# LOG OF MEETING

**SUBJECT:** Chairman's Roundtable, Evaluation of Effectiveness of Residential Smoke Alarms

**DATE OF MEETING:** October 29, 1998

**DATE OF LOG ENTRY:** November 5, 1998

**PERSON SUBMITTING LOG:** James F. Hoebel, Directorate for Engineering Sciences

**LOCATION:** US Consumer Product Safety Commission, Bethesda, MD

**CPSC ATTENDEE(S):**
Ann Brown, Chairman
Thomas Moore, Commissioner
Walter Sanders
Michael Gougisha
Ronald L. Medford
Julie Ayres
Linda Edwards
James F. Hoebel
William King, Jr.
Edward Krawiec
Hammad Malik
Margaret Neily
Diane Porter
John Preston
Warren Prunella
Chuck Smith
Linda Smith

**NON-CPSC ATTENDEE(S):**
Mark Ackerman, BRK/Cozen & O'Conner
Tom Barakat, Maple Chase
Jesse Beitel, Hughes Associates
Dr. Craig Beyler, Hughes Associates
H. Wayne Boyd, US Safety
Thomas Brace, National Association of State Fire Marshals
Richard Bukowski, National Institute of Standards and Technology
Fred Conforti, Pittway Systems
Patrick Coughlin, Operation Life Safety
Bowman Cox, Product Safety Letter
Mark Devine, First Alert
Bob Elliott, Factory Mutual Research

Hank Fellner, National SAFE KIDS Campaign
William Freeborne, US Department of Housing and Urban Development
Brett Fritts, Sentrol
Dwayne Fry, Lockheed Martin
Alex Furr, US Fire Administration
Dr. Larry Grosse, Colorado State University
Dr. John R. Hall, Jr., National Fire Protection Association
Pauline Harvey, National Center for Injury Prevention and Control
Bob Hayes, Cozen & O'Conner
Steven W. Hill, US Fire Administration
Alan Korn, National SAFE KIDS Campaign
Mary Marchone, Montgomery County
Kevin McDonald, Sentrol
Scott A. McKenney, Lockheed Martin
Richard A. Mendlen, US Department of Housing and Urban Development
Dr. James A. Milke, University of Maryland
Thomas E. Minnich, US Fire Administration
Rick Mulhaupt, National Fire Protection Research Foundation
Dr. Soonil Nam, Factory Mutual Research
Bob Nelson, Pittway Systems
Ken Nelson, Sentrol
David C. Nimmer, US Department of Housing and Urban Development
Mark A. Nunn, Manufactured Housing Institute
John Ottoson, US Fire Administration
Bruce Paterson, Underwriters Laboratories Canada
Paul E. Patty, Underwriters Laboratories
Phil Perry, First Alert/Latham & Watkins
Edward P. Plaugher, Arlington County Fire Department
Robert Pollack, Underwriters Laboratories
Larry Ratzlaff, Fyrnetics
Philip Schaenman, TriData
Robert Schifiliti, RP Schifiliti Associates
Dr. Mark Stevenson, National Center for Injury Prevention and Control
Karen Suhr, National Association of State Fire Marshals
Mike Swieboda, First Alert
Mandy Taft, National SAFE KIDS Campaign
Steven Vastagh, National Electrical Manufacturers Association
J. Whalen, Bureau of National Affairs
Peter Winik, First Alert/Latham & Watkins
Sara Yerkes, National Fire Protection Association

## SUMMARY OF MEETING:

Chairman Brown welcomed the participants at 10:00 am. She noted that although smoke alarms have been successful in contributing to the decline in fire deaths, we still have almost 3400 fire deaths a year and more needs to be done. CPSC has proposed, in its year 2000 Budget, a project to evaluate current and new technology to determine which alarms are most effective. Her goals for the roundtable are to determine support for the project, to solicit expert advice on how best to conduct the work, and to enlist outside participation.

Ronald Medford chaired the meeting. He introduced James Hoebel, who noted that concerns continue to be raised about alarm performance. The ground-breaking tests usually cited as the basis for alarm performance, the "Indiana Dunes" tests, were conducted a long time ago with detectors that were not necessarily representative of today's alarms subjected to fires that were not representative of today's fires. CPSC developed a concept for full-scale experiments to help resolve many of the concerns. The concept was described. Mr. Hoebel noted that several issues need to be discussed, including need for the effort, test-related issues such as the types of test fires and alarms to be tested and test beds, participant issues, and enhancements.

Dr. John Hall presented information on smoke alarms effects on fatalities and what we know about fatal fires. He noted that about 93 percent of homes have at least one alarm, but that a disproportionate share of home fires occur in homes with no alarms. If a home fire occurs, smoke alarms reduce the risk of death by 40-50 percent. Perhaps 1300 lives are saved each year by the use of smoke alarms. Seven percent of homes have no alarms, 74 percent have working alarms, and 19 percent have alarms that do not work. When an alarm sounds, only 7 percent of people think there is a fire, and 69 percent do not think there is a fire. Data on fires deaths as a function of victim location and extent of flame damage were presented. Most victims in the U.S. are killed in fires that extend beyond the room of origin (unlike the experience in the UK). Only a small percent of victims die in fires that continue to smolder and do not become flaming fires. The primary fatal scenario involves post flashover fires, followed by fires with an extended smoldering followed by a flaming period where the flaming phase produces deaths. Dr. Hall provided an NFPA written report on U.S. Experience with Smoke Alarms.

Richard Bukowski presented a chronology of residential fire alarm testing from 1960 onward, and summarized what has been learned from these tests. Different fires, fuels and alarms have been tested, over the years. Usually, heat detectors did not provide adequate escape time, while both photoelectric and ionization smoke alarms provided adequate escape time. Ionization detectors tended to respond quicker to flaming fires, while photoelectric detectors responded quicker to smoldering fires. Ten past studies were reviewed. Limitations of the past studies included: a) they involved "first and second generation" alarms as contrasted to today's "third generation" alarms; b) today's detectors have improved sensors and smoke entry characteristics; and c) alarm thresholds have been lowered in today's alarms to reduce nuisance alarms.

Steven Hill provided the US Fire Administration perspective. They believe that the community is entering a critical period of time. Past maintenance advice focused on changing the battery. Education efforts need to change. We should now worry about when to replace the detector itself. Future efforts should involve not only technology, but maintenance and education as well. Mr. Hill also announced that the Fire Administration has been directed by Congress in their 1999 appropriations to conduct a smoke alarm pilot program in 20 high-risk communities that would involve distributing alarms and gathering data on the effects. They plan to work closely with the Consumer Product Safety Commission on this effort.

Mr. Medford asked Mr. Patty to describe the relationship of the UL standard's tests to fires. Mr. Patty noted that UL 217 includes four flaming tests and one smoldering test. The flaming tests uses wood, paper, gasoline, and plastic. They have proposed to replace the gasoline and plastics tests with a heptane/toluene test, for the sake of harmonization. The smoldering test is an indirect result of the "Dunes" tests, and produces a grey smoke. He said these are all relatively small fires. Response times in the tests vary: four minutes for the wood and paper tests, three minutes for the gasoline test, and two minutes for the plastics test. The size of the fire room is relatively large. The UL tests do not monitor gas production. UL's experience is that detection of gas production is not a promising new direction as a fire indicator. When they did measure gas production, CO levels were in the "background" range and $CO_2$ levels were only a little higher. UL tests respond to the particle size of smoke, the most important parameter.

Mr. Medford asked if the smoke alarms tested in the studies reviewed by Mr. Bukowski met the same UL standards described by Mr. Patty. Mr. Bukowski said yes, with the exception of the smoldering test which was added later. The UL tests are not necessarily intended to represent actual burning products in the home, rather they meant to "bound" the types of problem fires in the home.

The background related to the current advice to replace alarms every ten years was discussed. Mr. Bukowski noted that the NFPA 72, Chapter 2, fire alarm code was recommending replacement every ten years. Smoke alarms now display an explicit date code to enable consumers to determine alarm age. Mr. Bukowski stated that the precise determination of a ten year limit was not "black and white", but was arrived at by a kind of consensus.

Mr. Medford focused on a remark from Mr. Patty that the concentrations of gases, such as carbon monoxide and carbon dioxide, measured during UL tests never rose to more than a background level. Dr. Milke provided a contrasting view, noting that carbon monoxide is a good indicator of fire, and is highly discriminating. Rate of rise of carbon monoxide is also very good, as is rate of rise of carbon dioxide. These indicators avoid nuisance signals.

Dr. Milke also noted that UL's upper test temperature limit of 38°C (100°F) may not be high enough, since non-air-conditioned homes could exceed this.

Mr. Brace said that NASFM liked the idea of conducting new tests, and that fresh data are needed that also include heat detectors.

Mr. Korn asked about available information showing the difference between ionization and photoelectric alarms that could be provided to consumers. Mr. Medford and Mr. Patty responded that the UL tests do not differentiate between detectors: either must meet all UL tests. Proposed changes to NFPA's Fire Alarm Code 72 to address kitchen-related nuisance alarms were identified.

A discussion ensued about the relative efficacy of smoke alarms and smell. Mr. Schaenman noted that some immigrant homes rely on animals for fire detection. Mr. Bukowski referred to a Canadian study of 65 fires where many times the smoke detector was the first fire detector even when people were home.

Dr. Nam proposed a test protocol concept to minimize full scale testing by using carbon dioxide as an index for smoke, since there is a strong correlation between smoke and $CO_2$ production in home fires. The next step would be to generate an activation threshold and a table based on $CO_2$ concentrations. This can be used to predict detector performance and classify detectors. Many lab scale tests could be run at lower cost and full scale tests used for validation.

Mr. Beitel asked about international experience in fire tests. Mr. Patty responded by noting that the European EN 54 series of standards used six different fire scenarios, while ISO used seven. These standards allow the user to choose which of the various scenarios they wished to test to. This wouldn't be allowed in the US.

Mr. Schifiliti suggested an organizational framework that could be used as a model for this project. He noted the diverse parameters to be considered reflecting our diverse society, including homes, products involved, tenability criteria, etc. He also noted that the results of the project will be applicable to both product standards and installation codes separately.

Dr. Hall summarized by noting that the group has considered three types of information that the planned project might develop: 1) more current and convincing data on what we think we already know, 2) genuine new knowledge, such as the value of CO as a fire indicator, and 3) quantifying information in order to support value judgements, such as the service life of an alarm.

Mr. Medford believed that it was now time for an upward "bump up" in smoke alarm technology.

Mr. Mulhaupt was concerned over a trend in the application of tenability criteria in the international fire science community. The past emphasis has been on life safety. Both ISO and the International Building Code are shifting to incapacitation and injury as the primary criteria. North America is conducting a "rear guard" action to refute this change. After a meeting of ISO TC 92 the previous week in the UK, it seemed likely that the change will succeed. Additionally, performance codes are now couched in terms of injuries. Realize that when this work is finished, the anticipated goal line might have moved. Mr. Mulhaupt suggested that we decide what we are protecting against.

Mr. Conforti said that it is OK to seek a bump in technology, but that the audience should realize that current technology development in this industry is confined to the commercial and industrial sectors, not residential. The market has shrunk, and the number of brands manufactured for the residential market has declined from over a hundred to only two. It doesn't seem worthwhile to be in this business, so no money is going into research. The reality may be that there will be no one to undertake the results of the planned project's research. He also emphasized that any project plans include explicit failure rate expectations and that Federal and State governments should establish yardsticks.

Mr. Medford asked for elaboration.

Mr Conforti said that the government should set a standard of acceptable failure rate and a statute of limitations such as a limit on detector age beyond which the manufacturer has no more liability. Companies have left the residential business because of liability considerations and the threat of recalls.

Mr. Devine commented that in his company, there is some research for the residential market, but it is not nearly as substantial as the investment in the commercial market. Profit margins are slim in the residential field.

Mr. K. Nelson noted that when deaths occur, no alarms are present, occupants can't hear the alarms, there is no power nor any back up, and effects are felt from nuisance alarms. Solving these has nothing to do with technology.

Mr. Medford disagreed with the conclusion.

Mr. Nelson noted that the technology associated with photoelectric alarms, a continuous power source, and a correctly placed battery backup solves a lot of these problems.

The Roundtable then adjourned for lunch.

After lunch, Mr. Medford asked for comments on the need for a full scale fire test project, given the goals to get the most that we can from smoke alarms in modern homes and to try to get new prototypes tested..

Mr. Bukowski expressed strong support. He called for examination of current and new technology alarms, including combination detectors and heat detectors. Tests should involve modern fuels, arrangements, and types of housing. Test results will be valuable as an education tool. Full scale tests are absolutely necessary, especially to establish credibility. We should also look at the combination of smoke alarms and sprinklers.

Dr. Milke agreed. There is a need for full scale tests in real spaces/rooms that look like housing. Tests should be properly instrumented (gas, smoke, particulates, etc.). Then, using today's analytical technology, supplement the full scale tests with computations and small scale tests.

Dr. Nam was supportive of full scale tests. He called for lab scale tests to predict performance before jumping into full scale tests. The full scale tests would be used to validate the small scale.

It seemed to Dr. Hall that before we get consensus on what we want to do, we need consensus on what question we're trying to answer and what problem we're trying to solve. He said it sounds like the full scale tests would provide confidence that modern technology alarms in a modern home environment produces the same kind of general points of performance that were true 20 years ago, with the added advantage of additional quantification and understanding of phenomena of detectors that could be used to guide technology and decision making. However, this will leave other issues unaddressed, such as the relative performance regarding nuisance alarms and relative importance of nuisance alarms in the design of detectors.

Dr. Hall referred to the earlier discussion describing the UL approach of "bracketing" or "bounding" the possible fire situations rather than duplicating typical fires. Here, one could say that if a detector performed acceptably under the bracketing scenarios, it would be expected to perform acceptably under any likely scenario. We could do the same when setting up the parameters for full scale testing. He felt it extremely important to realize that if we decide the principal output is to produce convincing information on old points, then we've got to be able to deal with what people (supposed experts) already think is true (and isn't true). If we don't go directly at the evidence that bears on those beliefs, those people will continue to believe what they've been believing. A lot of people seem to set up syllogisms that most fatal fires are smoldering fires (actually not true), photoelectric detectors are better than ionization (may be true), therefore photoelectrics are better in an overall sense and ionization devices should be driven into the ground. At what point in a syllogism based on shaky or false premises do we intervene?

Mr. Medford asked the audience if we could conduct the research without full scale testing. For example, could we possibly solve the nuisance alarm problem without conducting full scale tests and thereby improve the fire record? He also wondered whether the UL approach of "bracketing" the expected fire characteristics would be sufficient without having to replicate real fires.

Mr. Brace didn't think it was necessary to make an either/or choice. He believes that the full scale tests are valuable. As a fire prevention official, he observed that certain communities have achieved very good alarm penetration (upwards of 93%), but others aren't even up to 50%. Maybe we should learn how to deal with those who can't hear alarms. He recalled earlier fire tests where many experimental conditions were uncontrolled. He believes that a lot of people support objective and scientifically supportable testing.

Mr. Vastagh asked what data have been published to suggest that new tests are needed to prove new technology or that current technology is not sufficient to sense fires.

Mr. Hoebel noted that there have been published data suggesting that ionization detectors do not adequately sense smoldering fires. An example is a Norwegian study

Dr. Beyler noted that current sensors are not used at their sensitivity capability limits, but are set at a compromise level to prevent false alarms. The technology issue really means "can we discriminate against false alarms?" Furthermore, current standards contain no false alarm tests. We need to understand false alarm signatures in order to guide new technology. He believes that the UL "bounding" approach was established on the basis of current sensor technology. What is bounding for photoelectric and ionization alarms may not be bounding for other fire signatures. Some tests can be lab tests, and these could be used to understand signatures. On the other hand, siting requirements, smoke aging, etc. need the complexity of buildings (door gaps, etc.). So there is a definite value in both laboratory and full scale tests.

Mr. McDonald said his company was excited about the possible tests. They will help people appreciate the new technology. He also said participants need access to the raw data quickly.

Mr. Schaenman warned that the results of full scale tests might have no effect on the success of current smoke alarms. On the other hand, the by-products of the program might be critical. For instance, up-to-date films could convince people to maintain alarms and contribute to solving the false alarm problem.

Mr. McDonald felt that the by-products of the tests would be critical, providing current evidence and possible help for the false alarm issue. It could illustrate the importance of network alarms, for which there are no current data.

Dr. Milke cited problems with current technology. For instance, there is a ratio of 16 or more to 1 of nuisance alarms to actual incidents. Some of these are human related, but a fair number of these problems are technology-related.

Mr. Freeborne was concerned that the discussion centered around new housing. There are over 100 million existing residences. He referred to HUD's Healthy Homes initiative addressing existing housing and their PASS program dealing with new housing..

Mr. Medford reviewed what he has gotten from the meeting so far. He felt that the main reason to conduct the project was different from the reason articulated earlier. the best reason seems to be to get real data on existing homes with modern furnishings. This would allow small scale testing, with full scale tests used for validation. New technology could be developed knowing the current parameters of performance. We would have a much broader characterization of fire performance in today's homes. So the benefit is of a more basic nature than originally conceived. The information gathered would be useful not only to CPSC but also to manufacturers and others. The research data could be used to design products, develop fire models, validate models, etc.

Mr. Mendlen asked the manufacturers in attendance about the percent of new alarms that are actually factory-tested. Mr. Devine responded that 100 percent of First Alert alarms are factory-tested, multiple times.

Mr. Medford asked HUD if they specify any particular type of detector for manufactured housing. Mr. Mendlen said that either major type of alarm is accepted.

Mr. McDonald said his company has introduced a number of technologies, such as "floating background", but they are not available through the retail level, but only through a security system acquisition.

Mr. Korn raised the issue of how the alarm is affixed to the home itself. He suggested evaluating the affixing material to determine how it would be affected by heat.

Mr. Nimmer felt that the full scale tests were very important. He emphasized that there were unique problems with manufactured housing that must be addressed. He offered their support.

Mr. Schaenman hoped that the test structures didn't represent a rich man's house. He also raised the issues of compartment size, climate, and ventilation.

Mr. Bukowski noted that the Department of Defense may have available existing housing that might be used for the full scale test program.

Dr. Hall referred to the UL test duration. Full scale tests could help redefine appropriate time scales. This could be one tangible result we could get out of full scale tests that would probably change the current specifications.

Mr. Bukowski said that we must be more selective in choosing the test housing. For example, about 70 percent of U.S. homes are single story ranch style, without basements. Furnishings are also an issue. Tests run in the past by the California Fire Chiefs were not completely furnished. He did not believe that full scale test houses need to be completely furnished.

Dr. Milke wondered about factors that influenced performance differences, such as space, dimensions, products of combustion, what is the profile of American homes, etc. He said that we should go beyond just fire tests and run some nuisance tests.

Mr. Hoebel asked for opinions on the need for special field investigations to help define the characteristics of fatal fires. As an alternative, one might examine typical fuel loads in houses as a basis for designing fires.

Mr. Brace said that the Fire Marshals may have some data. If we could outline what we would look for, they might be able to get it.

Dr. Hall thought that one could reasonably infer the test fire characteristics from available fire data, lab data, and current investigations. He wondered whether we should simulate typical fires or challenging fires. If detectors react well to challenging fires, they should be good for other fires. It is important to make this decision up front. He would recommend using challenging fires.

Dr. Milke wondered whether an approach based on challenging fires or an approach based on bracketing fires would be most appropriate. We ought to be able to come up with appropriate bracketing specifications. We also need to come up with a set of objectives for the program. Will we be looking for tenability criteria, incapacitation, or not to "get dirty" at all?

Mr. Conforti noted that we should agree on tenability levels up front.

Ms. Smith thought that we should compare data available from other past and ongoing investigations with what we want to know to support this project.

Mr. Schifiliti suggested that we might consider training current investigators to collect the data we need.

Mr. Boyd has a file on detector performance in fatal fires that is available.

Mr. Medford concluded by observing a consensus that we can do more, that large scale tests are desirable, and that a lot of work will be needed to design the experiments. He envisions a project team with a number of working groups. CPSC (Ms. Ayres and Mr. Hoebel) will take the lead to begin the planning and consider an organizational meeting in about a month. All persons interested in participating should contact Ayres or Hoebel.

The Roundtable adjourned about 3:15 pm.