VALIDATION OF THE RELAP5 CODE FOR THE SIMULATION OF THE SIPHON BREAK EFFECT IN POOL TYPE RESEARCH REACTORS

RMB Reator Multipropósito Brasileiro

Tecnologia Nuclear a Serviço da Vida

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Summary

- Objectives
- Bibliographic review
  - IDAHO Experiment (DOE-USA)
  - POSTECH Experiment (South Korea)
- RELAP5 modeling of POSTECH facility
- Results
- Conclusion

Objectives

- Global:
  - Analyze the performance of Siphon Breakers devices in a LOCA in RMB
- This work:
  - Verify the capacity of the RELAP5 code in simulating the phenomena involved in the action of Siphon Breakers devices in a LOCA

Bibliographic review

- There is a wide literature on experiments and simulations of the Siphon Breaker effect.
- At least two reported problems in the simulation with the RELAP5:
  - IDAHO (DOE-USA)
    - Project carried out from1988 to 1991.
    - Perform the experiment and simulate it with the RELAP5
    - Huge amount of experiments carried out
      - Failed to perform simulation with RELAP5
  - POSTECH Experiment (South Korea)
    - 1:1 Scale experimental circuit
    - Several articles from several authors are available
    - Discrepancies in simulation with RELAP5

Idaho Experiment

Idaho Experiment

- Tank at top with 500 gallons (1.9 m³)
- 4” Discharge transparent acrylic pipe
- Collecting tank
- Return pump

December 20, 1991

Dr. Thomas J. Dolan
EG&G Idaho, Inc.
P. O. Box 1625, MS-2516
Idaho Falls, ID 83415

Dear Tom:

This letter is a request for an extension of the final report due date on the Siphon Breaker under contract no. DE-FG07-90ER12820.

The principal reason for this request is that we still cannot provide any theoretical comparison for the Siphon Breaker performance data. We have encountered a long string of problems with the RELAP code and no one has been able to get even a simple siphon flow model to run to completion. These code problems are so severe and so tangled that we are abandoning RELAP, at least for awhile, and going to try to upgrade the code we wrote some 15 years ago.

The graduate student working on this phase of the project, John Shatford, has been working full time at CSA, Inc. in Idaho Falls so our problem doesn't get much time devoted to it. John is a good student and good with computer codes, but he isn't in any position to fix RELAP. We have had a number of consultations with EG&G's RELAP experts but so far "no joy."

All the experimental runs have been completed and the data is at least 98 percent reduced. We could put it all together as a final report without any comparison to the theoretical model but that's a poor last resort.

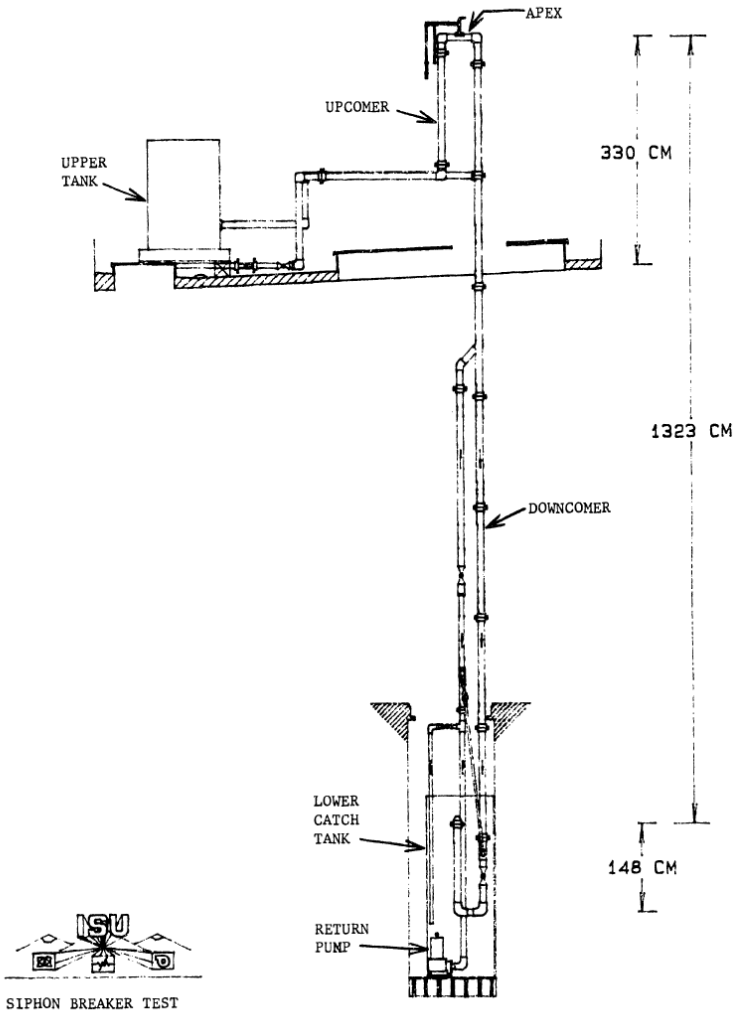
ISU would prefer to have a contract extension with no additional funds rather than closing the contract but still have a final report obligation. If that cannot be accomplished, please let me know.

Very truly yours,

D. T. Neill, P.E., Professor
College of Engineering

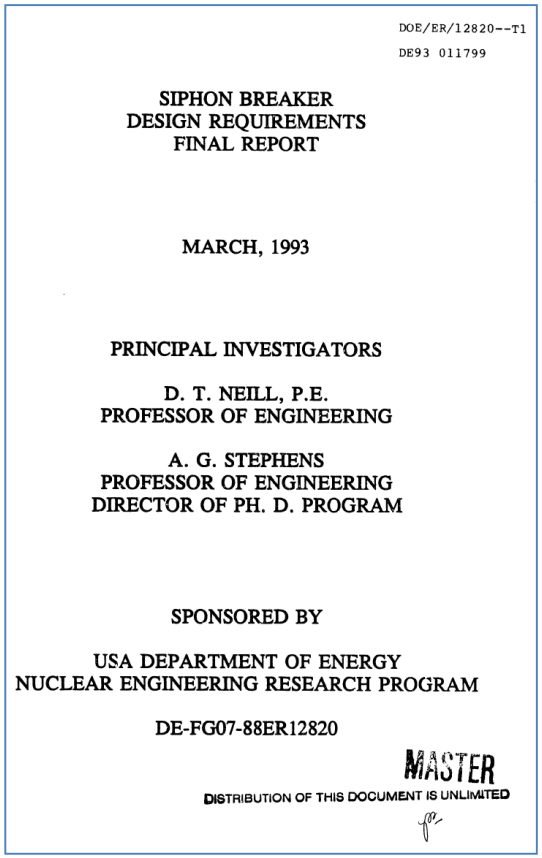
DTN:lk

Figure Number 1



SIPHON BREAKER TEST STAND LAYOUT

Idaho Experiment



DOE/ER/12820--T1
DE93 011799

SIPHON BREAKER
DESIGN REQUIREMENTS
FINAL REPORT

MARCH, 1993

PRINCIPAL INVESTIGATORS

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DE-FG07-88ER12820

MASTER

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CONCLUSIONS

- Three distinct behaviors of the siphon breaker effect:

1

- Air entering is not dragged by discharging water
- Air accumulates at the top of the discharge pipe
- Siphon breakage occurs shortly after the start of air ingress

2

- Part of the air that enters is dragged and discharged along with the water
- Air accumulates slowly at the top of the discharge pipe

3

- All the entering air is dragged and unloaded along with the water
- If the discharged water flow decreases sufficiently, the transition to the partial air drag mode will occur.

Experimento da POSTECH

REATOR M

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Numerical approach to siphon break phenomena in a research reactor pool using the CUPID code

Ik Kyu Park*, Han Young Yoon, Hong Beom Park

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ABSTRACT

Pool-type reactors, as research reactors, are equipped with a siphon break line to prevent continuous siphonage flow that can cause core uncovery during a loss of coolant accident (LOCA). In this study, the siphonage flow rate and siphon break phenomena during a LOCA in a pool-type research reactor are assessed using the three-dimensional two-phase transient flow analysis code, CUPID. The calculation indicates that the siphonage LOCA break flow rate relies on the wall friction model for the main drainage pipe, and the initiation of a siphon break is significantly affected by the interfacial drag model. The CUPID simulation of the siphon break confirms that the siphonage LOCA break flow rate and the initiation of siphon break phenomena are accurately predicted using the three-dimensional two-phase flow analysis code with the relevant physical models for wall friction and interfacial drag.

showed good agreement with experimental results with reasonable uncertainty range. The proposed simple numerical uncertainty estimation procedure aims to encourage the discussion towards an uncertainty quantification culture in the CFD community.

POSTECH Experiment

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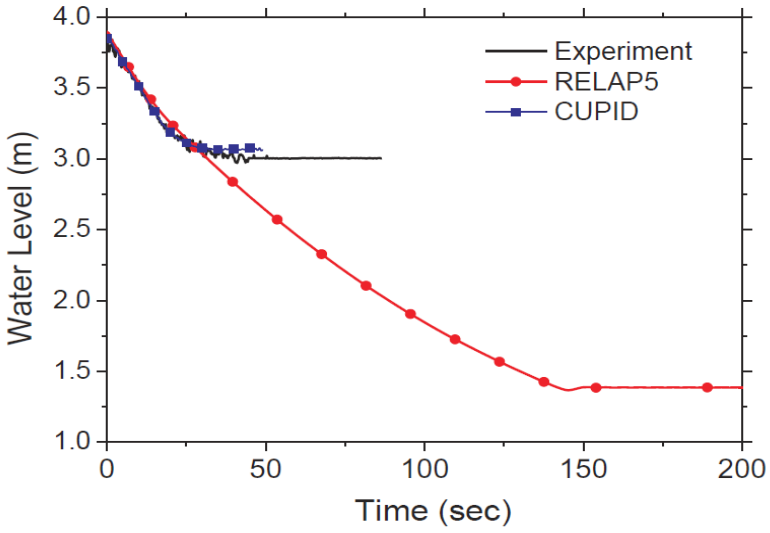
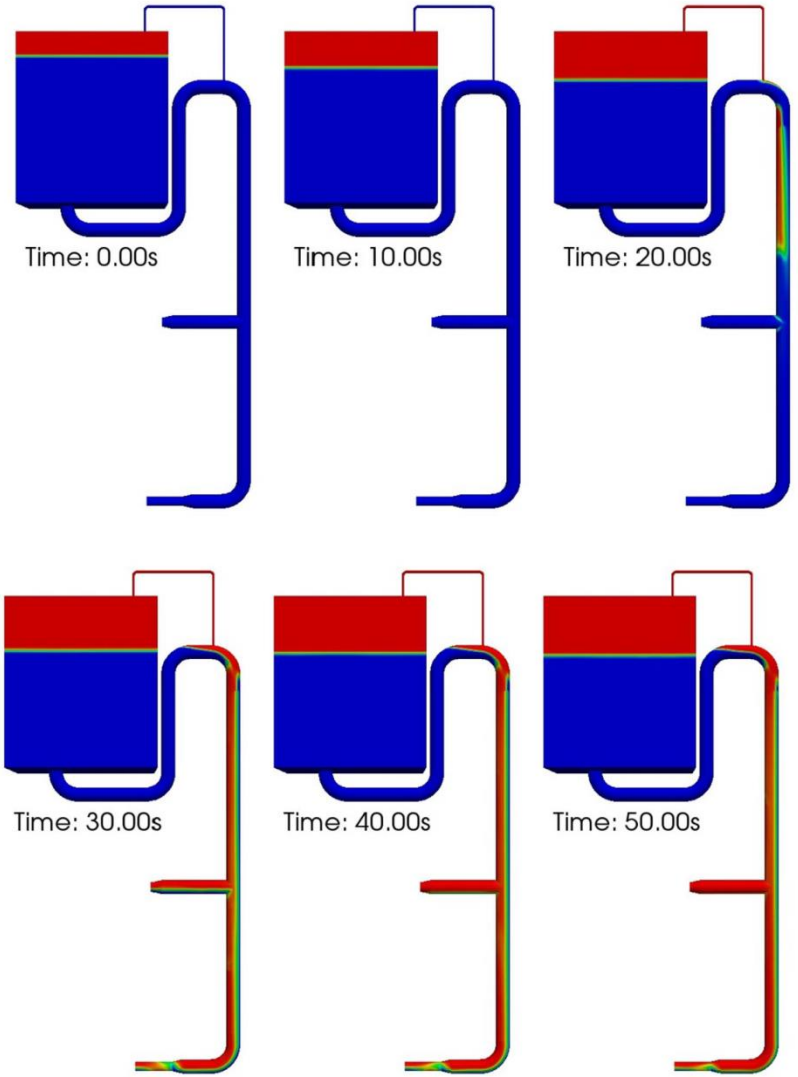
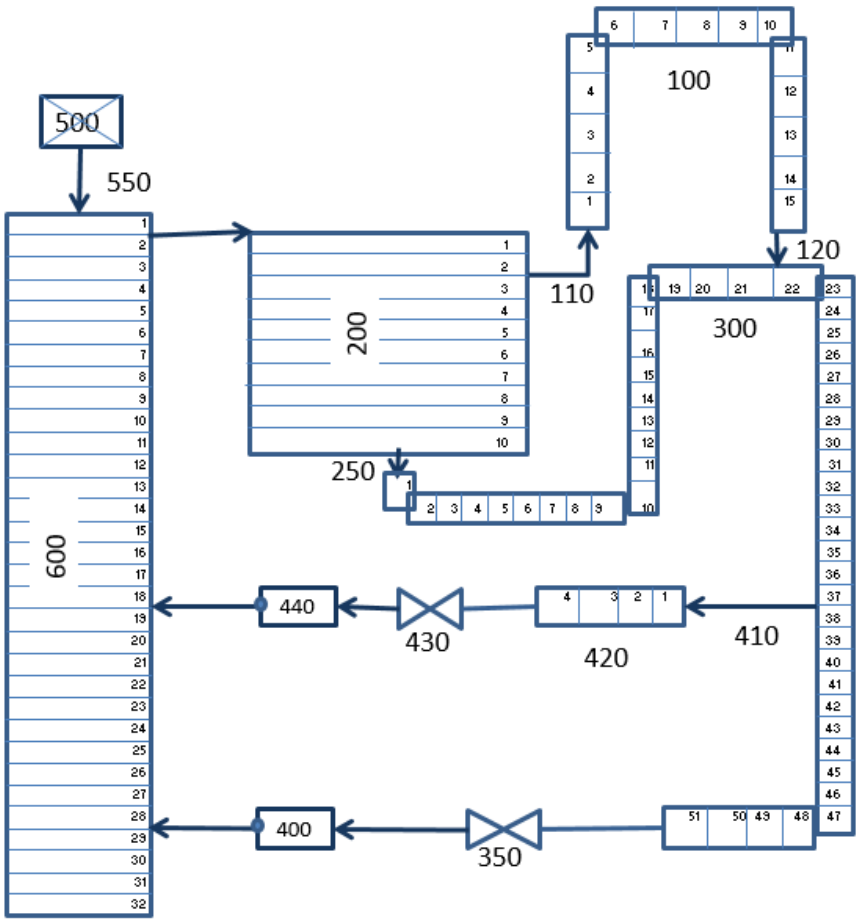
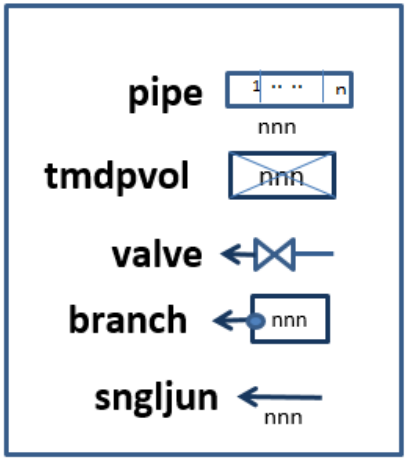
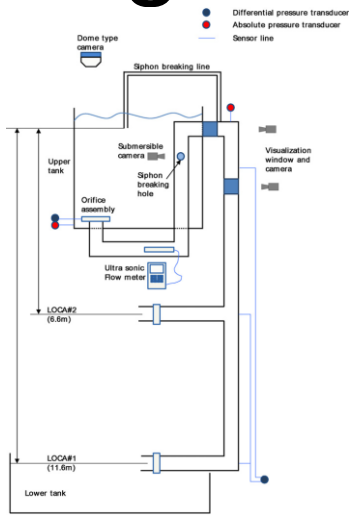




POSTECH RELAP5 Modeling

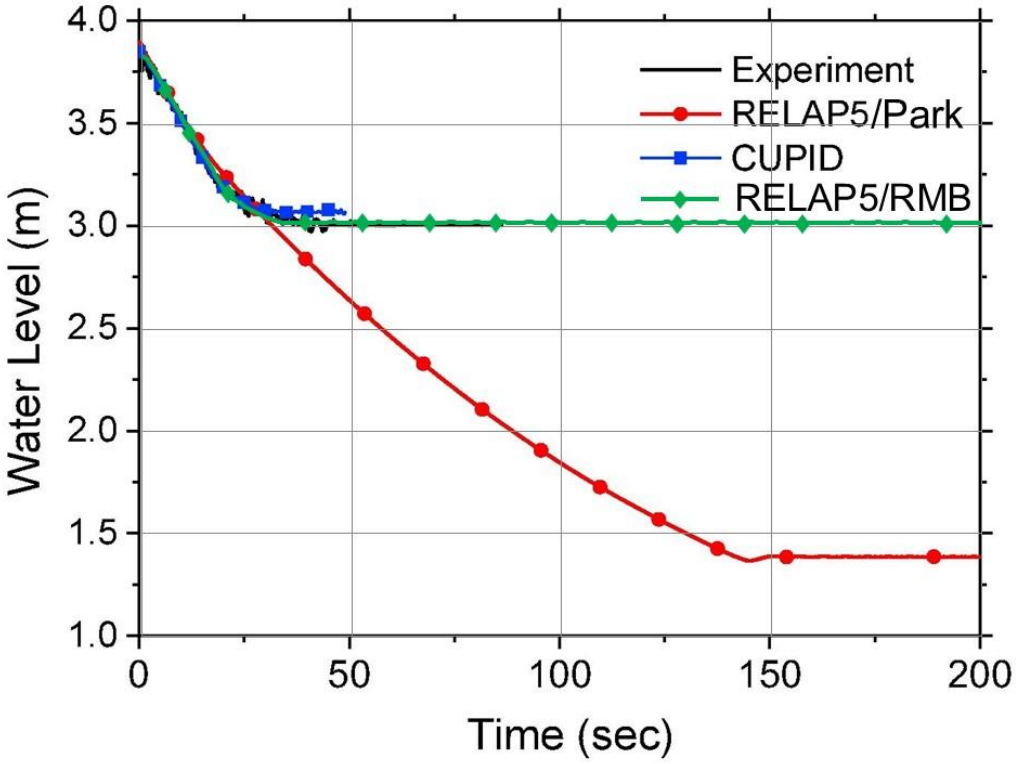




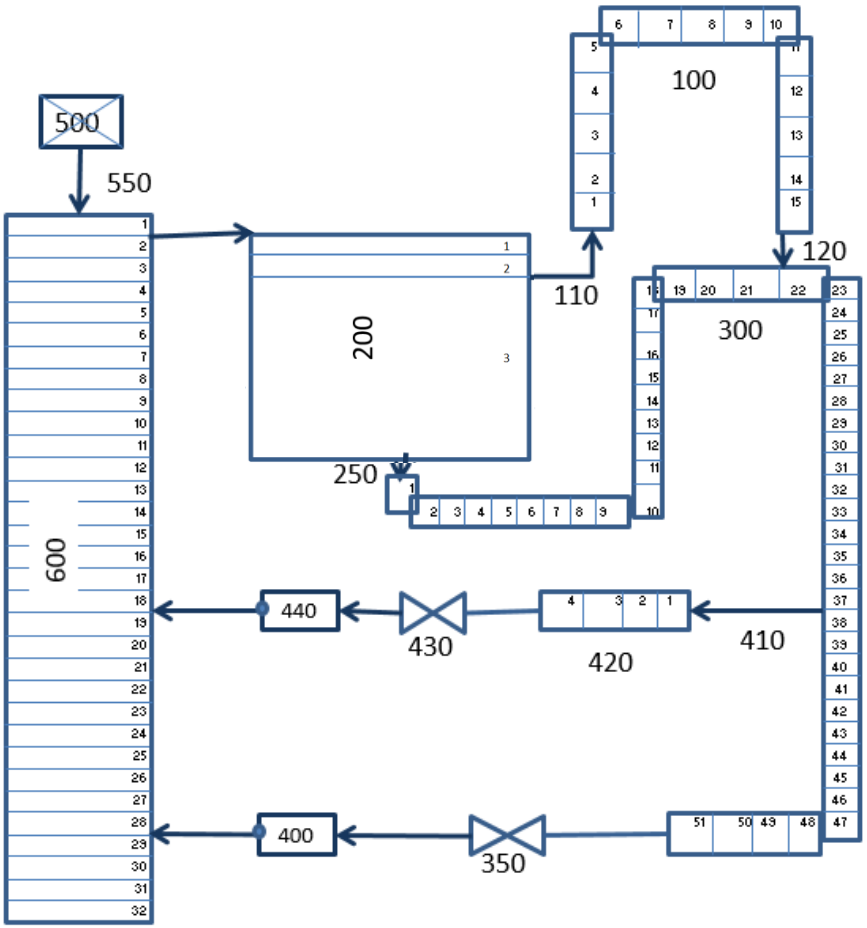


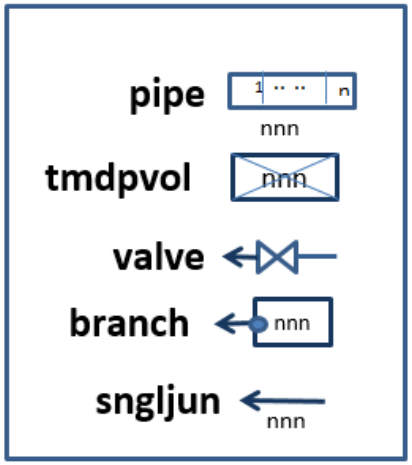
Results

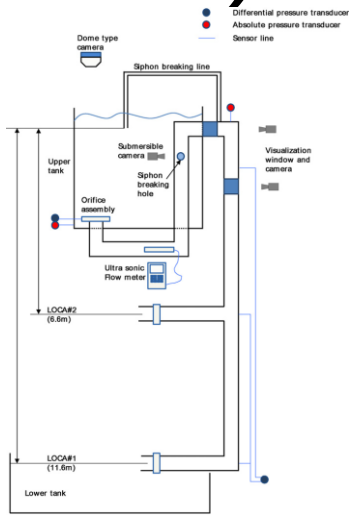
Rupture in position A
Siphon Breaker Line 2,5”



POSTECH RELAP5 (User Effect)

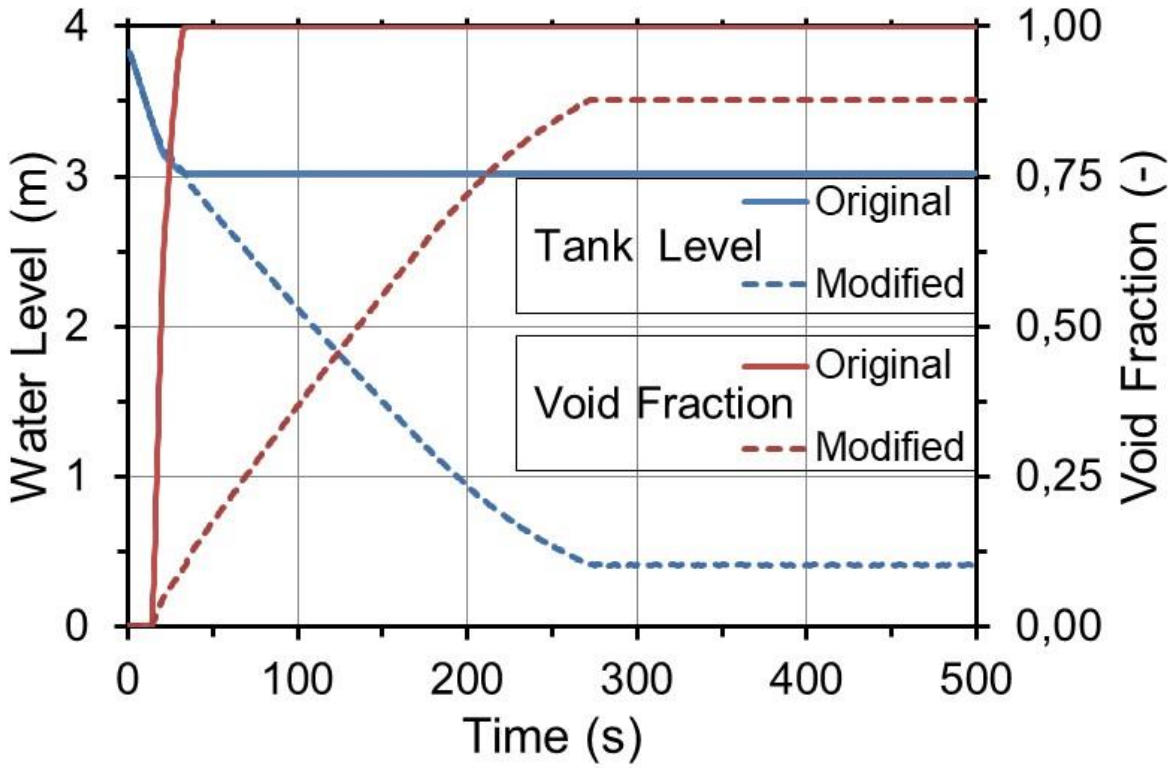






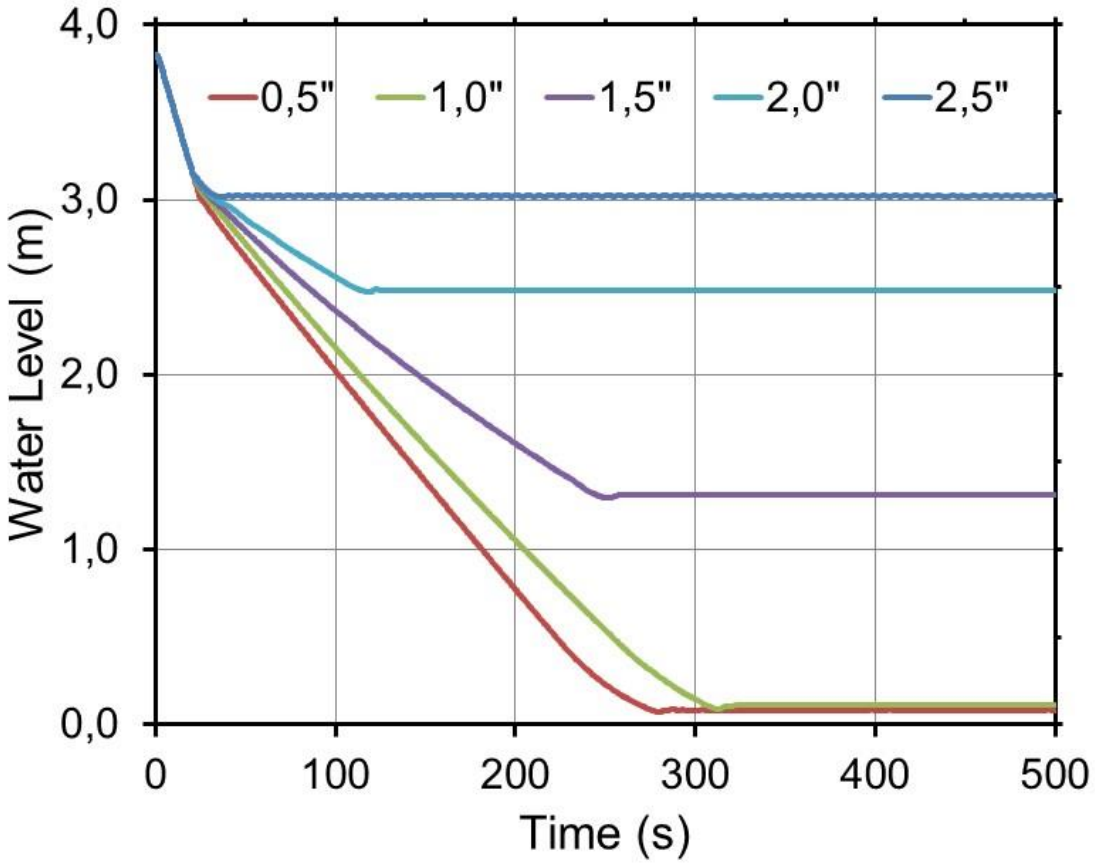
Results (Induced User Effect)

Rupture in position A
Siphon Breaker Line 2,5”
Merging Upper Tank Volumes



Results

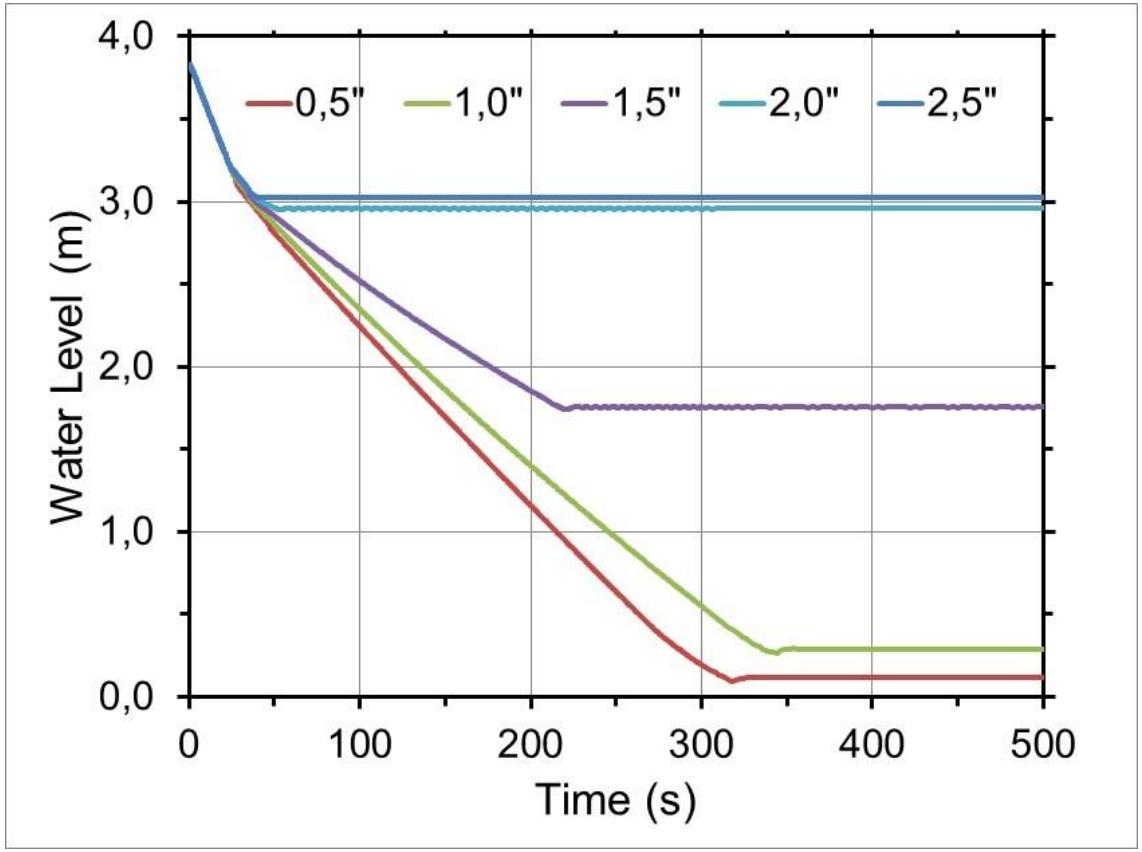
Rupture in position A
Several siphon line breaker diameter



Results

Rupture in position B

Several siphon line breaker diameter



Results

D_{SBL} (mm)	Final Level (m)			
	Position A		Position B	
	Exp.	RELAP5	Exp.	RELAP5
69,0 (2,5”)	3,02	3,02	3,14	3,03
53,2 (2,0”)	2,56	2,48	3,05	2,96
43,8 (1,5”)	1,89	1,31	2,83	1,75
27,9 (1,0”)	não	0,11	1,30	0,29
17,1 (0,5”)	não	0,08	não	0,12

Conclusion

- The RELAP5 was able to simulate satisfactorily, with a nodalization developed preliminarily, the POSTECH siphon break experiment
- Further details of the experimental circuit are necessary for a refinement of the RELAP5 nodalization
- In all simulated cases the water loss was higher than in the experiments
- The lower the level at the end of the experiment, the greater its difference compared to the calculated value
- All RELAP5 results were conservatives regarding water losses
- The RELAP5 can be considered suitable for simulating the siphon break effect on a loca in the RMB

Thank you