Combustion Science & Engineering Inc

1998 - 2018 20th ANNIVERSARY

CSE Fire Protection Design Services

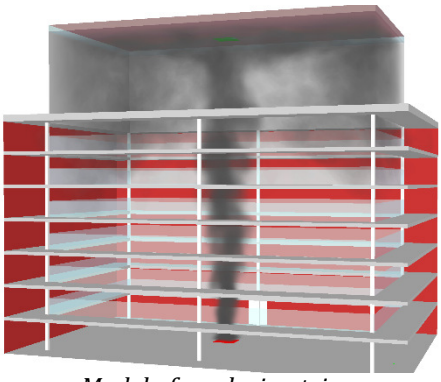
Smoke Control System Analysis

The spread of smoke represents the greatest hazard to occupants, especially in large buildings. An analysis of the predicted smoke movement and extraction, coupled with an occupant egress time calculation, can determine whether the proposed design will allow occupants to safely egress before being exposed to hazardous conditions. Combustion Science & Engineering, Inc. (CSE) can provide detailed analysis and 3D modeling of complex smoke control systems, both mechanical and natural ventilation, using the latest modeling tools and computer hardware. For smoke control systems that go beyond the prescriptive designs, the experienced staff of CSE will evaluate proposed systems in accordance with the prescriptive and performance based options in the International Building and Fire Codes, NFPA 92 and other codes.

The smoke control analysis can be used as an important part of the performance-based design process, to evaluate existing systems, or third-party review of proposed designs. This can allow for enhanced life safety while simultaneously reducing both initial and long-term costs compared to a prescriptive design. An advanced smoke control analysis is often beneficial for complex facilities such as:

- Atriums and vertical connecting spaces
- Large open spaces; arenas, theaters
- Stairwells and elevator shafts
- Underground facilities and parking garages

Detailed analysis and Computational Fluid Dynamics (CFD) modeling can also be beneficial to other unusual designs, where multiple occupied spaces are connected but it is impossible or undesirable to provide smoke-proof separation.



Model of smoke in atrium

Fire Modeling

For complex structures the primary tool for detailed smoke control analysis is a Computational Fluid Dynamics (CFD) model simulation. To predict the flow of smoke through a building over the full course of the fire, a 3D model of the space is constructed. Staff members at CSE each have over two decades of experience using the Fire Dynamics Simulator (FDS) model for design, research and forensic applications, including presentation of results to Authorities Having Jurisdiction (AHJ). The model is developed by the National Institute of Standards and Technology (NIST) and has been extensively validated and is used by fire protection engineers around the world. Using their expertise, CSE will interpret the results and provide easy to understand visual representations of the fire and smoke conditions in the building under different system configurations, weather conditions, fire scenarios, and many other variables.

Expertise

- Smoke control
- System performance
- CFD modeling
- FDS simulation
- Alarm and sprinkler activation
- Egress analysis
- Human movement
- Tenability and exposure
- Smoke toxicity
- Gas dispersion
- Pressurization
- Fire exposure
- Weather effects
- Natural ventilation
- Spill plumes
- Prescriptive-based (NFPA 92) design
- Performance-based design

Applications

- Atriums
- Stadium/arenas
- Theaters
- Parking facilities
- Stair/elevator shafts
- Warehouses
- Industrial facilities
- High-rise buildings

Please contact us to discuss your needs

www.csefire.com
info@csefire.com
(410)-884-3266

Combustion Science & Engineering, Inc
8940 Old Annapolis Rd
Suite L
Columbia, MD, 21045
USA

Combustion Science & Engineering Inc

1998 - 2018 20th ANNIVERSARY

Benefits of Smoke Control Analysis

Atriums

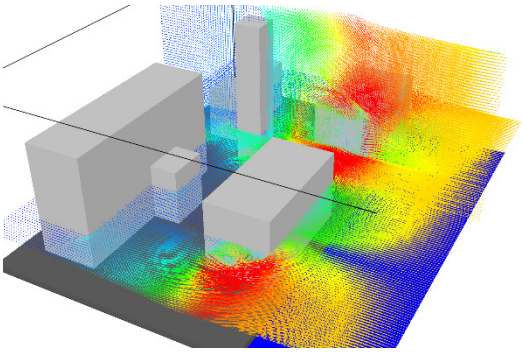
The prescriptive codes require that atriums, and other vertically connected spaces, have a smoke exhaust system in order to maintain the smoke layer at six feet above the highest occupied level for a 20 minute design fire. This leads to large and expensive exhaust and makeup air fans in the atrium, high maintenance costs, and reduces architectural flexibility. A detailed fire modeling analysis of the space can predict the rate of smoke filling versus time for a number of different exhaust rates, fan placements and configurations, and makeup air methods. By showing that the occupants are able to safely escape, the performance-based options of the building codes allow the smoke to descend past that level, resulting in significant savings and allow for more flexible design options.

Structural exposure

Heat exposure to structural members can be vital to analyze structural integrity and risk of collapse during and after a fire. The FDS model employs detailed heat transfer algorithms which can give the time history of temperatures of critical members, as well as detailed 3D maps of material surface temperatures for the whole structure.

Wind modeling and gas dispersion

Modeling of wind can be done for single buildings, or larger areas up to several city blocks, limited by the desired level of detail. This can be useful for identifying high- and low-pressure zones, for example to evaluate the effects on doors and windows. The model can also predict spread of gasses released through an area, such as from chimneys, vehicles or accidental chemical releases.



Wind flow around buildings

Sports arenas and theaters

Similar concerns to those found in atriums are present in large assembly spaces such as basketball arenas, theaters, concert venues etc. With the added complexity of large numbers of people and often long egress times. A large fire on the lowest level of the space can lead to significant smoke exposure to people on the highest levels. With particularly severe fire loads (for example stage and concert equipment) the effects of heat on the structural integrity of the roof and supporting structure can also be a concern. Large and open spaces such as airports, malls or warehouses can also have difficult and complex smoke spread which can be predicted using a CFD model to determine the best exhaust and egress strategy.

High fuel load, high occupancy, large space

Egress Modeling

In addition to fire and smoke modeling, CSE also has skills and experience in modeling of occupant movement and exiting using the Pathfinder model. Many commercial buildings will lead to more complex egress situations, for example merging of crowds from several floors, door prioritization, or effects of multiple occupant groups with different movement speeds such as wheelchairs, children or elderly.

Realistic avatars in Pathfinder egress model