Effect of Ignition Location on Heat Release Rate of Burning Upholstered Furniture

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Upholstered furniture has long been identified as the consumer product most frequently involved in home fires which result in personal injury or death. Hence an understanding of the way upholstered furniture performs when ignited, is desirable.

One aspect of furniture burning which has not received much attention is the possible dependence of the burning behavior on the location of the ignition. We selected four sites to investigate: (1) the center of the chair seat cushion, (2) lower center of the chair front, (3) lower center of the chair side, and (4) lower center of the chair back, as the four ignition locations for the current chair burn tests.

Based on previous furniture flammability studies, it has been found that the single most important characteristic, in terms of hazard, associated with upholstered furniture fires is the rate of heat release (RHR) history, especially the peak heat release rate.[1] We therefore concentrated on the rate of heat release history as a function of ignition location.

A series of twelve full scale chair burns were carried out inside the NIST full-scale fire test facility. Four kinds of full-size chairs were tested in our furniture calorimeter which, with its instrumented exhaust products collection system, can measure accurately fire heat release rates up to 700 kW.

The heat release rate was determined via oxygen consumption calorimetry. Other measured test data were CO concentrations, which is relevant to hazard from fires, mass loss rate from the weighing platform (needed to get the CO **yields**, and as a check on the RHR), and smoke production rates during the test period. A heat flux gauge was located 0.76 m from the chair front to monitor the radiative heat flux. The (flaming) ignition source was a propane gas tube burner of 10 kW capacity applied to the chair for sixty seconds.

The figure presents the heat release rate data, the peak heat release rate values and the times at which the peak heat release rate occurred for chairs of style C, with ignition at the four different locations. The heat release rate data were calculated based on the oxygen depletion and mass flow rate of exhaust gases through the exhaust duct.

The most striking effect on ignition-delay time is seen for chairs of style C, which used melamine-treated polyurethane foam. There the **shortest** delay before significant fire onset was about 10 minutes, generally enough time to alert occupants and permit extinguishment or escape. The rise to the peak RHR took another 4 minutes.

Ignition of the seat front (chair C4) almost failed to take place: although the fabric was ignited, the wood frame right under it acted as a heat sink, and failed to ignite at first. The burning then continued was largely smoldering but with a small sustaining flaming fire, and the transition to strong flaming only occurred after about 2200 seconds - i.e. about 36 minutes - when the cushion area was reached. The growth to the peak RHR was also somewhat slower here: it took another 5.3 minutes to reach the peak.

The principal conclusion of this study is that the location of the initial ignition can have a significant effect on the elapsed time to reach the peak heat release rate.

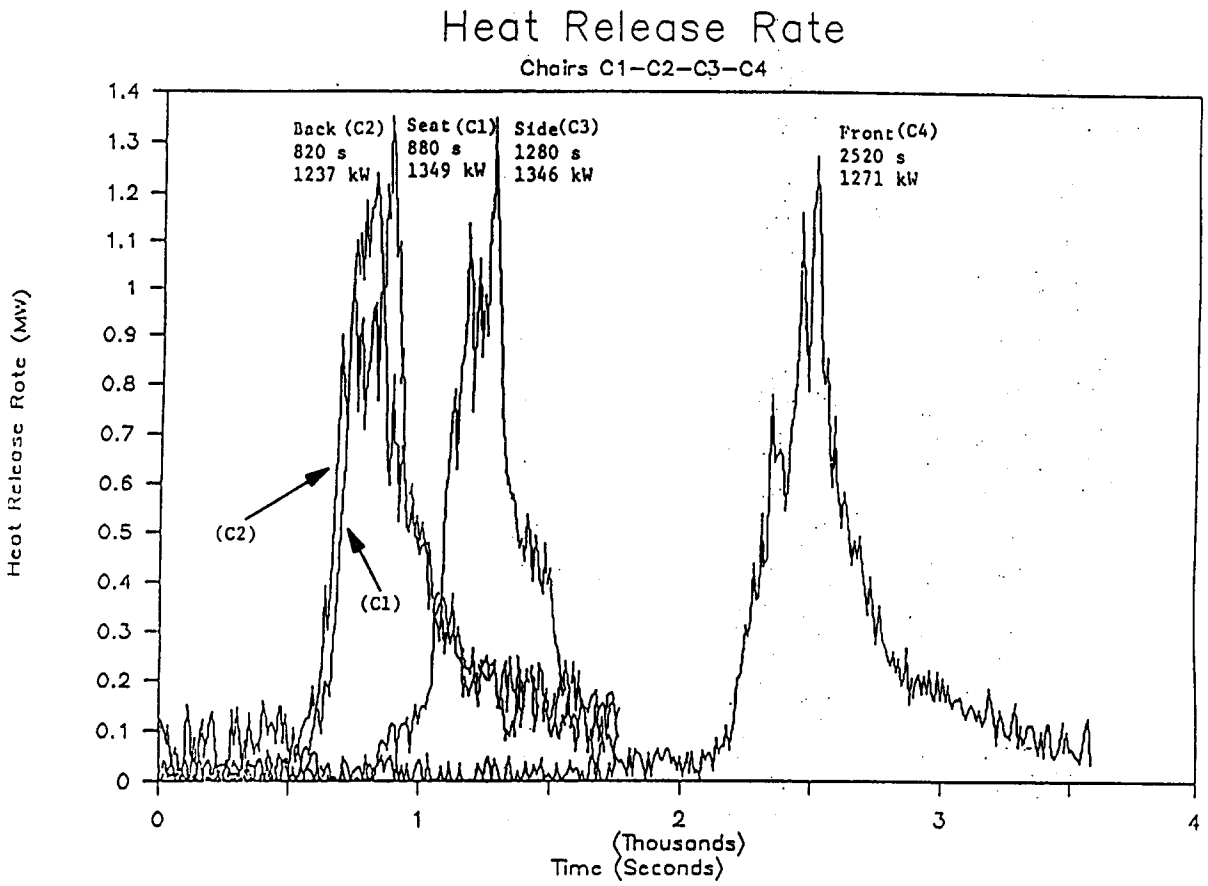

Figure 5. Heat Release Rate (Chairs C1, C2, C3 and C4)

References

1. V. Babrauskas and R.D. Peacock, "Heat Release Rate: The Single Most Important Variable in Fire Hazard," Fire Safety J. 18 (1992) 255-272