LOG OF MEETING

DIRECTORATE FOR ENGINEERING SCIENCES

SUBJECT: Smoke Alarm Research Planning

DATE OF MEETING: November 22, 1999

DATE OF LOG ENTRY: December 17, 1999

SOURCE OF LOG ENTRY: Margaret Neily, ESME

LOCATION: CPSC, 4th Floor Hearing Room, East West Towers

CPSC ATTENDEES: See attached attendees list.

NON-CPSC ATTENDEES: See attached attendees list.

SUMMARY OF MEETING:

Introduction

Margaret Neily reviewed the organization of this effort of U.S. Consumer Product Safety Commission (CPSC) staff and interested parties following two earlier planning meetings in October 1998 and February 1999. The test program involves conducting full scale tests to evaluate the responses of current and emerging smoke alarm technologies to serious residential fires and their resistance to nuisance alarms. Funding for the test program is not available in the CPSC budget for FY 2000; however, funding for FY 2001 as well as options involving other government agencies will be sought. The Fire Protection Research Foundation is another organization capable of organizing funding from the private sector and administering such a research program.

Data Analysis Task Group

Linda Smith presented fire loss data on fires contributing the greatest number of deaths and injuries. Among smoldering fires, upholstered furniture, mattresses and bedding, and trash were the major contributors. Among flaming fires, mattresses and bedding, clothing (mostly not being worn), upholstered furniture, wiring insulation, and cooking materials were the major contributors. Data were also presented for each item on the rooms in which those fires occurred.

Detector/Sensor Task Group

Elizabeth Leland presented a list of approximately 20 current and emerging smoke alarm technologies as possible candidates for project testing. The Detector/Sensor Task Group developed this list at the February 1999 meeting. Ms. Leland indicated that at that meeting the Detector/Sensor Task Group had expressed the desire to consider for

testing current and emerging technologies for which information could be publicly divulged.

Discussion focused on how many technologies needed to be tested, with some participants believing that the list of 20 candidates should be shortened and others indicating their belief that as many technologies as possible should be tested. The possibility of testing the most commonly used technologies was mentioned, as was the possibility of testing only 3 technologies, namely, ionization, photoelectric, and combination technologies. Some suggested testing only pure sensors and characterizing the environment that the sensors were seeing. These last two suggestions summarized the most promising approaches of the discussion. It was also suggested that a screening process could be developed on a small-scale basis to select a range of sensitivities for testing. However, it was pointed out that the smoke aging effect could not be tested adequately in a small-scale test. A smaller scale test such as that under development at the National Institute of Standards and Technology (NIST) could be used to reproduce the observed environments for additional tests of smoke alarms without repeating expensive full scale tests.

Questions were raised about the goal of the project. Some participants have the understanding that the project is to be aimed at evaluating the performance of currently-marketed detectors, while others believe that the goal of the project is to provide the next level of improved performance as well as an improved framework for evaluating current and future technology. Concern was expressed that patented technologies, for which information could not be publicly divulged, might not be able to be included and that, as a result, a particular technology might be neglected when in fact it might be the one that performed best. The concern was raised that a monopoly situation could arise if a particular technology or technologies were to be promoted as a result of the testing.

It was pointed out that the Detector/Sensor Task Group should meet with the Test Development Group during the design phase of the project.

Tenability Group

Sandy Inkster presented a brief outline of the ongoing controversy in the international fire hazard community i.e. appropriateness of using lethal versus sub-lethal endpoints in assessing affects of exposure to fire environments, especially with regard to the various combinations of chemicals that could be present in smoke. Ms. Inkster noted that a pending vote on "smoke toxicity issues" by the International Standards Organization (ISO) could have far-reaching impact on performance requirements for smoke detectors. She also summarized the NIST N-gas model for assessing the lethal potency of smoke produced from test materials/products, which has formally been adopted in various voluntary standards. Fire effluents of primary and secondary concern to life safety were discussed.

Paul Patty noted that the National Fire Protection Association (NFPA) has several well-established tenability criteria and that smoke obscuration was the basis of the current smoke detector performance standards. John Hall noted that there were five areas of contention regarding application of sub-lethal tenability issues: (i) inter species correction factors, (ii) variation in individual susceptibility from most sensitive to average person, (iii) the non-lethal endpoint used , (iv) how behavior in the smoke environment was affected by relative distance from the fire, (v) basis of the safety factor adjustments used.

It was noted that it is difficult and expensive to measure all the components in the secondary list and that it might be better to rely on measurements of primary components like those made in the earlier Indiana Dunes tests. Rick Peacock noted that it would be relatively easy to monitor CO, CO_2, O_2, NO_x, and HCN levels, but other "secondary" components would be difficult and expensive. Taking "grab" samples at 30 second intervals would be pushing the instrumentation limits. There was discussion as to the merits/disadvantages of collecting streamlined versus broad amount of data on the chemical composition of smoke environments, with support for both extremes expressed. Other "secondary" components might be useful for distinguishing between real versus nuisance fires and should be explored, since nuisance alarming was a primary reason that people removed batteries from smoke detectors. John Hall observed that the project could become very expensive and detailed. While it might prove useful in research terms, we should ensure that we did not lose sight of the primary question that needed to be answered for consumers, i.e. the adequacy of ionization versus photoelectric sensor technologies. He said we must get a primary payoff regarding this question.

CPSC staff indicated that the primary components were absolutely required measurements and that the secondary list was desirable as determined by the participants' wishes and cost constraints. John Hall noted that when variations in individuals' behavioral reactions to fires were considered, the role of secondary toxic chemicals in smoke might even be inconsequential.

Test Development Group

Arthur Lee presented a draft test plan for discussion. The plan covered an Introduction, Test Development, Test Structures (one- and two-story structures), Phase I—full scale tests in both structures, Phase II—tenability (longer running, full scale) fires, and Phase III—smaller scale test development. Overheads from the presentation are attached. The following summarizes suggestions/comments by the group.

Detectors should be placed in every room. A "system" of detectors should be part of the test set-up, installed according to present NFPA 72, National Fire Alarm Code, requirements. Each detector group/array should have the same instrumentation and configuration. Nuisance response measurements could be made throughout the entire structure, but this would increase the cost associated with full structure measurements.

New (fully characterized) detectors should be used for each test. "Strip" down some detectors (remove enclosures and disable processing) to measure the sensor responses only. This may reduce the number of detectors needed.

Air velocity and particle concentration and size should be measured. MIC values could be considered as an alternative to the particle measurements. Measurements taken should be continuous to record conditions of smoke and fire growth. Obscuration should also be measured at the fire origin. Tenability levels should be measured along egress routes. The cost of making gas measurements is high and dependent on the type of gas and the number of measurement locations needed.

While some argued the merits of conducting small scale tests prior to full scale tests, convincing points were made for the opposite order. Some factors such as smoke concentration and aging do not scale well which supports conducting full scale tests first. Phase II tests could be combined with Phase I.

Smoldering fires need to be defined more clearly. A database from post fire interviews (e.g. characterizing smoke) may give some insight into the types of tests that need to be done. Ignition methods for smoldering and flaming fires have been documented and should be considered. The test plan should include extra, undesignated tests to be defined later in the program.

Homebuilder organizations should be involved in these meetings. The Department of Housing and Urban Development PATH program also has parallel interests to this project.

The test data should be available in an electronic form that could be used for further research and evaluation.

The final suggestion from John Hall, NFPA, was to expand the core concept group to include more representatives from other groups, tenability, modeling, and fire analysis. The group would help define the finer details of the test plan and the quantitative relationships of its components to specific fire scenarios. This will be essential to accurately characterize the implications of various smoke alarm responses measured in the test program.

ATTENDANCE

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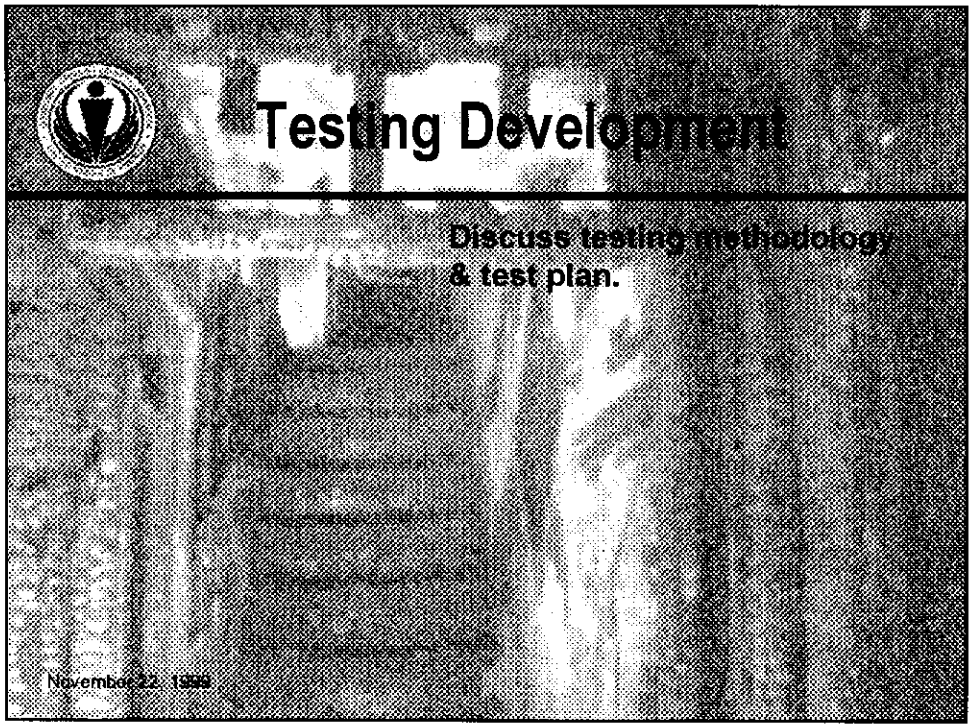
all task groups



Introduction

- Have discussions and gather comments for achieving a successful smoke detector test program.
- Arthur Lee, Electrical Engineer
  Directorate for Engineering Sciences.

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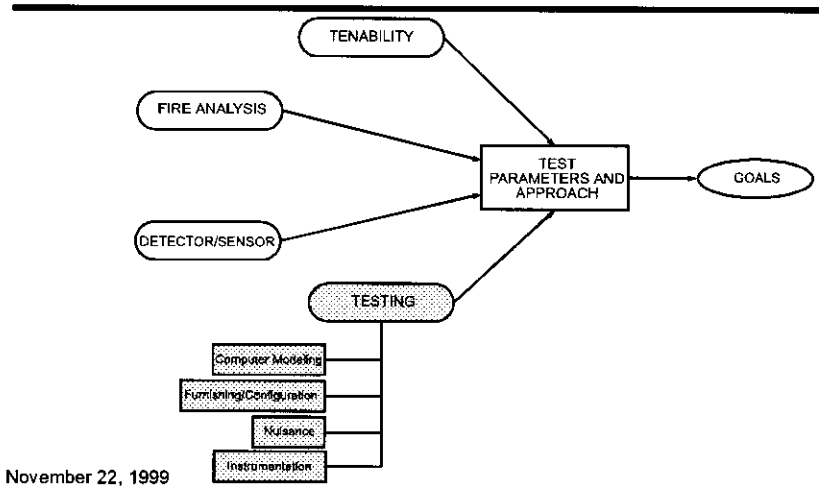
Test Development



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Furnishings/Configuration

- Fuel Sources
  - Furnishings, Trash/Paper, Cooking
- Types of Furnishing
  - Mattress/bedding, Upholstered Furniture
- Types of Fire
  - Flaming, Smoldering
- Structure Configuration
  - Single and Multi-Level Structures

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Furnishings/Configuration

- Furnishing Materials
  - Mattress
    - Inner coil-spring mattress
    - CORE fiber insulator layer
    - Polyurethane foam layers
  - Upholstered Furniture
    - Polyester Fiberfill over Urethane for Seat Filling and Arm Filling
    - Polyester Fiberfill Wrap over Polyurethane for Back Filling
- Cooking
  - Soybean oil

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Smoke/Fire Spread Modeling

- Review different types of models.
- Examine different models to help reduce the numbers of test.
- Use models to help determine placement of detectors and instrumentation.

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Instrumentation

- Look at most affordable methods to collect data.
- Examine the different instrumentation capabilities.
- Define limitations of the instrumentation.
- Identify instrumentation backup and format.

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Nuisance

- Identify nuisance sources.
  - Cooking Fumes
  - Humidity (shower, cooking, and laundry room)
  - Tobacco Products
  - Misc. (dust, high air velocity, cleaning solvents and spray aerosols).
- Examine methods to generate nuisance sources.

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Testing Structure

- Phase I Testing
  - Full-Scale Testing
- Phase II Testing
  - Tenability Fires
- Phase III Testing
  - Smaller-Scale Test Development

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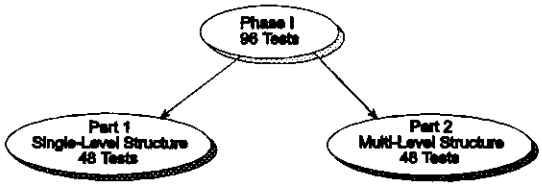
Phase I Testing

- Pre-Phase I - Instrumentation and setup verification.
- Divided into two parts.
  - Part 1 - Single-Level Structures.
  - Part 2 - Multi-Level Structures.
- Total 96 tests



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Pre-Phase I - Setup and Verification

- Determine and Evaluate Methods
  - for consistently starting smoldering and flaming fires.
  - for generating nuisance sources.
  - for determining detector activation.
  - for collecting obscurity measurements.
  - for collecting gas composition.

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Pre-Phase I - Setup and Verification

- Determine and Evaluate Methods
  - for data recording, locations for mounting the detectors, gas and obscurity sampling.
  - for purging the test area of smoke contaminants.
- Layouts of the structure
- Types of detectors.
- Characterizing the detectors.

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Phase I - Single (Part 1) and Multi Level Structures (Part 2)

- Use representative structures.
- Locations of Fires (48 Tests)
  - 20 Living Room Fires
  - 24 Bedroom Fires
  - 3 Kitchen
  - 1 Spare

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Phase I - Single (Part 1) and Multi Level Structures (Part 2)

- Variables
  - Type of fire
  - Location of fire
  - Fuel material
  - Doors open, closed, or ajar.
- Monitor the rooms and egress route.

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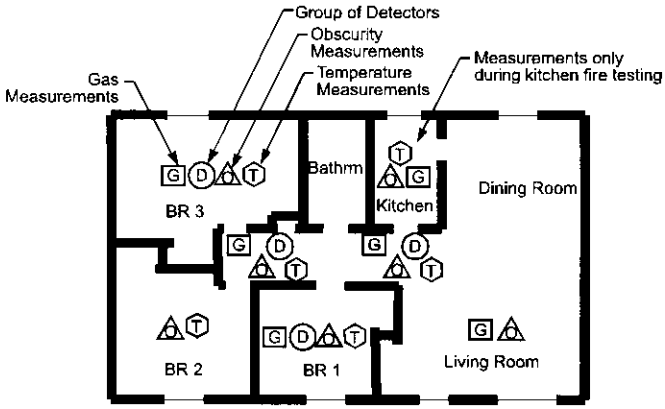
Phase I
Part 1 - Single-Level Structure



Single-Level Home

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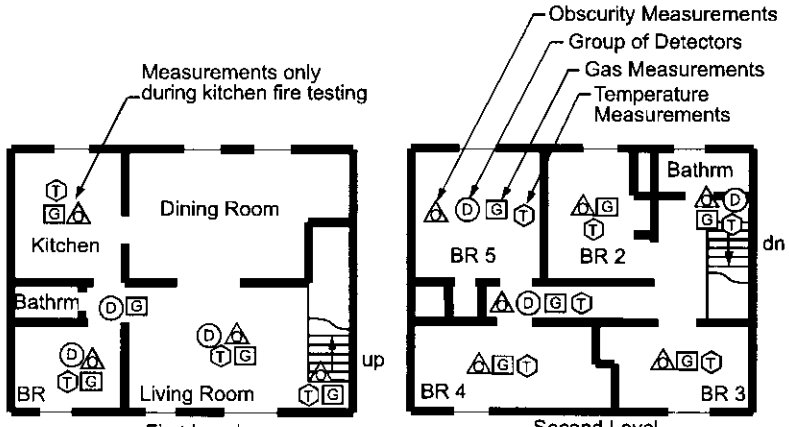
Phase I
Part 2 - Multi-Level Structure



Two-Level Home

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Phase II- Tenability Fires

- Past testing ran fires for short period of time.
- Allow fires to burn longer to characterize tenability levels in the parts of the structure furthest from the fire origin.
- Total of 10 tests (5 tests per structure).
- Fire origins in bedrooms and living rooms.

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Phase III - Smaller-Scale Test Development

- Develop representative test setups from data gathered in Phase I and II Testing.
- Consider
  - Tenability Levels vs. Time
  - Evaluate egress routes and times.
  - Smoke characteristics vs. Linear Distance/Time.
  - Repeatable sources.

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