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Commentary on: Chi JH, Wu SH, Shu CM. Using fire dynamics simulator to reconstruct a hydroelectric power plant fire accident. J Forensic Sci 2011;56(6):1639-44.

Sir,

During my review of this article, I found errors, unreliable methodologies, and results that are not consistent with existing data. Further, the assumptions in the analysis made were not verified with data from the actual fire loss. More specifically:

Equation 1, as provided, produces a mathematical result (11.4 kW/m^2) for the heat release rate (HRR), that is, orders of magnitude different than the published mathematical result (11,500 kW/m^2). The error seems to be traceable back to the units of the Molecular Weight (MW), which is traditionally expressed in units of grams per mole. Equation 1 did not account for the total mass of the transformer oil from units of kilograms (kg) to units in grams (g).

In the article, the authors rightly identify the very important role of HRR and its effect on the output variables associated with the thermal environment and concentrations of the products of combustion. The calculated HRR of 11,500 kW/m^2 for transformer oil is an order of magnitude higher than existing data. The effective *heat of combustion* for transformer oil is reported as 46,400 kJ/kg, and the *mass loss rate per unit area* is reported as 0.039 kg/m^2 sec (1). Thus, the product of the ΔH_c and the mass loss rate per unit area produce an HRR per unit area[1] of 1810 kW/m^2.

The article does not discuss whether the assumption of the area of the pool in this specific event was a valid assumption when compared to the physical evidence after the fire. The analysis assumes that the transformer oil burns with an exposure surface area equal to the area foot print of the transformer that contains the transformer oil. Most fire incidents involving electrical transformers involve the burning of the transformer oil outside of the electrical transformer owing to a liquid spill or an internal overpressure. The HRR of a liquid pool fire is dependent on the surface area of the liquid pool. As is shown with the HRR per unit area, the larger the surface area of the liquid pool, the greater the HRR.

The calculation of the HRR in Eq. (1) does not verify the implicit assumption that all of the energy contained within the transformer oil was released in 7200 sec or 2 h (2). Again, the article does not discuss whether the assumption of the burning duration of the liquid pool fire in this specific event was a valid assumption when compared to the physical evidence after the fire. Were there any remaining amounts of transformer oil after the fire that would validate or refute this implicit assumption?

There is no indication that the analysis used anything other than the default carbon monoxide (CO) production submodel in Fire Dynamics Simulator (FDS), which would significantly underpredict the amount of CO produced in this fire because the results show a significant reduction in the percentage of available oxygen (see Fig. 4*d*). It is well established that CO production in fires is much less dependent on the type of fuel than it is on the amount of available oxygen to support the combustion process (3). While the FDS model can be calibrated to produce CO based on the percentage of available oxygen, the default in FDS is for the production of CO to be based on a well-ventilated fire, where CO production rates are relatively low when compared to ventilation-limited fires.

The article did not report on the level of CO in the blood of the victims. While the concentration of CO is a required element in a tenability analysis, it is the percent concentration of carboxyhemoglobin (%COHb) in the blood of the victims that is the determining factor. Such data also provide a further means to verify the results of the fire model against the physical evidence from the fire incident.

The article provides no references as to the ability of aluminum blinds to "fracture" at temperatures not much above room temperature as shown in Fig. 4*a* at 15 sec after ignition. If the failure of this barrier to limit the transport of flame and smoke outside the room of fire origin is a sensitive variable with respect to an analysis of the Available Safe Egress Time (ASET), then the analysis should provide a scientifically reliable means to assess the structural integrity of this fire barrier.

These errors, unreliable methodologies, results not consistent with existing data, and assumptions not verified with data from the actual fire loss should have provided an indication to any knowledgeable reader that there are significant problems with the analysis presented in this article.

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[1]With respect to consistency of units, a kW is a kJ/s.