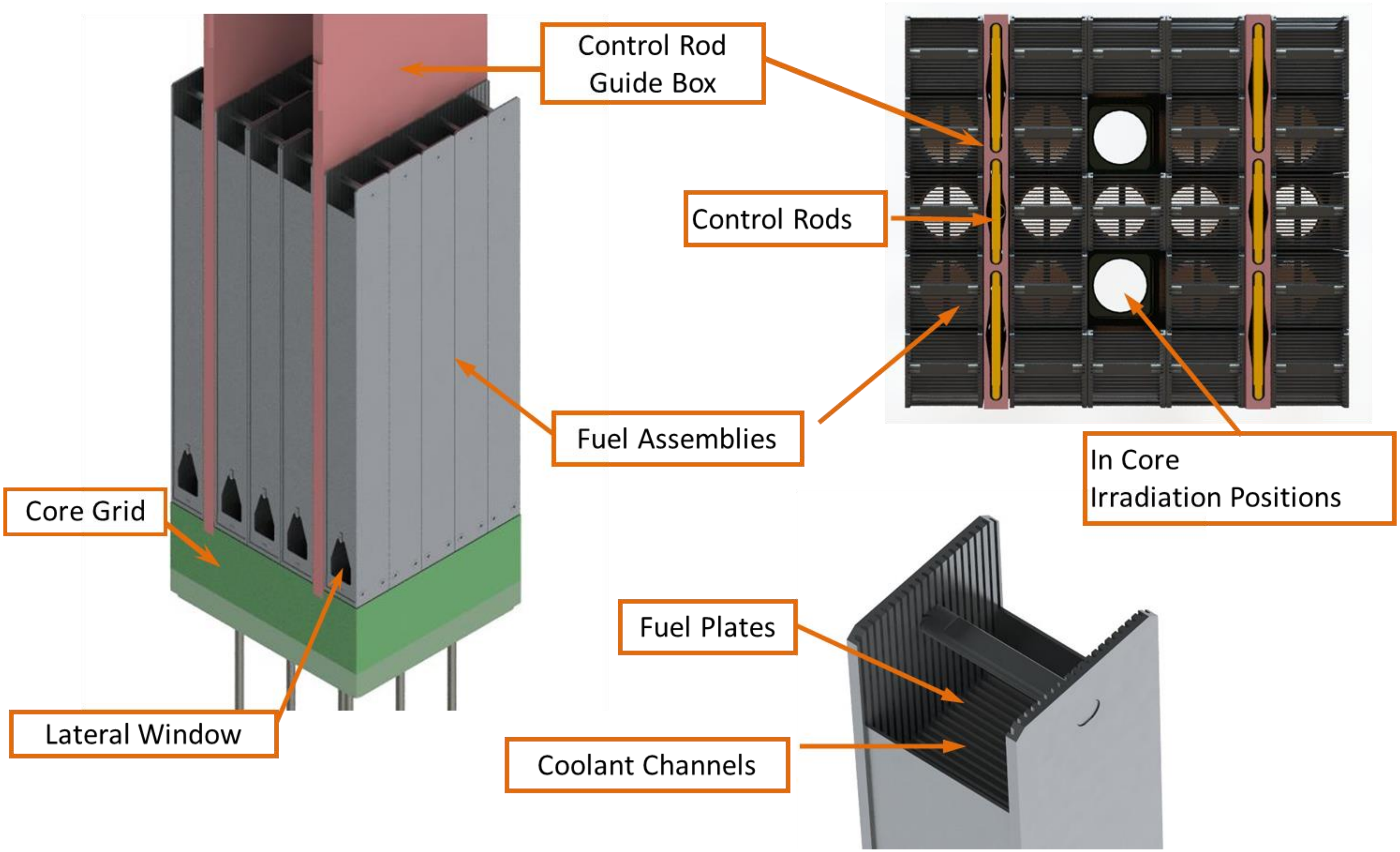
Nominal power	30 MW_{th}
Coolant / Reflector material	Light water / D_2O & Be
Fuel assembly type	MTR (LEU)
Core Arrangement	5 x 5 (23 Fuel Elements)
In-core irradiation position	2 positions
First Shutdown System / material	6 plates / Hafnium
Second Shutdown System	Parcial emptying of D_2O tank
Nuclear fuel	U_3Si_2-Al enriched at 20 %
Inlet / outlet core cooling temperature	34 °C / 41,6 °C
Core mass flow rate	3100 m^3/h
Mass flow rate from pool to chimney	400 m^3/h

RMB CURRENT CONCEPT

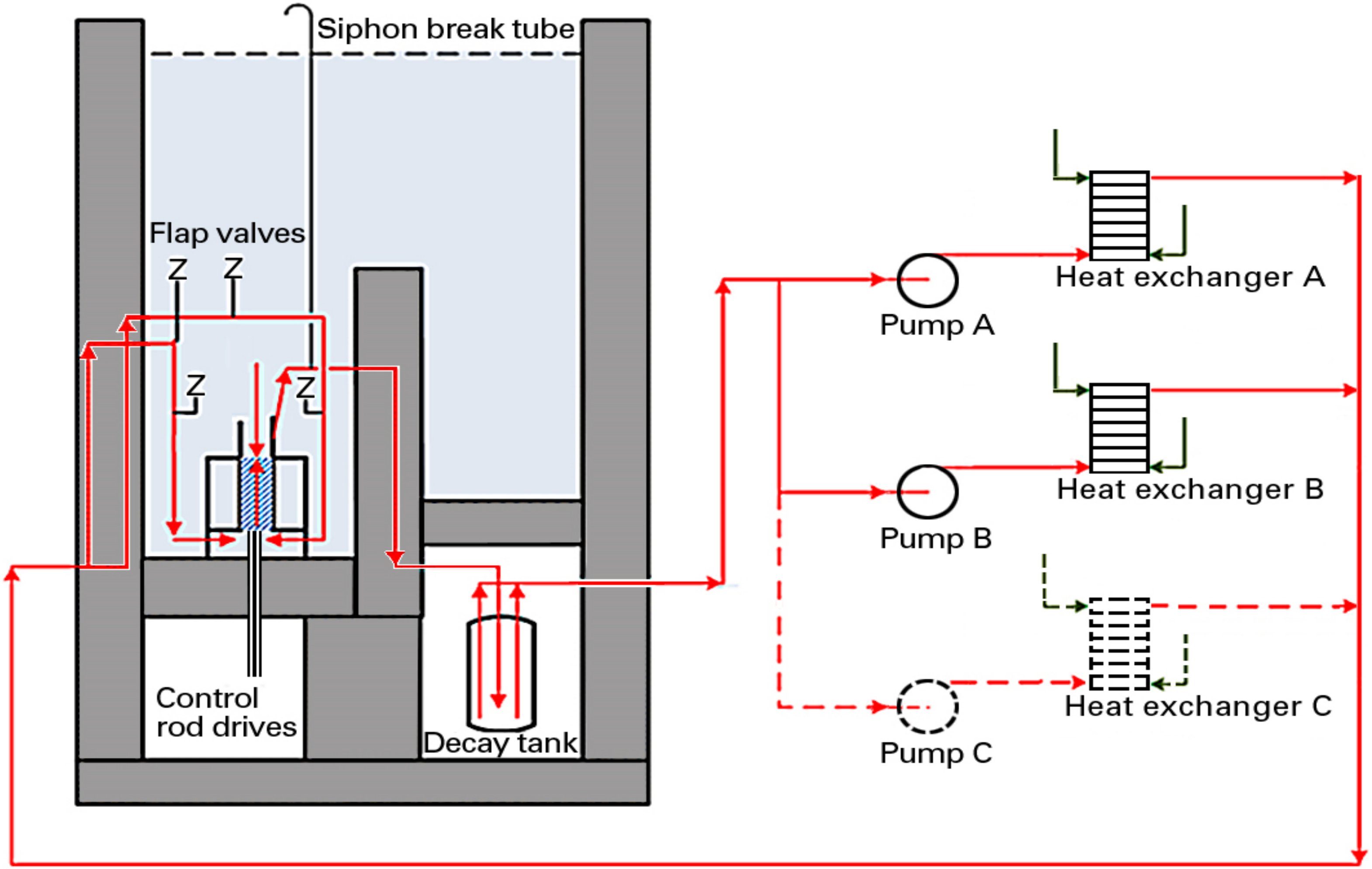


* Some dimensions are aproximate

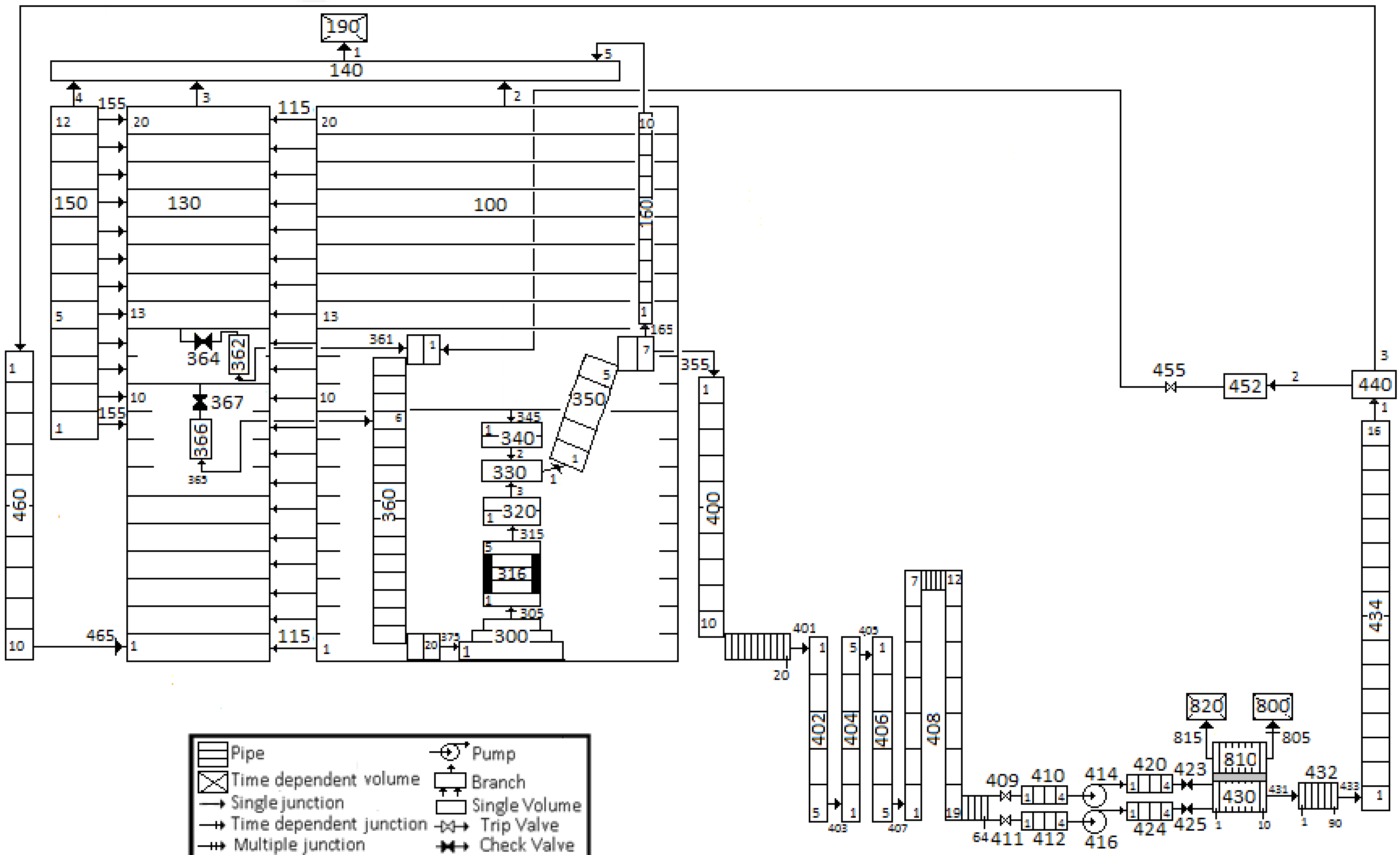
Core and Fuel Assemblies



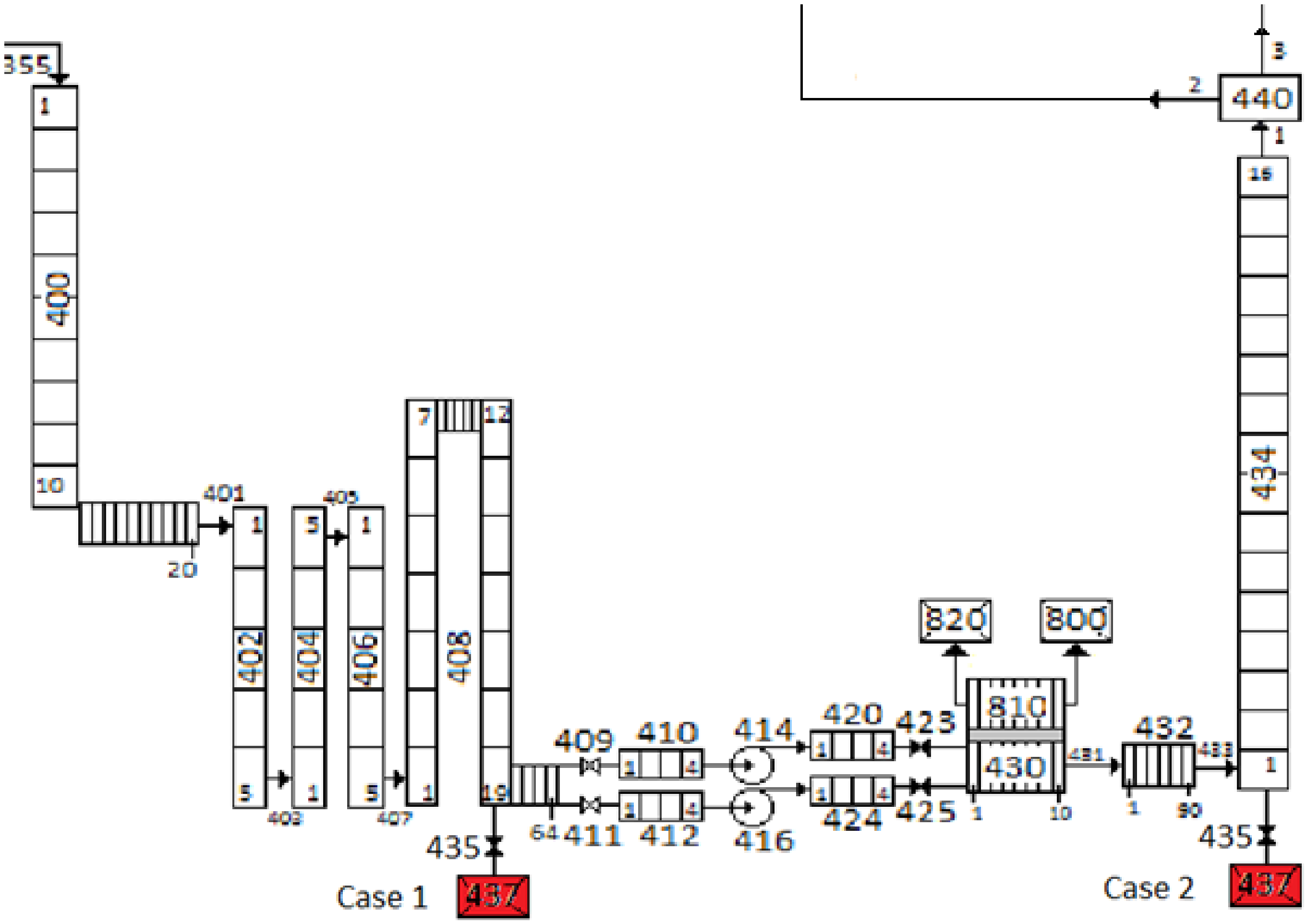
SIMPLIFIED SCHEME OF THE CCS OF THE RMB



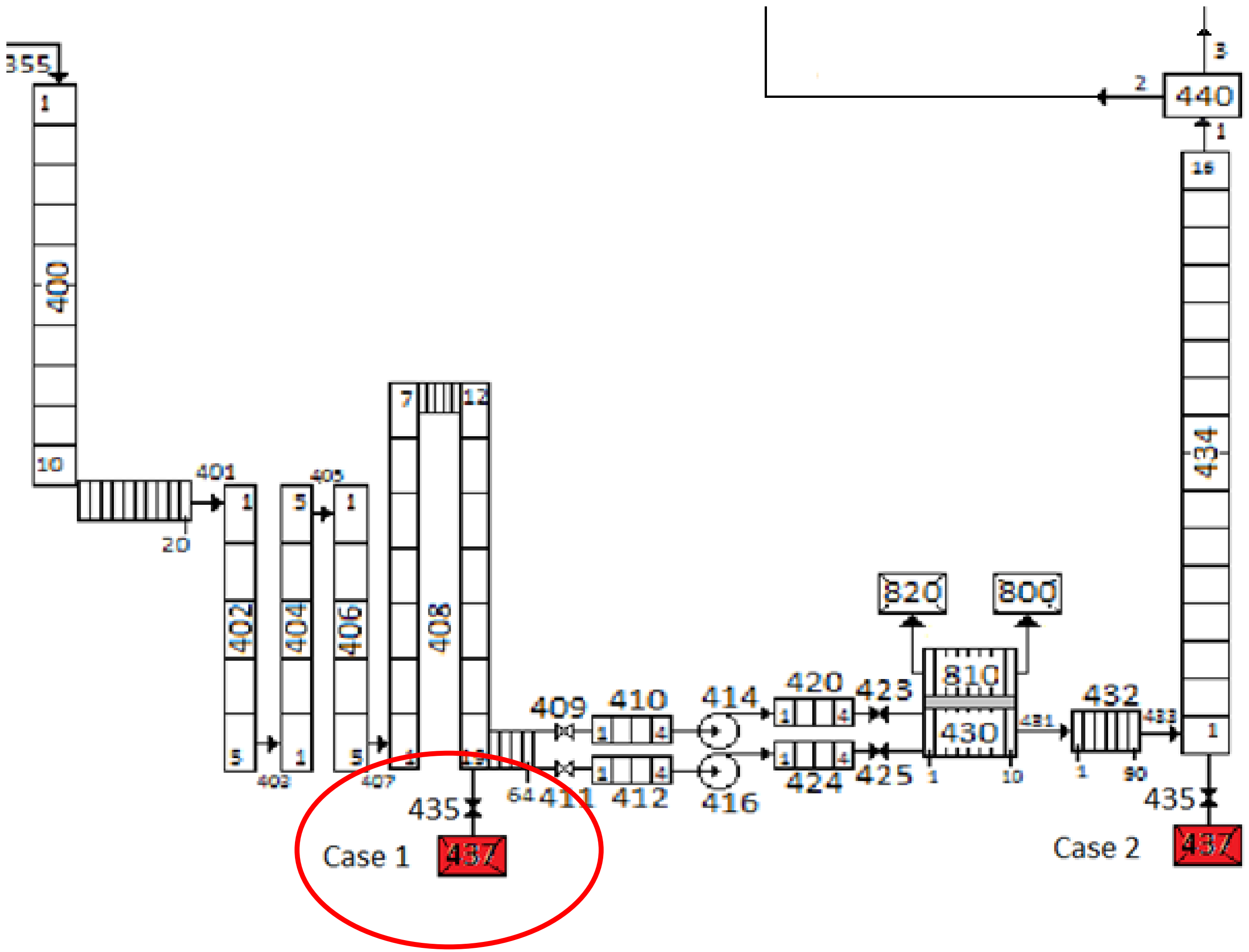
RMB NODALIZATION FOR RELAP5/MOD3



PART OF THE RMB NODALIZATION FOR RELAP5/MOD3 HIGHLIGHTING THE POSITION OF THE LOCA EVENTS.



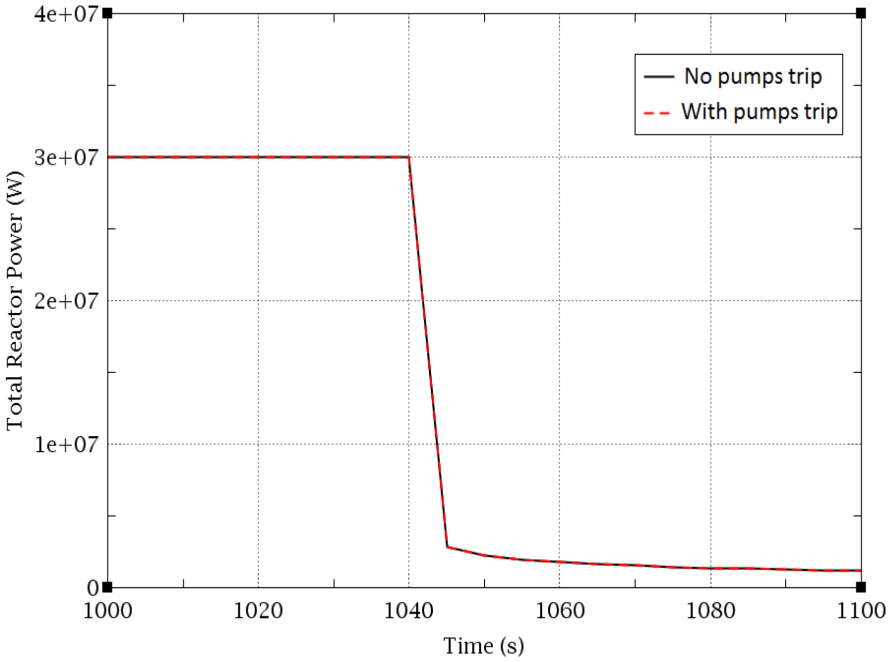
CASE 1: RUPTURE ON THE PUMP SUCTION LINE

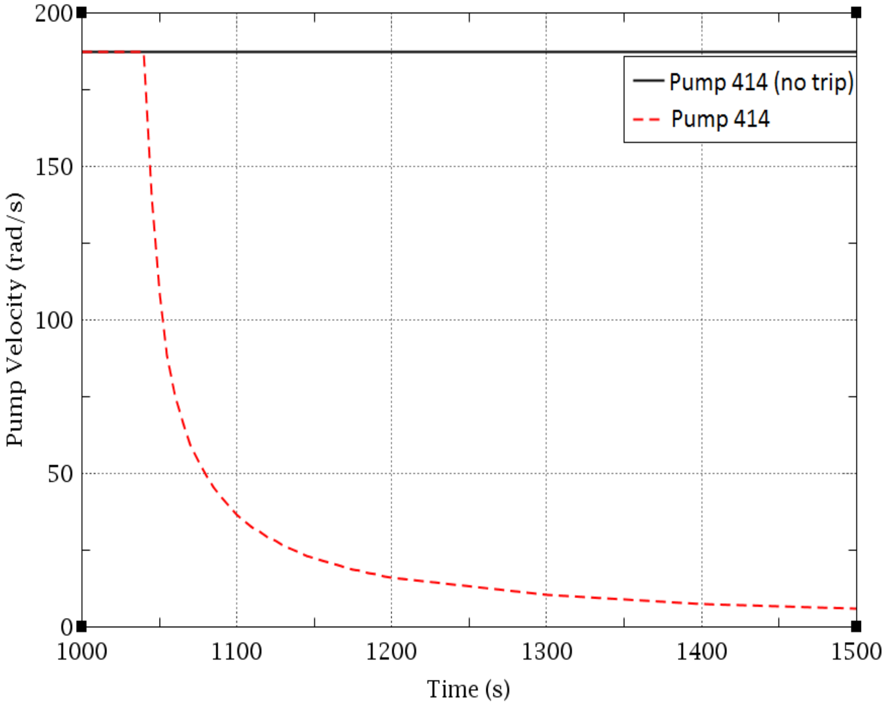


CASE 1: RUPTURE ON THE PUMP SUCTION LINE

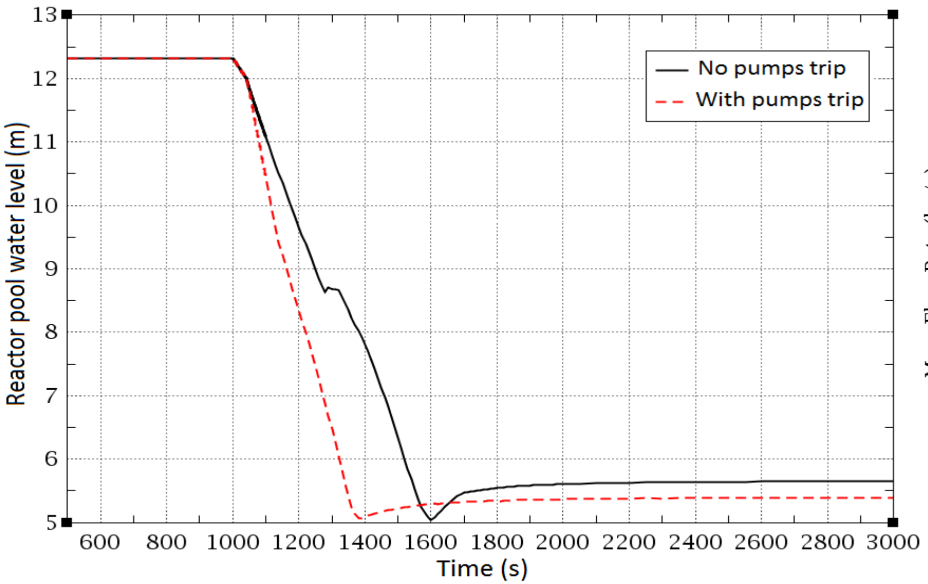
a: **No pumps trip** – pumps continue to run normally;
b: **With pumps trip** – After the reactor shutdown, a trip runs in the pump stopping it. In this event, the pump flywheels provide decreasing flow during shutdown.

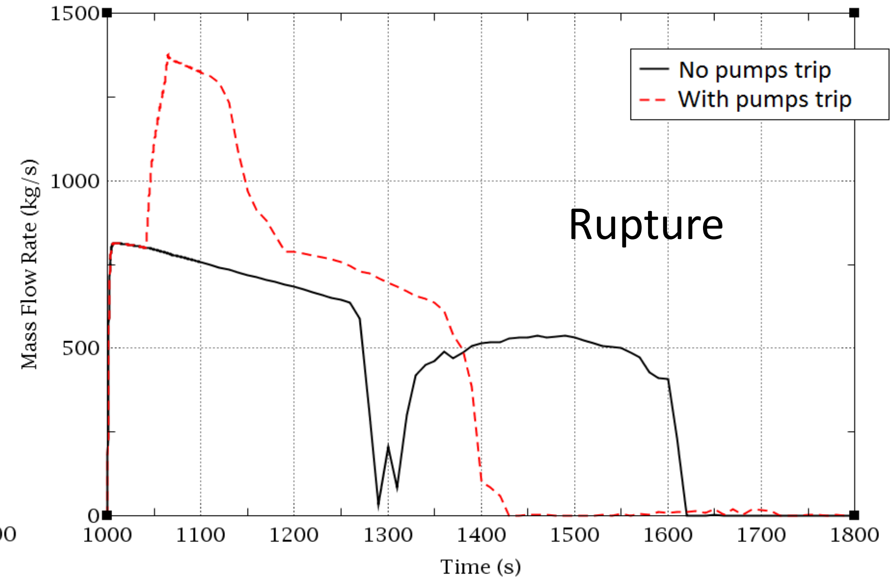
RESULTS



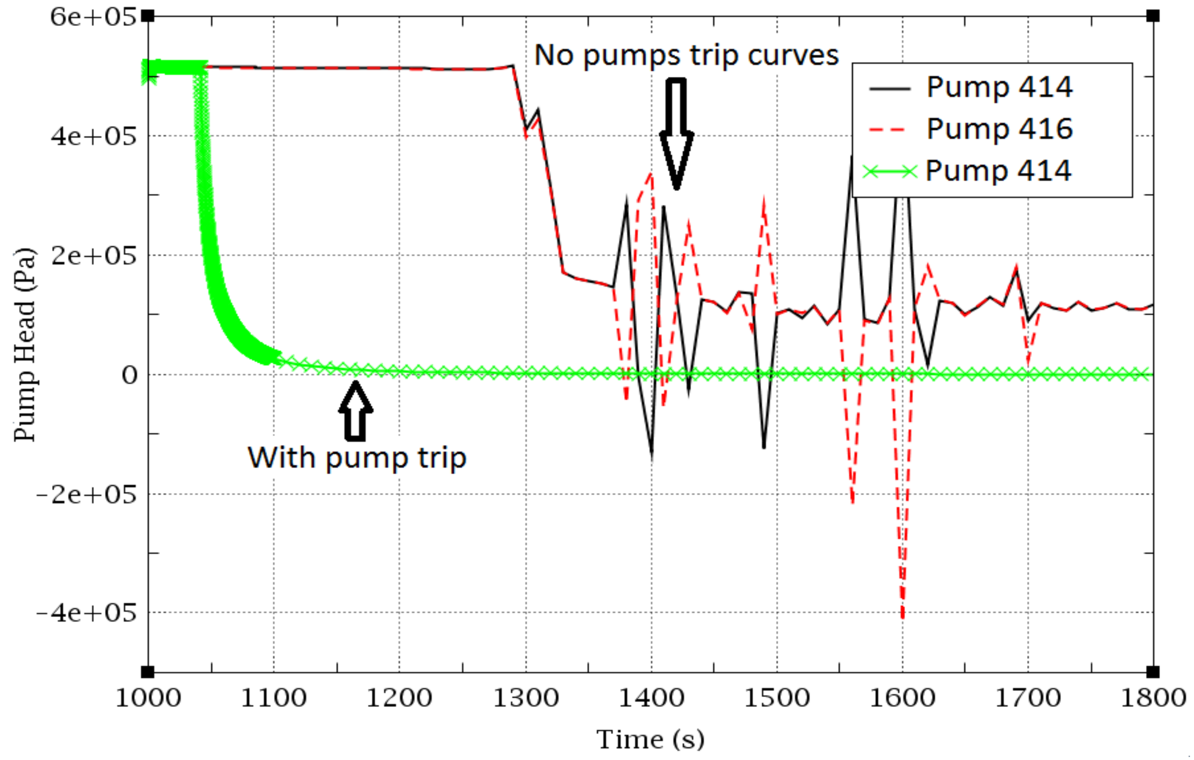


RESULTS


No pumps trip
With pumps trip
Reactor pool water level (m)
Time (s)


No pumps trip
With pumps trip
Rupture
Mass Flow Rate (kg/s)
Time (s)

RESULTS


6e+05
4e+05
2e+05
0
-2e+05
-4e+05
Pump Head (Pa)
1000
1100
1200
1300
1400
1500
1600
1700
1800
Time (s)
No pumps trip curves
With pump trip
Pump 414
Pump 416
Pump 414

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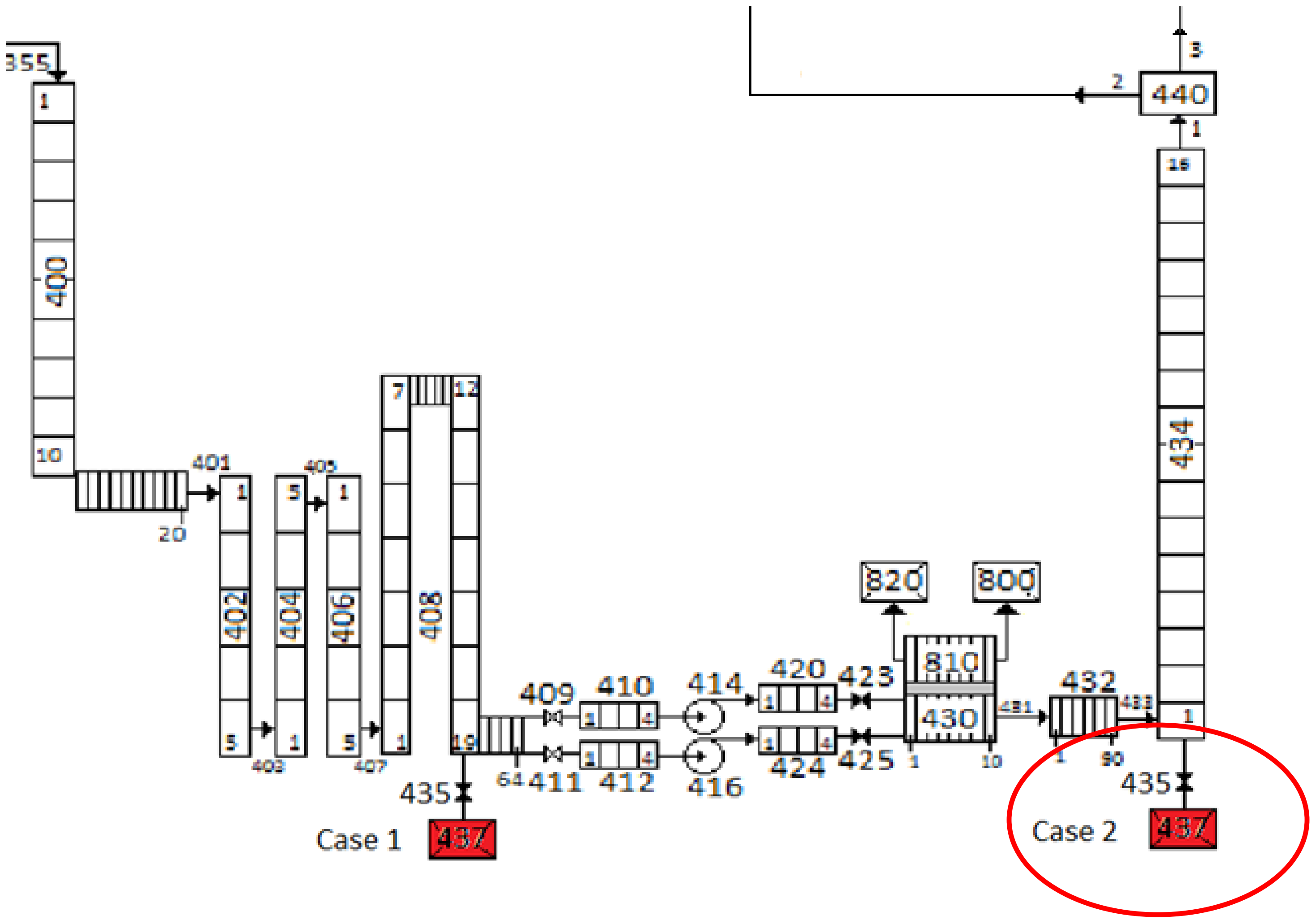
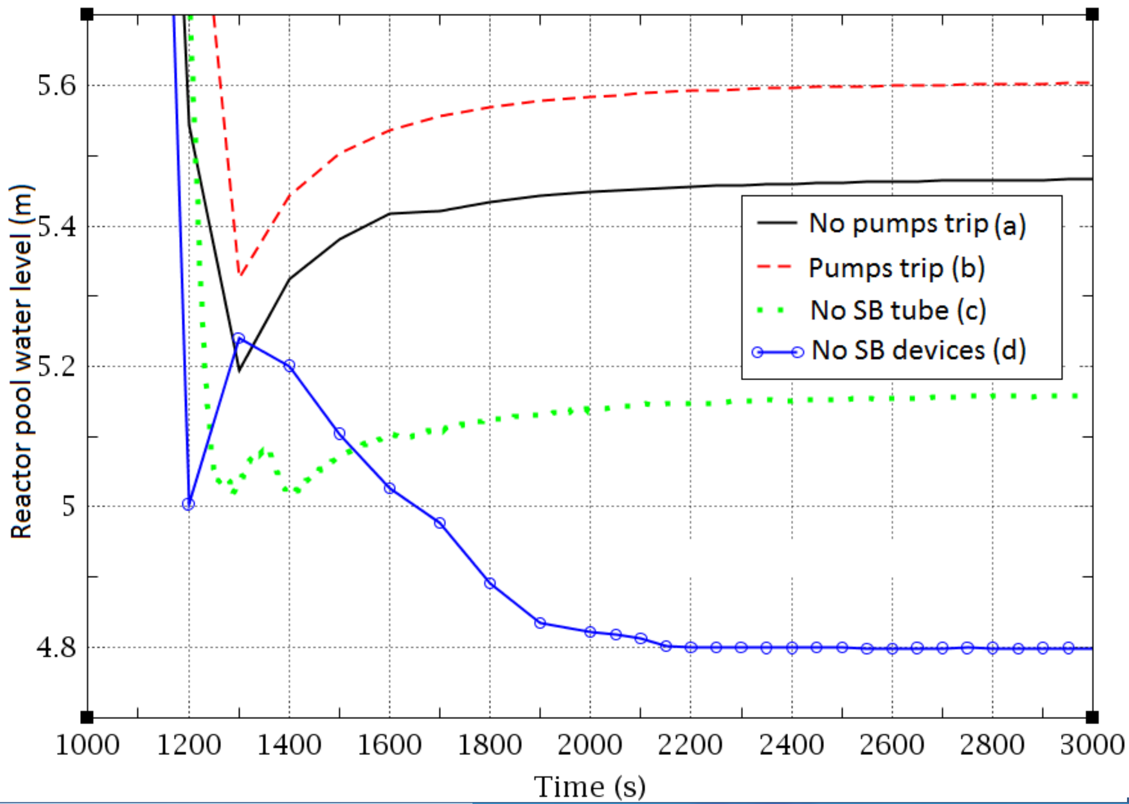
CASE 2: RUPTURE ON THE PUMP DISCHARGE LINE



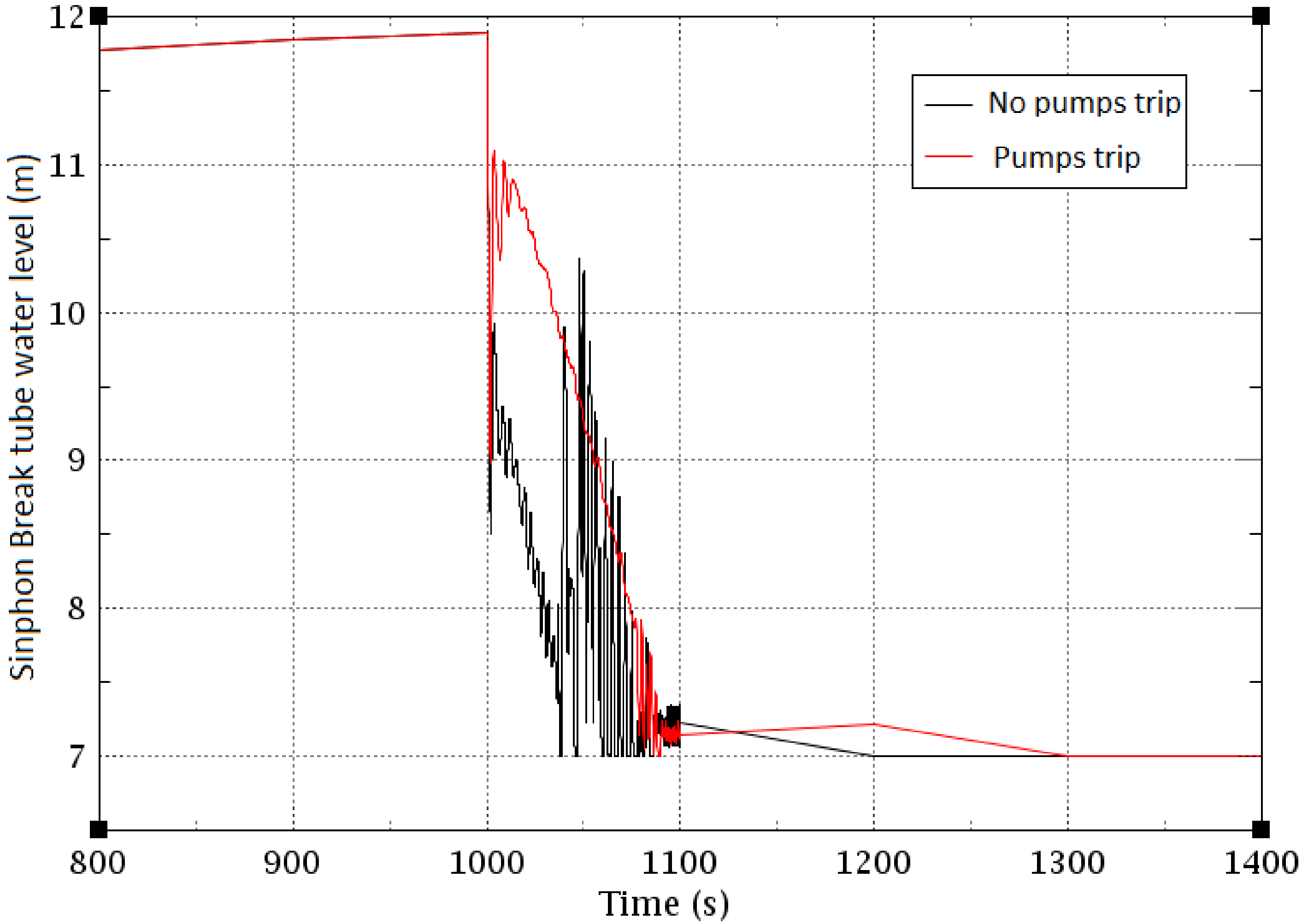
CASE 2: RUPTURE ON THE PUMP DISCHARGE LINE

a: No pumps trip
b: With pumps trip
c: Pumps trip and no siphon break tube 160;
d: Pumps trip and no siphon break devices (valve 364 and tube 160).

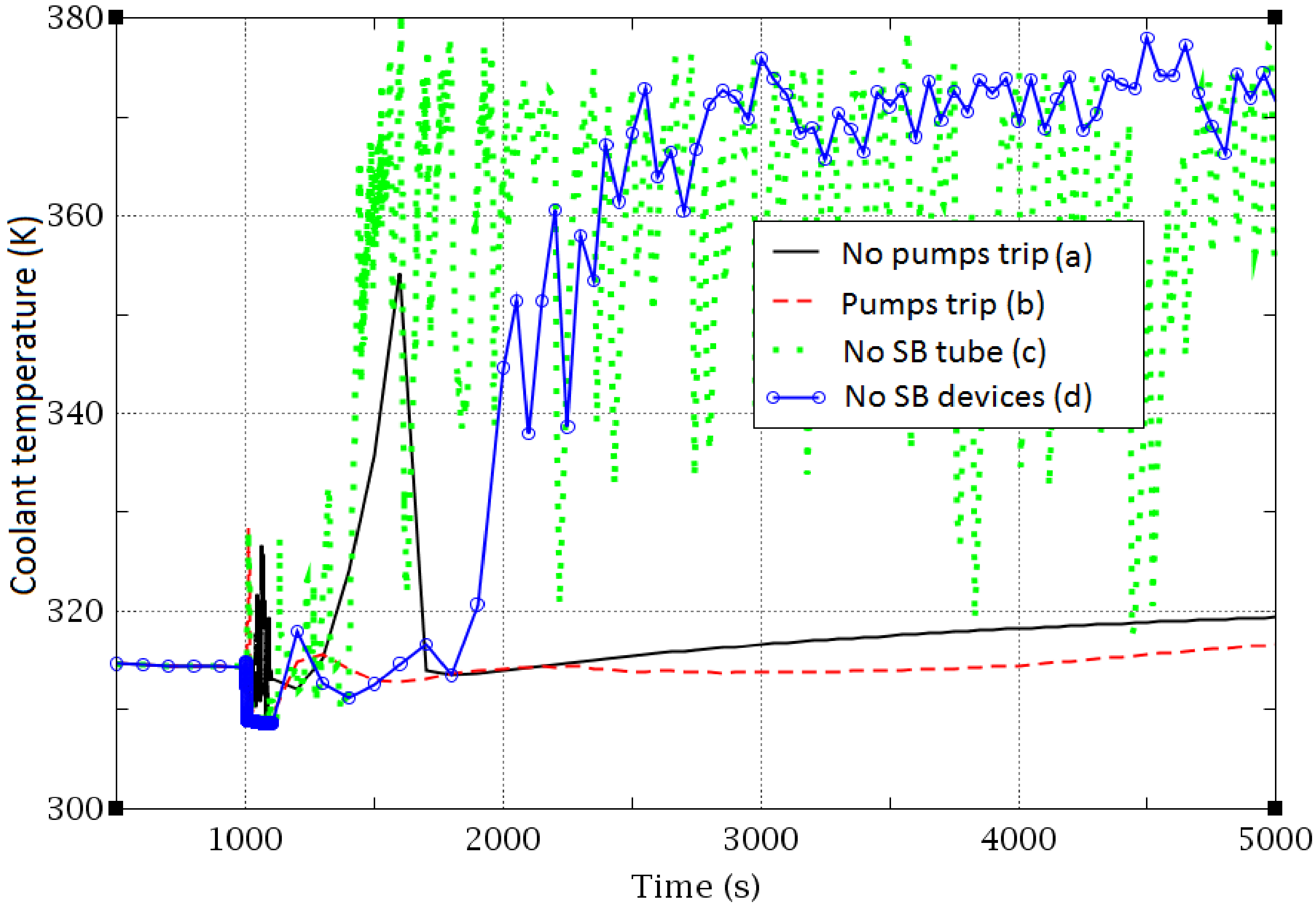
RESULTS



RESULTS


Sinphon Break tube water level (m)
12
11
10
9
8
7
800
900
1000
1100
1200
1300
1400
Time (s)
No pumps trip
Pumps trip

RESULTS



Core outlet temperature evolution.

CONCLUSIONS

- The phenomenological behavior of a LOCA transients in the RMB in two different positions of the Core Cooling System was analyzed with the thermal hydraulic cod e RELAP5/Mod3.

- The results from the numerical simulation showed that the siphon break devices are efficient to ensure the fuel physical integrity and consequently the RMB remains in a safe state during the LOCA transients.

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ACKNOWLEDGMENTS

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THANK YOU FOR ATTENTION!