Performance Based
FIRE PROTECTION ENGINEERING

Building a Better

Smoke and Heat Venting Solution *for* Cold Storage Facilities *with* Fire Modeling

How Performance Based Fire helped La Tortilleria Purple Crow Facility find an alternative method for cold storage smoke and heat venting.

Cold storage facilities like the La Tortilleria Purple Crow Facility face unique challenges for smoke and heat venting. They must follow strict guidelines to ensure their facilities allow for adequate smoke and heat removal. When the job requires out-of-the-box thinking, Performance Based Fire leads the charge.

Performance Based Fire Protection Engineering, PLLC helped La Tortilleria Purple Crow Facility eliminate 160 square feet of automatic roof smoke venting and provided an effective alternative solution for smoke venting: positive pressurization.

ABOUT

La Tortilleria Purple Crow Facility

La Tortilleria Purple Crow Facility is a cold storage facility located in Winston-Salem, NC. The facility stores a variety of Hispanic food products, from tortillas and chicharrones to tostadas and chorizos.

PROBLEM

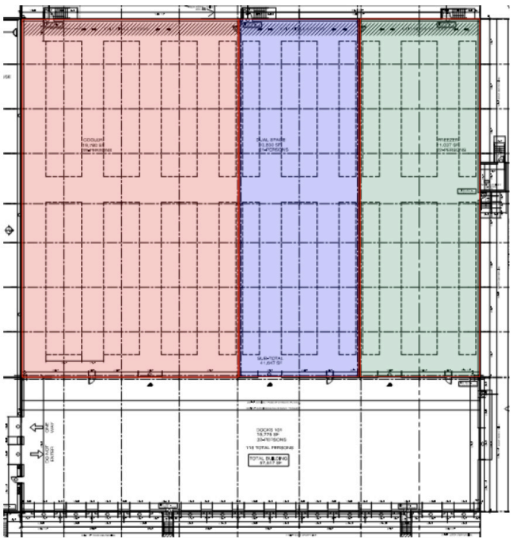
La Tortilleria Purple Crow Facility was in the process of expanding its cold storage warehouse to provide on-site cold storage capabilities, including:

- *Three cold storage compartments*
- *One freezer*
- *One cooler*
- *One dual space that functions as a cooler or freezer depending on the facility's needs*

Because the cold storage warehouse contained combustible high-piled rack storage within three separate compartments of the building, the design team needed to provide smoke and heat removal in accordance with Section 910 of the 2018 North Carolina Building Code (NCBC) and Section 910, Section 3206 and Section 3208 of the 2018 North Carolina Fire Code (NCFC).

The simplest solution to remove the smoke and heat venting requirement is to provide an Early Suppression Fast Response (ESFR) sprinkler system, But the project's owner and design team found that ESFR protection was not feasible due to the installation demands of such a sprinkler system, specifically needing to be in conditioned space. Smoke and heat vents proved difficult because any additional penetrations–specifically at the roof level – would result in decreased cooling efficiency. The team also had concerns about the smoke and heat vents' operational reliability and whether they could potentially cause greater hazardous conditions than if smoke and heat venting were not used at all.

However, the International Building Code (IBC) required smoke and heat venting in the cold storage warehouse, which is most often provided through roof penetrations. The project team feared these requirements would reduce the warehouse's refrigeration efficiency and create maintenance issues.



Cold Storage Areas of La Tortilleria Facility

SOLUTION

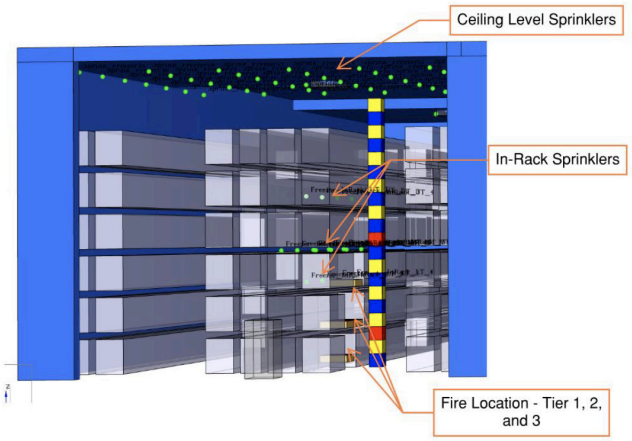
La Tortilleria Purple Crow Facility turned to Performance Based Fire for an alternative means and methods approach, in accordance with Section 105 of the North Carolina Administrative Code.

Performance Based Fire conducted computational fire modeling using a Fire Dynamics Simulator (FDS) to examine the conditions that severe case fire scenarios would be expected to create within the cold storage spaces, specifically regarding sprinkler activation times, automatic smoke and heat vent activation and post-fire smoke removal.

For the analysis, Performance Based Fire considered two baseline fire scenarios within both the cooler and freezer space.

ITERATION A

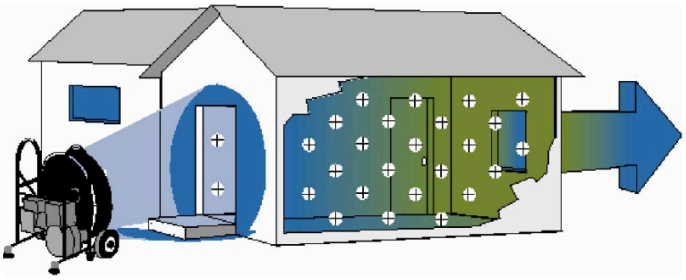
Interaction A considered that automatic smoke and heat vents are provided and allowed to operate at their specified activation threshold of 165 °F (as specified by the design team and contractor's cut-sheet).



Interior FDS Geometry for Freezer Fire

ITERATION B

Iteration B then followed for each space as a separate and distinct simulation, this time excluding the automatic smoke and heat vents. In place of the vents, the model considered utilizing available exterior door locations and upper elevation operable openings for fire department positive pressure ventilation (PPV) operations.



The "Cone of Air" and How PPV Works[6]

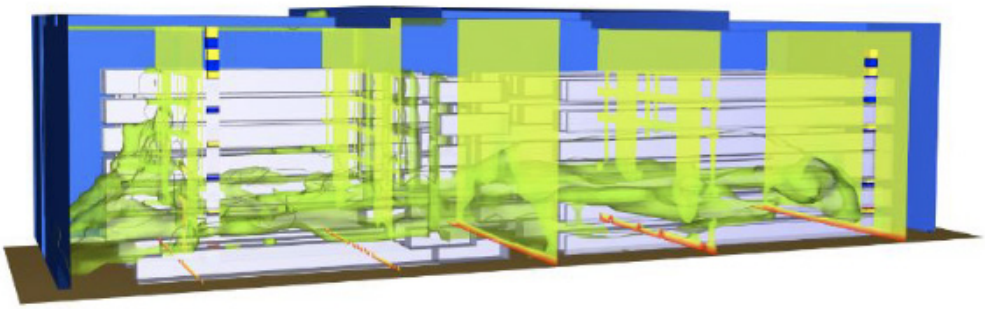
RESULTS

Performance Based Fire studied the prescriptively required smoke and heat vents (Iteration A) and the alternative method of positive pressure ventilation (Iteration B) during winter, summer, and ambient exterior temperatures, as well as normal interior operating conditions. The results were interesting, in which the prescriptive method led to a decrease in performance as compared to the performance-based design approach.

ITERATION A

The first strategy uses smoke and heat vents according to code. In all temperature scenarios, a maximum of one smoke and heat vent activated. However, the vents located farther away from the fire did not experience enough heat to reach the activation temperature. Additionally, the winter sensitivity analysis indicated there is a possibility that the smoke and heat vents may not operate at all during local extreme cold conditions.

Also, in some cases reverse stack effect occurred, where the buoyancy of the fire event did not outweigh the temperature differentials between the exterior and the chilled compartments. This resuled in the smoke and heat vents actually serving as an inlet, not an exhaust. As a result, following the prescriptive code for smoke and heat vents led to a decrease in performance, a phenomenon that the code structure does not account for in cold storage spaces.



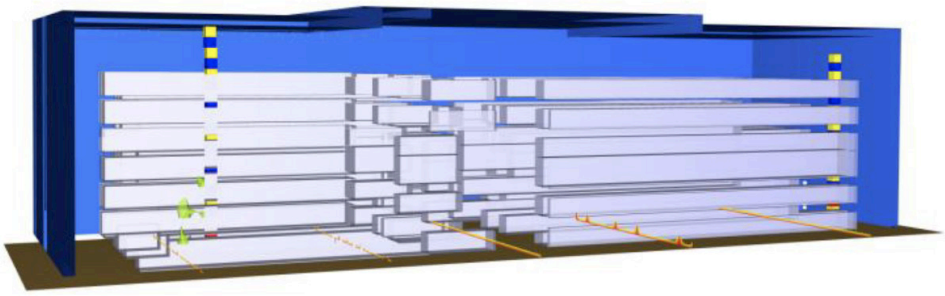
Visibility Conditions in Dual Space at 2,400 Seconds - Smoke and Heat Vents

ITERATION B

The other ventilation strategy used positive pressure ventilation (PPV). To accomplish this, the responding fire department manually implements PPV during its operations. PPV fans are standard equipment on fire apparatus, and it is expected that at least one, if not more, PPV fans will be available on-site for a typical commercial building structure fire response. In this iteration, Performance Based Fire used a single 16-18-inch fan. The data indicates that PPV provides steadier and more reliable ventilation over the course of the fire event.

For example, in one of our simulations, PPV provided similar results to smoke and heat venting. However, during winter and wind sensitivity evaluations, PPV improved the interior conditions more quickly than natural ventilation via smoke and heat vents.

For the freezer fire scenario, PPV was the only method demonstrated to provide effective ventilation for the space. This was because the lower operating temperatures reduced the temperature of the smoke layer and therefore reduced the natural buoyancy of the plume, limiting the flow through the smoke and heat vents. This approach was demonstrated to be a more effective method of smoke removal and provided for overall safer conditions.



Visibility Conditions in Dual Space at 2,400 Seconds - PPV

Bottom Line

La Tortilleria Purple Crow Facility used PPV, which eliminated 160 square feet of roof smoke and heat vents. It also provided an effective alternative solution for smoke ventilation that saved money, energy, and increased safety to emergency responders.

ABOUT PERFORMANCE BASED FIRE

Performance Based Fire Protection Engineering, PLLC is a fire protection engineering company that is passionate about meeting the fire protection and life safety challenges for architects, developers, builders and engineers.

Centered on creating safe, useful and beautiful environments for clients, Performance Based Fire has an expert team of fire protection engineers with decades of experience in the space. Performance Based Fire is headquartered in Raleigh, NC, with offices in Florida, Kentucky and Maryland.

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