

NIST Special Publication 1066

Residential Kitchen Fire Suppression Research Needs: Workshop Proceedings

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ABSTRACT

The *Workshop on Residential Kitchen Fire Suppression Research Needs* was held on April 11, 2006, at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD. The Workshop provided a forum to discuss test methods, technologies, and research and development that can significantly improve residential fire protection, with emphasis on residential kitchen applications. The Workshop program included representatives from standards, codes, testing, and research organizations, the fire protection industry, the fire service, and federal government agencies. In total, 30 people attended.

The goal of the conference was to identify barriers that impede advances in the application of localized suppression systems in residences. In this regard, the Workshop explored: recent developments in suppression system technologies, characterization of the performance of residential kitchen fire suppression systems, the role of federal agencies and standards groups, and opportunities for collaboration.

The workshop attendees were divided into two breakout groups to discuss the following questions:

- What is needed to reduce losses from kitchen fires?
 - Focus on prevention?
 - Focus on suppression?
- What are the prioritized research needs for kitchen fires?
- What needs to be done in order to place effective retrofit systems into a significant number of homes?

The results of each group's deliberations were discussed when the full Workshop reconvened. The responses from each group were considered and listed so that attendees could vote on the issues that they felt were most important. Attendees were grouped by their affiliation with the standards, codes, testing and research organizations, or the fire protection industry, or the fire service for purposes of voting.

The issues that relate to prevention and suppression were voted to be the most important topics. The development of methods to ensure mass acceptance of fire suppression use was the second-most important subject overall. The fire service votes indicate that they are equally interested in prevention and research. The standards, codes, testing and research organizations attached equal importance on suppression as on mass acceptance of the technology for their first choice. The industry attendee votes revealed that prevention and suppression issues were most important. The results of the workshop were divided into short and long-term goals. In the short-term, education was viewed as the most important approach to address the problem of kitchen fires. In the long-term, the development of a low cost, low maintenance, retrofit system and the supporting research and standards was the priority.

Keywords: fire prevention, fire suppression, kitchen fires, localized suppression, performance metrics, residential fires, research needs, sprinklers

ACKNOWLEDGEMENTS

The success of any workshop is dependent on the hard work of the individual speakers, facilitators, and participants. These proceedings are an assimilation of the contributions from everyone involved in the workshop; copies of the presentations are included in the Appendices. Thanks to all who made presentations and to those who participated in the workshop.

Special thanks go to Woodrow Stratton of the U.S. Fire Administration, who served as a chair of a breakout session and helped bring focus to the discussions. In addition, we wish to acknowledge the assistance of Jay McElroy of NIST, who helped with logistics and Nelson Bryner, also of NIST, who assisted with facilitating a breakout group.

WORKSHOP ON RESIDENTIAL KITCHEN FIRE SUPPRESSION RESEARCH NEEDS

INTRODUCTION

Cooking is the leading cause of home fires according to the National Fire Protection Association (NFPA). In 2003, there were 118 700 reported home structure fires, in the United States, that involved cooking equipment. These cooking equipment fires resulted in 250 fatalities, 3 880 injuries and \$512 million in direct property damage [1].

Two out of three of these reported home cooking fires involved the range or stovetop. The major cause of home cooking fires was cooking equipment left unattended [1]. Forty-one percent of the fatalities from cooking equipment fires occurred while the victims were asleep [2].

Previous Research

There are many potential approaches to reducing the problem of cooking fires including: consumer education, improved detection, thermostatic safety controls on cooking equipment, and suppression systems. There have been a number of federal research efforts to address the feasibility of some of these solutions.

The Consumer Product Safety Commission (CPSC) working with the National Institute of Standards and Technology (NIST) has previously studied various parameters of the cooking environment prior to ignition in order to identify a technology that may be used to detect these unique conditions and control the heat output to prevent fires [3 -7]. These studies demonstrated that the pan temperature is a reliable indicator of pre-ignition conditions. The CPSC continues to consider technologies that improve on the experimental temperature detection and control systems.

There are currently more than 124 million housing units in the United States, including single and multiple family homes [8]. The average life expectancy of a range (stove) is 16 to 18 years [9]. Based on these numbers, it is important to examine retrofit systems that are currently available for consumer use. One possible type of retrofit system is an automatic range-top fire suppression system. This workshop focuses on this type of system application.

The Air Force conducted a study in 1987 to evaluate the performance of range-top fire extinguishing systems [10]. The study examined eight systems in order to outline a draft performance specification for use in Air Force housing and to assess available technologies. The study was not intended to replicate Underwriter's Laboratories (UL) testing but to recreate actual reported, unattended range-top fires in a realistic manner. The study resulted in recommendations regarding the specifications of the systems that should be used in Air Force housing.

Part of the work sponsored by the CPSC addressed fire suppression systems for ranges [11]. This study identified four types of fire suppression technologies that can detect and

extinguish fires on range-tops. No evaluations of the feasibility of specific systems were performed.

The United States Fire Administration (USFA) in conjunction with CPSC has examined “smart stove” technology [12]. In addition, USFA has recently collaborated with the National Fire Protection Association (NFPA) to research the types of behaviors and sequences of events that lead to cooking fires and developed recommendations for behavioral mitigation strategies that will reduce such fires and their resultant injuries and deaths [13].

UL 300A

Currently, there is no voluntary standard that lists all types of residential range-top suppression systems. However, Underwriters’ Laboratory (UL) has published UL 300A, *Outline of Investigation for Extinguishing System Units for Residential Range Top Cooking Surfaces* [14]. This outline examines the performance of self-contained, residential range top suppression systems in reaction to a variety of fire tests, which include both gas and electric range-tops, and multiple size fires. The test set-up does not include any common kitchen combustibles such as cabinetry, counters or food stuffs. There are four self-contained, residential range top extinguisher units that have been tested and listed under UL 300A [15].

Workshop Focus

Given the large number of kitchen fires and the relatively narrow definition of the majority of cooking equipment fires in kitchens, CPSC, NIST and the USFA decided to combine and focus resources on that specific problem with the goal of reducing loss of life and property. A decision was made to hold a workshop with representatives from a wide range of stakeholder groups including suppression system manufacturers, standards, codes and testing organizations, and fire safety organizations. The goal of the workshop was to identify barriers that impede advances in the application of localized suppression systems in residences and make recommendations to overcome the barriers.

WORKSHOP ORGANIZATION AND OBJECTIVES

The Workshop provided a forum to discuss test methods, technologies, and research and development that can significantly improve residential fire protection, with emphasis on residential kitchen applications. The Workshop program included representatives from standards, codes, testing and research organizations, the fire protection industry, the fire service and the government. In total, 30 people attended. The workshop agenda and a list of attendees are provided in Appendices 1 and 2, respectively. The presentation slides or abstract for each presentation are provided in Appendices 3 through 6.

The goals of the workshop were to identify barriers that impede advances in (1) fire safety in residences, in general, and in particular, (2) the application of localized suppression systems in residences. In this regard, the workshop explored:

- Analysis of kitchen fire data
- Characterization of the performance of suppression systems
- Recent developments in suppression system technologies
- The role of standards
- Federal agency activity
- Opportunities for collaboration

After introductions, the Workshop goals were reviewed. The first two presentations described the magnitude of the residential kitchen fire problem through consideration of recent statistics, and through hands-on experience. The next two presentations described the UL 300A and NIST kitchen testing to date.

After the presentations, the Workshop participants were divided into two groups. Each group was composed of representatives from standards, codes, testing and research organizations, the fire protection industry, the fire service and government organizations. The groups were asked to respond to these questions:

- What is needed to reduce losses from kitchen fires?
 - Is it prevention?
 - Is it suppression?
- What are the prioritized research needs for kitchen fires?
- What is needed to get effective retrofit systems into a significant number of homes?

A chairperson (Shivani Mehta, CPSC and Woodrow Stratton, USFA) moderated each group. The results of each group's discussions were presented and discussed when the workshop reconvened. The responses by the groups to the discussion questions were combined and listed, and a vote was taken to prioritize the responses. Attendees were grouped by their affiliation. An analysis of the results is presented in a following section.

PRESENTATIONS

Presentations were given to the group to address the kitchen fire problem, testing methods and results on the evaluation of suppression systems. The presentations are included in the Appendices 3 through 6.

The Residential Fire Problem: A Statistical look at Kitchen Fires ***Marty Ahrens, NFPA***

Ms. Ahrens a statistician at the NFPA, reviewed the current trends in kitchen fires. Trend data were presented by location of fire within the kitchen, alarm time, extent of flame damage, methods of extinguishment, age of fire victims and possible human factors contributing to the fire. The data overwhelmingly indicate that the majority of fires in kitchens occur on the range-top. The data also show that the majority of reported fires “self-extinguish” or are “extinguished by occupants with fire extinguishers” or “make-shift aids.” There was no further information available on the types of “make-shift aids.” A large portion of the injuries, 58 %, occurred while the injured were attempting to fight the fire. Only 9 % of the fires extended beyond the kitchen, however this small percentage of fires was responsible for 70 % of the fatalities. The data also address residential fire protection systems. There were no operating smoke alarms in 36 % of the kitchen fires. In the limited number of fires where sprinklers were present (< 1 %), 70 % of the time the sprinklers did not operate, typically because the fires were too small to activate the sprinklers.

The Residential Fire Problem: A Fire Chief's Perspective ***Michael Love, International Association of Fire Chiefs (IAFC)***

Chief Love, Division Chief and Fire Marshal with the Montgomery County (MD) Fire and Rescue Service, represented the IAFC. He spoke briefly about the statistics of kitchen fires. He focused on a single sprinkler in the kitchen as an alternative for effective fire suppression. Data from NFPA were discussed that indicated that a large portion of kitchen fires were effectively controlled by a single sprinkler, in cases when a sprinkler was present and operated.

The IAFC supports the use of a NFPA 13D [16] compliant, residential sprinkler system in new residences. However, the IAFC supports the retrofit of a single sprinkler in the kitchen as an effective fire suppression method in existing residential occupancies.

UL listing of Self Contained Residential Range Top Fire Protection Systems ***Kerry Bell, UL***

Mr. Bell spoke briefly of the process by which a UL standard comes into existence. UL seeks input from interested parties and considers existing standards, then follows a UL process to develop a new standard. Prior to the development of a new UL standard, UL may publish an Outline of Investigation based on a few product tests. Some products may be subject to multiple UL standards, such as range-top fire extinguishing systems.

Residential range-top fire suppression systems are tested to an Outline of Investigation, UL 300A, in which the entire system is subjected to fire tests. Additionally, the components of the system such as the cylinders that house the agent, the heat responsive links, audible signals, detectors and control units are tested separately per individual UL standards. The fire tests evaluate the system's ability to suppress fires of varying sizes, and over both gas and electric stoves. Thirteen different fire/range scenarios are tested. UL feels that these tests demonstrate that the systems are very effective in extinguishing fires, but that they may not be suitable for protecting all cooking surface/range top arrangements. In general, a successful system must meet 3 criteria: 1) flame in the cooking vessel must be completely extinguished, 2) no re-ignition within 5 minutes, and 3) the oil temperature must decrease below its auto-ignition temperature. Systems listed in accordance with UL 300A are in the "Residential Range Top Extinguisher Units (GMCH)" category. Mr. Bell provided an overview of a typical system and its components. In closing, it was indicated that UL is open to suggestions for enhancing existing requirements to UL 300A.

Overview of NIST/USFA Localized Residential Suppression System Project
Daniel Madrzykowski, NIST

The objective of this study is to mitigate the hazard from a typical kitchen fire, such as a cooking oil fire on a stove, by using "passive" or "active" fire protection systems that are inexpensive and easy to retrofit into existing homes.

This project is co-sponsored by NIST, the U.S. Department of Housing and Urban Development (HUD), Partnership for Advancing Technology in Housing (PATH) and the United States Fire Administration (USFA).

Progress -The project has three major components: 1) kitchen fire hazard characterization, 2) investigation of "passive" and "active" fire protection systems and appropriate test protocols, and 3) limited full-scale evaluation.

Kitchen Fire Hazard Characterization – An understanding of the fire hazard in terms of engineering units is required to determine how effective a standardized test may be in evaluating a potential solution for mitigating the adverse effects of kitchen fires. The fires were measured in terms of heat release rate (kW) and heat flux (kW/m²). Several different types of cooking oil were heated to auto-ignition and were compared to heptane. Corn oil was chosen for the full scale experiments. The heat release rates of the UL 300A test scenarios are also being measured.

Toaster fires and coffeemaker fires were also initiated and measured. A burning coffeemaker provides a higher heat release rate and burns for a longer duration than a toaster with burning toaster pastries. Therefore, the coffeemaker was chosen as the design hazard for the counter top appliance.

Passive Fire Protection Systems - Passive systems have no moving parts. They are intended to contain the fire and limit and delay the growth of the fire. Several potential

“passive” fire protection solutions were considered including: spacing, coverings, choice of materials, and coatings. Of these possible solutions, intumescent paint appeared to have the best cost benefit and best potential for easy retro-fit.

Intumescent Paint Experiments and Results – Cone calorimeter tests comparing painted gypsum board and varnished wood with and without applications (coats) of two commercially available intumescent paints yielded positive results. However, in a limited number of full-scale kitchen tests, the intumescent paint did not significantly reduce the growth and spread of the fire.

Active Fire Protection Systems – Active fire protection systems have moving parts and are intended to control, suppress, or extinguish the fire. Three types of active systems were considered: 1) a dry chemical system installed under the exhaust hood above the range, 2) a wet chemical system installed under the exhaust hood above the range, and 3) a single automatic fire sprinkler installed in the kitchen. Although the best situation is a fully sprinklered residence in accordance with NFPA 13D, 13R, or 13 [16-18], systems of this type are out of the scope of this study due to the relatively high cost of retrofitting.

Localized Suppression System Experiments and Results – Full-scale kitchen experiments were conducted in several kitchens in a vacant apartment building. The experiments were conducted to investigate the effectiveness of dry chemical and wet chemical kitchen hood fire extinguishing systems and single residential sprinklers. Under laboratory conditions, these technologies have demonstrated the ability to control or extinguish a range-top fire. In the series of experiments, both self-contained systems, one wet chemical and one dry chemical, were effective in extinguishing the cooking oil fire in a skillet.

The concept of a single low flow residential sprinkler was tested, with both a pendant and sidewall configuration, and was found to control both the cooking oil fire and the appliance fire, despite shielding by the cabinets, while extinguishing the fire spread to the cabinets and walls.

None of these solutions was perfect. The inexpensive (< \$200) self-contained systems as well as the single sprinkler did not de-energize the range. There are UL listed suppression systems that also de-energize the appliance, but the installed cost is on the order of \$1000. For the single sprinkler, the challenge for the homeowner/installer will be to assure that sufficient water pressure and flow are available to provide an adequate supply to the retro-fit sprinkler.

Finally, the testing to date has only addressed a skillet fire. Recent experiments by Hamins at NIST, have shown that a 254 mm (10 in) pot with 102 mm (4 in) of corn oil has a significantly higher heat release rate than the 254 mm (10 in) skillet fire used to date.

BREAKOUT GROUP RESULTS

The unanalyzed results (poster board notes) of the breakout group discussions are located in Appendix 7. The results reflect more than just simple answers to the discussion questions. In some cases, the items listed are important points or questions raised through discussion within the breakout groups and, as such, may not be a direct answer to the original question at hand. As the discussions proceeded, it became clear that some items were relevant to multiple categories.

Commonalities among the results of the two groups were apparent when the breakout groups reconvened. However, sometimes the same response was not always listed in exactly the same manner among both groups; e.g., education of consumers was considered in discussions surrounding three of the four categories. Therefore, the common ideas among groups are presented in general categories in Tables 1 through 4.

The themes of the discussion revolved around four topic areas: prevention, suppression, research, and mass acceptance.

Table 1. “What is needed to reduce losses from kitchen fires? Is it prevention?”

Category	Scope
Education	Provide education on hazards of kitchen fires generally and targeted to vulnerable groups specifically.
Smoke Alarms	Development of reliable alarms (lower false alarm rate) and placement in suitable locations.
Insurance Industry	Involvement of insurance industry to educate, and encourage residential prevention.
Pre-ignition	Detection and control of pre-ignition sources.

Table 2. “What is needed to reduce losses from kitchen fires? Is it suppression?”

Category	Scope
Commercialization	Inexpensive, low or no maintenance suppression system that can be retrofitted at little installation cost.
System characteristics	Fast response time and automatic activation.
Control of fire	Reduce heat release rate until suppression is possible.
De-Energization	Stopping range top heat source enables suppression and reduces chance of re-ignition.
Extinguishment	Extinguishment, rather than control is needed to assure safety.
Life safety	Mitigate problem with little risk to life safety.
Minimization of property damage	Mitigate problem with little clean-up or damage.

Table 3. “What are the prioritized research needs for kitchen fires?”

Category	Scope
Incident data	Focus more on appropriate incidents in a more timely manner.
Human behavior	Research international successes in educating consumers on safe practices.
Performance test development	Characterization of various cooking and kitchen configurations to represent realistic scenarios. (In addition to current UL standards).
	Evaluate currently available technologies.
Alternative technologies	Examine new methods that may be more economical or easier to implement, or employ different mechanisms by which they suppress fires.
	Specifically, research the applicability of low flow/low volume systems.

Table 4. “What is needed to place effective retrofit systems into a significant number of homes?”

Category	Scope
Low Cost	If systems are inexpensive, and low or no maintenance, consumers will be more encouraged to install them.
Low maintenance	
Education	Provide information to consumers on the effectiveness of retrofit systems.
Legislative rulings	Enact mandatory requirements to ensure use by consumers.
Insurance/tax credits	Encourage use by providing incentives similar to other safety improvements, e.g., security systems.
Case study	Install systems in a small community, e.g. elderly housing, to demonstrate effectiveness.
Verify and correlate data	Review incident data to validate findings and provide confidence in data.

Prioritization

After the group reports, the attendees were asked to prioritize the topics listed in Tables 1 through 4, that the attendees felt were most critical to address. The responses from each group were considered and listed, so that the attendees could vote on the issues they felt were most important. Attendees were grouped by their closest affiliation, either with 1) the fire service, or 2) standards, codes, testing and research organizations, or 3) the fire protection industry.* Each organization received 10 votes. It should be noted that some organizational representatives chose not to participate in the voting or did not use all of their votes.

In Figures 1 through 4, the votes by each representative group are presented. Figure 1

* Representatives from CPSC, NIST, and USFA did not vote.

displays the four prevention topics that were voted on. As a whole, the group found the development of methods and equipment to detect a potentially hazardous condition on the range and then control it, to be just as important as focusing educational efforts on high-risk populations for a specific fire hazard. The next item addresses the use of improved methods of smoke detection and alarm, as well as improved knowledge of appropriate locations either within the kitchen or adjacent to the kitchen. The last topic showed support for the involvement of the insurance industry in the prevention/education process.

Figure 2 addresses the seven suppression topics that were voted on. Again, there was a tie for the most votes. Mass acceptance or commercialization was found to be equally important as controlling the fire. The votes support the need for an effective low cost, low flow, low maintenance, easy to install system as the key to having a large number of units installed in residences. There was not a significant distinction between controlling the fire and life safety within the work group. Fire control was considered as the ability of the system to mitigate the hazard from the fire as opposed to life safety which was considered as enabling additional time to escape. De-energizing the range at the time of a suppression system activation and complete extinguishment of the fire had an equal number of votes. It was mentioned that all of the systems listed in accordance to UL 300A include a mechanism to de-energize the range, in order to prevent re-ignition.

In the area of research, Figure 3 shows that the votes were split over 7 topics. The desire to have a better understanding of the circumstances of kitchen fires to enable targeted education and enable identification of cost effective solutions were the most popular. The next three topics involved developing and or assessing the performance of technologies that are or could be used in residential kitchen fire suppression systems. The 5th and 6th topics involve analyzing incident data, cooking technologies and arrangements, protection options, and people's interaction with them to find solutions to the kitchen fire problem. The last topic identifies a need to further examine UL 300A.

The last figure shows a vote split among 7 topics. Mass acceptance is another way of describing consumer appeal. Two of the top three topics address low cost and low maintenance. These were supported by comments of ease of installation and the fact that the systems should be reliable. Educating the public on the causes of cooking fires was the 2nd most popular topic and tied into two other topics of verifying and analyzing the data via a case study. The data piece not only extends to preventing the cause of the cooking fire but also developing data on the performance of range-top fire protection systems, perhaps with a case study or demonstration project in an environment with a higher risk of cooking fires. The 4th and 5th topics address mandating range top suppression systems and providing incentives to encourage the purchase and installation of such systems, respectively. Two votes were cast supporting the idea that a legislative requirement would be needed to compel the installation of fire protection systems in residences.

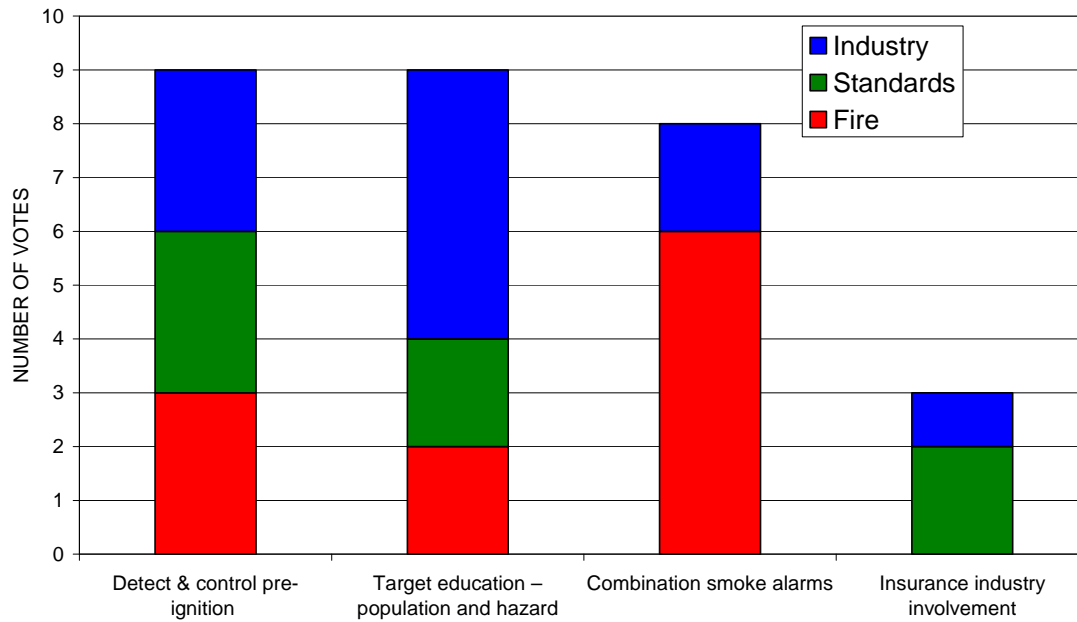


Figure 1. Prevention topic vote distribution.



Figure 2. Suppression topic vote distribution.

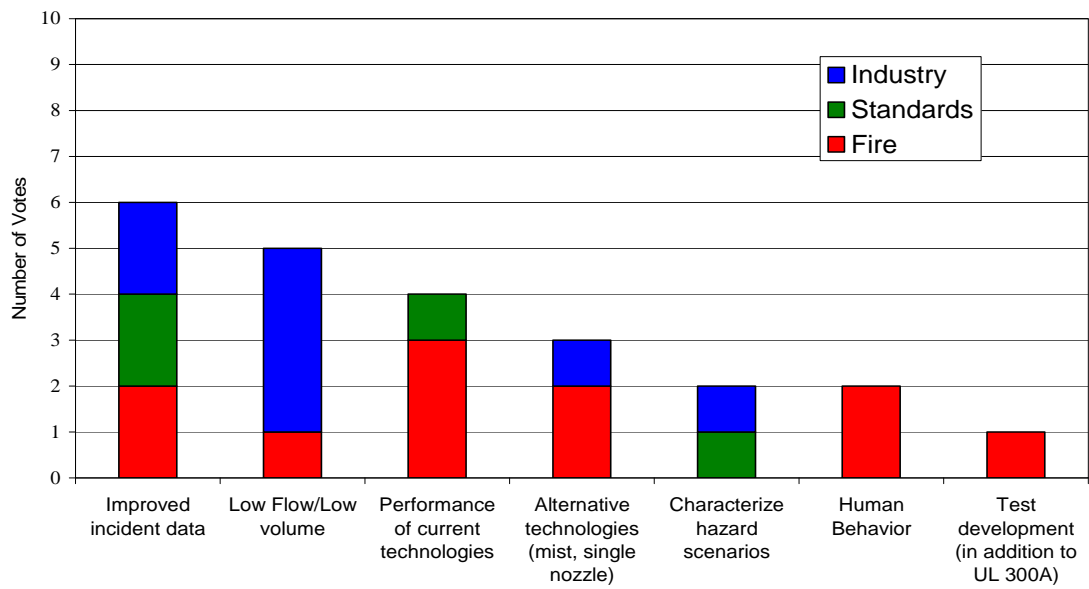


Figure 3. Research topic vote distribution.

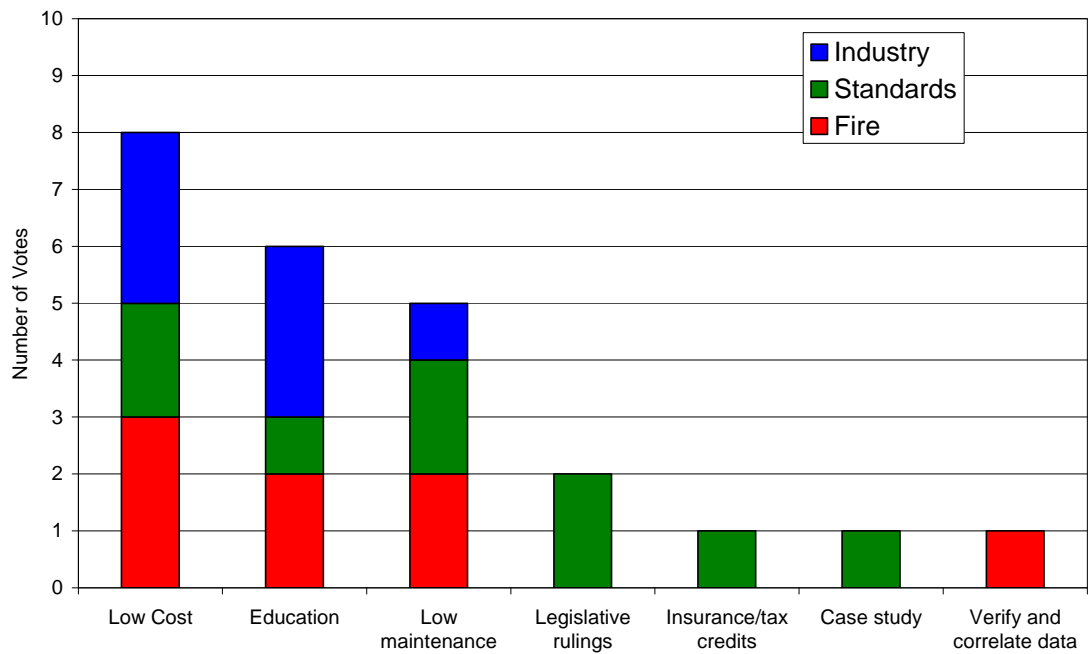


Figure 4. Mass acceptance vote distribution.

Table 5. Priorities by affiliation

Topic Area	Fire Service	Standards	Industry	Total
Prevention	11	7	11	29
Suppression	8	9	11	28
Research	11	4	8	23
Mass Acceptance	8	9	7	24
Total	38	29	37	104

Table 5 summarizes the voting in terms of general topic and organization/group affiliation. The votes cast for topics related to prevention and suppression indicate that the importance is split between how to address the problem of kitchen cooking fires. Research and mass acceptance of the systems were closely behind and earned almost equal importance.

The fire service community placed a high priority on both prevention and research, while determining that suppression and mass acceptance of retrofit systems had a lower priority level. Within the prevention topics, they were more interested in consumers using smoke detectors than reacting to pre-ignition conditions. Among the research topics, their priorities were evenly spread. Understandably, within the suppression topic, the first responder votes indicated that the systems should be able to control the fire.

The standards, codes, testing and research entities attached equal importance to suppression as on mass acceptance of the technology for their first choice. Prevention topics held the second level of priority by only two votes.

The fire protection industry representatives revealed that prevention and suppression issues were most important. Research topics and mass acceptance shared a similar priority. Education as a form of prevention ranked high in their priorities. For the suppression and mass acceptance topics, industry prioritized economically feasible systems.

Examining the votes across the categories indicated that low cost systems are important to all groups. The economic benefits of systems may drive the final decision of a consumer to purchase the product.

Education of the public on the general hazard of kitchen fires and methods of suppression emerged as an important topic to the attendees.

SUMMARY

The wrap up discussions delineated a two-phase approach: short-term and long-term efforts. Each group's strategic focus contained some piece of the four areas: prevention, suppression, research and mass acceptance.

In the short term, education was viewed as the most important approach to immediately attack this problem. The education should be focused on prevention and a near term study should be conducted to identify the capabilities and limitations of existing, commercially available suppression technologies. The results of this study could be used as part of the education/prevention effort, as well as potentially serving to aid in mass acceptance by the consumer. Incorporating incident data was also considered critical to the success of the education effort.

In the long term, the need for a low cost, low maintenance, low pressure, low volume, retrofit system was the priority. A follow on was the need for appropriate standards to address those systems, one of the groups referred to it as "15K". It was re-iterated that the cost of an effective suppression system was of high importance with regard to technological advancements, because low cost will enable mass acceptance.

FUTURE WORK

This Workshop was a first attempt to gather representatives from many sectors interested in the kitchen fire problem with the goal of identifying barriers that impede advances in the reduction of residential losses in kitchen fires. Participants included representatives from the fire service, codes and standards organizations, testing and research laboratories, the fire protection industry, and government agencies. The Workshop provided an opportunity for participants to learn from each other and to work together to guide future developments.

This Workshop provided a strong foundation for follow-on efforts among government agencies, the fire service, and the private sector groups to:

- Examine and refine methods by which incident data is received.
- Further identify and refine research needs to reduce fire losses.
- Evaluate existing performance standards.
- Enhance current public education materials.

Work is ongoing to evaluate existing range top fire suppression systems through research at NIST, USFA, and CPSC.

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APPENDIX 1- WORKSHOP AGENDA

Workshop on Residential Kitchen Fire Suppression; April 11, 2006

8:00 - 8:30 - Registration (Building 224, Room B245, NIST)

8:30 Welcome - *William Grosshandler, Chief, Fire Research Division, BFRL, NIST*

8:45 Opening Remarks – Workshop Goals and Logistics, *Anthony Hamins, NIST*

8:55 Self Introductions

9:00 The Residential Fire Problem: A Statistical Look at Kitchen Fires - *Marty Ahrens, NFPA*

9:30 The Residential Fire Problem: A Fire Chief's Perspective - *Michael Love, IAFC*

9:45 Break

10:00 Residential Self Contained Fire Suppression Systems Tests at UL - *Kerry Bell, UL*

10:30 Overview of NIST/USFA Residential Suppression Project - *Dan Madrzykowski, NIST*

11:00 Charge Work Groups - *Dan Madrzykowski*

Purpose and Guidelines for the Working Sessions (NIST)

What is needed to reduce losses from kitchen fires?

- Prevention
- Suppression
- What are the prioritized research needs for kitchen fires?
- What is needed to get effective retrofit systems into a significant number of homes?

Noon– Working Lunch, Pick-up lunch, Bldg 224/Room B245, return to break-out room.

3:00 -3:15 Break - Reconvene in B245 for Group Reports

3:15-4:30 Group Reports

4:30 Summary

5:00 Adjourn for the Day

APPENDIX 2 - LIST OF ATTENDEES

Name	Organization
Ahrens, John P.	Fairfax City FD
Ahrens, Marty	NFPA
Andres, John	Kidde
Bell, Kerry	Underwriters Laboratories
Bender, John F.	International Fire Marshals Association
Brown, Larry	National Association Home Builders
Bryner, Nelson	NIST
Chamblin, William	Life Mist Technologies
Dalton, James, F.	National Fire Sprinkler Association
Goss, Kay, C.	Fail Safe Safety Systems
Gulbinas, Ed	Ontario OFM
Hamins, Anthony	NIST
Kelly, Robert	Manufactured Housing Institute
Khanna, Rohit	CPSC
Kuchnicki, Dick	ICC
Lawler, Meredith	USFA/DHS
Love, Michael	MCFRS
Madrzykowski, Daniel	NIST
Maruskin, M. Larry,	USFA/DHS
Mehta, Shivani	CPSC
Merck, Richard E.	MCFRS
Morris, Wayne	Association of Home Appliance Manufacturers
Neily, Margaret	CPSC
Peterson, Patrick	Williams-Pyro
Pitts, Bill	NIST
Rouse, Paul	Twenty-First Century Fire
Stell, Andy	Williams-Pyro
Stratton, Woodrow	USFA/DHS
Trotta, Andrew	CPSC
Weintraub, Preston	Williams-Pyro

APPENDIX 3 - Presentation by Marty Ahrens, NFPA



Home Kitchen Fires Reported to US Fire Departments

Marty Ahrens
Residential Fire Suppression Research
Needs Workshop
NIST
April 11, 2006

1



To Be Covered

- ♦ Data sources
- ♦ Context
- ♦ Kitchen fire trends
- ♦ Causes of kitchen fires
- ♦ Time of day
- ♦ Extent of flame damage
- ♦ Method of extinguishment
- ♦ Victim information
 - ♦ Age
 - ♦ Activity when injured
- ♦ Contributing factors
- ♦ CPSC Data

2



Data Sources

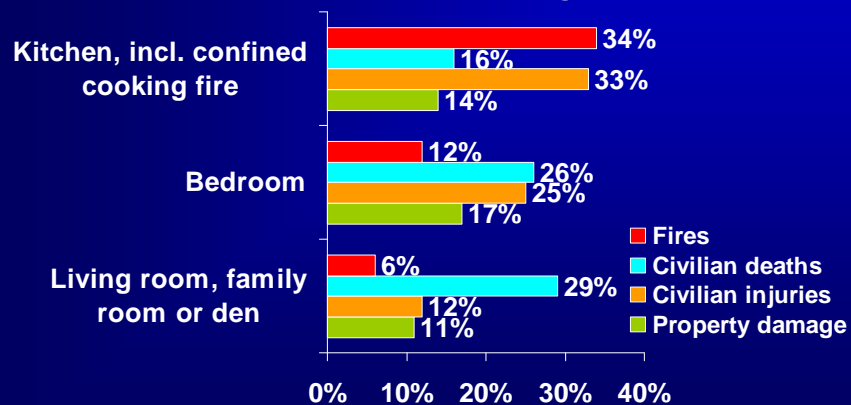
- ♦ National estimates derived from
 - ♦ USFA's National Fire Incident Reporting System (NFIRS)
 - ♦ NFPA's annual fire department experience survey
- ♦ Changes in Version 5.0 of NFIRS pose challenges
 - ♦ 64% of 5.0 kitchen fires were confined cooking fires
- ♦ Homes include one-and two-family dwellings, manufactured housing and apartments

3



Area of Origin

Leading Areas of Origin in Home Fires
1999-2002 Annual Averages



4



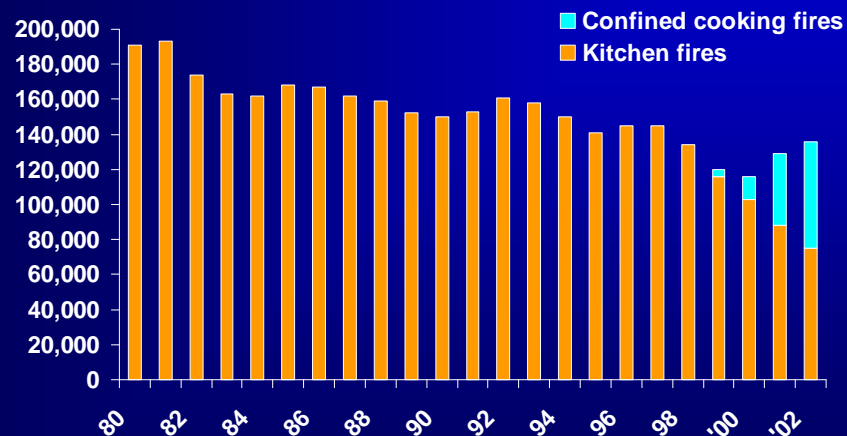
Size of the Kitchen Fire Problem

- ♦ Annual averages for reported US home fires starting in the kitchen in 1999-2002, including confined cooking fires
 - ♦ 125,500 fires
 - ♦ 460 civilian deaths
 - ♦ 5,090 civilian injuries
 - ♦ \$771 million in direct property damage

5



Home Kitchen Fires by Year

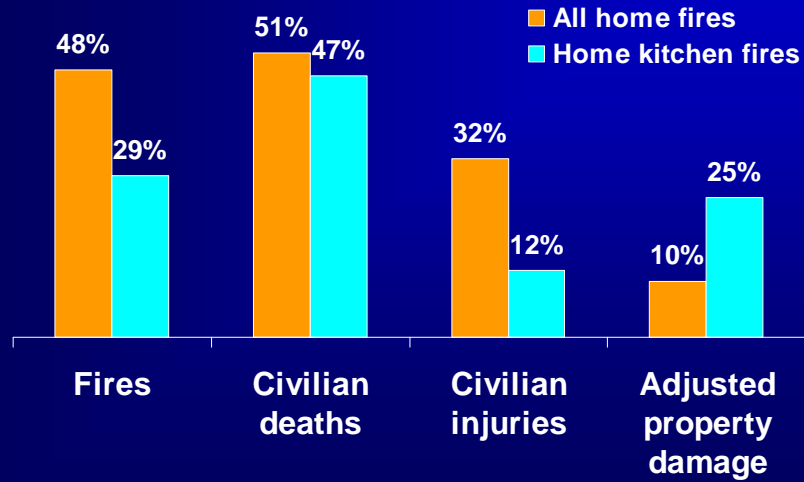


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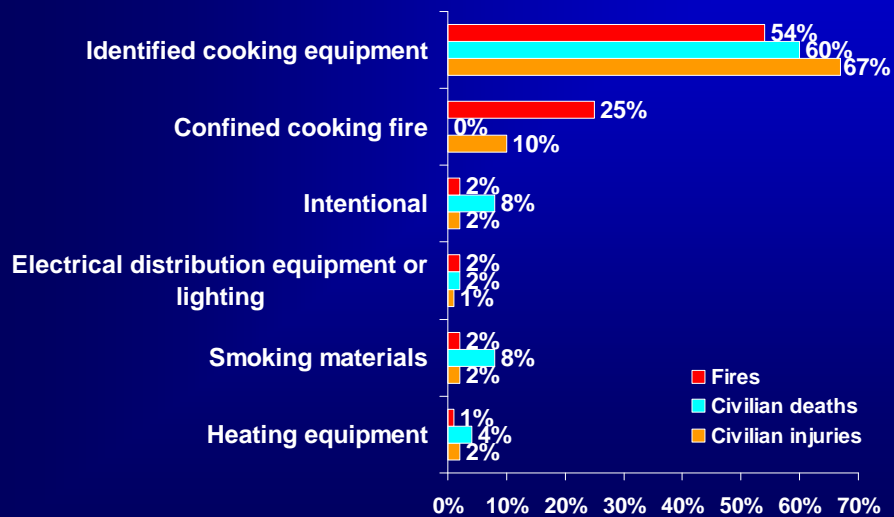
Percent Reduction 1980-2002



9



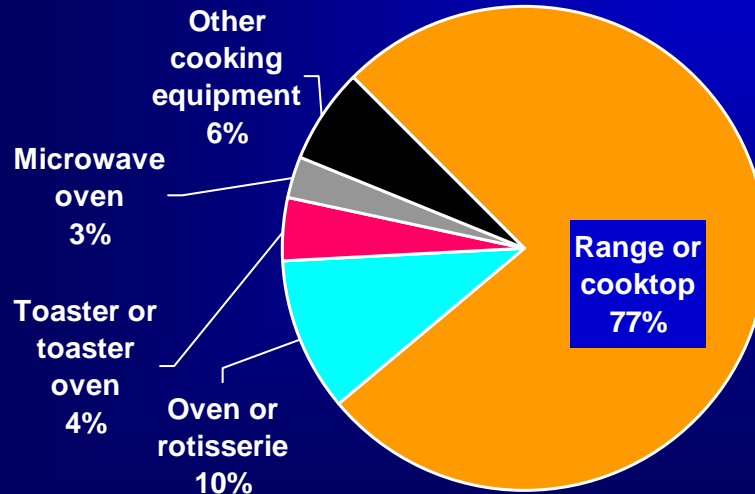
Causes of Home Kitchen Fires 1999-2002 Annual Averages



10



Identified Cooking Equipment: 1999-2002 (5.0 only)



11



Home Kitchen Fires by Alarm Time

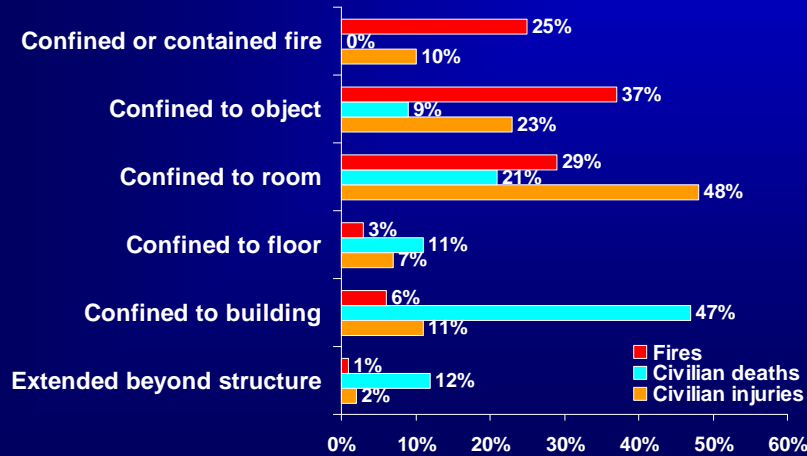


12



Extent of Flame Damage

Home Kitchen Fires by Extent of Flame Damage
1999-2002 Annual Averages

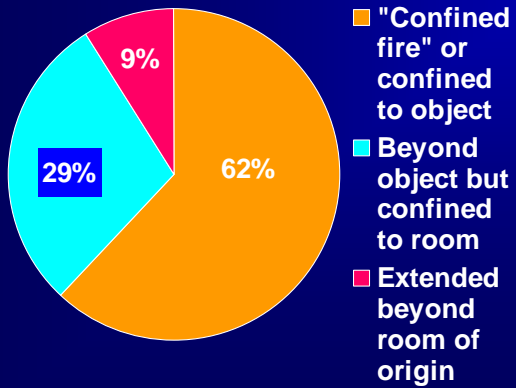


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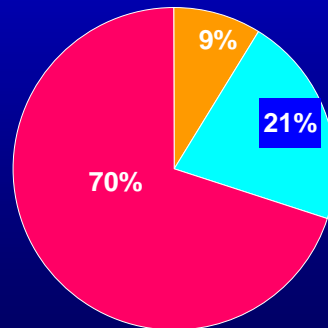


Extent of Flame Damage

Home Kitchen Fires



Home Kitchen Fire Deaths

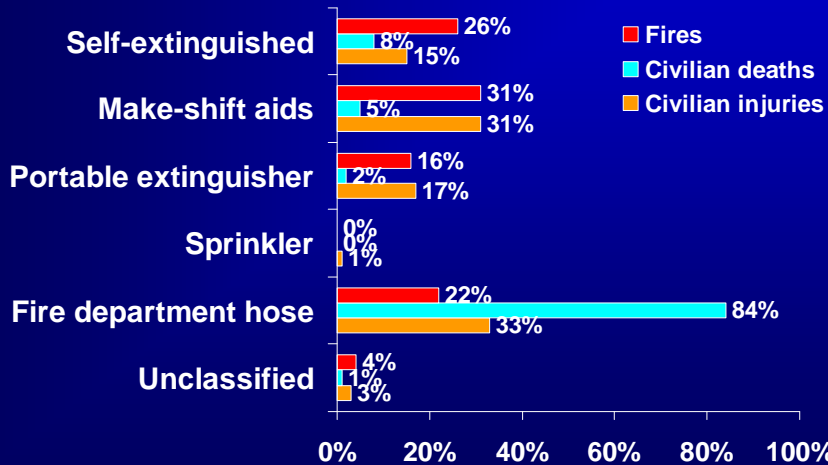


14



Method of Extinguishment 1994-1998 Annual Averages

Home Kitchen Fires

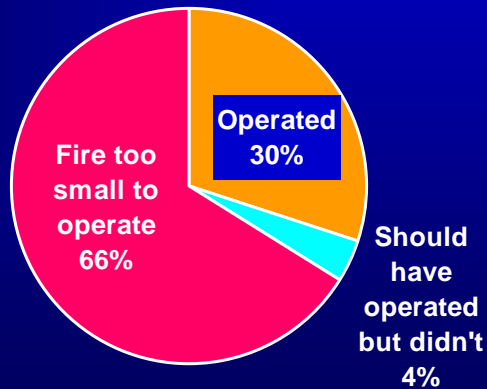


15



Automatic Suppression Systems

Sprinkler Operation (When Present) in Home Kitchen Fires 1994-1998 Annual Averages

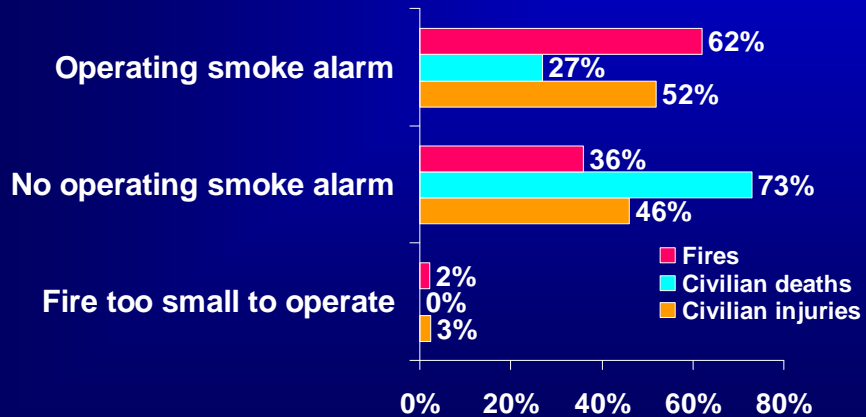


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Smoke Alarm Status (5.0 only)

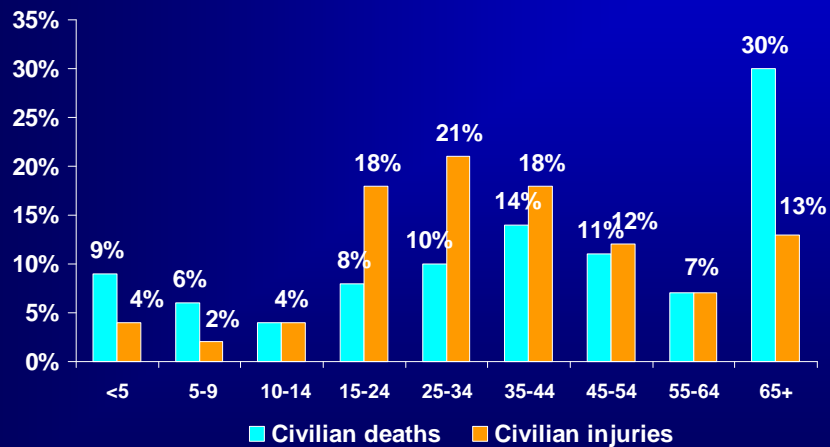
Smoke Alarm Status in Home Cooking Fires
1999-2002 Annual Averages



17



Home Kitchen Fire Victims by Age: 99-02 Annual Averages

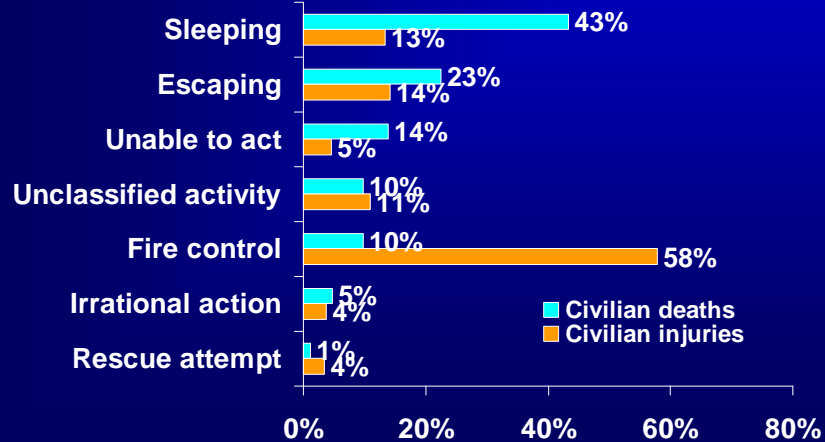


18



Activity at Time of Injury

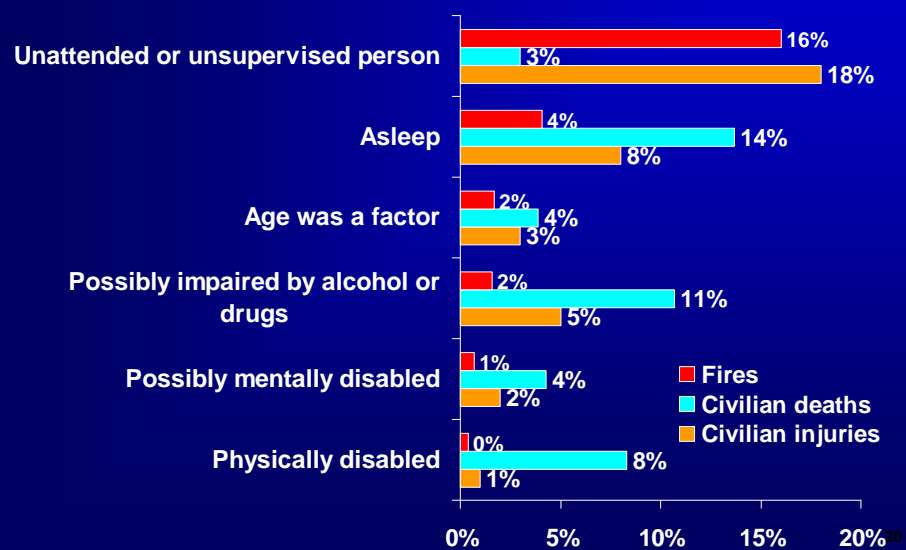
Victim's Activity in Home Kitchen Fires:
1999-2002 Annual Averages



19



Human Factors Contributing (NFIRS 5.0 data only)





CPSC Data

- ♦ Ranges or ovens were involved in an estimated 11,700 (24%) of the 48,200 residential fire injuries seen at hospital emergency rooms
 - ♦ Fire service attended in 56% of injuries
 - ♦ NEISS data for 7/1/02-6/30/03
 - ♦ <http://www.cpsc.gov/library/neissfire.pdf>
- ♦ Range fire investigations 10/94-7/95
 - ♦ 75% began with food
 - ♦ 63% of food ignitions occurred when someone was frying
 - ♦ <http://www.cpsc.gov/LIBRARY/FOIA/Foia99/os/range.pdf>



Summary

- ♦ Kitchens are the leading area of origin for fires and injuries
- ♦ Ranges or cook tops were leading equipment involved
- ♦ Flame damage extended beyond room of origin in only 10% of fires
- ♦ 58% of those injured were trying to fight the fire themselves
 - ♦ Unclear on their techniques

APPENDIX 4 – Presentation by Michael Love, IAFC



International Association of Fire Chiefs *Fire and Life Safety Section*

April 11, 2006 - Workshop on Residential Kitchen Fire Suppression

Representing International Association of Fire Chiefs – Fire and Life Safety Section.
Mike Love, Division Chief and Fire Marshal with Montgomery County (MD) Fire and Rescue Service.

I have been a member of IAFC for 11 years and present our position statement in regard to the problem of kitchen fires in un-sprinklered residences.

Kitchen fires are a significant piece of the overall residential fire problem as reported by data presented here today by NFPA.

The United States Fire Administration in the document *Structure Cooking Fires: Topical Fire Research Series, Volume 5: Issue 6 August 2005* reported that in 2002 just under 40% of all structure fires were caused by cooking; with cooking the highest fire cause. The same report listed cooking as the leading cause of fire related injuries in structures at 25%. Approximately 75% of firefighter injuries occur in residential structures.

Fire sprinklers are effective at controlling residential kitchen fires with NFPA reporting from data collected between 1999 and 2002 that a single sprinkler operating effectively in 88% of all kitchen fires.

Data supports a high effectiveness of a single sprinkler activating in residential kitchen fires.

With this high rate of effectiveness experienced on the leading cause of residential structure fires we assert that successful kitchen sprinkler activations would further promote the use of NFPA 13D sprinkler systems which is a reoccurring and highly supported goal in the fire and life safety industry.

Another assertion would offer that there needs to be an effective, low cost retrofit solution that would directly reduce the number of kitchen fires. Without such an approach the occurrence of residential kitchen fires is unlikely to reduce much.

There is sprinkler industry interest in promoting 13D retrofit programs. Perhaps the sprinkler industry would also offer a *kitchen only system*? Compared to the NFPA 13D system, a kitchen retrofit should be a very simple installation.

Despite the increase in communities adopting NFPA 13D residential sprinkler requirements in new residences these installations will not have an appreciable affect on the number of kitchen fires. There needs to be a way to achieve critical increases in the number of sprinkler retrofits.

There is evidence that fire sprinkler technology can address the kitchen fire problem and every effort should be made to assure a nationwide kitchen retrofit program with full support of the sprinkler industry.

My challenge to you/us today is to keep an open mind and creatively come up with ideas that we can employ to reduce the impact of the highly preventable kitchen fire. If that means coming up with ideas for new or unproven non-conventional means of extinguishing fires before they can either spread, progress to flashover or directly injure people this would satisfy our mission.

Thank you for the opportunity to address you with the International Association of Fire Chiefs – Fire and Life Safety Section’s point of view.

Residential Cooking Surface Fire Protection



Presentation on UL Listing of Self-Contained Residential Range Top Fire Protection Systems

April 11, 2006 NIST Workshop

Kerry M. Bell, P. E.

Outline of Presentation



- Brief Overview of UL
- Requirement development and publication
- Hardware Tests
- Fire Tests
- Product Listings
- Summary

Key Elements of UL Listing



- **Qualification** -- UL investigates product to determine that the product complies with the applicable requirements which are generally described in a UL Standard.
- **Surveillance** -- UL field representatives regularly visit the manufacturing facilities to inspect product, production procedures/records and select samples for additional performance

UL by the Numbers in 2004



- 5722 employees
- 58 laboratory testing locations
- 125 inspection centers
- 97 countries with UL customers
- 102,305 product evaluations
- 552,377 surveillance visits
- 19 billion UL marks appearing on products
- 125--average number of UL certified products in a home

Development of Product Listings and Requirements



General Approach to Investigating New Products

- Draw requirements from existing standards
- Develop new requirements

Levels of Published UL Requirements



- **ANSI/UL Standards** (>50% of total UL standards) – Standard subject to voting by a balanced Standards Technical Panel (STP). UL has one vote in STP.
- **UL Standards** - Standard developed by process whereby input is sought from broad spectrum of constituents. Final requirements determined by UL.
- **UL Outlines of Investigation** – Requirements based upon a single or a few product investigations.

Applicable Standards



Requirements for Residential Range Top Fire Extinguishing System Units

- *Fire Tests* – Subject 300A, Outline of Investigation for Extinguishing System Units for Residential Range Top Cooking Surfaces
- *Cylinder Assembly* – ANSI/UL 1254, Pre-Engineered Dry Chemical Extinguishing System Units and ANSI/UL 8, Water Based Agent Fire Extinguishers

Applicable Standards



Requirements of Residential Range Top Fire Extinguishing Systems

- *Heat Responsive Links* – ANSI/UL 33, Heat Responsive Links for Fire Protection Service.
- *Detectors (if provided)* – ANSI/UL521, Heat Detectors for Fire Protective Signaling Systems

Applicable Standards



Requirements of Residential Range Top Fire Extinguishing Systems

- *Audible Signal Appliances* (if provided) – ANSI/UL 464, Audible Signal Appliances
- *Control Units* (if provided) – ANSI/UL 864 – Control Units and Accessories for Fire Alarm Systems.

Hardware Tests



Exposures

- Exposure to cooking oils
- 10 day corrosion
- Extinguishing agent compatibility tests with system components
- Elevated temperature exposures
- Aging tests of polymeric materials
- Aging tests of elastomeric materials
- Stress corrosion cracking tests

Hardware Tests



Leakage, Operation and Strength

- One year leakage
- Hydrostatic strength at least 4 times working pressure
- Pressure gauge functional and strength tests
- Mounting device strength
- Operation and extinguishing agent distribution tests

Fire Tests



Fire Testing Conducted in Accordance with Subject 300A, Outline of Investigation for Extinguishing System Units for Residential Range Top Cooking Surfaces

Fire Tests (Cont.)



Fire Tests Consider System End Use Limitations Including:

- Range of nozzle locations
- Range of heat responsive link locations
- Minimum and maximum nozzle discharge rates
(established by using minimum and maximum
operating pressures)

Fire Tests (Cont.)



Fire Tests Consider Both Gas and Electric Ranges:

- Manufacturer can request to be limited to only gas
or electric range top.
- Maximum area of cooking surface is tested and
specified in manufacturer's instructions.
- Exhaust hood is installed above cooking surface.

Fire Tests (Cont.)



Fire Tests Consider Two Different Cooking Oils:

- Vegetable Oil
- Peanut Oil

Fire Tests (Cont.)



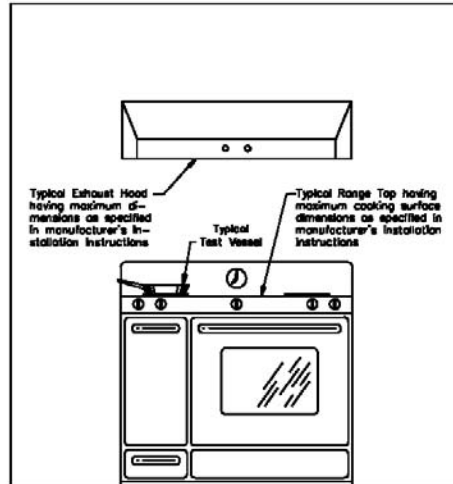
Fire Tests Consider Four Different Cooking Vessels:

- 13-14 inch diameter by 2 in. high skillet with 1 inch of oil
- 10 inch diameter and 7 inch high steel pan with 4 inches of oil
- 4-5 inch diameter by 2 inch high sauce type pan with 1 inch of oil
- A 3 inch high steel pan having length and width dimensions equal to dimensions of cooking range surface with $\frac{1}{4}$ inch of oil

Fire Tests (Cont.)



Typical test apparatus for range top
(full scale) testing



Fire Tests (Cont.)



General Test Method:

- **Extinguishment tests** -- Unit pressurized to its lowest operating pressure and nozzles are installed at the maximum distance above cooking surface (all pan sizes are used for these tests)
- **Splash/Extinguishment tests** -- Unit is pressurized to its highest operating pressure and nozzles are at the minimum distance above cooking surface in an orientation considered to create splashing of hot oil (Both 14 and 5-inch diameter pans are used for these tests)

Fire Tests (Cont.)



General Test Method:

- Each range, test vessel and oil type is tested (13 fire tests referenced in Subject 300A)
- Test vessel positioned in a location considered to be most challenging to achieve extinguishment
- Test vessel with specified oil depth is heated with stove adjusted to its maximum heat output unit auto-ignition occurs
- Tests conducted with units operated automatically and after a minimum of a 1 minute free burn

Fire Tests (Cont.)



General Test Criteria:

- 1) Flame in cooking vessel must be completely extinguished
- 2) Re-ignition of oil in test vessel must not occur within 5 minutes
- 3) Oil temperature must decrease below its auto-ignition temperature

UL Listing Information



Listing Category: “Residential Range Top Extinguisher Units (GMCH)

- Four companies are currently authorized to apply UL to mark:
 - **Badger Fire Protection**
 - **Pem-All Fire Extinguisher Corp.**
 - **Smartx Inc.**
 - **Twenty First Century International Fire Equipment Co.**
- List of UL Listed equipment is available on our on-line certifications directory at UL’s web site www.ul.com

Typical Features of UL Listed Extinguisher Units



- Wet chemical solution commonly used as extinguishing agent
- Provisions for shutdown of fuel or energy to the range
- Heat responsive links typically used to detect fire
- Temperature rating of heat responsive links is typically 212 to 280 °F
- Provisions are provided for local alarm

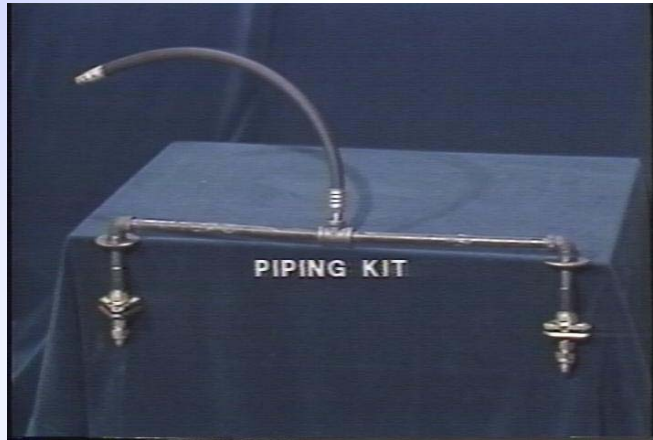
Typical Extinguisher Unit



Typical Extinguisher Unit



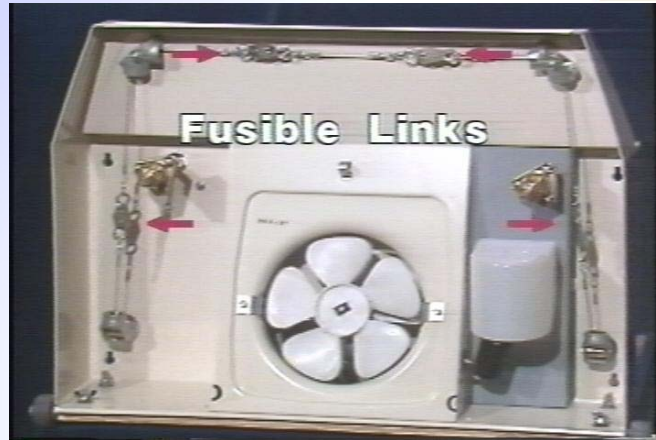
Typical Extinguisher Unit



Typical Extinguisher Unit



Typical Extinguisher Unit



Typical Extinguisher Unit



THE GUARDIAN
Stops Rangetop Fires Instantly

OWNER'S MANUAL

Limitations on End Use Application



- Large variety of kitchen range top configurations such as island range tops with overhead hoods and island range tops with downdraft ventilation.
- Current units are not designed for all types of cooking surface arrangements

Summary



- UL Listed residential range top extinguisher units are subjected to a rather rigorous series of hardware as well as fire tests
- These units are very effective in extinguishing fires occurring on range tops
- These units may not be suitable for protecting all kitchen cooking surface arrangements
- On an on-going basis, UL is receptive to receiving suggestions for enhancing existing requirements for these units

Localized Residential Fire Suppression Systems

- Kitchen fire hazard characterization
- Investigate “passive” and “active” fire protection systems
- Full-scale demonstrations/evaluations

Sponsors: USFA, HUD & NIST



Kitchen Fire Hazard Characterization



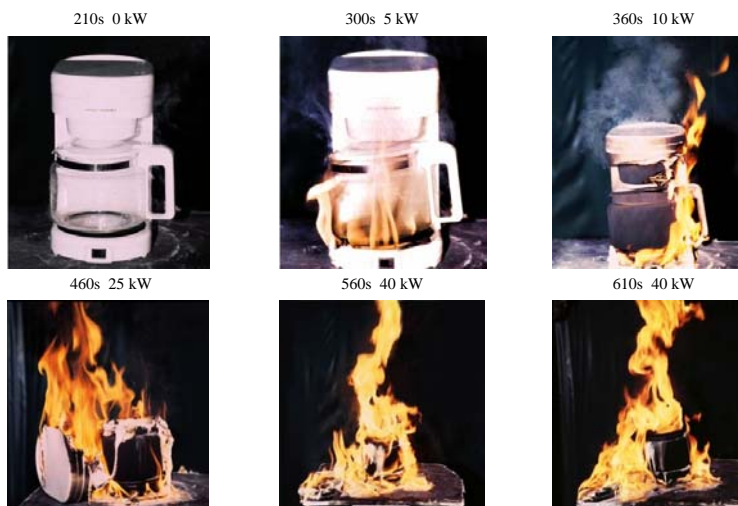
- Cooking Oil Fires
 - Canola
 - Corn
 - Olive
 - Peanut
 - Sunflower
 - Vegetable
 - Heptane

Kitchen Fire Hazard Characterization

- Appliance Fires
 - Coffeemakers
 - Toasters
- Measurements
 - Heat release rate
 - Heat flux
 - Mass loss



Coffeemaker Heat Release Rate



Passive Fire Protection

- Spacing
- Coverings
- Materials
- Coatings
 - Intumescent Paints
 - Significantly reduced HRR in bench scale testing



Intumescent Paint Results



- Full-scale fire experiments
 - Limited delay of fire spread
 - Similar measured temperatures in kitchen with and without intumescent paint
 - Paint delaminated in some cases

Active Fire Protection

- Range Hood Systems
 - Dry Chemical
 - Wet Chemical
- Localized Suppression Systems
 - Single low flow sprinkler in kitchen
 - Pendent
 - Sidewall

Dry Chemical Results

- Fire extinguished
- Flames need to impinge on device to activate
- Pilot out
- Area protected limited to stove top



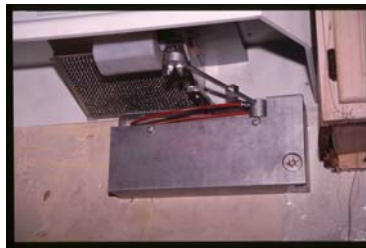
Splash



Wet Chemical Results



- Fire extinguished within seconds of auto-ignition prior to full pan fire development.
- Potential for re-ignition
- Protected area limited to stove top



Single Sprinkler Results

- Fire suppressed
- Larger fire required to activate sprinklers compared to range units
- Protects entire kitchen area



Single Sprinkler – Small Kitchen



Single Sprinkler – Large Kitchen





No Sprinkler in Kitchen



II. Research Plan for FY2006

- A workshop of interested stakeholders –April 11, 2006
- Technical challenges:
 - review and evaluate UL 300A
 - compare method with a representative hazard.
 - examine repeatability
 - examine suppression systems

III. Impact

- Conduct research that will promote acceptance of retrofit fire suppression technologies for residential applications.
- As the use of localized suppression systems increase in existing housing, the number of fatalities and injuries due to kitchen cooking fires would be expected to decrease.

UL 300A Fire Characterization

- 14 test scenarios including
 - Pan A – 4" dia., 2" deep, SS, 1" of oil
 - Pan B – 13" dia., 2" deep, cast iron, 1" of oil
 - Pan C – 10" dia, 7" deep, SS, 4" of oil
 - Pan D – 3" deep, size of range top, ¼" of oil
- Oil: Vegetable; Peanut
- Stove: electric; gas
- Measurements:
 - heat release rate
 - heat flux (vertical and horizontal)
 - pan temperature (bottom, middle, top)
 - ignition time
 - flame height
 - Stove mass flow

Test 1, March-7-2006

Pan C- 100 mm
187 g Corn Oil (25mm)

Time to Ign ~ 18 min
Peak HRR ~ 70 kW



Ignition



9 s



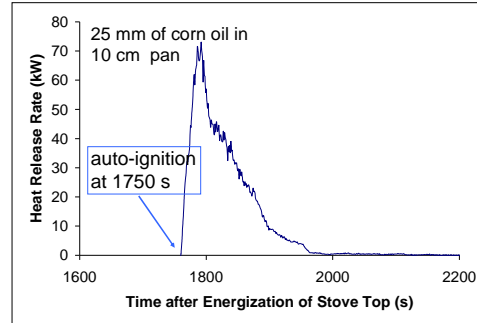
60 s



75 s



180 s



UL 300A Fire Characterization

Pan Diam (in)	Time to Ignition (min)	HRR max (kW)	Oil Type	Stove Type
4" pan	18	70 to 100	corn	electric
4" pan	18	65	peanut	gas
10" pot	78	400	corn	electric
10" pot	145		peanut	gas
13" skillet	>93*	-	peanut	gas
13" skillet	61	>100**	peanut	electric
13" skillet	57	>100**	corn	electric
18 x 21 pan	24	>100**	corn	gas

* Ignition not observed

** stopped before
maximum achieved



What's Next

Your Task

- **What is needed to reduce losses from kitchen fires?**
 - Prevention?
 - Suppression?
 - What research is needed?
 - What is needed to enable mass marketing of retro-fit kitchen suppression systems?

Process

- Work in break-out groups
- Develop priority items in small groups
- Report out to whole group
- Consolidate Priority Items (10-12 Total)

Voting

- Each organization represented has 10 votes (dots)
- Red dots – Fire Service
- Blue dots – Manufacturers
- Green dots - Organizations

APPENDIX 7 - Notes from breakout groups

The unanalyzed transcription of notes from the two breakout group discussions (red group and yellow group) are given below.

Notes from the Red Team

Prevention

- Education
 - TV advertisements
 - Fire blankets
 - Resource materials
- Define objectives- Prevent ignition
- Technology
 - Safety element of stove
 - Thermostatically controlled fryers
 - Motion detector shut-off
 - Auto-ignition temperature of oils
 - Smoke detector reliability/effectiveness
 - Detect and control pre-ignition conditions
 - Smart stoves
 - Audible alarms
 - Kitchen design

Suppression

- Blankets
 - Fire retardant treated terry cloth
 - Automatic systems; avoid manual fire fighting
 - Manual suppression; effective systems needed
 - Auto-activation, time dependant
 - Localized sprinkler
 - Island, new kitchen designs, system research & development
- Objectives
 - Property protection
 - Safety
 - Alarm with activation system
 - Localized systems
 - Fast response (90 seconds or less)
 - Cost
 - De-energization avoids re-ignition
 - Installation, self or professional
 - Maintenance
 - Commercialization (cost, aesthetics, ease of installation)
 - Minimize property damage
 - Local and general suppression (sprinkler) complement each other

Research

- Behavior and human factor – what will it take to change behavior
 - International/cultural differences and successes.
 - School children (Japanese model)

- Performance sprinkler/other devices
 - Location of detectors and activation devices
 - Longevity
 - Maintenance
 - Disable stove
 - Auto-test
 - Visual indicators (Pressure gauge)
 - Cost
- Technologies
 - Stove Top design (ceramic stoves)
 - Cost effective technologies
 - Water Mist (UL paper), high Pressure
 - Residential portable wet-chemical (potassium citrate) – shock hazard, post discharge?
- Test Development
 - UL300A – is de-energization necessary?
 - Microwave hoods, no hood, down draft, cabinets
 - UL33, is 75 °F too large at 16 inches above stove?
 - Reliability testing developments: grease, cleaning, temperature exposure.

Notes from Yellow team

Prevention

- Targeted public education, specific for kitchen fires
- Recommend type of smoke detector and location; ionization detectors
- Re-new involvement of insurance industry

Suppression

- Retrofits that are low cost and low maintenance
- Short term: use currently available systems
- Long term: design low pressure/low volume systems.

Research

- Data – better and focused, an appropriate target group, more timely data
- Residential “K” type extinguisher
- Alternative technologies
- Characterize different cooking configurations, trends, targeted group, protection, cost economic analysis.

Mass Acceptance

- Short term
 - Education on fires
 - Make fire service, consumers, etc, aware of the existence of systems.
 - Insurance/tax credits
- Long term
 - Low cost/low maintenance systems
 - “15K” committee
- Single nozzle
- Specific hazard cook top
- Retrofit only.