

Summary of the Building and Fire Research Laboratory meeting on *Fire Retardants and their Potential Impact on Fire Fighter Health*

National Institute of Standards and Technology
Gaithersburg, Maryland
Building 101, Lecture Room A
September 30, 2009

A one-day meeting on "Fire Retardants and their Potential Impact on Fire Fighter Health" was held on the Gaithersburg campus at NIST on September 30, 2009. The meeting provided the context for discussion of the following questions:

- What are fire retardants and why are they used?
- What is the fate of the fire retardants and their combustion products in the environment?
- Are there increased or decreased health risks to fire fighters created by fire retardants?

This meeting was a the result of a request from the International Association of Fire Fighters (IAFF) and the National Association of State Fire Marshals (NASFM) to have NIST serve as an organizer and objective host of a scientific workshop on the potential health effects to fire fighters of flame retardants in the aftermath of a fire.

Technical experts from the government and private sector representing the fire services, health sciences, fire science, environmental sciences, and product manufacturers were invited to explore our state of knowledge about and stimulate open discussion by the meeting participants on:

- approaches to reducing the flammability of building products and the rate of fire spread in buildings;
- the composition and nature of products formed during and after an actual building fire, and how they are affected by the presence of a fire retardant;
- quantification of the concentration of the fire products;
- routes of exposure by emergency responders and clean-up crews to hazardous fire products;
- the possible relationship between acute and chronic health affects on emergency responders exposed to fire products, and the type and amount of fire retardant involved in the fire; and
- knowledge gaps and the identification of a possible future research agenda.

See the website to view the agenda, and from there the presentations.¹ A list of attendees can also be viewed. <http://www.bfrl.nist.gov/info/conf/fireretardants/>

¹ Certain commercial entities, equipment, products or materials are identified in the presentations in order to describe a procedure or concept adequately or to trace the history of the procedures and practices used. Such identification is not intended to imply recommendation, endorsement, or implication that the entities, products, materials, or equipment are necessarily the best available for the purpose.

After all of the invited presentations had been made the speakers and attendees were invited to suggest gaps in our knowledge and the research needed to support a scientific basis for answering the initial question: Are there increased or decreased health risks to fire fighters created by fire retardants? The discussion expanded to encompass the research needed to fill in knowledge gaps required to answer broader but related questions concerning the combined societal goals of health and safety for the public, fire fighters, and the environment.

The list of these knowledge gaps shown below was compiled with no attempt to prioritize or to minimize overlapping ideas. Group I is focused primarily on understanding and quantifying the effects of fire retardants on fire fighters; Group II generally addresses what we can do to mitigate future exposures of fire fighters to fire products; and Group III deals with the broader implications of fire retardants on health, safety and the environment. The comments and opinions expressed in the list are solely those of individuals and do not represent a consensus of those in attendance or of NIST, IAFF or NASFM.

Knowledge Gaps

Group I: Understanding and quantifying the effects of fire retardants on fire fighters

- Accurate measurement methods for low levels of chemicals in blood
- Measurement of the concentrations of fire retardants, dioxins, etc. in fire fighters' blood
- Determination of the time persistence of fire retardants and their metabolites in the blood
- Studies of fire retardants and residues in blood of fire fighters within a few hours of a fire (including phosphorus esters)
- A study of PBDEs, PBDFs and PBDDs in the serum of long-term fire fighters, comparing them with suitable controls -- Because the half-lives of these compounds are estimated to be quite long, on the order of years, it makes more sense to look at chronic exposure rather than acute exposure.
- Quantification of the extent to which the chemicals and their concentrations in fire fighters' blood differ from levels in others
- A standard method for the evaluation of FRs (and other chemicals) in terms of their toxicity -- This method should be harmonized internationally and have an agreed set of acceptance criteria.
- Meaningful toxicity limits for fire retardant chemicals
- Quantification of the health meaning of ppb levels of chemicals (including, but not limited to fire retardants and their indicators) in blood
- Epidemiology studies of fire fighter health during service and especially after retirement
- Investigation of the seeming disconnect between the results of laboratory experiments with flame retardants and mortality/morbidity statistics, possibly due to poor fire mortality/morbidity data
- Measurement of the toxicant composition and assessment of the resulting health effects of smoke from fires in which no fire retardants were present (as a background against which to assess the potential incremental health effects from fire retardants)
- Method for estimation of the distribution of (career) exposures of fire fighters to fire products – inhalation, contact, etc.

- A fire risk analysis composed of a statistically valid epidemiology study based on a sampling of fire departments and an exposure survey of fire fighters -- The epidemiology study (the numerator) would be used to collect information, including samples for analysis, to help answer the many questions raised at the workshop. The exposure study would serve as the denominator of the general fire fighter population for use in the risk analysis.

Group II: Monitoring the environment for fire fighting activities and ensuring that PPE is sufficient to protect the fire fighter from acute and chronic health effects

- Revisitation of the efficacy of fire fighters' personal protective equipment, given the prevalence of additive-containing products currently (and for the foreseeable future) in homes where fires will occur. This includes both the design of the equipment and the protocols (and personal culture) for their use
- Along with the development of protective gear, there is also a need to educate fire fighters to understand the limitations of their gear.
- Instrumentation for alerting fire fighters to the hazards they are about to encounter on the fire-ground (e.g., exposure to harmful vapors)
- A more proximate exposure study to measure PBDEs, PBDFs and PBDDs in wipes of protective suits, ash, etc
- Protocol for transition from fire fighting to overhaul, including changeover of personal protective equipment
- Quantification of the effects of fire suppressants and combustion products, and the exposure of firefighters to these products.
- Comparison of water & foam extinguishment and the effect on toxic chemical release in fires

Group III: Understanding and quantifying the broader implications of fire retardants on health, safety and the environment

- Stability/leaching of retardant from product during use
- Animal neurotoxicity studies on phosphorus-containing combustion products
- Measurements of the concentrations of fire retardants in the blood of people whose houses have fire retarded products (of various ages)
- Development of toxicology data for FRs that are introduced as alternatives for FRs that are removed, before the change is made
- Determine effect of all parameters important in real fires to influence the production of toxic combustion products
- Improved characterization of the fire properties of products with and without fire retardants
- List of fire parameters and quantification of the effects of varying these parameters on the yields and nature of combustion products, including those from fire retardants

- Improved pyrolysis models to account for mechanical changes and transport in fire retarded polymers, and simplified degradation chemistry models that can feed into the pyrolysis models
- GC-MS studies to identify and measure yields of phosphorus-containing substances in combustion products evolved from materials decomposed over a range of combustion conditions
- Quantitative structure-activity relationships (QSARs) for toxicity of fire retardants
- Quantitative structure-activity relationships for the design of fire retardants for effective use with various host polymers, compatibility with other additives, and effectiveness in selected design fire scenarios
- Bench-scale test apparatus and protocol for the accurate generation of the products of combustion, including the byproducts of fire retardant degradation and combustion
- Capability to model bench scale tests and to extrapolate the measured output to predict the performance of the fire retarded materials in real products in real building fires
- Risk-based analysis of the value of fire retardant chemicals
- A balanced evaluation of FRs, both existing (in use) and new, taking into account their environmental impact, their toxicity and their fire safety function -- This should be robust enough to cover both the general population and those with a higher exposure risk (e.g., fire fighters, workers producing FR-containing products, etc.). It is important that this process be transparent and developed as a collaboration between and among different disciplines.
- Quantification of the effects on fire losses (e.g., more fires, more serious fires, qualitatively different fires) of less effective fire retardancy.
- Complex life-cycle-assessment (LCA) tool to include toxicity data and exposure of public to FR chemicals
- Public (objective) funding for more complete life cycle analyses of fire retardants, including such aspects as exposures during manufacture, during use, etc. and their health effects.
- Comprehensive evaluation of all sources of the bioaccumulation of fire retardant-like materials and their intergenerational transference
- Screening test methods for predicting the likelihood of bioaccumulation of alternative fire retardants in pure form and in end-products