Questions & Replies from CIBSE/ASHRAE Webinar Zone Fire Modeling and CFD Analysis

December 13 2017

Note: Some questions were similar, and only one of these was answered.

Question: Why not just use the CFD, and not bother with CFAST?

Reply: CFAST can do some things quickly which can make a designer more competitive in the market place. CFD takes hours or days to do one atrium smoke control simulation, and several CFD simulations are usually needed for an atrium design analysis. CFAST runs in less time than it takes to pick up a pencil. CFAST can do a high quality job of helping to develop design fires, and it can be used to check the feasibility of an atrium smoke filling system. CFAST cannot take the place of CFD when a detailed simulation is needed. However, CFAST can save the engineer valuable time.

Question: Can CFAST be used also to calculate the extension of hazardous (explosive) areas?

Reply: CFAST can simulate gas expansion due to a fire, but it cannot simulate an explosion.

Question: Can CFAST model the thermal profile?

Reply: CFAST simulates a simple thermal profile with one temperature for the lower layer, and another temperature for the smoke layer. This simple profile has been compared to data from many full-scale fire tests, and it is surprising that it looks better than you might think. Of course, this simple profile does not include the ceiling jet temperature.

Question: Does CFD or CFAST take into account the use of smoke vents?

Reply: Yes, both models can take into account (1) volumetric ceiling and wall exhausts like those of fans and (2) openings in ceilings and walls with flows due to buoyancy.

Question: Is there any difference in modelling atria and warehouses?

Reply: While the fire physics is the same, a warehouse has fuel stacked up very high, but an atrium has much less fuel. A design analysis needs to take this into account.

Question: I am looking through the CFAST User's Guide now, and I cannot find how to determine visibility.

Reply: You should be using CFAST version 7.2.2, and the User's Guide dated May 2017. Visibility is mentioned on page 55 of the guide. The key to simulating visibility in

CFAST is to define the heat of combustion and the soot yield (p 30 of the guide). The soot yield is called the soot fraction in the Handbook of Smoke Control Engineering.

Question: Is CFAST capable of predicting stratification within the atrium.

Reply: There are two kinds of stratification: (1) the hot air layer under the ceiling due to solar radiation on the roof, and (2) the stratified smoke layer that can form under the hot air layer. CFAST cannot simulate these stratified layers. Stratification can be simulated with a CFD model, but it is somewhat complicated.

Question: Is CFD analysis alone enough to justify the design of a smoke control system? Or should it be backed up by other methods?

Reply: If you are talking about a design analysis of an atrium smoke control system, a designer could only rely on CFD simulations with tenability analysis. However, CFAST can reduce the number of CFD simulations regarding design fires. Plus, CFAST may demonstrate that smoke filling is not feasible thus eliminating the need for many CFD simulations.

Question: For your sofa example, did you use CFAST or CFD to calculate the visibility for the different atria?

Reply: The purpose of the sofa example was to show how CFAST could be used to check the feasibility of atrium smoke filling. CFAST can be used to calculate visibility. If the CFAST check looks favorable, CFD with tenability analysis is recommended for the design analysis of smoke filling systems.

Question: Regarding the idea of adding exit signs to improve the egress route visibility.....often the exit signs are not precise in their directional value, i.e. the wrong chevrons are uncovered, or none are. Is this part of the design specifics when credited so heavily?

Reply: If visibility is calculated for illuminated exit signs, the design team should address this issue with the code authority, and the exit signs should be designed and installed carefully.

Question: This is slightly off topic, you mentioned NFPA 92, with regards to the acceptance testing phase, does the construction need to be 100% complete? and if changes occur to installed equipment after the test has been completed does it need to be retested?

Reply: The commissioning needs to be done throughout the construction process, and the plan for acceptance testing should be developed and approved by the code authority early in the project. Acceptance testing should be done at the end of construction when everything is complete (with the possible exception of some painting).

Question: What CFD software might be used for tenability analysis, other than FDS?

Reply: In the early 1990s, I procured the first CFD model used for fire simulations at the U.S. National Institute of Standards and Technology (NIST). This model was from the Harwell Laboratory in the UK, and we had to write FORTRAN computer code to use the model for fire applications. Today, I think many CFD models (1) have tenability features or (2) can be adapted for tenability analysis.

Question: When using CFD, is it best to keep the model to a basic form - for example, where several areas are to be analyzed at the same time?

Reply: It is always best with CFD to simulate the atrium and areas open to the atrium at the same time.

Question: With regards to Jin's criteria (4 - 14m), it was said the range is suitable for occupants who are familiar with the space. Is this applicable to unfamiliar occupants who are queuing within vicinity of exit area (say within 5m of exit door)?

Reply: Jin suggested the range of visibility criteria of 4 to 14 m, and the low end of this criteria is for applications where the people are very familiar with the space. This low end of the criteria is not appropriate for applications so many people that there is queuing at the exits.

Question: Would CFAST boundary conditions allow for wall temperatures and heat transfer to be taken into account? I am interested in the effect which cooling may have on the smoke layer.

Reply: CFAST allows users to specify wall, floor and ceiling materials, and then heat transfer is calculated.

Question: CFAST can calculate when sprinklers or detectors will activate in the fire?

Reply: Yes.

Question: Could we use CONTAM for smoke control modelling in normal enclosure?

Reply: CONTAM was not mentioned in the webinar. CONTAM is a network model that can simulate the flow of air or smoke through a large multi-compartmented building. CONTAM can be downloaded free of charge from NIST, and CONTAM has been extensively used for analysis of pressurization smoke control systems. It is not appropriate to try to simulate atrium smoke control with CONTAM.

Question: It would be good if I could get examples of how to use CFAST.

Reply: When you download CFAST, you should download CFAST, documentation and examples from https://pages.nist.gov/cfast/ . This is the NIST page for downloading CFAST, and **do not use any other webpage**! With other webpages, you many get out-ot-date material or possibly malware. It is recommended that you start using CFAST by modifying the examples that come with it.

Question: Is the evacuation time the time to leave the atrium or the building?

Reply: For analysis of atrium smoke control system, the logical evacuation time to use is the time that people in the atrium and spaces leaving through the atrium need for evacuation. Calculated evacuation time needs to include people movement time plus an allowance for premovement as discussed in the Chapter 4 of the Handbook of Smoke Control Engineering.

Question: Is CFAST only to be used as a preliminary tool and then to use CFD or formula method for design?

Reply: For atrium smoke filling, CFAST can be used as a preliminary tool to check feasibility. If it shows that smoke filling may be feasible, CFD with tenability analysis is recommended for design analysis. The equation (or formula) method is not good practice for atrium smoke filling because it does not include tenability. Adapting the equation method for tenability analysis is not feasible because of (1) the time required, and (2) the poor quality of the resulting analysis.

Question: What are the pros and cons of CFD vs. FDS.

Reply: FDS is a CFD model. The main advantages of FDS are (1) it was specifically developed for fire applications, (2) it has been rigorously verified and validated in accordance with the requirements of the U.S. Nuclear Regulatory Commission, (3) it runs quickly because the numerical solver based in fast Fourier transforms, and (4) it can be downloaded from NIST free of cost. A disadvantage of FDS is that the cells must be rectangular parallelepipeds. Some other CFD models can have curved and irregular shaped cells, but these models tend to require more running time.

Question: How can zone fire models be used to help develop design fires?

Reply: CFAST has the ability to calculate the activation time of sprinklers in a room of specific geometry with specific openings to the outside. This activation time can be combined with a fire growth curve and a sprinkler decay curve to give a design fire for that specific room.

Question: BRANZFIRE is now known as B-RISK.

Reply: Thanks! – I checked this, and B-RISK is the new zone fire model from BRANZ.