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FIRE CONSULTING

Resolving an

Atrium Smoke Control System Dispute *with*

Computational Fire Modeling

How Summit Fire Consulting helped prove the renovated atrium in Accusoft Headquarters' building improved tenability without a smoke control system.

Florida requires new buildings with three-story atriums to have a smoke control system. When Accusoft Headquarters wanted to renovate its existing building, the city of Tampa said the building needed a smoke control system unless a fire protection engineer indicated otherwise. When Accusoft Headquarters sought to make its case that a smoke control system was unnecessary, there was only one company it could count on: Summit Fire Consulting.

Summit Fire Consulting helped Accusoft Headquarters prove the tenability created by its proposed atrium design was better than adding a smoke control system, saving the client about $500,000 in construction costs.

ABOUT

Accusoft

Accusoft is a software development company headquartered in Tampa, FL. The building that houses the company's offices has a unique layout consisting of two offset wings separated by an adjoining atrium.

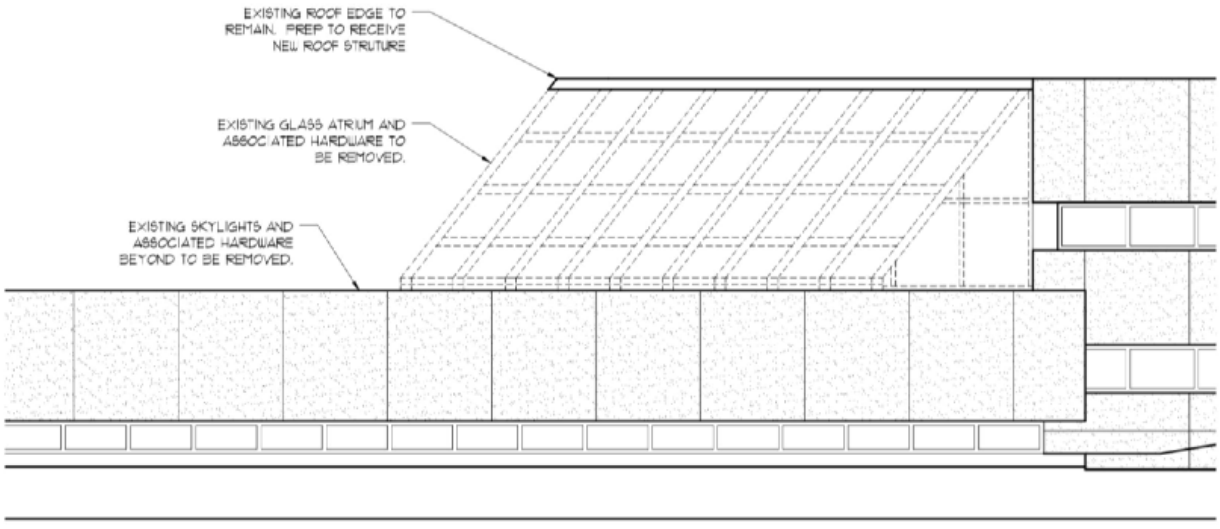
PROBLEM

Accusoft Headquarters wanted to renovate its building to improve offices and accessory support areas for business use. The scope of the project included modifying approximately 7,000 square feet of the first-floor office space and the atrium roof. The existing atrium roof was comprised of glass, which was creating difficulties in keeping the space cool during the hot Florida summers. Also, the existing atrium roof was steeply pitched and causing the space to feel tight and crowded.

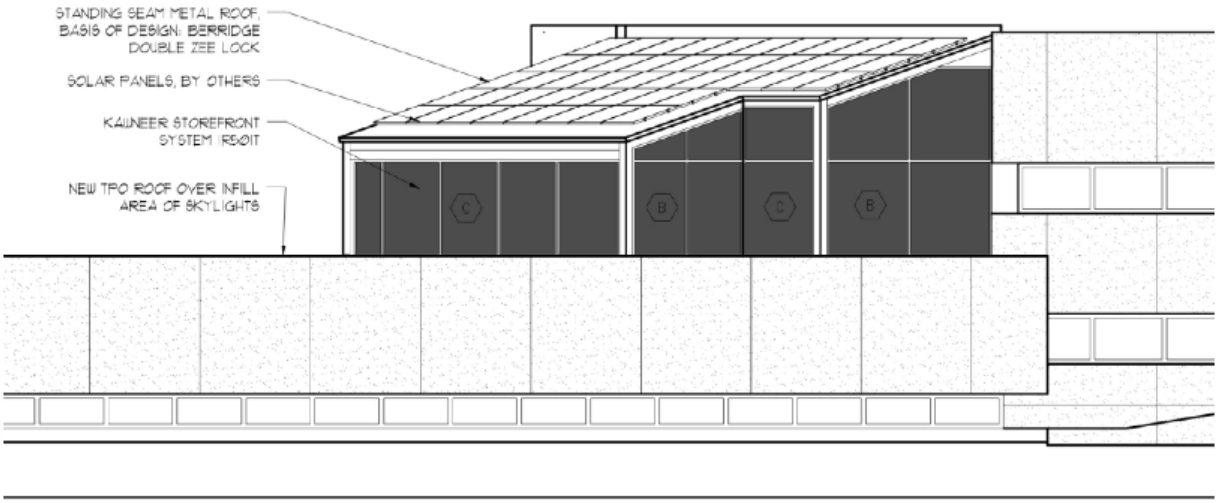
The currently adopted codes include:

- *The Seventh Edition (2020) of the Florida Building Code (FBC)*
- *The Seventh Edition (2020) of the Florida Building Code Existing (FBCE)*
- *The Seventh Edition (2020) of the Florida Fire Prevention Code (FFPC)*
- *The adopted edition of all referenced standards*

The FFPC is based on the 2018 Editions of the National Fire Protection Association (NFPA 1), Fire Code, and NFPA 101, Life Safety Code.



Existing Atrium Roof



Proposed Atrium Roof

The Accusoft Headquarters' renovations are classified as level 2 alterations per the FBC existing. According to the FBCE, a level 2 alteration must comply with the requirements of both level 1 and level 2 alterations, which state:

> ***An existing building or portion thereof must not be altered so that the building becomes less safe than its existing condition.***

To comply with the FBCE requirements, the renovated building must demonstrate that the proposed renovations do not reduce the current level of life safety provided. The city of Tampa plan review commented that the roof alteration increased the atrium volume and suggested that this reduced the level of life safety provided.

Historical editions of the building code required atrium smoke control systems to be sized based on the air changes per hour. The larger the atrium, the more exhaust is required. However, air changes per hour no longer appear in modern codes for the design of atrium smoke control systems. The design of an exhaust method smoke control system is based on maintaining a tenable smoke layer height.

Through this approach, smoke control engineers typically leverage larger volumes, specifically clerestories and vaulted ceilings, to serve as a smoke collection and reservoir space that delays smoke layer descent. This process leads to a decrease in mechanical demand as the additional volume fills with smoke.

Accusoft Headquarters faced two potential paths to code compliance:

1. Add an atrium smoke control system or
2. Submit a separate record that shows the alterations did not reduce the life safety level.

SOLUTION

Accusoft Headquarters turned to Summit Fire Consulting for a fire modeling analysis, which would serve as the required rationale to evaluate if the proposed renovations to the atrium created more hazardous conditions than the existing arrangement.

Summit Fire Consulting performed computational fire modeling to evaluate tenability conditions during selected fire scenarios for the existing atrium and the proposed alteration. The fire protection engineers used a Fire Dynamics Simulator (FDS) to examine the expected smoke movement throughout the atrium.

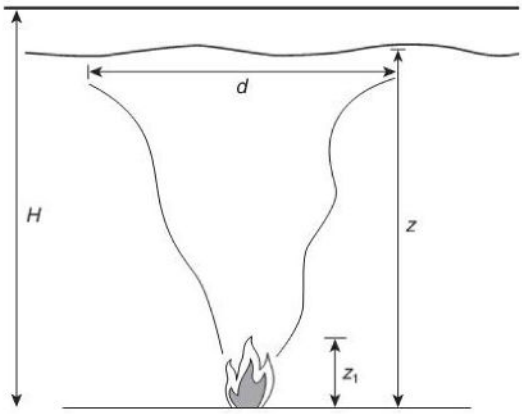
FDS is a computational fluid dynamics model of thermally-driven flows with an emphasis on smoke and heat transport from fires. It accurately captures the geometry of spaces to provide realistic determinations of smoke movement and tenability conditions that are not possible with algebraic hand calculations.

In order to evaluate the fire modeling, the engineers utilized tenability conditions as benchmarks for comparison. The intent of the analysis is to determine if the proposed modifications to the atrium space result in more or less favorable tenability conditions.

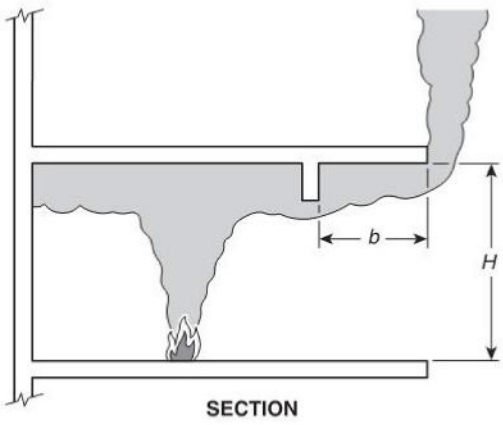
One of the most important parameters used to define a design fire is the Heat Release Rate (HRR). The HRR is the rate at which the fire produces energy and therefore smoke, heat, and products of combustion. The higher the HRR, the more rapidly these products are transported into the modeled domain. HRR is specified as a function of time, with phases consisting of the incipient stage, growth stage, fully developed stage, and decay stage.

Summit Fire Consulting's engineers selected two design fire scenarios to be evaluated as part of the fire modeling analysis:

1. An axisymmetric plume fire occurring in the center of the atrium on the First Floor
2. A balcony spill plume fire occurring in the reception area on the Second Floor



Axisymmetric Smoke Plume



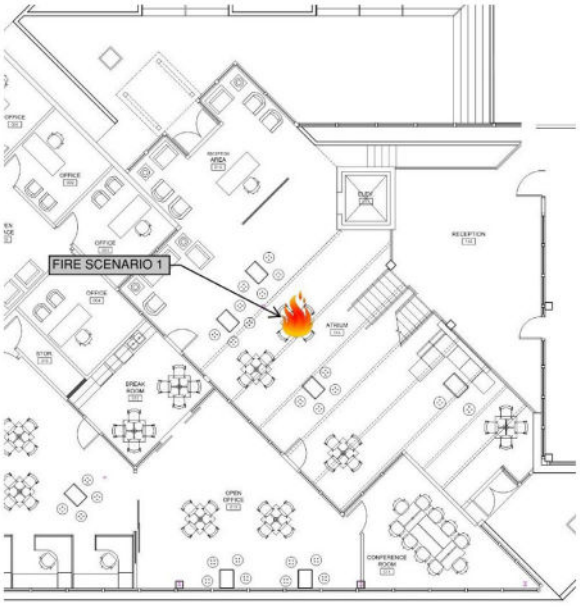
Balcony Spill Smoke Plume

In an axisymmetric plume fire, the smoke plume rises directly above the fire and is unimpeded by contact with walls or other obstacles until it reaches the main ceiling of the atrium. A balcony spill fire plume originates in an area under a confined ceiling, flows under a ceiling and/or balcony overhead, and spills upward into areas open above.

Summit Fire Consulting selected each scenario so that smoke and other products of combustion would directly impact the atrium.

FIRE SCENARIO 1: First Floor Axisymmetric Plume

The first fire scenario originated in the open area of the First Floor, directly below the atrium opening. This was considered a severe case fire event due to the possible fuel loading from upholstered furniture, displays, kiosks, holiday décor and similar furnishings.



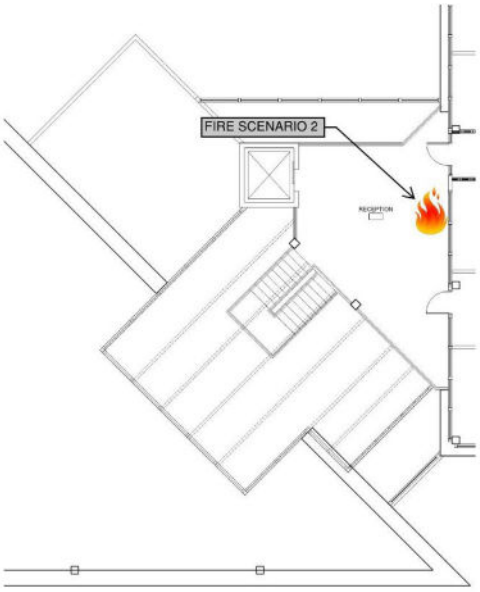
Design Fire Scenario 1, First Floor

Also, this location allows for an unobstructed smoke and fire plume to the atrium's ceiling overhead, approximately 32 feet above the finished floor. This condition would result in the fire's smoke plume being quickly transported to upper levels of the atrium as an axisymmetric plume, impacting occupants on upper floor levels relatively quickly.

The HRR of Fire Scenario 1 was 2,366 kW, representing various wood frame chairs and sofas with foam cushions.

FIRE SCENARIO 2: Second Floor Balcony Spill Plume

The second fire scenario originated in the reception area of the Second Floor. Although this scenario provides a lower energy fire than Fire Scenario 1, the balcony spill plume conditions result in a wide spill plume around the floor above prior to reaching the ceiling of the atrium. This results in a cooler, less buoyant smoke plume and can have a greater impact on occupant tenability.



Design Fire Scenario 2, Second Floor

The HRR of Fire Scenario 2 was specified as 366 kW, which represents a trash bin fire.

RESULTS

Summit Fire Consulting performed a fire modeling analysis to evaluate the level of life safety provided by the existing atrium versus the proposed new geometry of the atrium, which includes a raised atrium roof and increased atrium volume. Tenability conditions, including visibility and temperature, were leveraged as benchmarks for comparison.

Data slice files were utilized to visually portray and evaluate tenability conditions for each floor level, fire scenario and atrium roof condition at identical time steps between the existing and proposed atrium geometries.

FIRE SCENARIO 1: First Floor Axisymmetric Plume

Fire Scenario 1 (Existing): Temperature Conditions 6 feet above First Floor, t=230 seconds

Fire Scenario 1 (Proposed): Temperature Conditions 6 feet above First Floor, t=230 seconds

FIRE SCENARIO 2: Second Floor Balcony Spill Plume

Fire Scenario 2 (Existing): Temperature Conditions 6 feet above Third Floor, t=300 seconds

Fire Scenario 2 (Proposed): Temperature Conditions 6 feet above First Floor, t=300 seconds

The above model output slice figures show that the proposed atrium roof geometry improves the tenability conditions within the atrium when comparing time-step to time-step to the existing conditions. These specific figures depict the temperature conditions, where the colored areas indicate conditions where the temperature exceeds the allowable thresholds.

The increased atrium volume allows more time for the smoke to fill the space before descending and impacting each occupied floor.

BOTTOM LINE

Thanks to Summit Fire Consulting's thorough analysis, Accusoft Headquarters was able to prove that its proposed atrium geometry improved life safety. Thus, it did not have to install an atrium smoke control system. This saved Accusoft significant time and expense – resources that the company could put back into operating its business.

ABOUT SUMMIT FIRE CONSULTING

Summit Fire Consulting is a team of licensed fire protection engineers and code consultants partnering with owners, architects, and developers to solve complex code challenges, accelerate approvals, and unlock designs others say can't be built.

Going beyond compliance, Summit Fire Consulting designs safer, more efficient buildings that maximize long-term value. Backed by the strength of the full Summit Companies network, our team delivers responsive, code-aligned solutions wherever your project takes you.

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