

FEMTC2018

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

Model Applied to a Data Center

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Thunderhead Engineering

Goal

Introduction

Physical
ModelSimulation
ScenarioGrid
Sensitivity
AnalysisResult
Analysis

Conclusion



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.

Goal

Physical Model

Physical Model

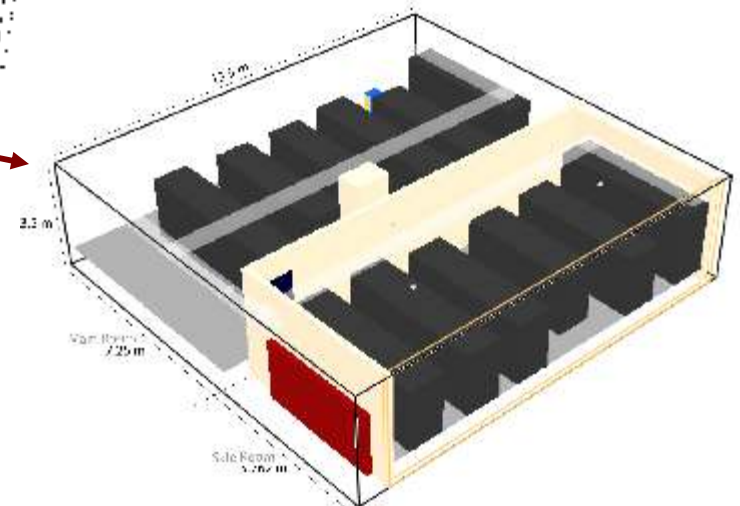
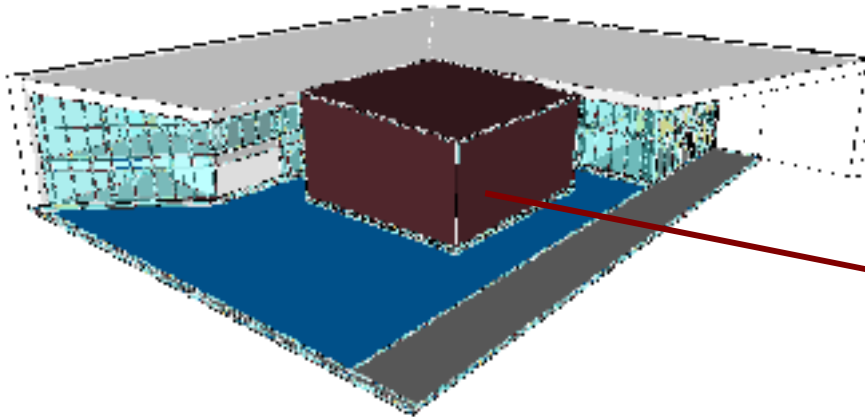
This work focused on the study of the Data Center in Cabo Verde, where only the **mesh of the safe room** was examined, as the area of greatest turbulence due to the fire source location

Simulation Scenario

Grid Sensitivity Analysis

Result Analysis

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Simulation Scenario

Physical Model

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

Simulation Scenario

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

Grid Sensitivity Analysis

Result Analysis

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

Conclusion

Label					
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Goal

Simulation Scenario

Physical Model

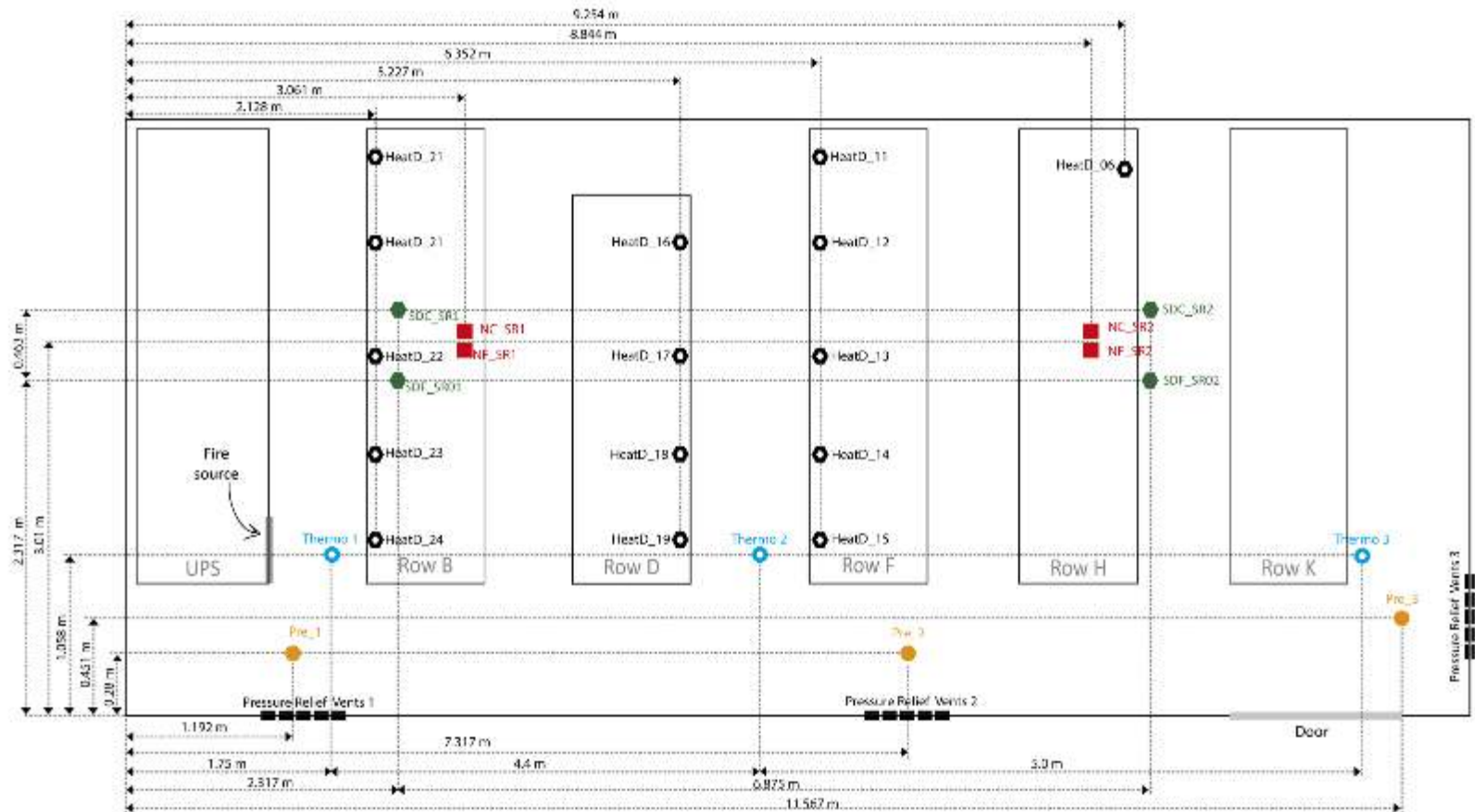
Device Mapping Top View

Simulation Scenario

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Physical Model

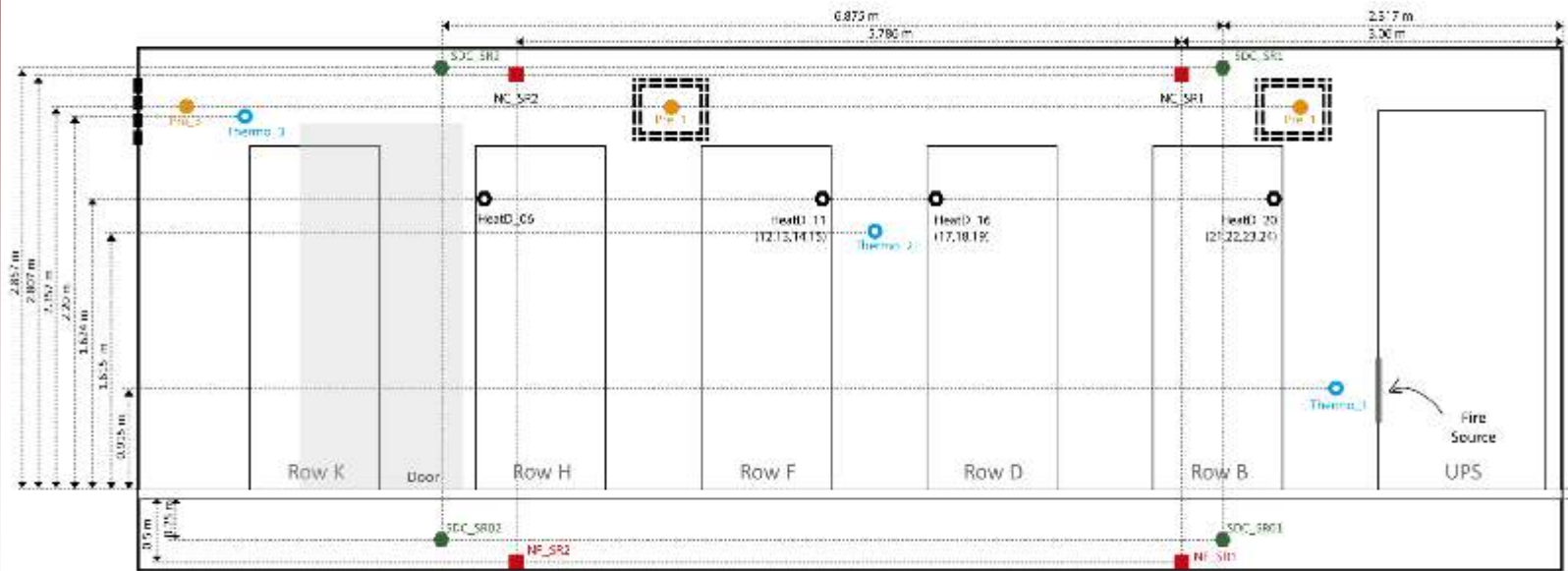
Device Mapping Side View

Simulation Scenario

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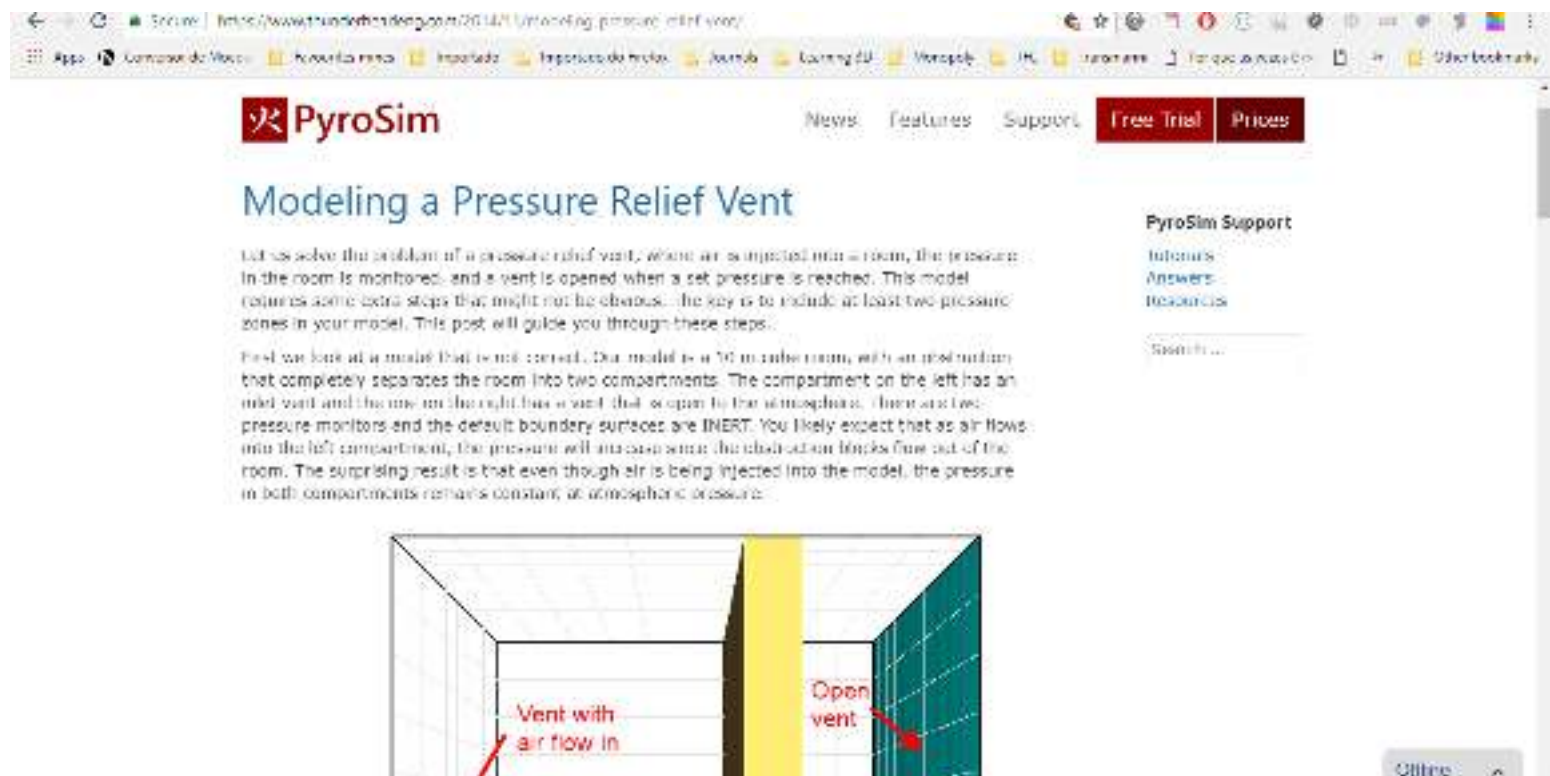
The **pressurization system** was also examined in the model where the pressure relief vents trigger according to devices.

Simulation
Scenario

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]

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The screenshot shows a web browser displaying the PyroSim website. The page title is "Modeling a Pressure Relief Vent". The article text describes a simulation setup for a pressure relief vent in a room. It mentions that the room is divided into two compartments by a wall, and the pressure is monitored in both. The article also includes a diagram of the room setup, showing a vent with air flow in and an open vent.

PyroSim News Features Support [Free Trial](#) [Prices](#)

Modeling a Pressure Relief Vent

Let us solve the problem of a pressure relief vent, where air is injected into a room, the pressure in the room is monitored, and a vent is opened when a set pressure is reached. This model requires some extra steps that might not be obvious. The key is to include at least two pressure zones in your model. This post will guide you through these steps.

First, we look at a model that is not correct. Our model is a 10 m cube room, with an obstruction that completely separates the room into two compartments. The compartment on the left has an inlet vent and the one on the right has a vent that is open to the atmosphere. There are two pressure monitors and the default boundary surfaces are INERT. You likely expect that as air flows into the left compartment, the pressure will increase until the obstruction blocks flow out of the room. The surprising result is that even though air is being injected into the model, the pressure in both compartments remains constant at atmospheric pressure.



The diagram shows a 3D perspective view of a room. A vertical yellow wall in the center divides the room into two compartments. On the left side, there is a red arrow pointing into a hole in the wall labeled "Vent with air flow in". On the right side, there is a red arrow pointing out of a hole in the wall labeled "Open vent". The room is rendered with a grid pattern on the walls and floor.

Goal

Grid Sensitivity Analysis

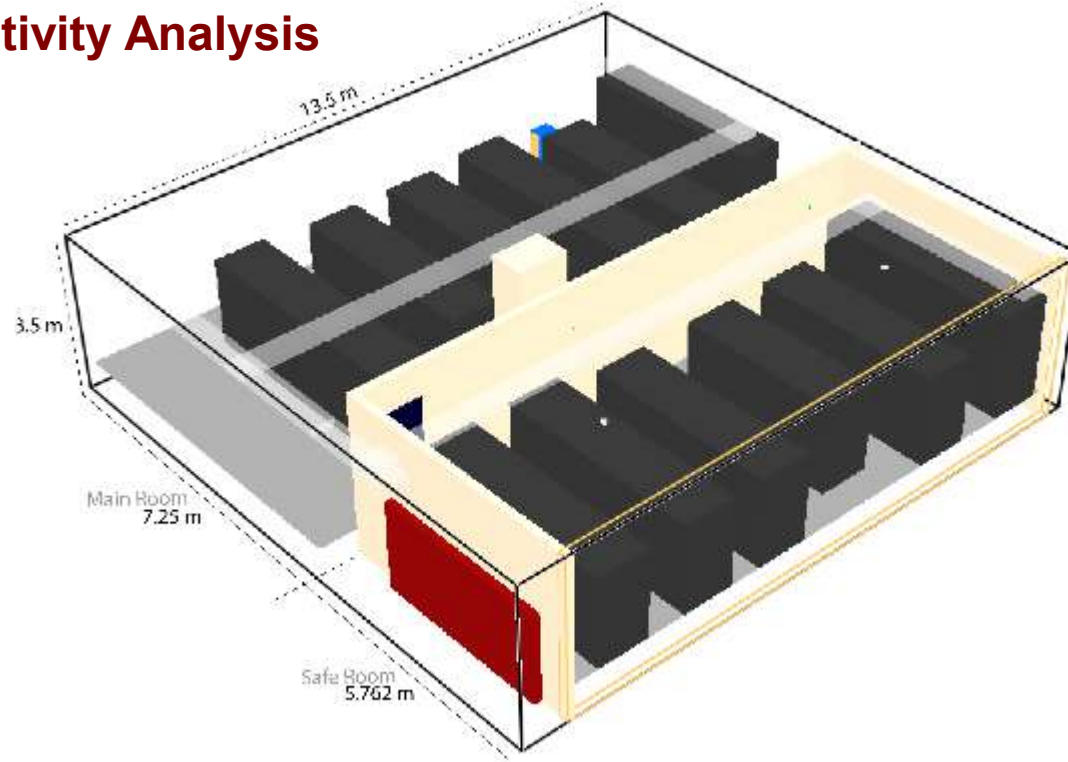
Physical Model

Simulation Scenario

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A simulation was performed initially with a fire power of

Both dimensions of 0.12m						
estimated by the software		Tests Performed				
		X axis		Y axis		Z axis
Test 3		108		45		28
Cell Dimensions	Test 4	0.20m	0.16m	0.12m48	0.12m	2.08m

Goal

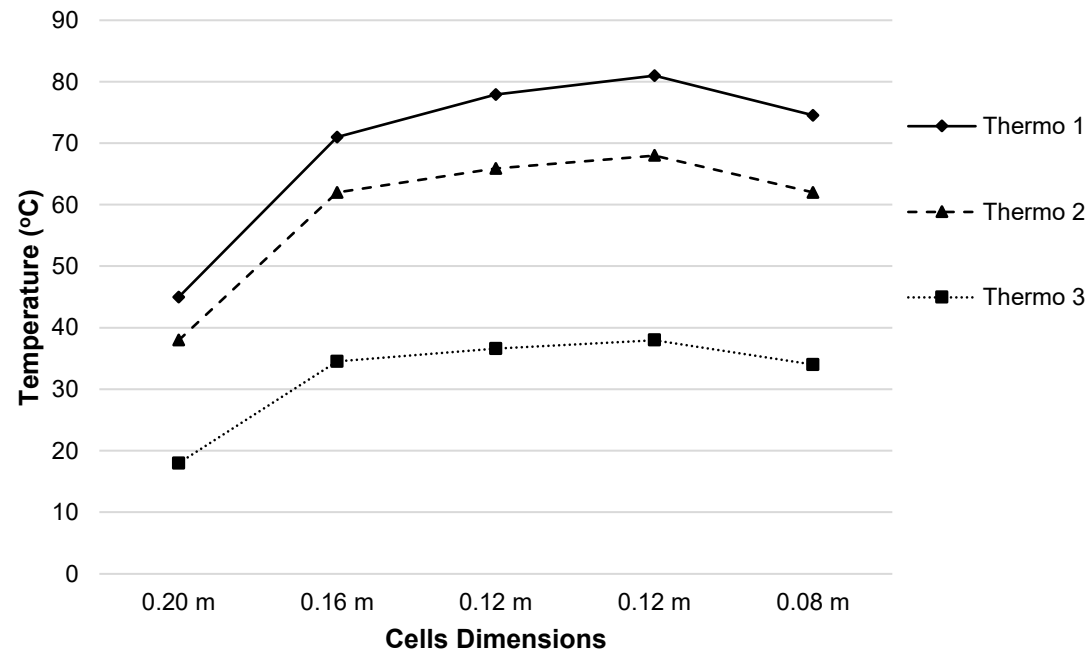
Grid Sensitivity Analysis

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

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Grid Sensitivity Analysis

Physical Model

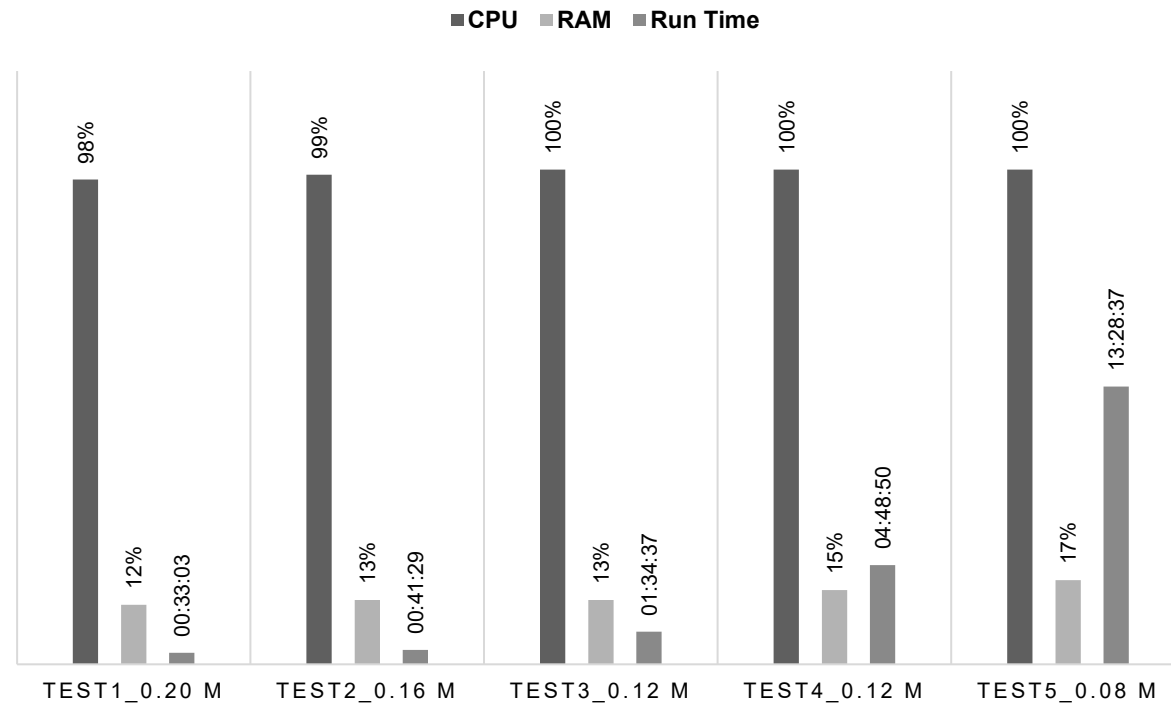
The machine used is a server with the following characteristics: Windows System Server 2012 R2 Standard based on a 64bit, Intel(R) Xeon(R) CPU X5675 @ 3.07GHz, processor with 16GB of RAM.

Simulation Scenario

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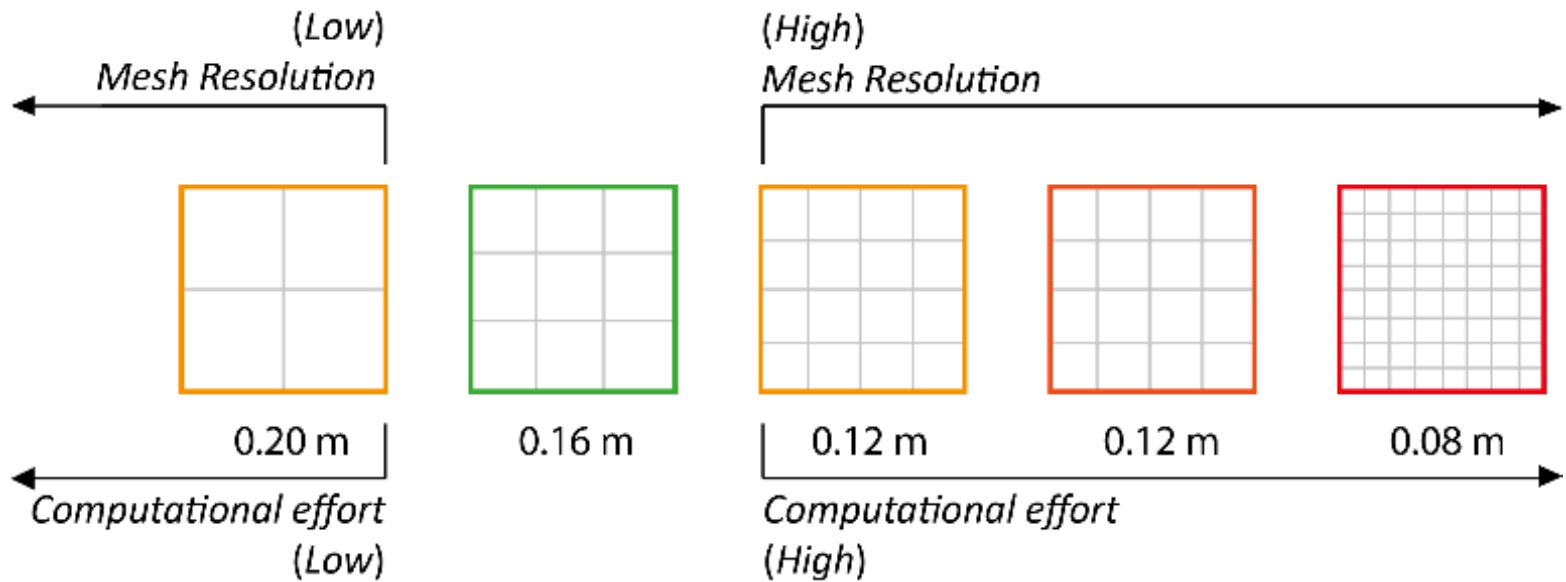
Goal

Grid Sensitivity Analysis

Physical Model

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

Simulation Scenario



Grid Sensitivity Analysis

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Final Model Summary

Physical Model

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- 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 **22°C within the Cube** and **26°C outside of it**;
- It was performed **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.

Goal

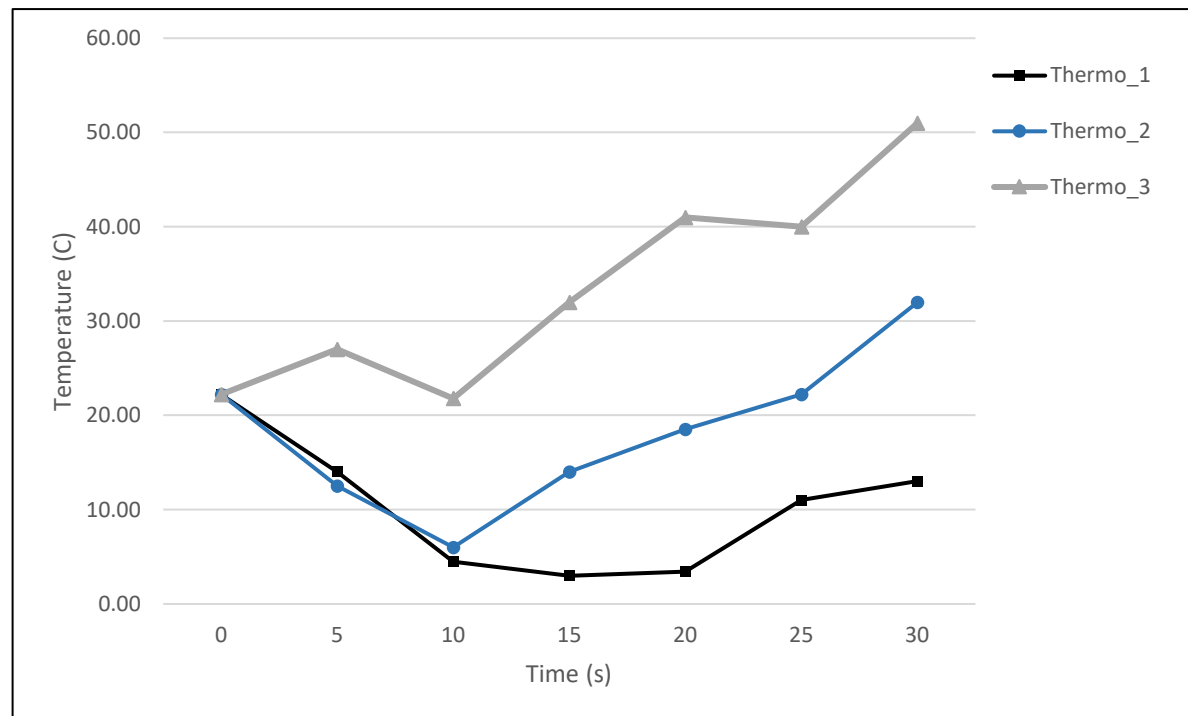
Result Analysis

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

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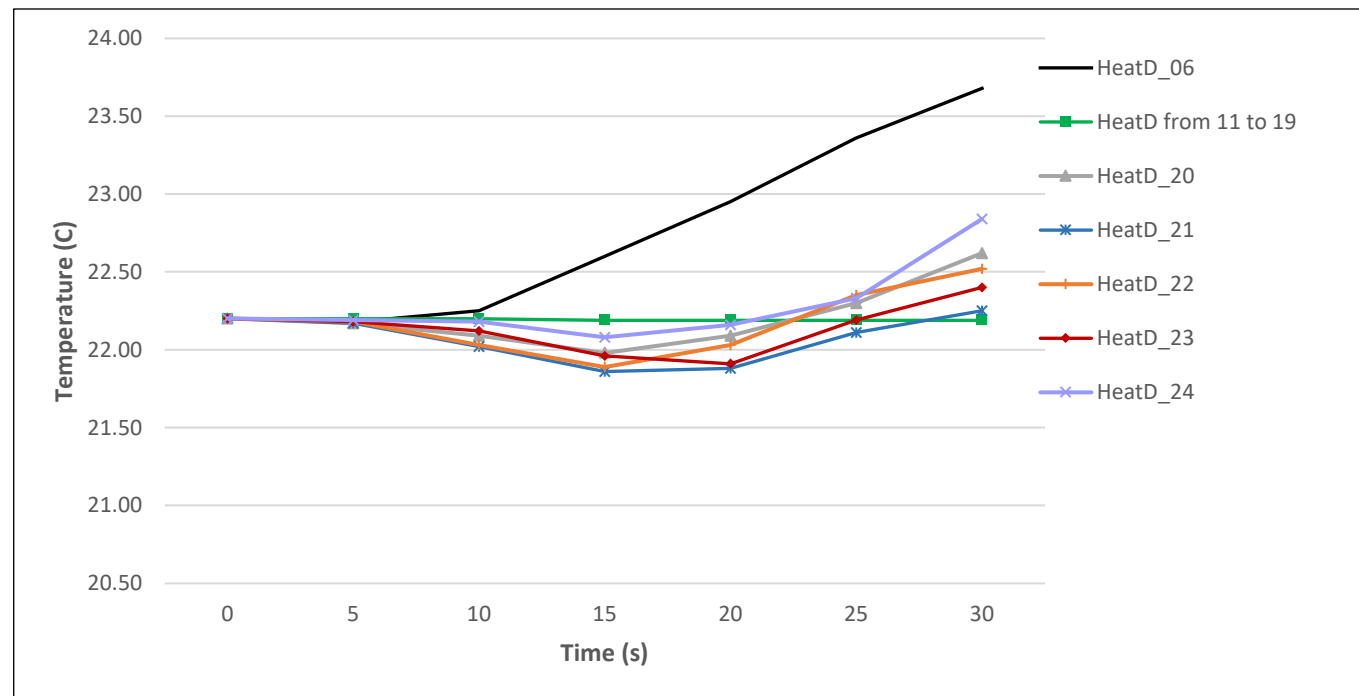
Result Analysis

Physical
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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.

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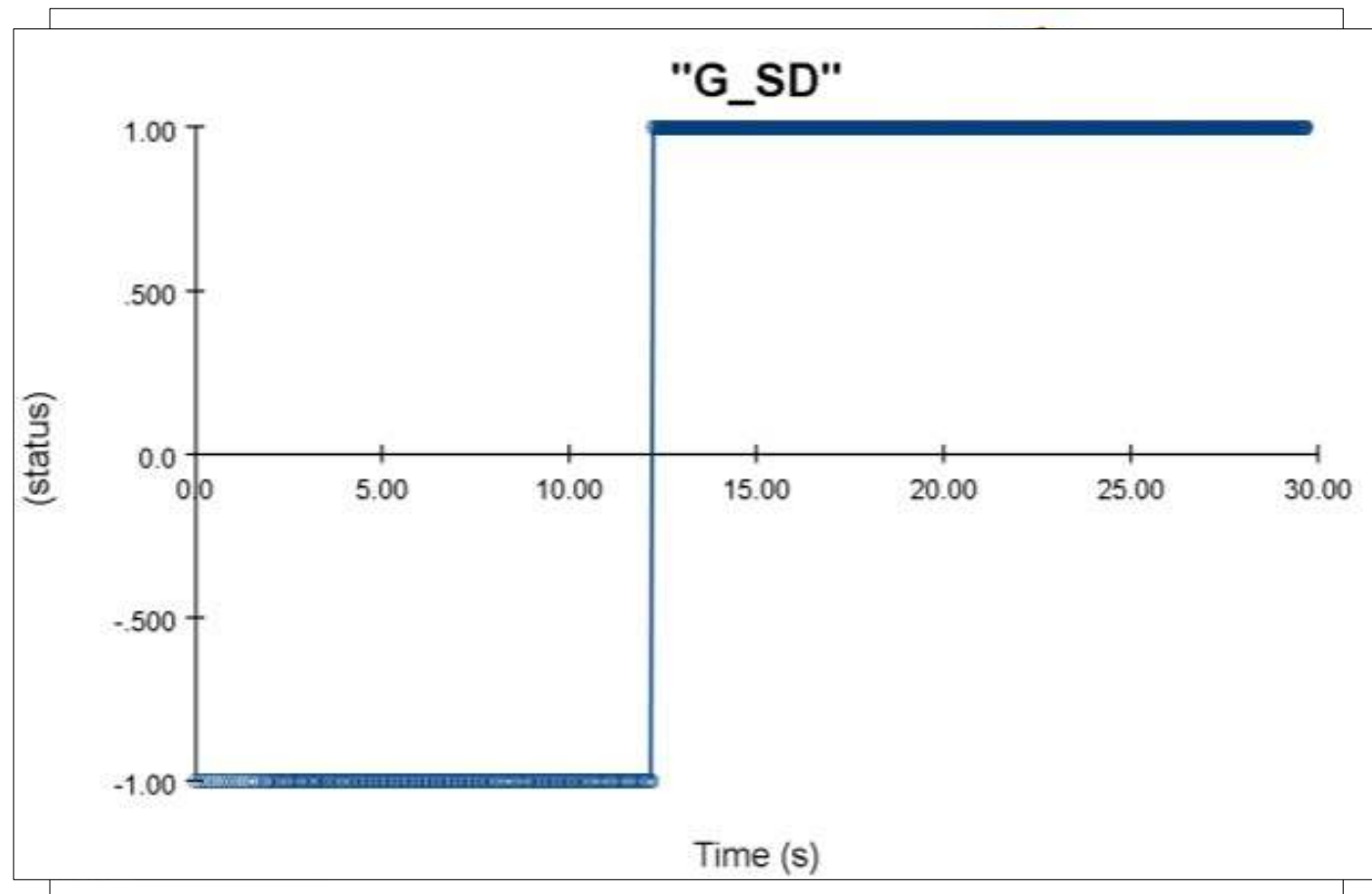
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Physical
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Analyzing the spread of smoke, and gas activation, there is evidence of consistent results, signifying that as a research tool the model is useful in some situations, in particular fire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

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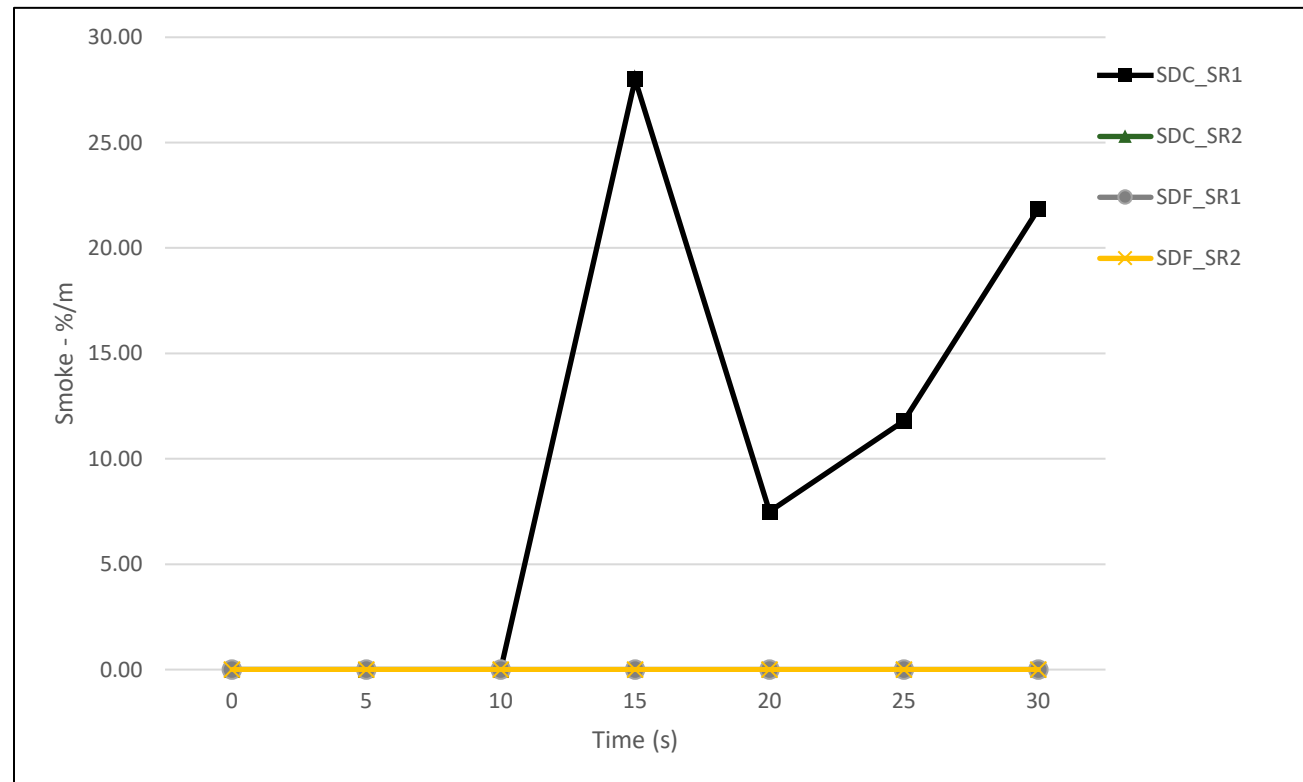
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Physical
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The activation of the gas was allowed by measuring obscuration by smoke detectors, specifically, the controller works after obscuration reaches the smoke detectors, where an obscuration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

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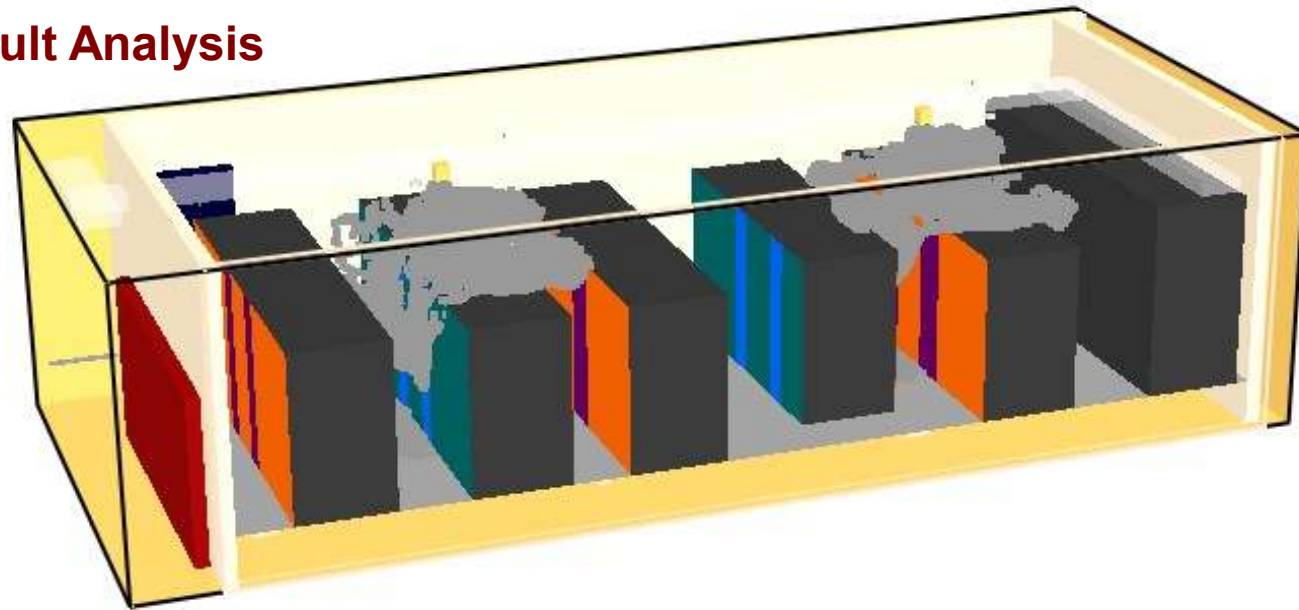
Conclusion



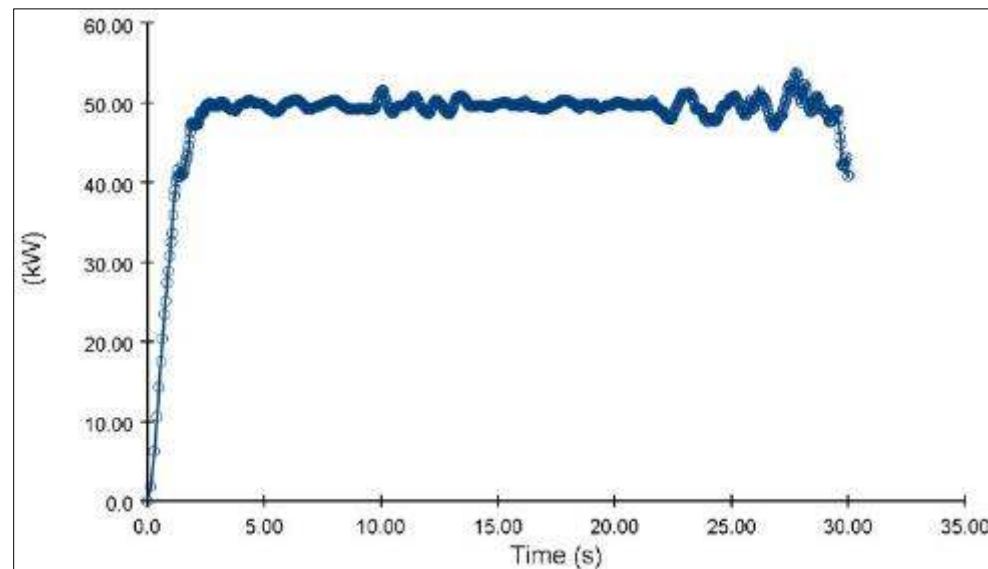
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Note that this rate remains almost constant during simulation, and it tends to decrease from 28s until the end.



Goal

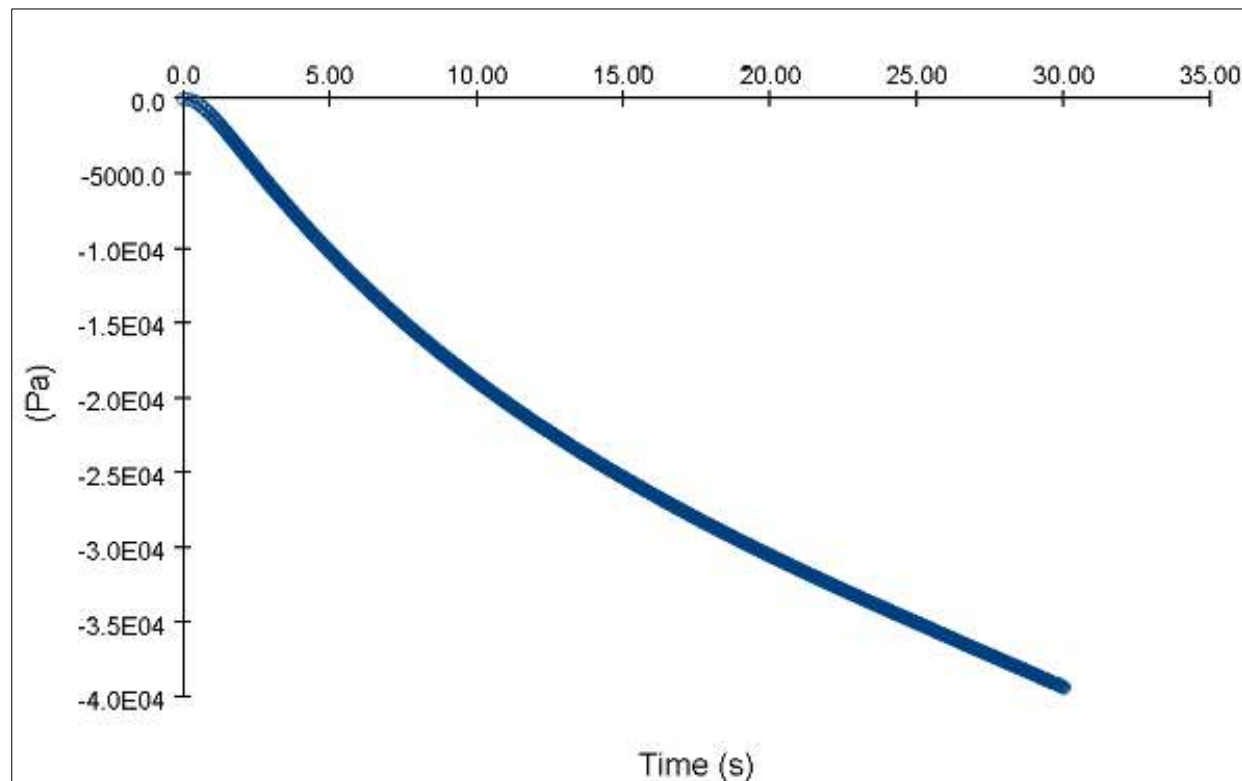
Result Analysis

Physical
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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

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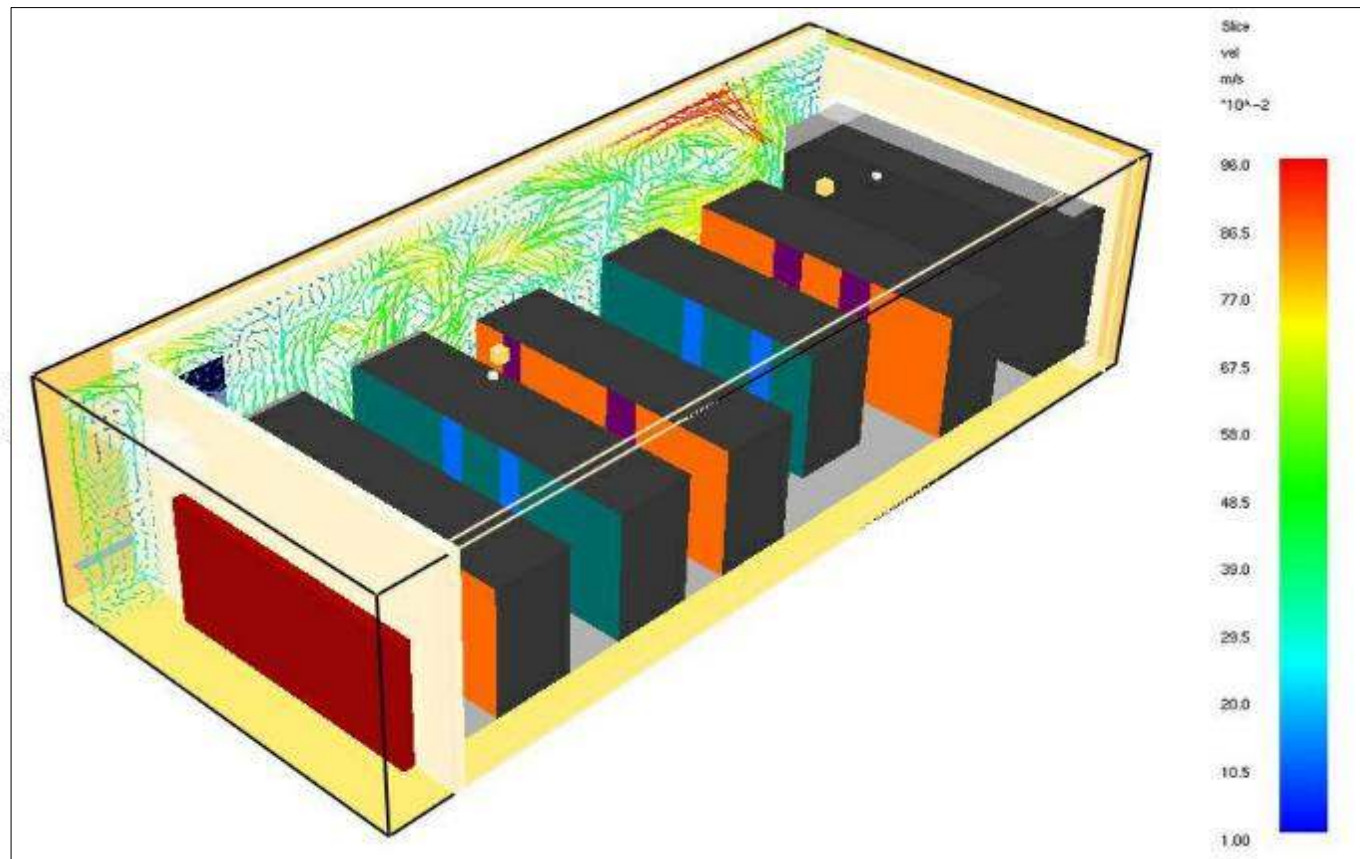
Result Analysis

Physical
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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

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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/>

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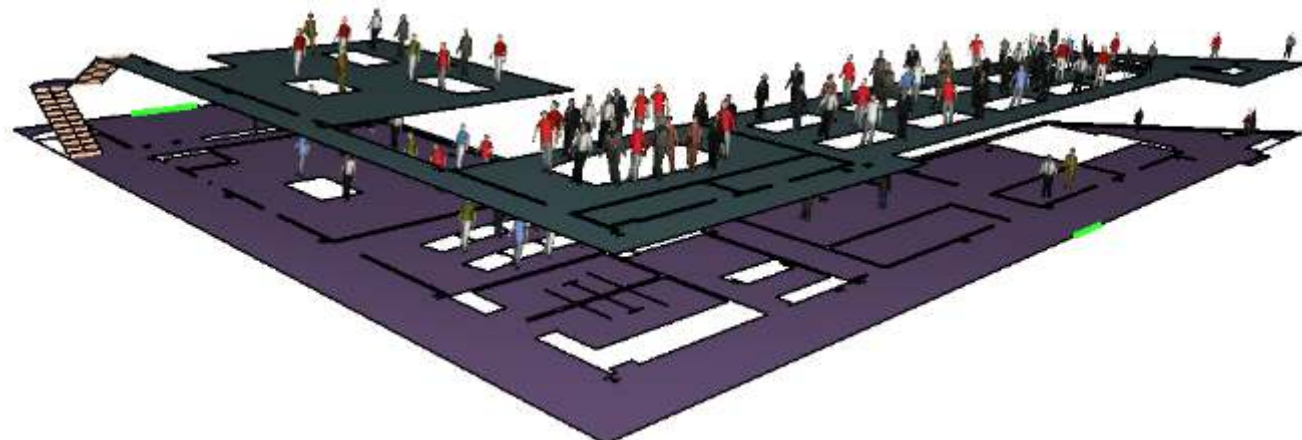
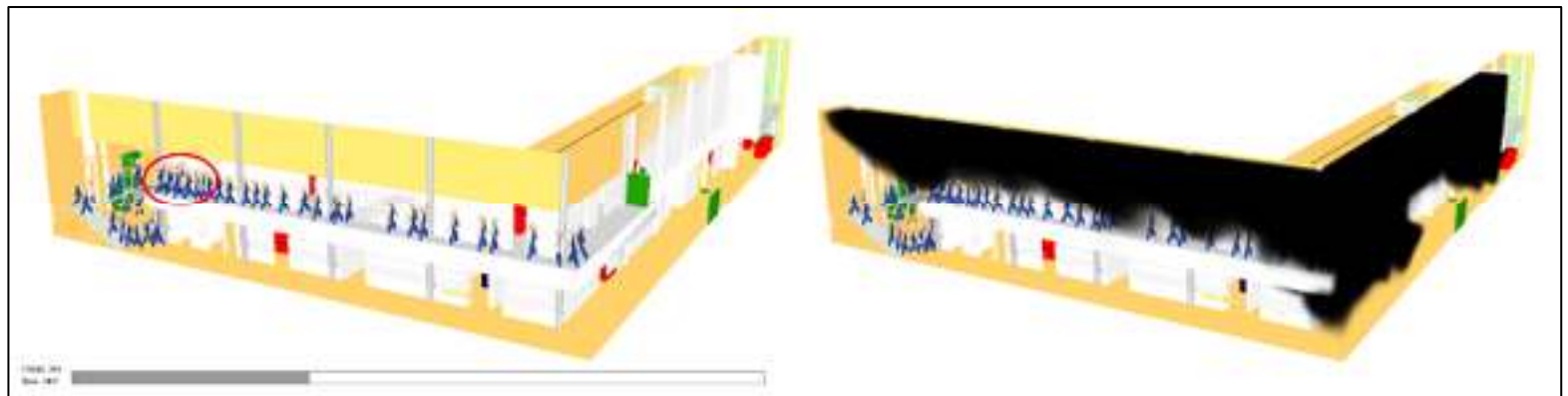
Future Works

Physical
Model

- 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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