The 1988 NIST FR products study and industry misrepresentations of its implications

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In 1988, the National Institute of Standards and Technology (NIST, formerly called NBS) published a large-scale study on plastic commodities comparing the fire behavior of non-FR and FR items[1]. This study was widely cited by makers of halogenated FR chemicals as supporting their views that (a) FR chemicals provide a fire safety benefit when added to consumer products such as upholstered furniture foams; and (b) their use reduces, instead of increasing the evolution of toxic chemicals. These type of presentations are technically incorrect and misleading and imply conclusions which are technically unsound and unjustified.

To appreciate the problems with the FR chemical makers' presentations, several points must be understood.

(1) The test items procured for the large-scale NIST tests were **not** chosen to represent products sold for consumer use. Instead, the project was formulated to examine FR treatments for various product categories that are commercially available, but are of the highest FR performance. For example, upholstery cushions were loaded with an organic chlorinated phosphate FR, an organic brominated FR, and alumina trihydrate. The loading of the FR chemicals was so high that the foam reached a density of 64 kg m^{-3}. By contrast, residential grade upholstered furniture foams generally have a density in the range of 16 – 29 kg m^{-3}. Foams of 64 kg m^{-3} are used in certain institutional and governmental applications, but do not represent products that consumers purchase.

(2) The 'FR room' consisted 100% of fully FR-treated products; the non-FR room consisted, of course, of normal products without FR treatments. Creating a test room where 100% of the fuel load was FR-treated allowed some interesting observations to be made about the behavior of such environments, and was intended as an updated revisitation of the 1973 Hillenbrand study[2]. It should be noted that the Hillenbrand study was conducted for NASA, and was intended to examine how NASA-quality materials would perform when an entire room was constructed of such materials. The NIST tests confirmed what Hillenbrand had found in 1973—that if only NASA-quality materials are used in a room, there is no possibility for a fire to develop there. However, while this may be important to NASA, it does not have an applicability to domestic or even commercial occupancy environments. In the latter, even if some FR combustibles are present, fire will have the potential to burn due to the inevitable presence of non-FR goods which burn well, and such combustibles include even ordinary paper, books, and clothing.

(3) The 1988 NIST study did not examine any human or environmental health issues of the chemicals themselves, in the absence of fire. Nor did the study examine firefighter health issues associated with burning of FR-containing chemicals. Both of these issues have become important recently as information about environmental toxicity and elevated cancer deaths in firefighters has been emerging. Thus, in no way can the NIST study be considered a study on the 'toxicity' from FR-treated products in general. Instead, it was a study solely focused on the acute toxicity of common combustion products. But with the knowledge available today, it is clear this is not the whole problem and that both environmental[3] and firefighter

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1 Babrauskas, V., Harris, R. H., Jr., Gann, R. G., Levin, B. C., Lee, B. T., Peacock, R. D., Paabo, M., Twilley, W., Yoklavich, M. F., and Clark, H. M., Fire Hazard Comparison of Fire-Retarded and Non-Fire-Retarded Products (Spec. Publ. SP 749), [U. S.] Natl. Bur. Stand., Gaithersburg MD (1988).

2 Hillenbrand, L. J., and Wray, J. A., A Full-Scale Fire Program to Evaluate New Furnishings and Textile Materials Developed by the National Aeronautics and Space Administration (Contract NASW-1948), Battelle Columbus Laboratories, Columbus OH (1973).

3 Shaw, S. D., Blum, A., Weber, R., Kanna, K., Rich, D., Lucas, D., Koshland, C. P., Dobraca, D., Hanson, S., and Birnbaum, L. S., Halogenated Flame Retardants: Do the Fire Safety Benefits Justify the Risks? *Reviews on Environmental Health* **25**, 261-305 (2010).

health[4,5] issues (which comprise chronic, not acute exposures) must be considered and that these can be of paramount importance[6].

NIST, in fact, had published a study[7] a few years prior to the 1988 report which documented in detail the fact that the level of FR chemicals added to consumer-grade residential furniture foams (TB117 formulations) gives no improvement in the fire behavior of such furniture. In view of this, it is especially troubling that the industry has persistently touted the supposed value of FR chemicals in TB117 foams and claimed that the 1988 study justified this claim.

To make this all this very clear, the factually supportable conclusions are the following:

(a) Use of FR chemicals can provide major improvements to fire behavior of plastics. However, the loadings need to be high, and while this is found in in certain military, government, industrial, and other classes of products, it is not what is provided when FR chemicals are added to consumer goods.
(b) The effectiveness of halogenated FR chemicals depends both on the loading of the chemical and the volume of fire confronted. Plastics with modest FR loadings can perform well in some small-flame tests, but do not show a similar behavior when large flames are involved.
(c) Room-fire type tests configured with all-FR products can reflect certain environments in NASA and other specialized applications, but results from such tests cannot legitimately be applied to normal buildings or homes.
(d) Social responsibility demands that environmental and health concerns be adequately addressed for any chemicals promoted for their claimed fire safety benefits.

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4 Bates, M. N., Registry-Based Case-control Study of Cancer in California Firefighters, *Amer. J. Industrial Medicine* **50**:5, 339-344 (2007).

5 LeMasters, G. K., et al., Cancer Risk Among Firefighters: A Review and Meta-Analysis of 32 Studies, *J. of Occupational & Environmental Medicine* **48**, 1189-1202 (2006).

6 Babrauskas, V., Blum, A., Daley, R., and Birnbaum, L., Flame Retardants in Furniture Foam: Benefits and Risks, pp. 265-278 in *Fire Safety Science—Proc. 10th Intl. Symp.*, Intl. Assn. for Fire Safety Science, London (2011).

7 Babrauskas, V., Upholstered Furniture Heat Release Rates: Measurements and Estimation, *J. Fire Sciences* **1**, 9-32 (1983).