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TESTING FIRE MODELING: THE RESULTS OF THE DALMARNOCK FIRE TESTS

By Richard Schulte

In 2006, an experiment designed to test the capabilities of fire models and fire modeling teams was conducted in a 23 story reinforced concrete apartment building. An apartment in the building was furnished and instrumented and then a fire was ignited in the apartment.

In this experiment, a total of 6 modeling teams participated and developed 10 fire modeling simulations in order to predict the results of the experiment without knowing the results until after the modeling was completed. Eight of the modeling simulations utilized a computational fluid dynamics (CFD) model, Version 4 of the Fire Dynamics Simulator (FDS), while the other two simulations utilized zone models.

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A paper titled "*Round Robin Study of a priori Modelling Predictions of The Dalmarnock Fire Test One*" authored by Guillermo Rein, José L. Torero, Wolfram Jahn, Jamie Stern-Gottfried, Noah L. Ryder, Sylvain Desanghere, Mariano Lázaro, Frederick Mowrer, Andrew Coles, Daniel Joyeux, Daniel Alvear, Jorge A. Capote, Allan Jowsey, Cecilia Abecassis-Empis and Pedro Reszka and published in *Fire Safety Journal* in 2009 provides a discussion of the experiment.

The results of this experiment are contained in Table 2 of the paper referenced above. The following is the data included in Table 2:

"**Table 2: Comparison of simulated time to flashover and maximum average temperature in the smoke layer of the main compartment with experimental data.**"

Simulation	Time to Flashover [s]	Maximum Average Smoke Layer Temperature [°C]
A1	850	790
A2	290	500
B	840	690
C	no flashover	200
D1	200	720
D2	80	1150
E1	180	900
E2	180	610
F1	720	590
F2	850	720
Experimental	**300**	**750**

Discussion

If you review the data from the experiment contained in the table above, right about now you might be shaking your head in disbelief.

Given that, the lack of accuracy of the predictions is not all that unexpected.

While the fact that the simulations were unable to accurately predict the time to flashover and the maximum average temperature of the smoke layer reached might be upsetting, it is well-known that the fire models don't do fire spread very well. Given that, the lack of accuracy of the predictions is not all that unexpected.

What is disturbing, or alarming, about the results, however, is the scatter of the predictions. Each of the modeling teams was given a single problem and it would be expected that the teams would come up with a single or, at the very least, similar answers to that problem. Instead, we got 10 modeling simulations and 7 very different predictions as to when flashover would occur and 9 very different predictions as to the maximum average temperature of the smoke layer which would occur.

What this means is that, even if the physics contained in the model is perfect and even if the physics is perfectly implemented using mathematics, the correct input into the model is crucial to getting the correct output. There is nothing new about that-the axiom "garbage in, garbage out" has been around a long, long time. The problem lies in the fact that the "experts" apparently disagree on the correct input to the model.

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The results of this experiment are disturbing on another level. Many engineers using the fire models which have been developed, in particular models which use computational fluid dynamics, don't realize that the accuracy of every prediction produced is suspect. Many users say that they use the models with conservative input, but it is difficult for a modeler to determine the actual "factor of safety" being used for every input. Without knowing the "factor of safety" for multiple inputs into the model, how does a modeler know that the model input is actually conservative?

If teams of experts working on the same problem can't get similar predictions with the model, it seems reasonable to ask: are there really any "experts" in the field of fire modeling or is fire modeling just "junk science"? After considering this question for a couple of years, I have my suspicions that the answer to that question is "junk science".

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Perhaps my conclusion regarding fire modeling is incorrect, but certainly it seems that it is reasonable that a "prudent man" ask lots of questions before accepting the predictions of a fire model.

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