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LODD - Full-scale Experiments to Investigate a Smoldering Sofa Fire Incident

G.D. Lougheed
National Research Council

Outline

- Background
 - Fire incident;
 - Cause of fire;
 - Research project.
- Room scale experiments
- Full-scale experiments

Fire Incident



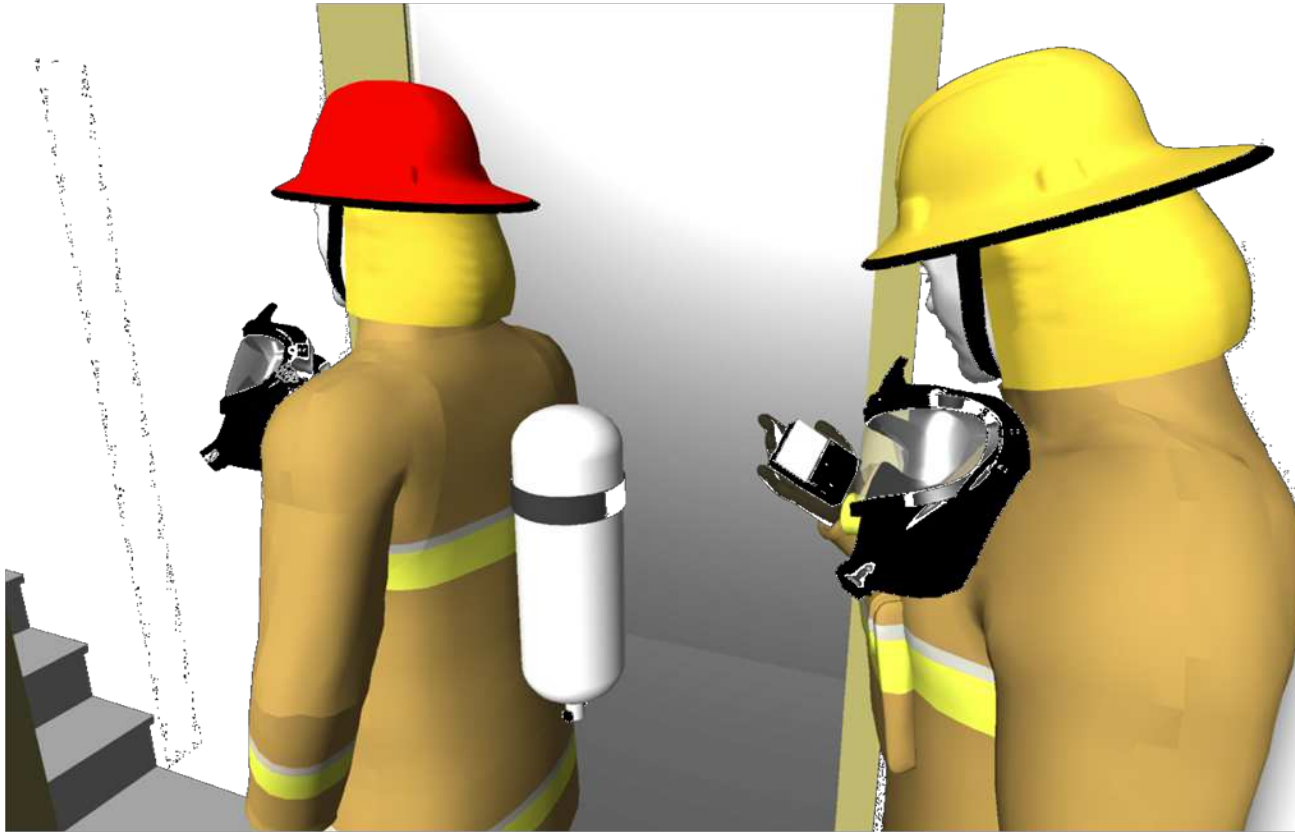
At approximately 3:27 a.m. on January 21, 2006, the Montreal Fire Department dispatched two engines in response to a 9-1-1 call complaining of a strong odor.

Fire Incident



Upon arrival, the firefighters found a number of occupants outside of the three story apartment building. The occupants complained that the odor had been present for approximately 24 h.

Fire Incident



The crew from the first arriving unit entered the building and noticed a strong chemical odor that was not typical of a Class A, Class B or Class C fire. Initially, no smoke was observed and negative results were obtained using a gas detector.

Fire Incident



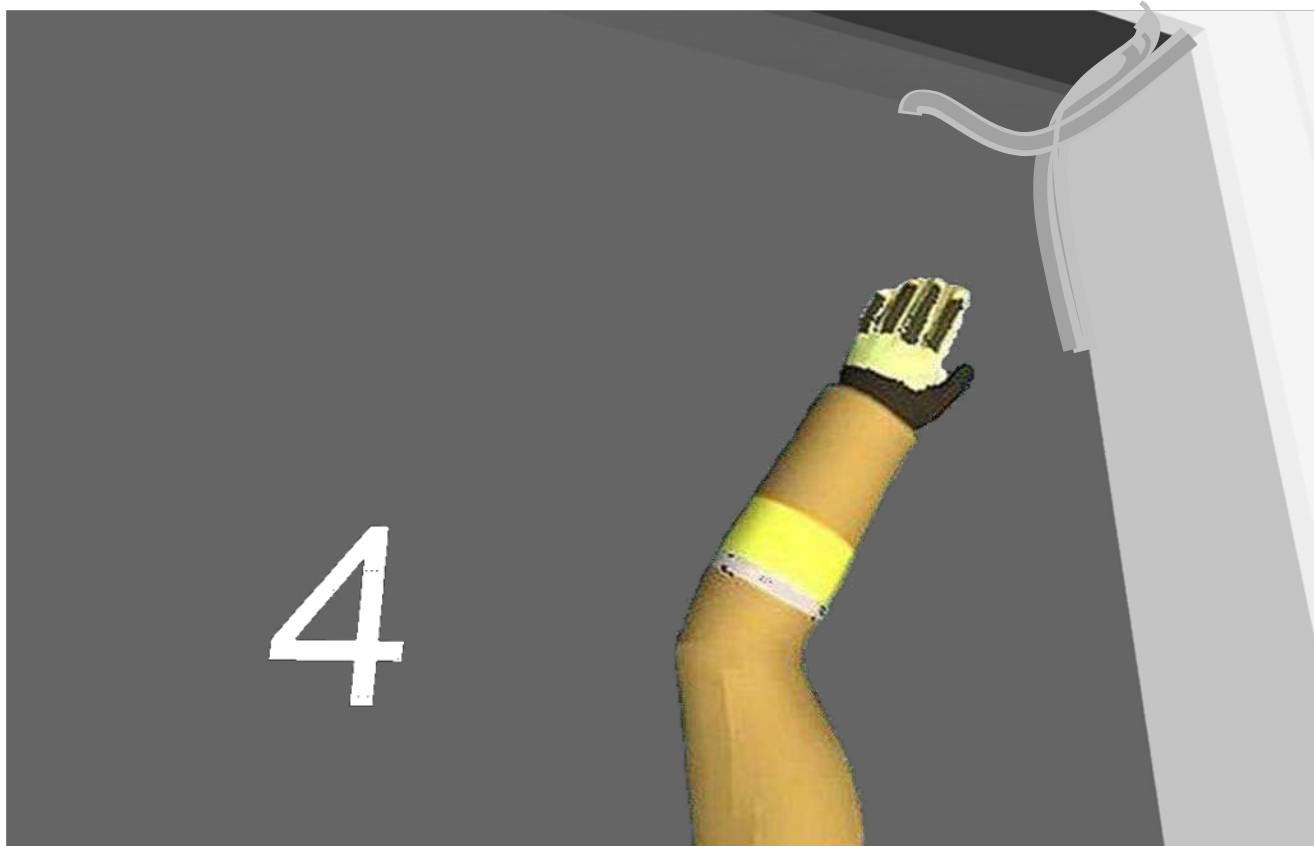
The remaining occupants were asked to vacate the building.

Fire Incident



After the second crew arrived, the building was searched. Nothing was found until the two crews met back on the landing on the first floor. A firefighter noticed white puffs of smoke coming from the light fixture in the landing.

Fire Incident



Pushing on the top of the door to apartment #4 resulted in smoke escaping from the apartment. It was later determined that the occupants of this apartment had been away on vacation for 2 weeks.

Fire Incident



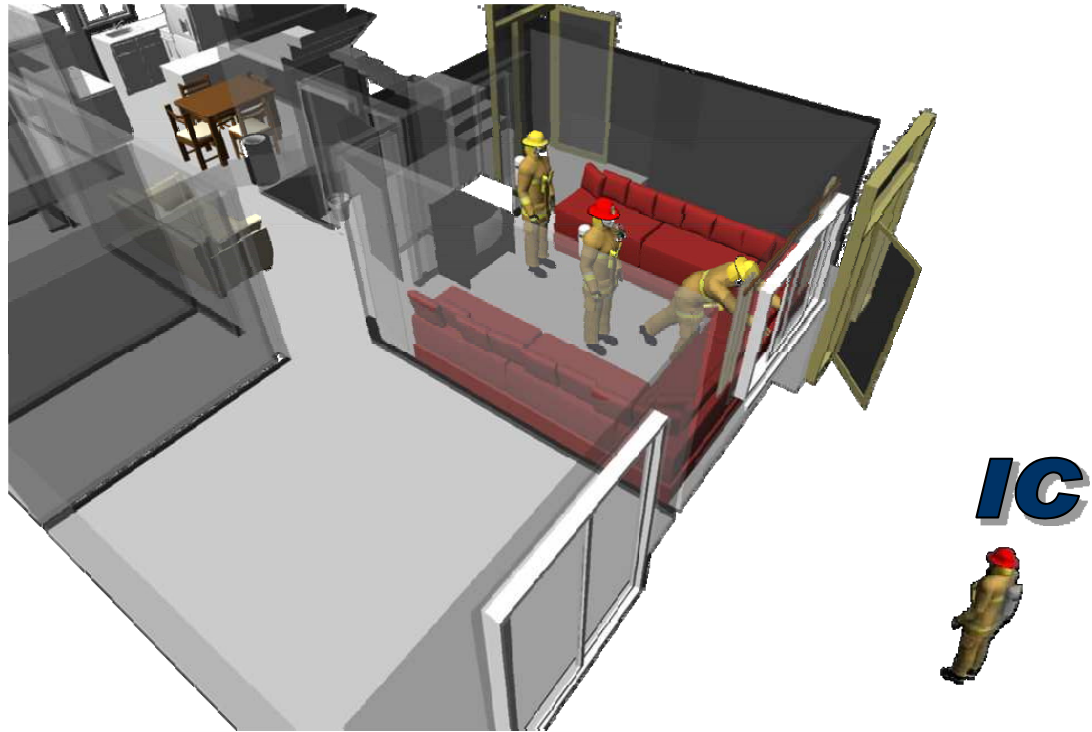
The apartment door was forced open releasing a large cloud of smoke into the stairwell. This smoke engulfed a firefighter on the second floor landing forcing him to enter an apartment to get fresh air on a balcony.

The firefighters entered the apartment on the first floor to search for occupants. Windows and doors in all rooms were opened to ventilate the apartment.

Fire Incident

During ventilation, a smoldering sofa was found.

The firefighters decided to open the window in the room and toss the cushions and sofa out the window.



Fire Incident

Upon moving the sofa, it evolved into a flaming fire, which ignited the curtains on the window and the smokey layer at the ceiling.

Two firefighters in the room escaped. However, a captain was overcome by the flash fire and died.



Cause of Fire

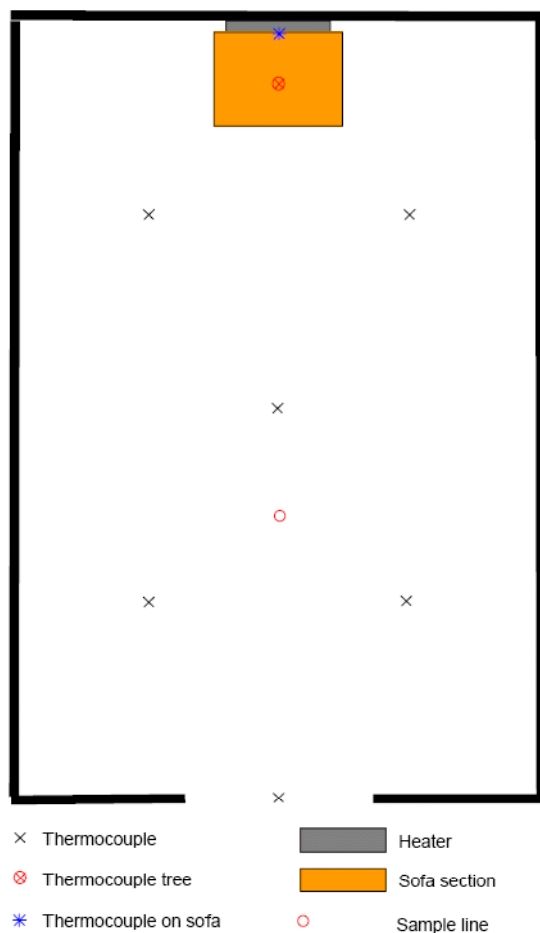


- The fire investigation concluded the fire was caused by a faulty baseboard heater from which the safety systems had been removed.
- The heater was in close contact with a Moroccan style sofa that consisted of a 1650 mm long, 395 mm high and 700 mm deep piece of polyurethane foam covered with a cotton textile material.
- The foam seat was mounted on a 89 mm high wood frame covered with the same textile material.

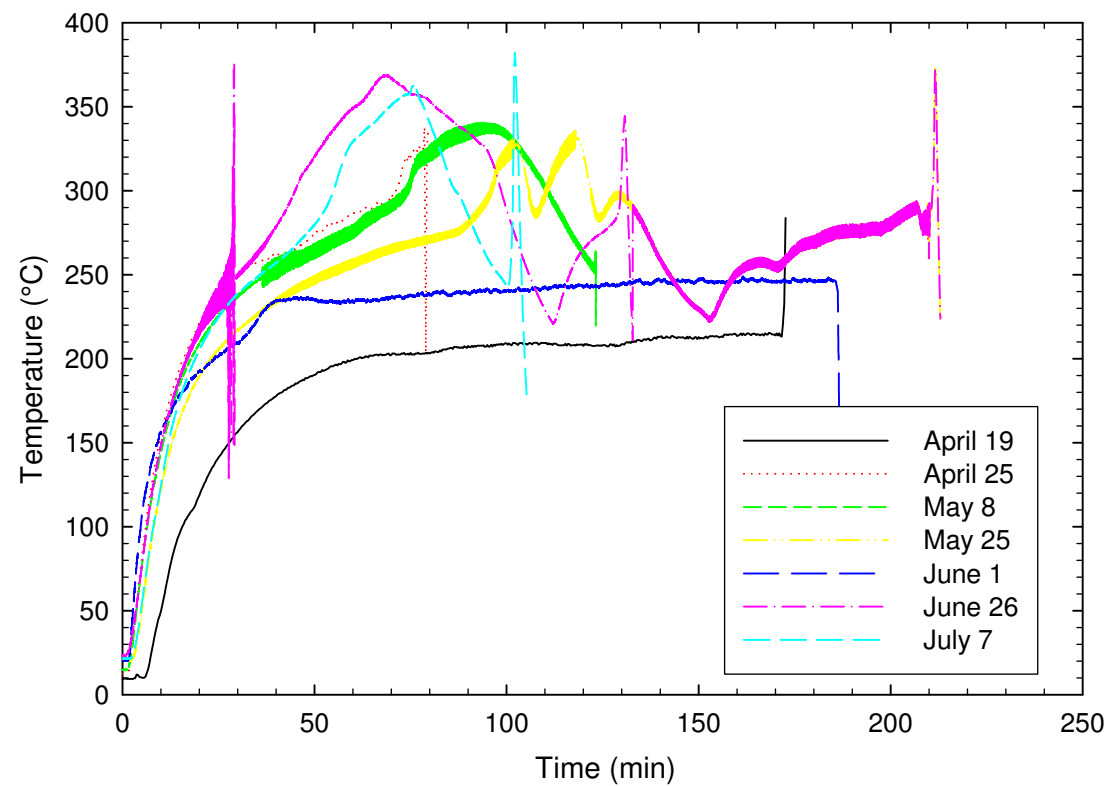
Research Project

- The Montreal Fire Department requested that NRC undertake a project to investigate the fire incident to determine:
 - Causes of the fire;
 - The composition of the smoldering combustion products;
 - The flame spread in the combustion products;
 - The effects of standard and alternative firefighting tactics.

Room Scale Experiments -Setup



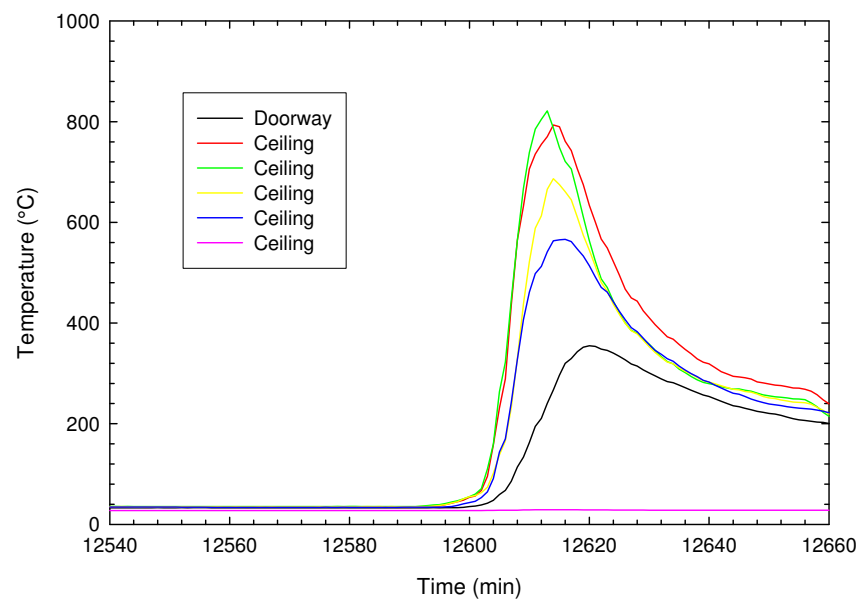
Foam Temperature



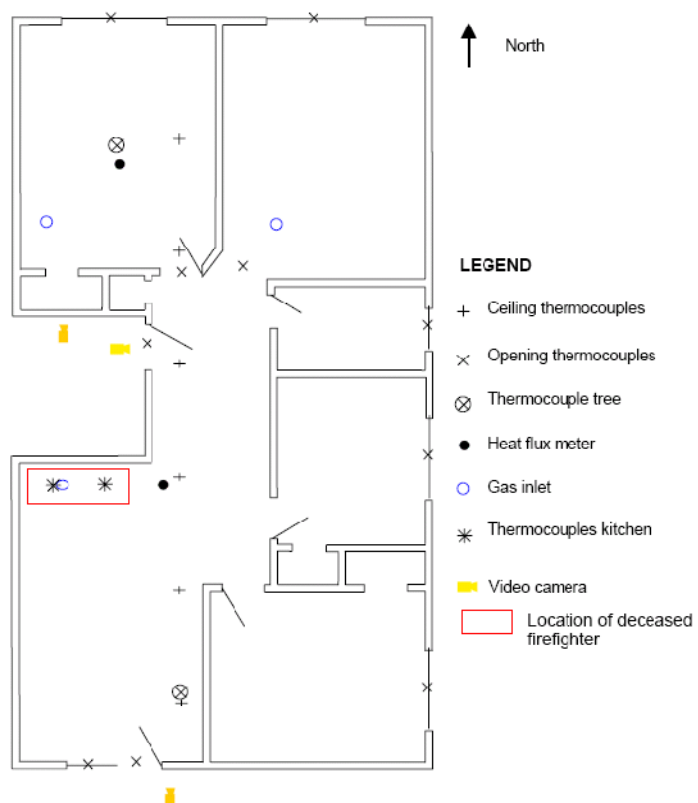
Smoke Production



Fire Development



Full Scale Experiments



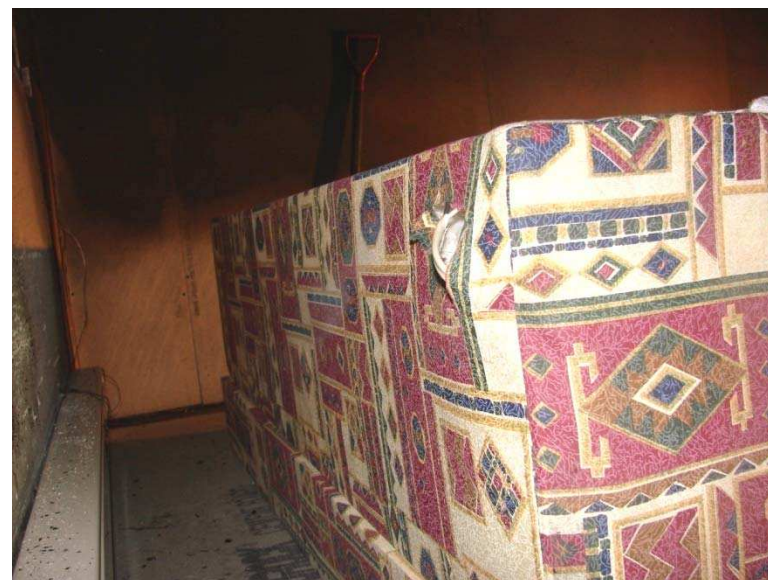
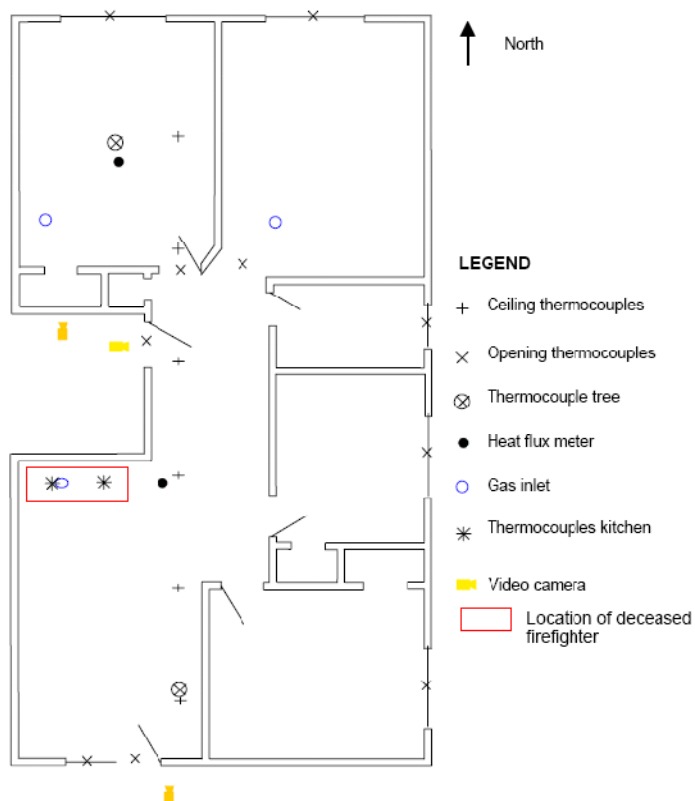
Fire Scenario

- Room scale experiments indicated difficult to produce a flammable gas mixture at the ceiling of the test facility.
 - Factors such as leakage areas, temperature conditions in apartment.
 - Length of smolder time could not be duplicate.
- Preliminary tests conducted to develop scenario for use in full-scale experiments.

Fire Scenario

- Scenario for full-scale experiments:
 - Sofa allowed to smolder for approximately two hours.
 - Methane used to produce upper flammable layer.
 - Methane layer and sofa ignited using a heated coils.
- Three experiments:
 - Test 1 – Methane ignited in room of fire origin + single sofa;
 - Test 2 – Single sofa fire;
 - Test 3 – Methane ignited in room of fire origin and propagated into entryway/kitchen + 4 sofas ignited.

Fire Scenario - Smoldering Fire



Sofas in Fire Compartment



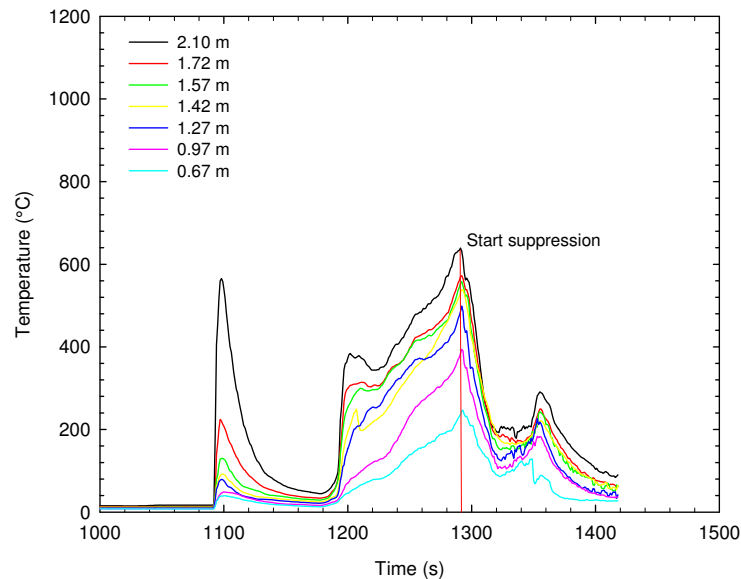
Test 1 and Test 2



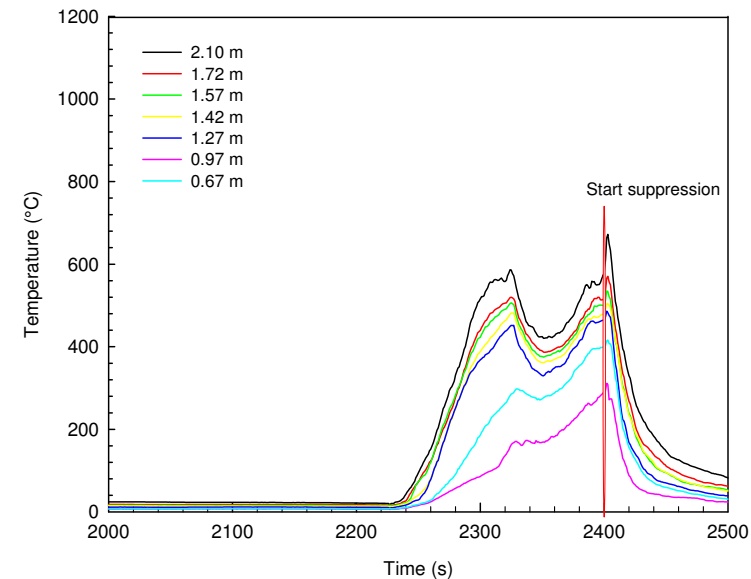
Test 3

Temperatures - Fire Compartment

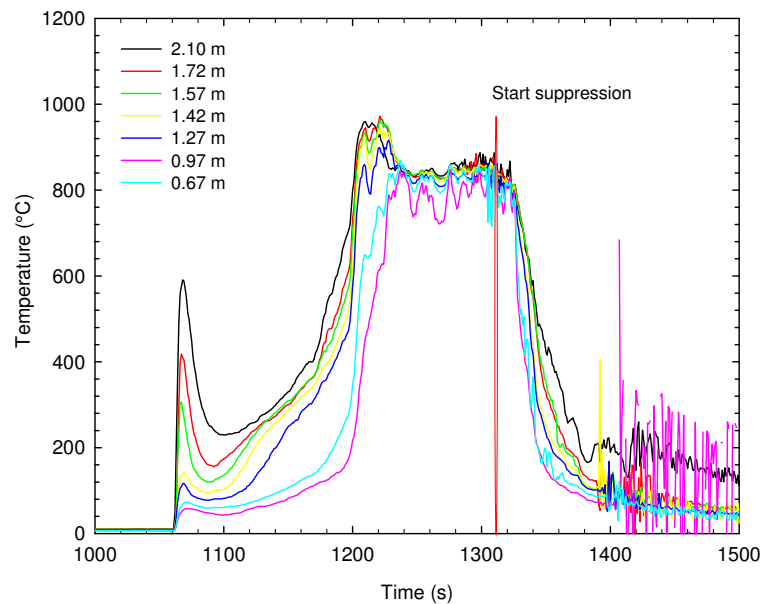
Test 1



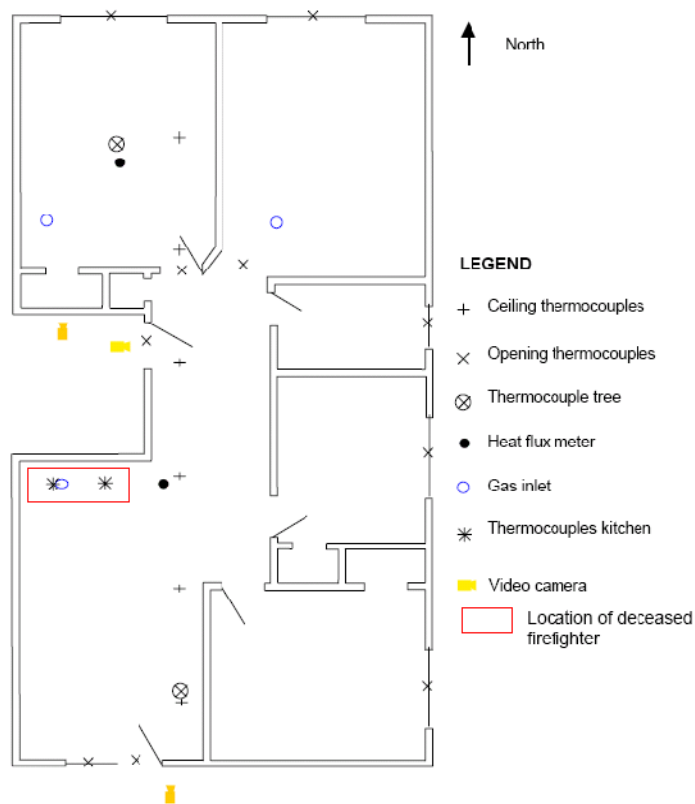
Test 2



Test 3

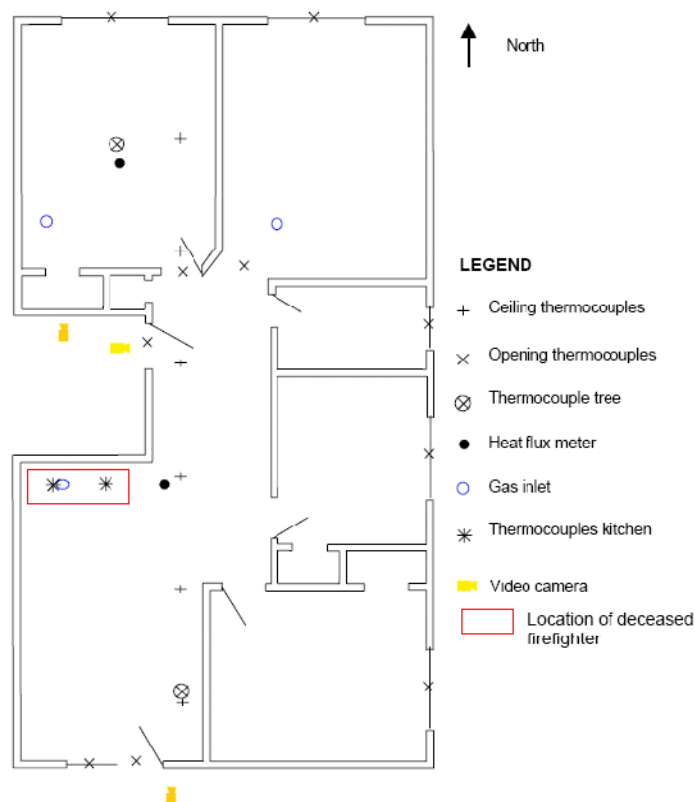


Effect on Captain



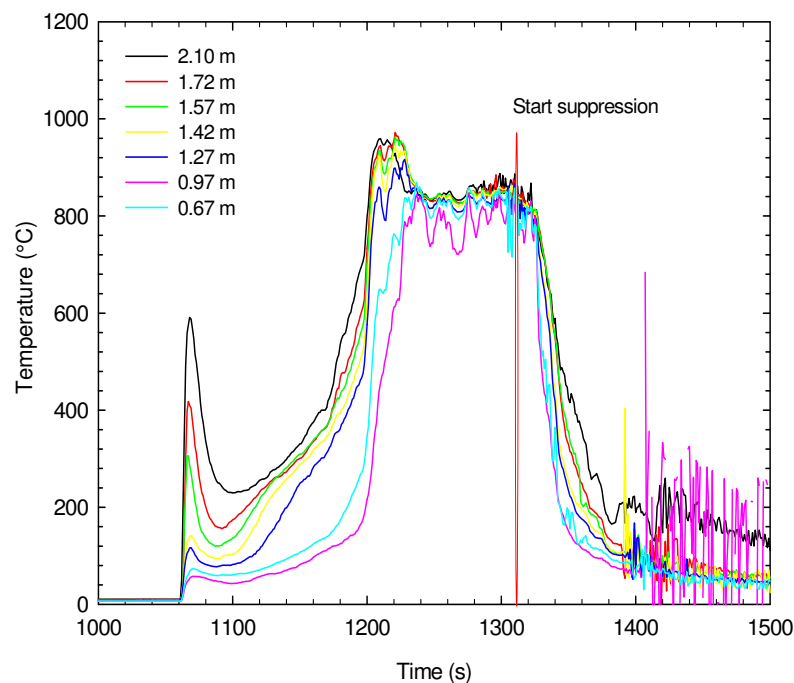
- Captain last seen in entryway.
- Looking back at flames entering area through doorway to room of fire origin.
- Not wearing SCBA mask.
- Effect of exposure on face.
- Effect of flash on vision.

Suppression



- Firefighters suppressed fire for each test.
- Test 1 – Solid stream applied water intermittently on ceiling and upper part of walls.
- Test 2 - Fog stream with 30° angle water on ceiling and upper part of walls.
- Test 3 – A solid stream used to apply water on sofas.

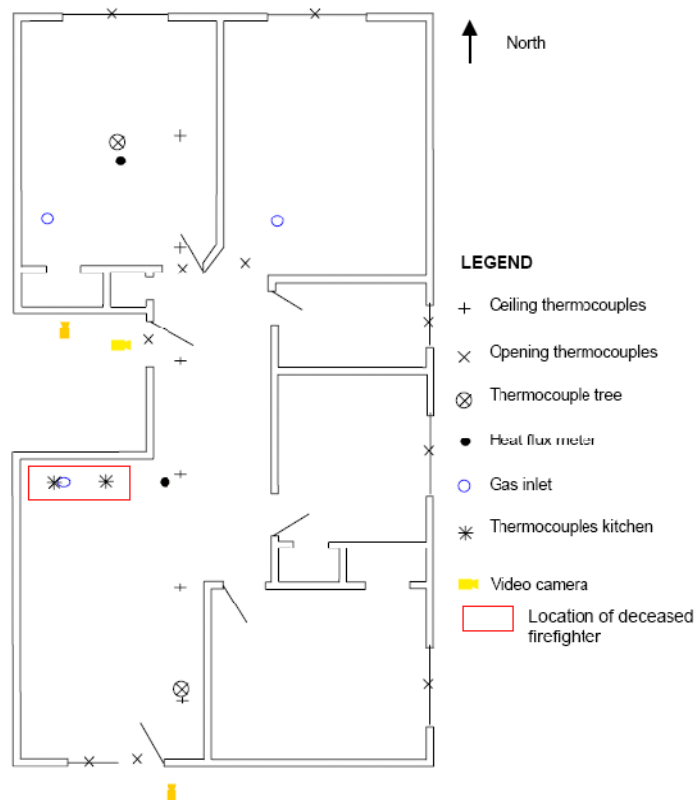
Results Suppression



Test 3

- Temperatures in room of fire origin reduced to $< 200^{\circ}\text{C}$ in < 60 s.
- Temperatures reduced to $< 100^{\circ}\text{C}$ in < 100 s.
- Fire in room of origin could be suppressed swiftly and safely by applying water from main entrance door to apartment.

Experiment 4



- First 3 experiments focused on early stage of fire.
- Fourth and fifth experiments conducted to investigate conditions in kitchen with extended fire.

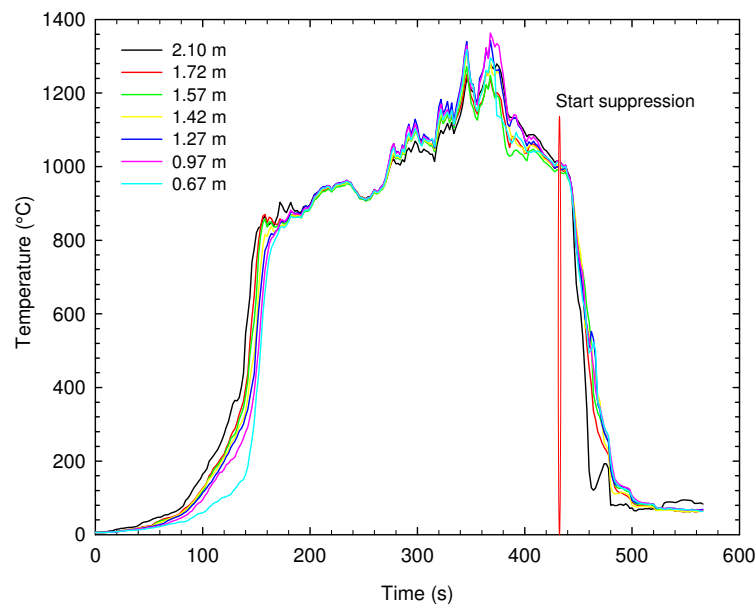
Fire Compartment and Kitchen



Results Experiment 4

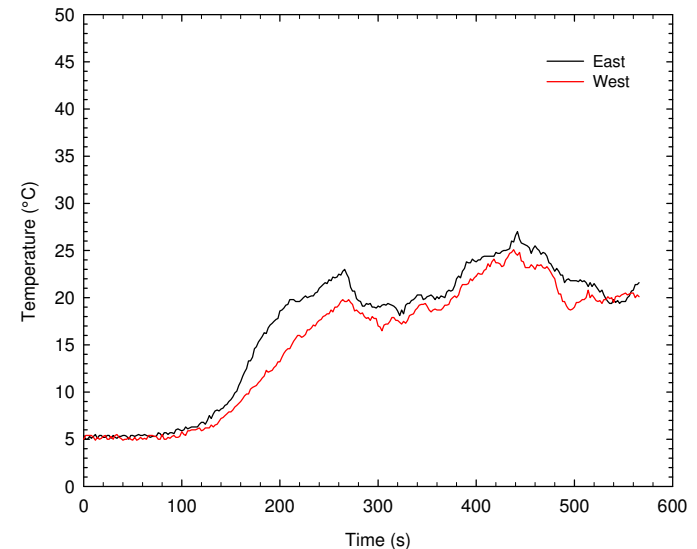
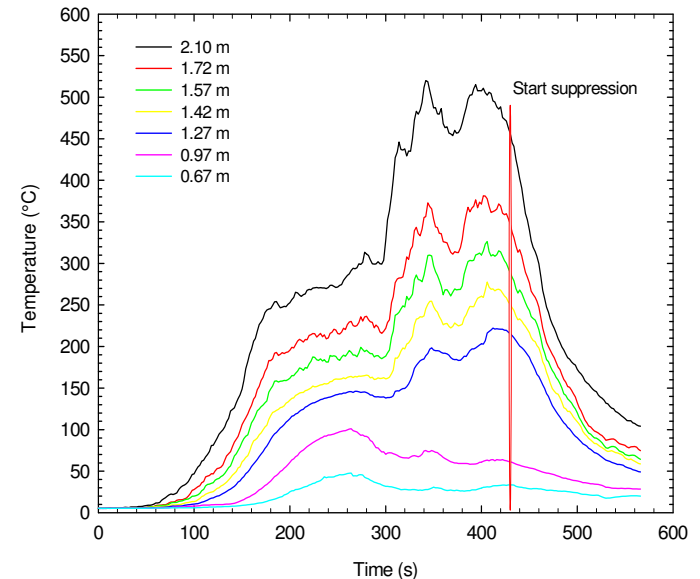
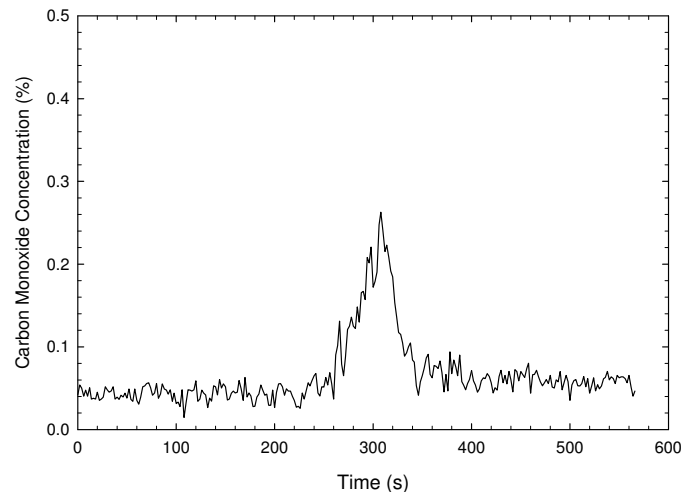


- Propane T-burner used to ignite foam.
- Rapid fire growth.
- Initial temperatures approximately 900°C.
- Increased temperatures in later stages.



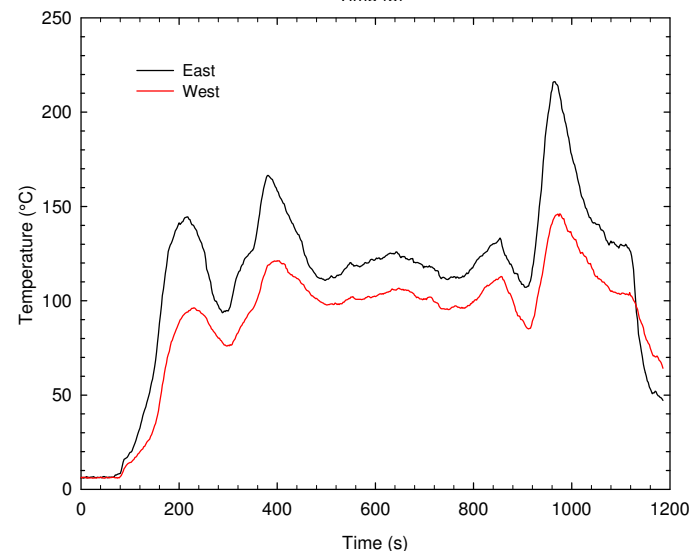
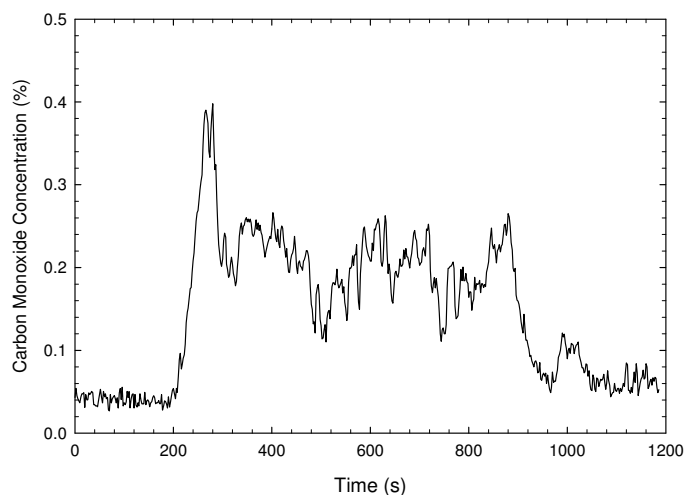
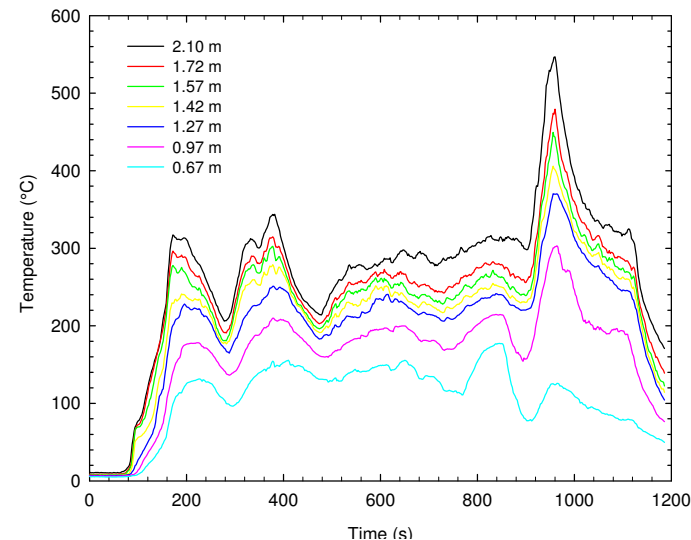
Results Experiment 4

- Fire did not propagate into entryway.
- Maximum temperatures in kitchen approximately 500°C.
- Minimal temperature and CO increase at floor level.



Experiment 5

- Single sofa in fire compartment. Same fuel load as experiment 4 in all other rooms.
- Sofa entryway sprayed with accelerant and ignited with propane torch. Sofa fire compartment ignited with propane burner.



Conclusions

- Research project investigated possible scenarios for fire incident.
- Experiments with combined flammable gas and sofa fire resulted in initial flames through doorway into entryway in <10 s.
- A fully-developed fire in room of fire origin would have limited effects on conditions at floor level in kitchen.

Conclusions

- Fire in entryway could lead to conditions at floor level that were untenable.
- Results indicate that a person in kitchen may have been able to survive until kitchen reached flashover.
- Limited water was used in suppression tests with objective of rapidly lowering temperatures. In all tests, temperature in fire compartment reduce to $< 100^{\circ}\text{C}$ in < 100 s.

Video of Ignition Sequence



Gary_Dec_18_LongView.mpg

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