# EFFICIENCY OF THE FIRE SAFETY SYSTEM, BASED ON FIRE DYNAMICS SIMULATOR (FDS)

## Model Applied to a Data Center

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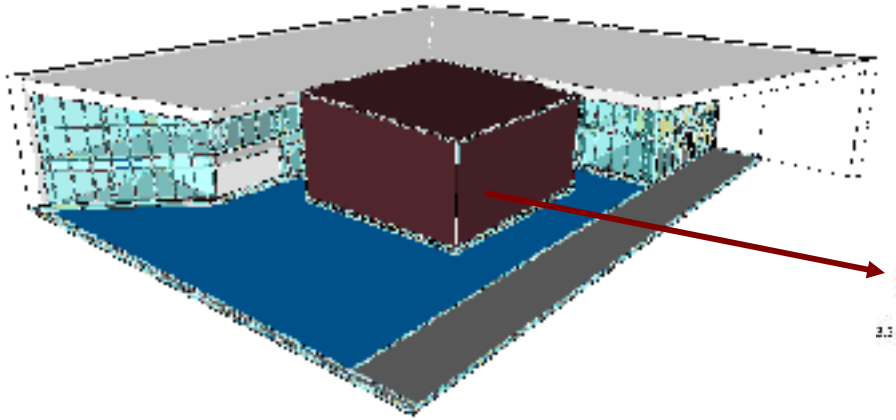
## Introduction

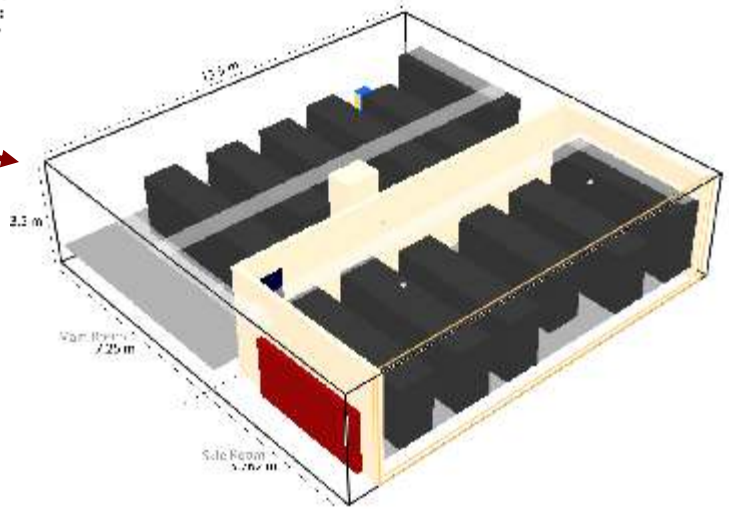
The risk of fire is present, practically in all places built and frequented by humans [3]

The **objective** of this work is designing a model, based on the FDS, which allows for analyzing the efficiency of the fire safety system of the Data Center of Cape Verde, examining temperature predictions and local pressure measurements.

## Physical Model

This work focused on the study of the Data Center in Cabo Verde, where only the **mesh of the safe room** was examined, as the area of greatest turbulence due to the fire source location





## Simulation Scenario

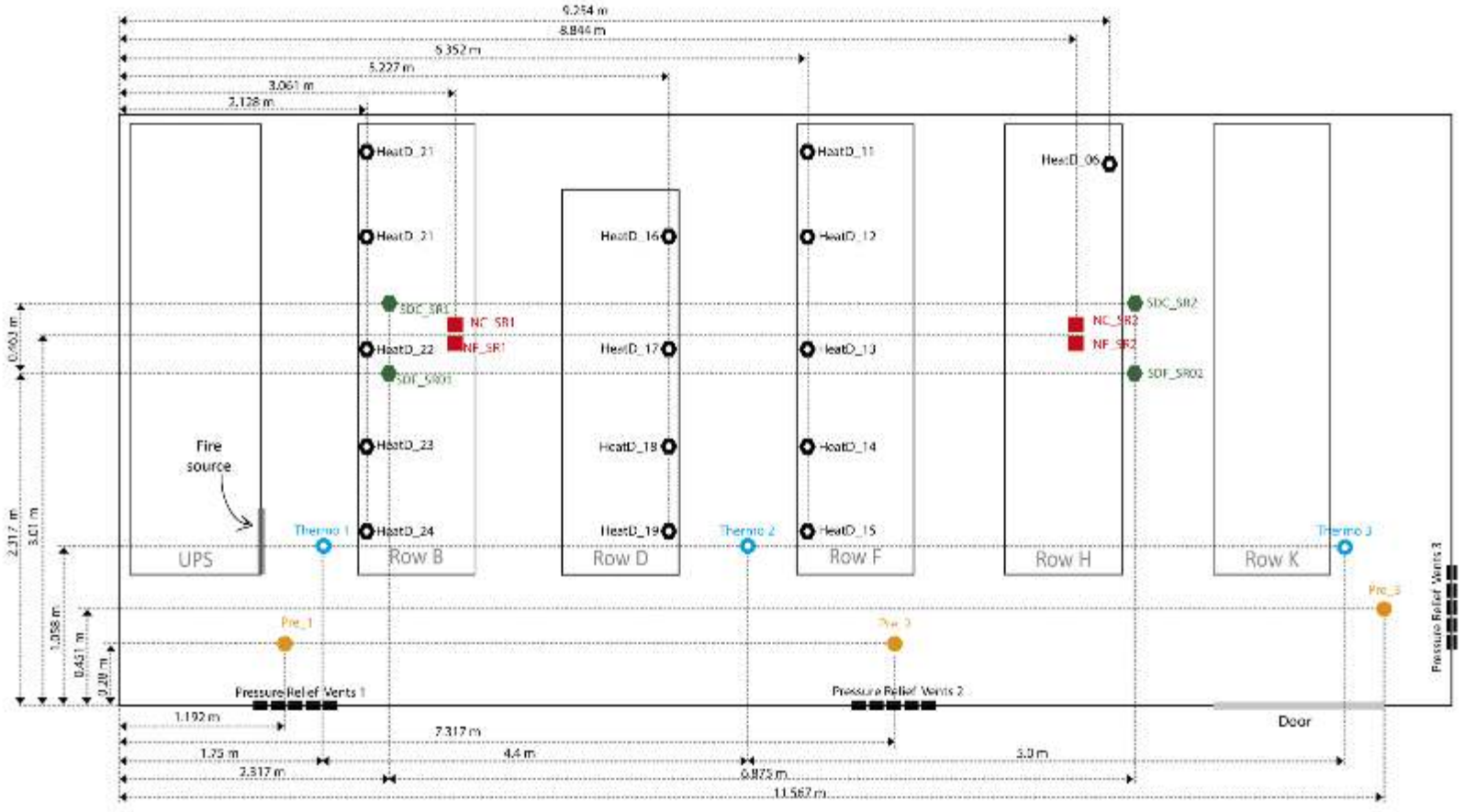
The model was designed according to the existing fire safety system, based on IG-55 extinction gas.

To extract the results, devices were distributed accordingly to the existing system and additional devices were inserted to extract results.

| Devices | Thermocouples | Gas-Phase | Supply (Nozzles) | Smoke Detectors | Heat Detectors |
|---|---|---|---|---|---|
| | Thermo_ | Pre_ | NC_SR | SD(C/F)_SR | Heat_D |
| Label |  |  |  |  |  |

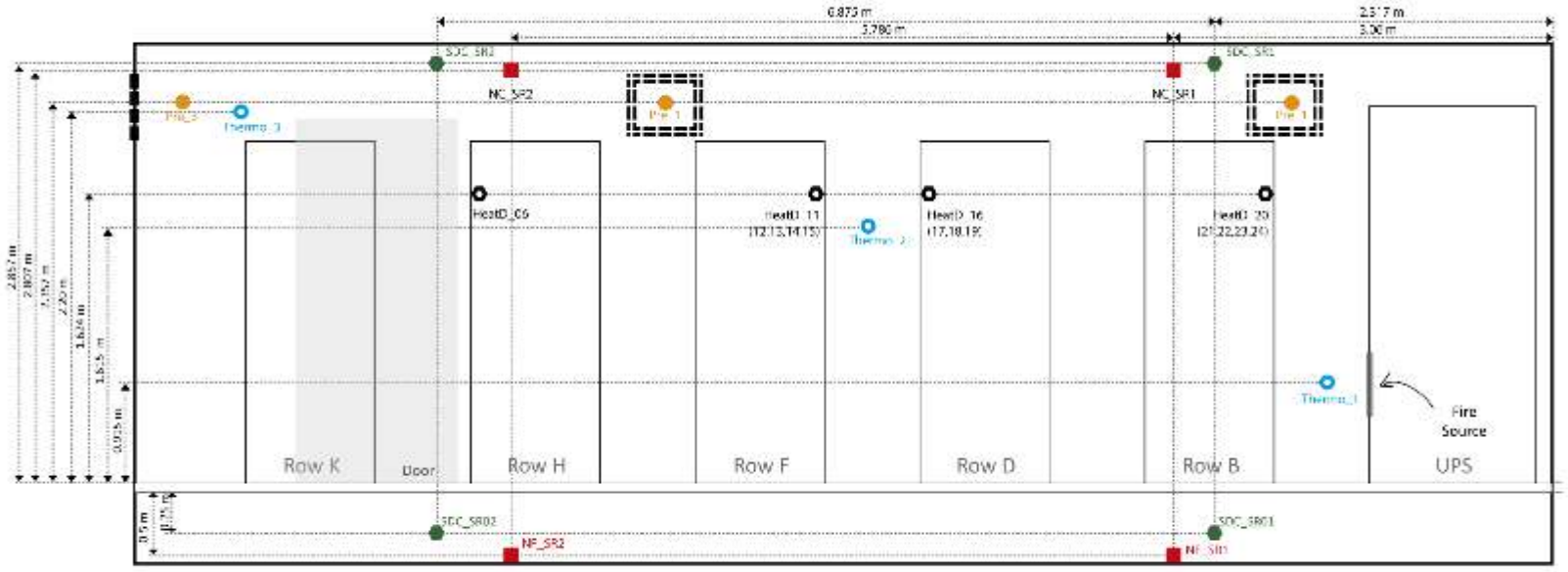
# Simulation Scenario

## Device Mapping Top View



# Simulation Scenario

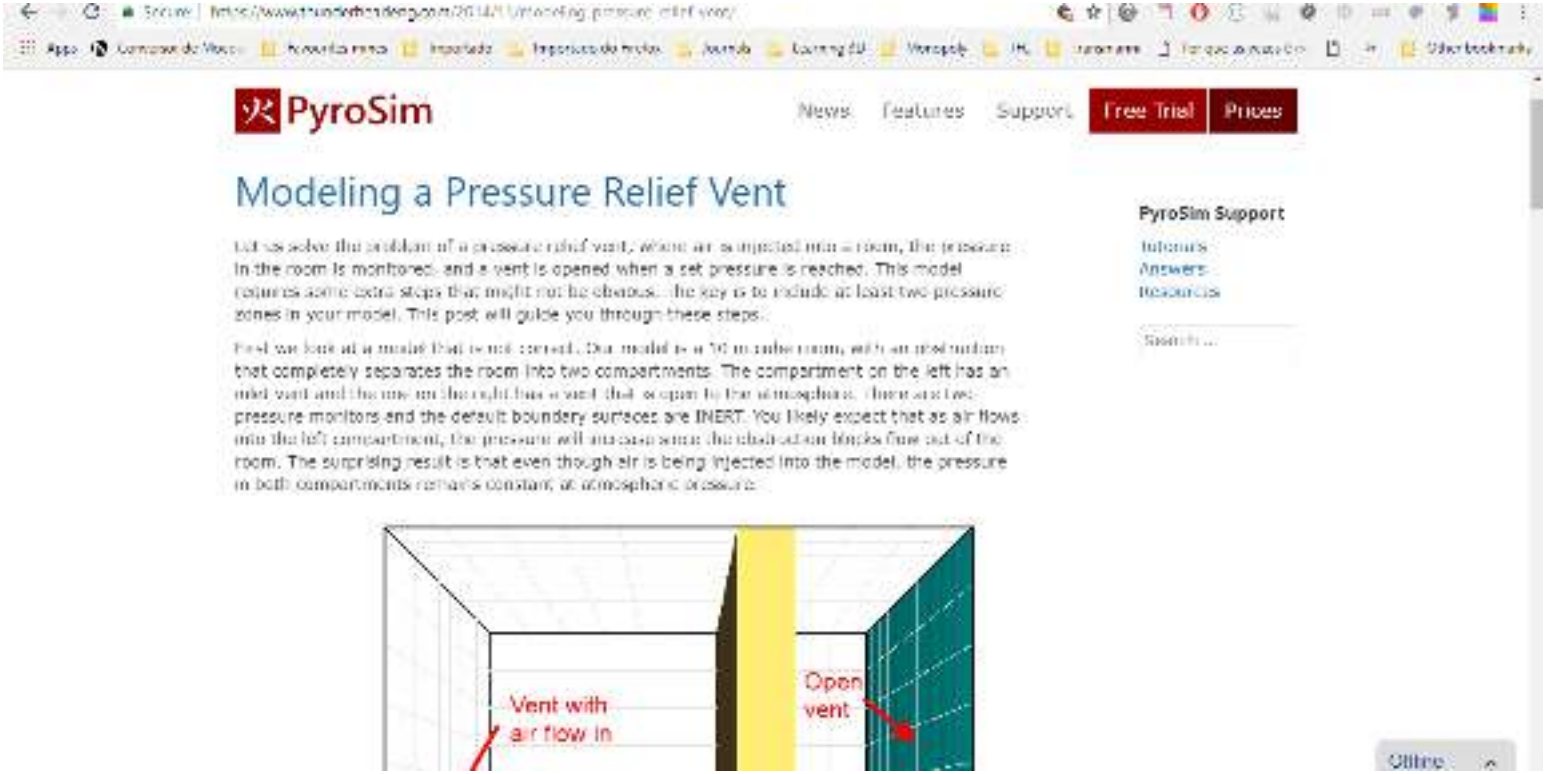
## Device Mapping Side View



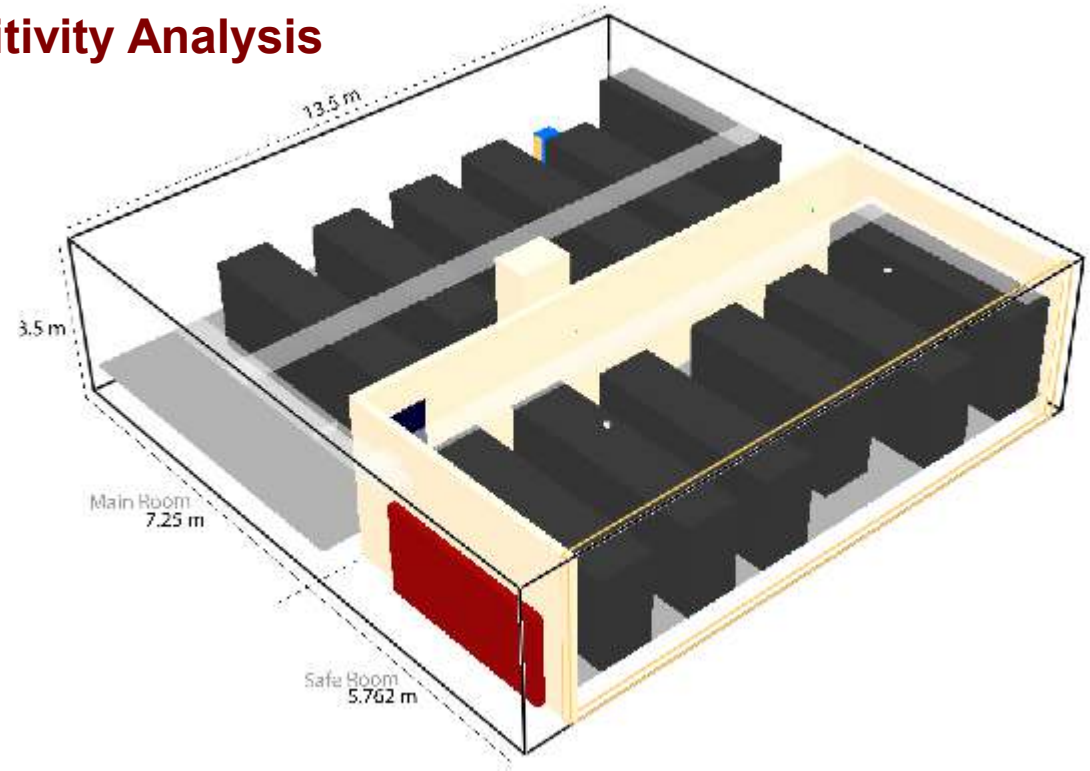
## Simulation Scenario

The **pressurization system** was also examined in the model where the pressure relief vents trigger according to devices.

To achieve this, holes were modeled, that only activate when the pressure value is equal to or greater than 270Pa measured by the gas-phase device. [7]



## Grid Sensitivity Analysis

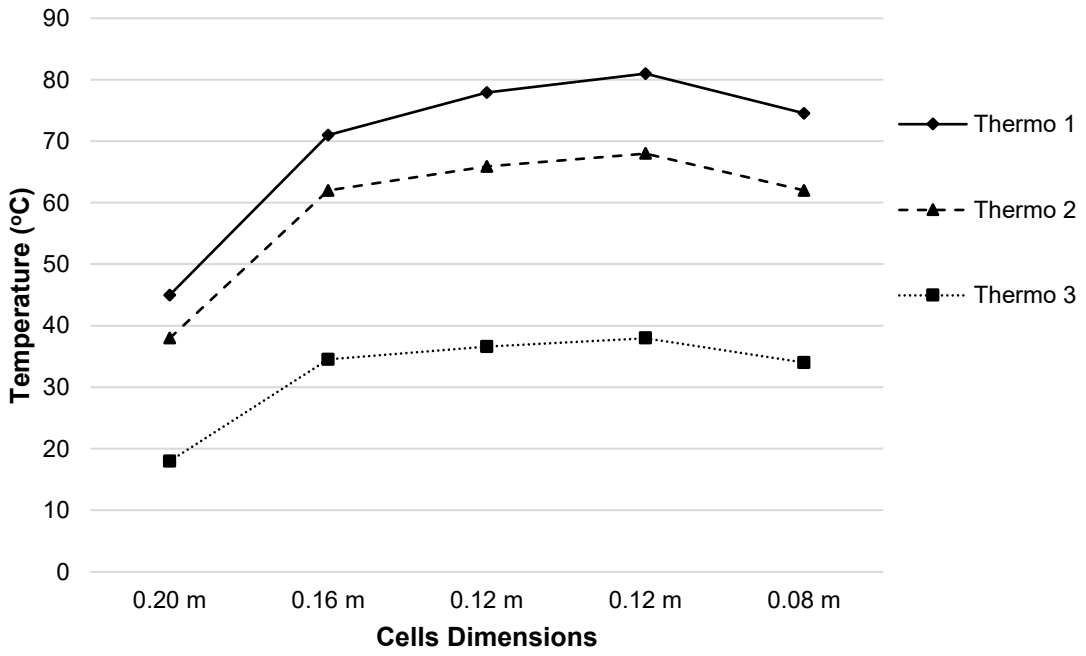



A simulation was performed initially with a fire power of estimated by the software of 0.148.

| Both dimensions of 0.12m | | | | | | |
|---|---|---|---|---|---|---|
| Tests | Cells Division | | | | | |
| | X axis | | Y axis | | Z axis | |
| Tests Performed | | | | | | |
| Test 3 | 108 | | 45 | | 28 | |
| Test 4 | 162 | | 48 | | 24 | |
| Cell Dimensions | 0.20m | 0.12m | 0.12m | 0.12m | 0.08m | |

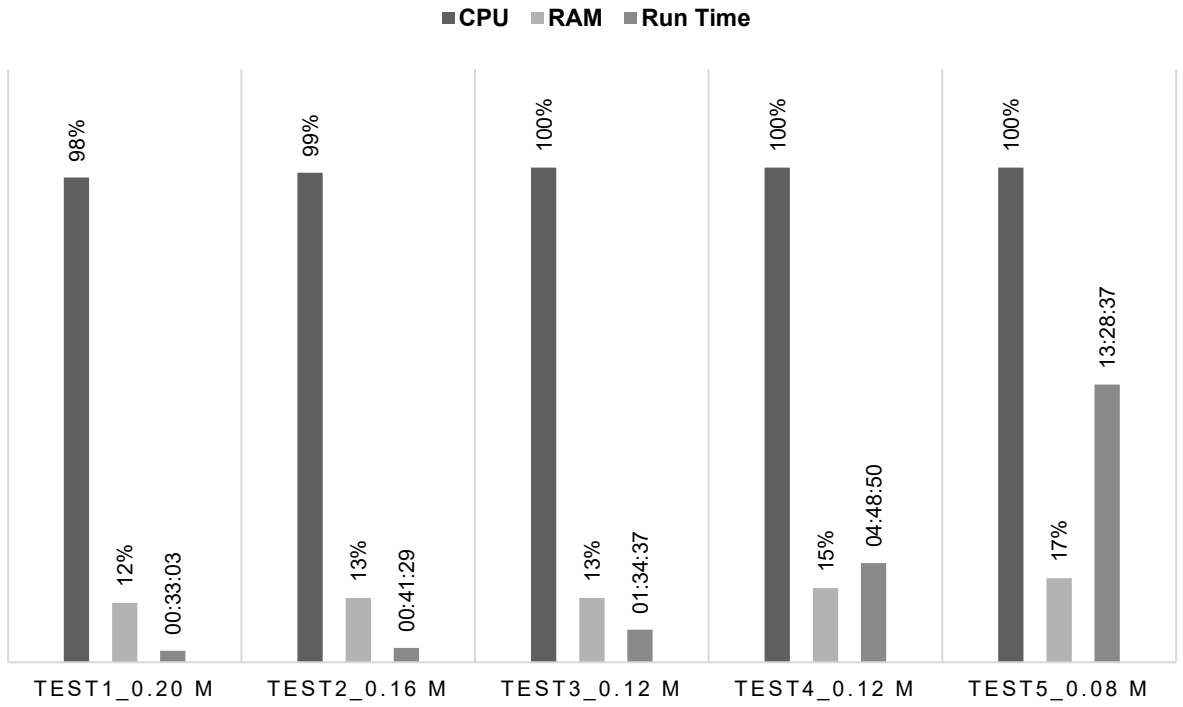
## Grid Sensitivity Analysis

This figure presents the temperature trends at 30s of simulation measured by the devices, according to the different cells dimensions analyzed.



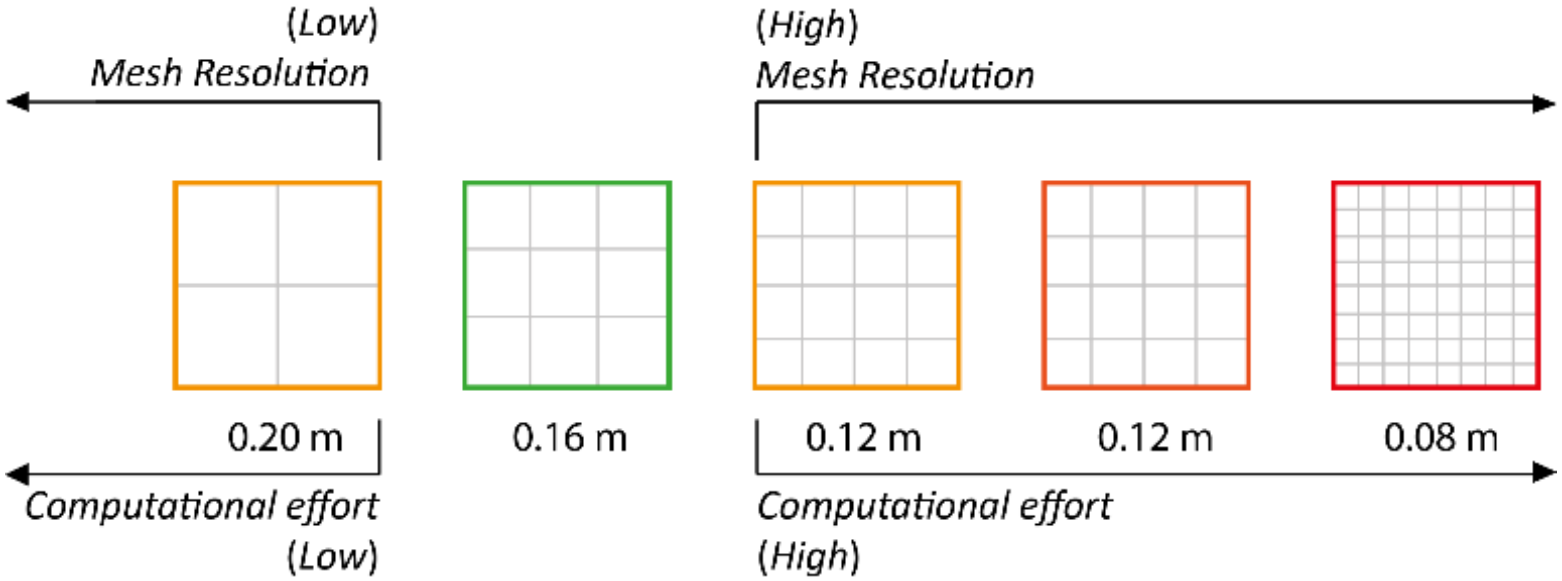
## Grid Sensitivity Analysis

The machine used is a server with the following characteristics: Windows System Server 2012 R2 Standard based on a 64bit, Intel(R) Xeon(R) CPU X5675 @ 3.07GHz, processor with 16GB of RAM.



## Grid Sensitivity Analysis

Based on the results, the grid analysis showed that the cell dimension of 0.16 m is the optimal solution found.



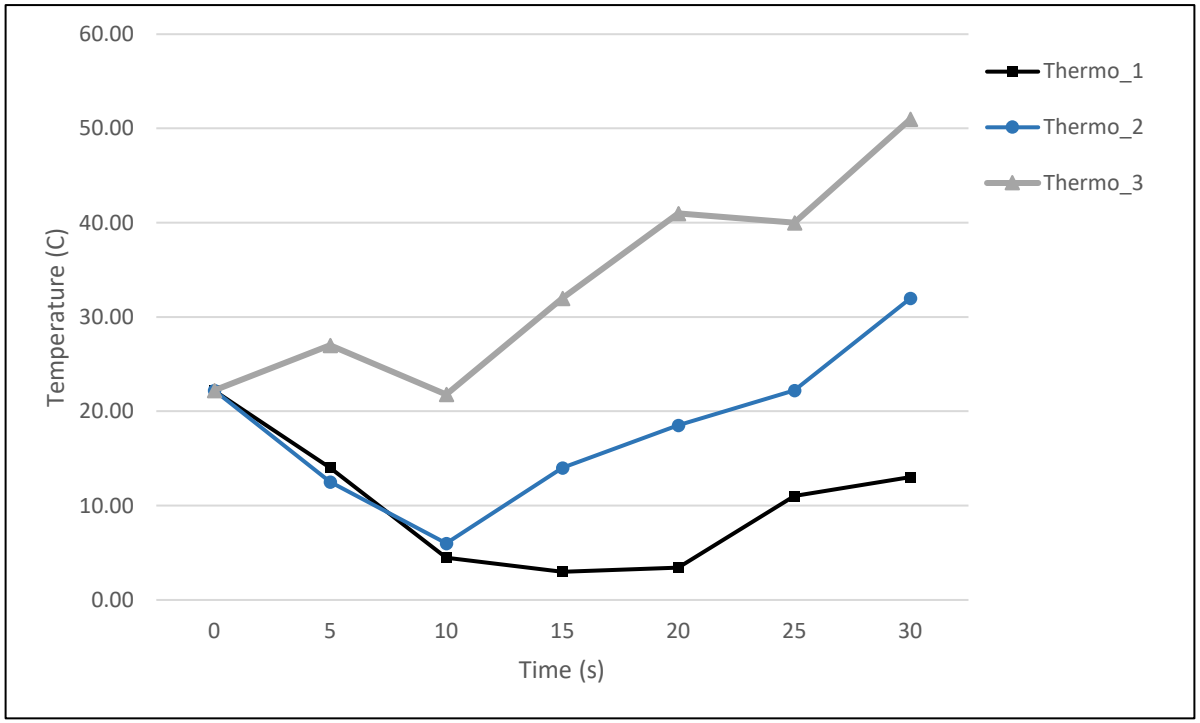
## Final Model Summary

- The Safe Room was the subject of the scenario;
- It was initially designed with a fire power of **300kW/m2**;
- It was examined through INIT REGIONS, with an initial environment temperature of **22ºC within the Cube** and **26ºC outside of it;**
- It was perfomed **30s simulation** with a **time step of 0,14s**;
- It was used a **mesh size of 0.16 m;**

We must note that all this parameters would influence the results. Thus, it becomes crucial to review these aspects for future studies that will be conducted on this model.

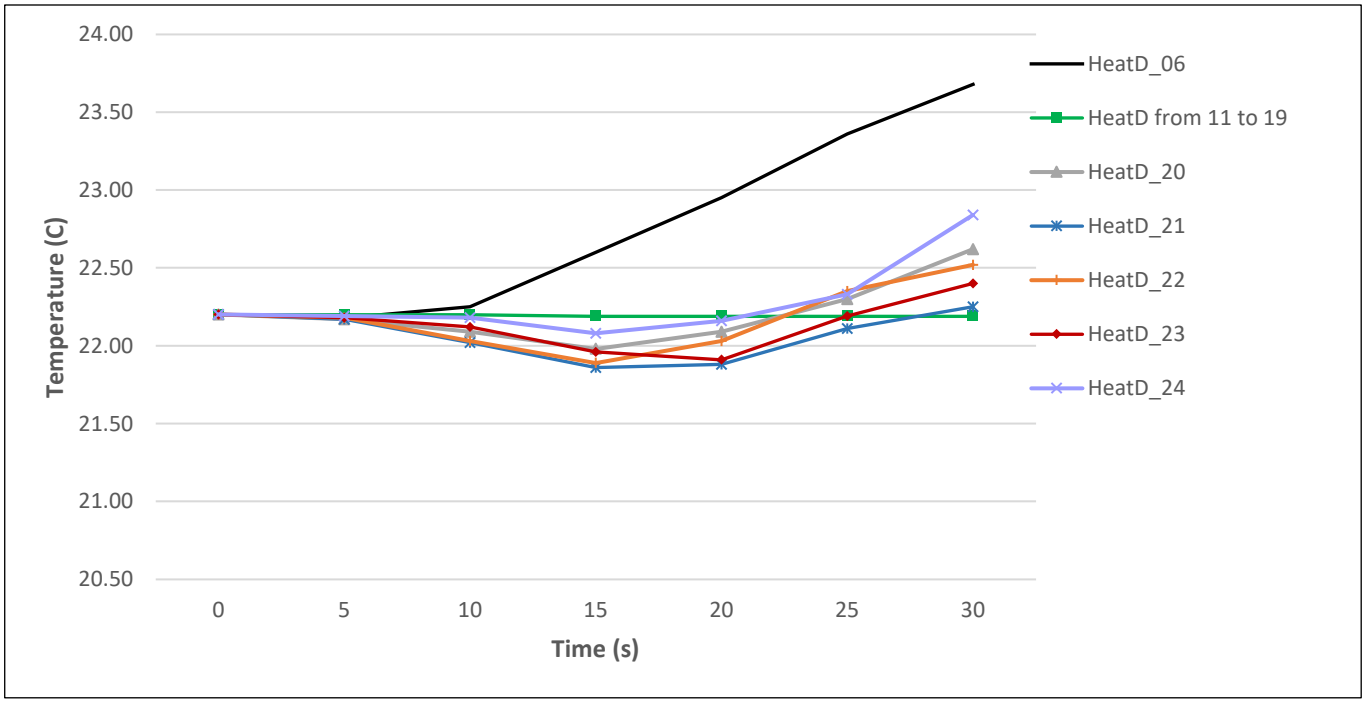
## Result Analysis

Regarding the temperature, initially in the safe room it was 22ºC. Theoretically larger temperature values was expected close to the fire source, although the different levels of positioning devices, Thermo 1, 2 and 3 have influenced these measurements



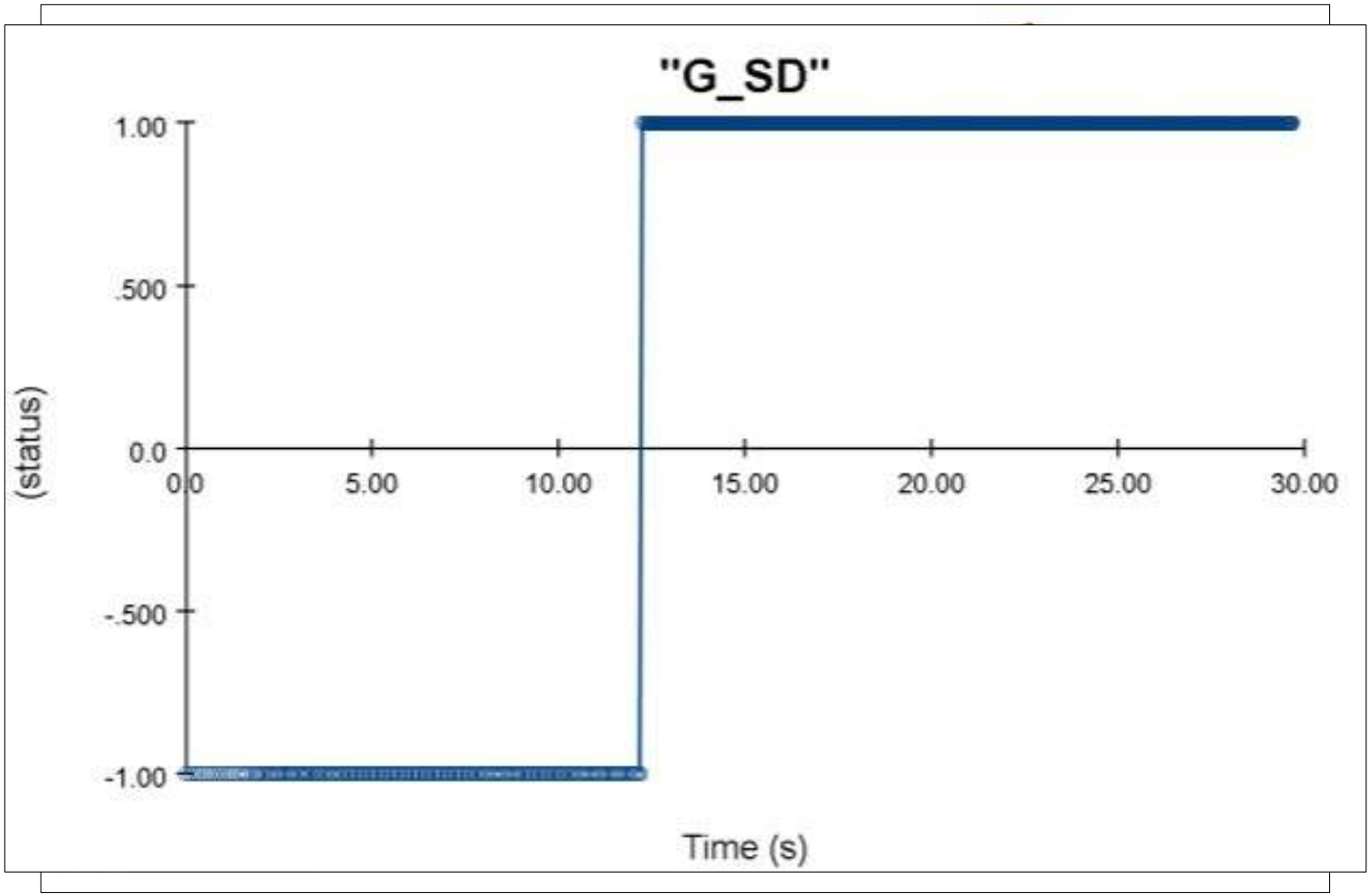
## Result Analysis

It can be seen that there is an increasing temperature trend at these specific points, and these results can be used as benchmarks for future studies and analysis.



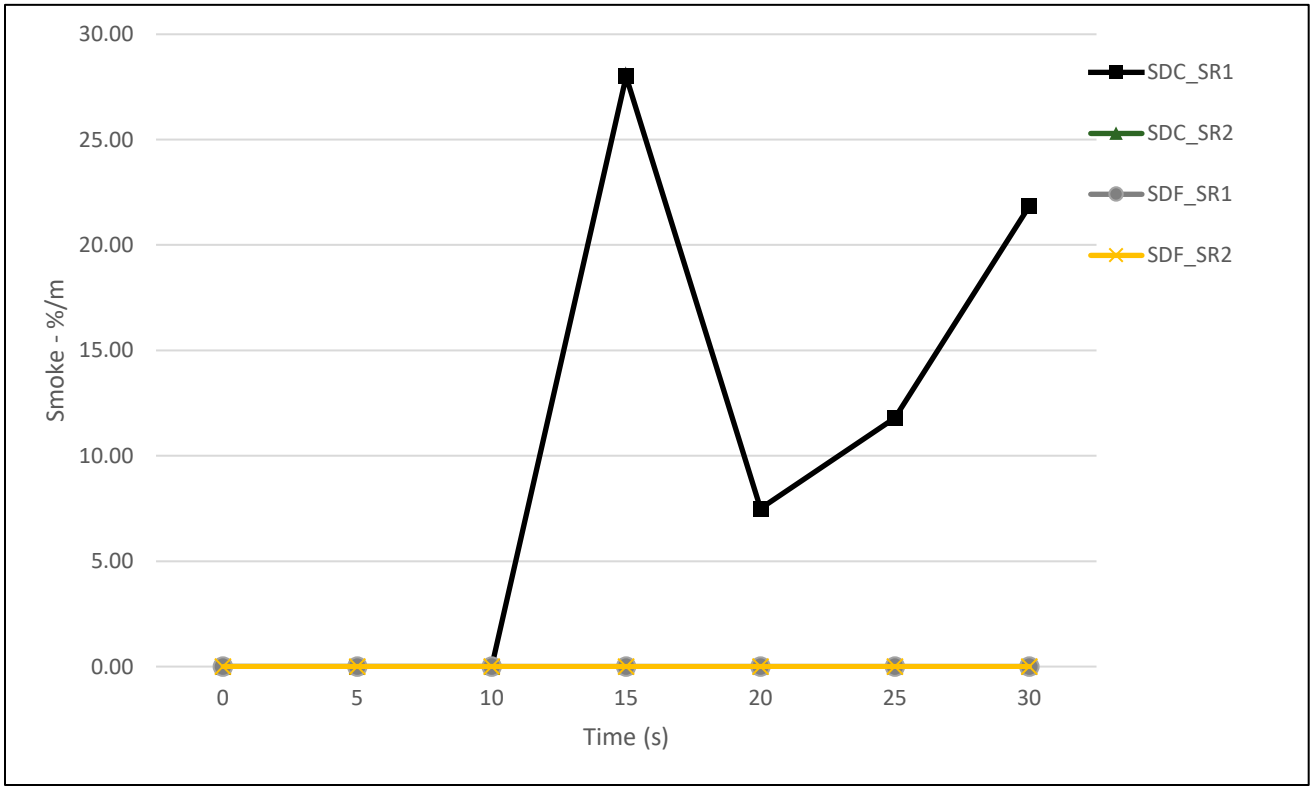
## Result Analysis

Analyzing the spread of smoke, and gas activation, there is evidence of consistent results, signifying that as a research tool the model is useful in some situations, in particular fire situations.

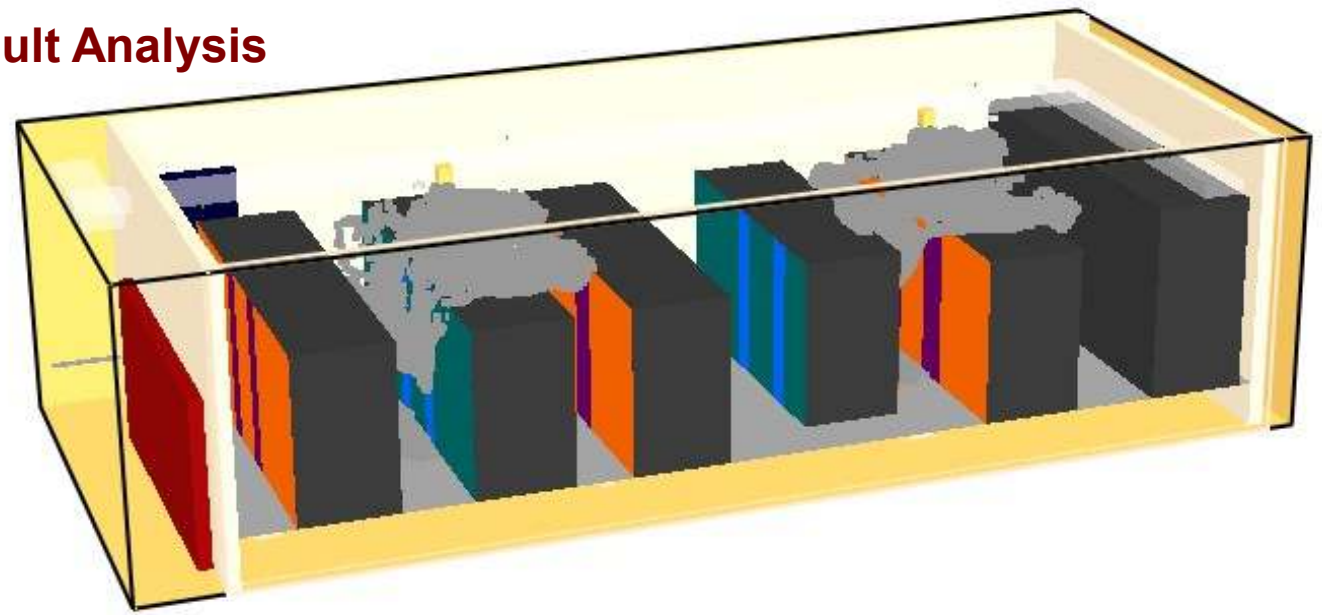


## Result Analysis

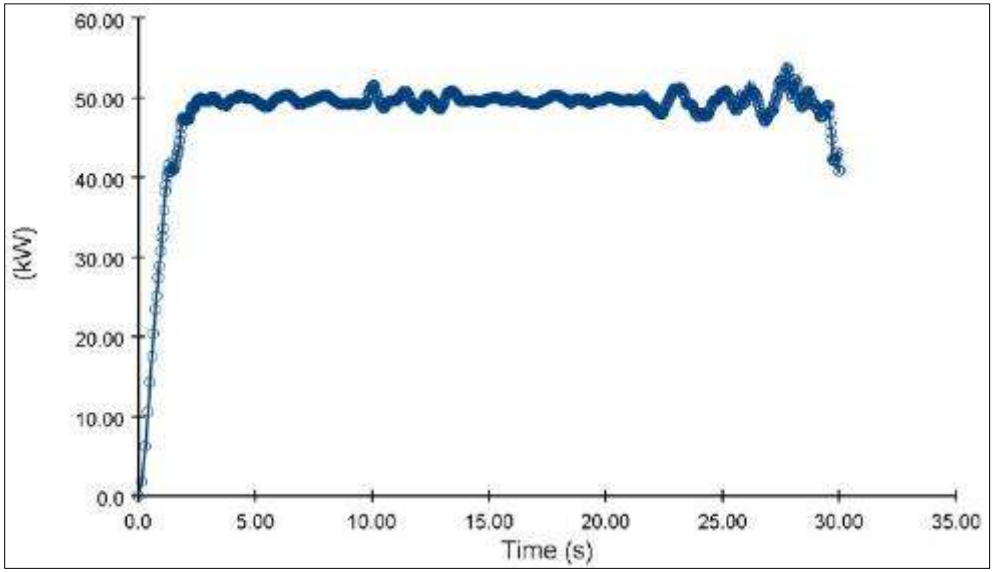
The activation of the gas was allowed by measuring obscurity by smoke detectors, specifically, the controller works after obscuration reaches the smoke detectors, where an obscuration threshold value of 3.31%/m was established.



## Result Analysis

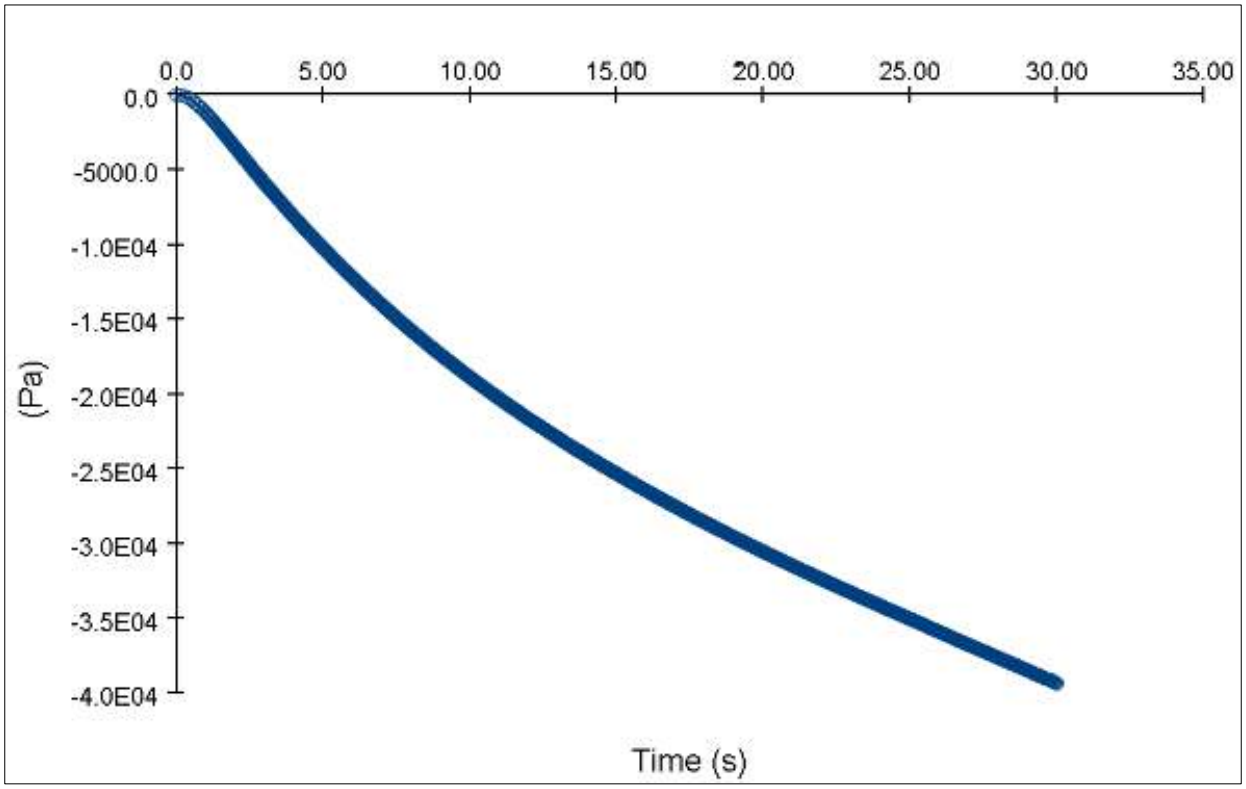


Note that this rate remains almost constant during simulation, and it tends to decrease from 28s until the end.



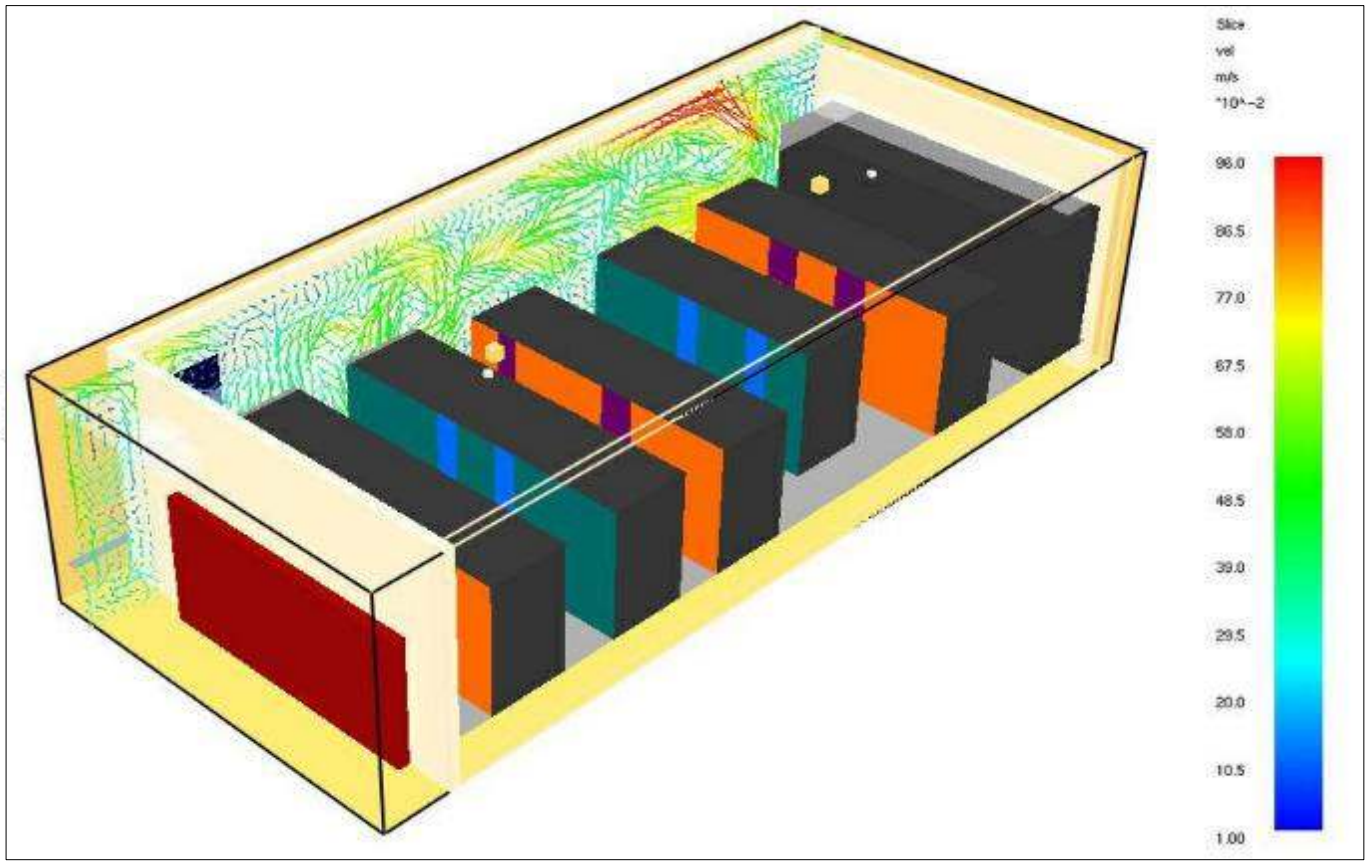
## Result Analysis

Regarding local pressure, theoretically, an increase in pressure after the gas injection was expected, since there was no system of pressurization parsed inside the Cube



## Result Analysis

To gain a better understanding of this result, a scenario was examined in which the exhaust and fans for hot and cold air were disabled



## Conclusion

The model proposed in this study allows decision-making in some security cases, particularly fire cases in the safe room, avoiding costs and possible damage caused by a real simulation. Likewise, the results of the grid sensitivity analysis can be used to enhance performance in future simulations, saving rendering time and reducing computational effort.

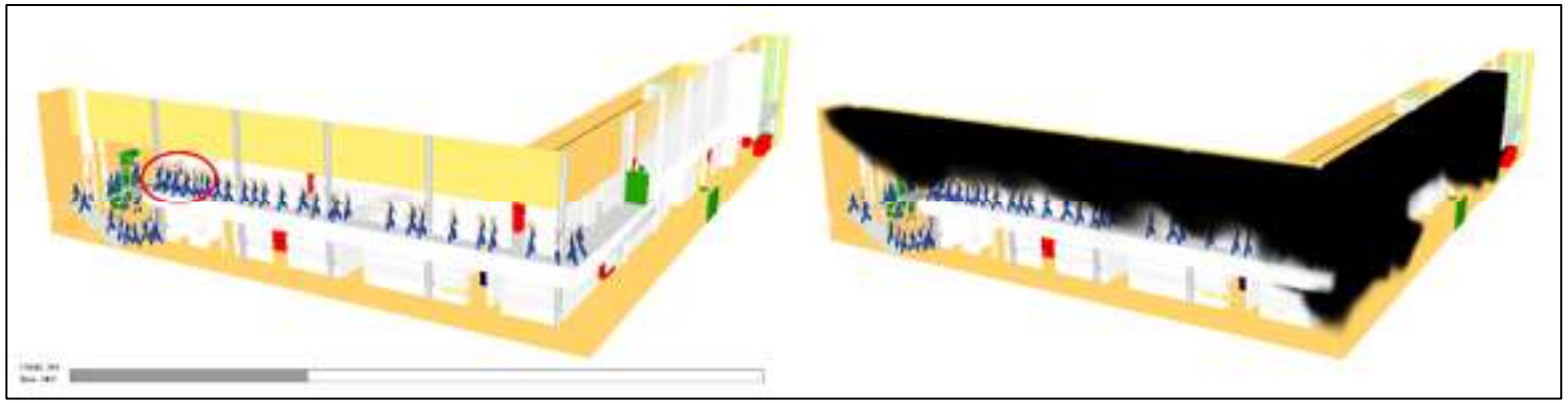
## References

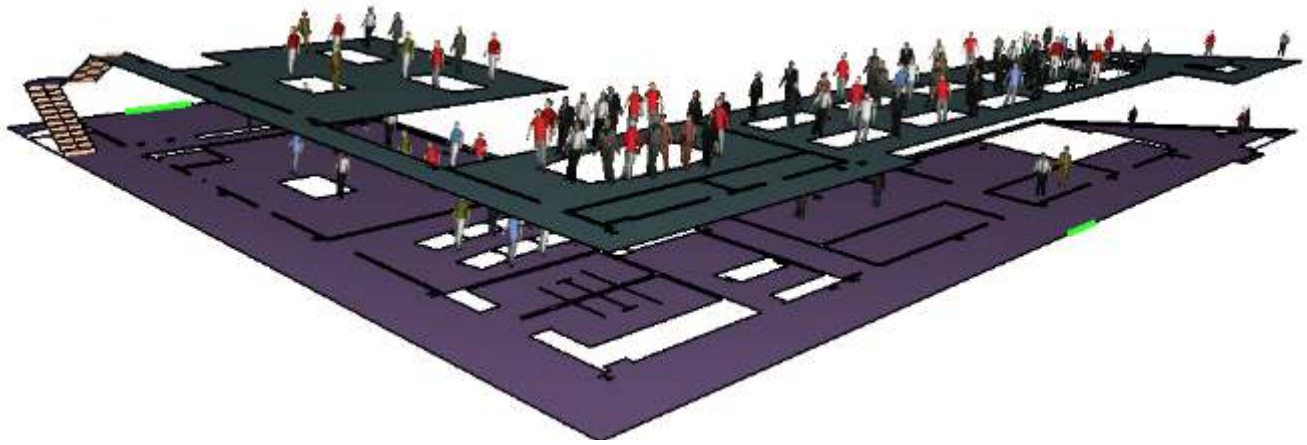
[3] Miller, R. (April 20th, 2014). Data Center Fire Leads to Outage for Samsung Devices. Journal Post. Obtained from Data Center Knowledge: http://www.datacenterknowledge.com

[7] Swenson, D. (18th of November, 2014). Modeling a Pressure Relief Vent. Obtained from Thunderhead Engineering: https://www.thunderheadeng.com/2014/11/modeling-pressure-relief-vent/

## Future Works

- Designing a model based on a Pathfinder and EVAC module from FDS that allows for the analysis of the building structure and influences decision making for emergency cases, especially evacuation, in this data center.





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**Thank You**

**Obrigado**

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